Preview

Australian Society of Exploration Geophysicists

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Australian Society of Exploration Geophysicists

15th Geophysical Conference and Exhibition

Conference Handbook

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ASEG 2001
A Geophysical Odyssey

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Conference Handbook

Section 1

ASEG 2001
A Geophysical Odyssey

Welcome from the Organising Committee

Welcome to ASEG 2001

On behalf of this year's Organising Committee, it is our great pleasure to welcome you to the Australian Society of Exploration Geophysicists' 15th Geophysical Conference and Exhibition at the Brisbane Convention and Exhibition Centre.

For this first conference of the new millennium, the ASEG is inspired by the exploits of Odysseus (aka Ulysses) of Ithaka, the greatest voyager of all time. After the siege of Troy, Odysseus experienced adventure, adversity and exhilaration during his 20-year long voyage home.

ASEG 2001, a Geophysical Odyssey, hopes to inspire attendees and guide them through an adventure, not of adversity, but exhilaration in learning new and interesting aspects concerning exploration geophysics.

The technical program is complemented by a dynamic trade exhibition featuring a range of specialist geophysical products and technologies available to exploration geophysicists in the new millennium.

The technical program will be opened by two keynote speakers who will set the scene in the mineral and petroleum exploration areas. Four simultaneous programs will then commence to present 134 selected papers.

This year the committee has changed the format of publication for the presented papers to allow more flexibility. The extended abstracts are published on a CD. The Technical Papers Committee has judged all these papers and invited some authors to publish a full paper in Exploration Geophysics.

We have continued the tradition of happy hours in the Trade Exhibition. We invite all participants to relax at the end of the day and mingle in the Exhibition area and enjoy an hour or so finding old friends and making new ones.

This conference and exhibition would not have been possible without the mighty efforts of the Organising Committee and Sub-Committee guided by Intermedia Convention and Event Management Pty Ltd. We would like to thank them all.

The support of this conference by sponsors has been exceptional, and those companies deserve the thanks of all the ASEG community for helping keeping conferences such as our viable.

Jenny Bauer and Nick Sheard
Co-chairs, Organising Committee
ASEG Conference and Exhibition, 2001
Brisbane, Queensland

Conference Organising Committee

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Jenny Bauer
Origin Energy Resources

Nick Sheard
MIM Exploration

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ASEG President

I would like to take this opportunity to welcome you all to the 15th ASEG Conference and Exhibition on behalf of the ASEG. The conference is a great opportunity to not only attend technical talks, but also see the latest technology in the exhibition and spend time in discussions with your colleagues.

The ASEG Conference is a great venue to learn what is happening in the other fields of geophysics and as such, I would encourage you to view all the exhibits, as there are a lot of new technologies being displayed on the exhibition floor. There is also a section for consultants, as there has been a considerable change in the Society's demographics over the last few years and this is being catered for at this conference.

Sister Societies

It is also my pleasure in welcoming the co-sponsoring societies of this conference, being the SEG, EAGE and the SEW and expressing the ASEG's appreciation for their assistance in publicising the conference to their respective members. I would like to welcome the SEG President Sally Zinke and the President Elect Walt Lynn, Gareth Williams, the Chairman of the EAGE Geophysical Division and the SEGJ President Satoru Ohya. I hope you not only have a chance to attend the conference but also to see some of the sights in Australia, if not spending a day on the Gold Coast.

Sponsors

It has been very encouraging to see so many companies sponsoring the conference and I would like to give my special thanks to the two Gold Sponsors, Fugro Airborne Surveys and Woodside Energy. Fugro Airborne Surveys is a world leader in airborne geophysics and Woodside Energy is one of the largest oil explorers in Australia. I would also like to thank the other Silver and Bronze Sponsors as without them the success of the ASEG Conferences could not be sustained and it would have severe ramifications to the rest of the society activities.

ASEG Council Meeting

The ASEG Council, which meets at each ASEG Conference, is constituted of representative from each State, the Chairman of the ASEG Standing Committees and the ASEG Federal Executive. There are a number of issues that were discussed at this years Council meeting, including:

- The long term strategy of the Society;
- The Society's Business Plan for the forthcoming years;
- The amendments of the Society Constitution to bring it into line with the present day activities of the Society;
- Discussion on how better to empower members to bring their skills to the society; and,
- Other issues relevant to the various groups within the ASEG.

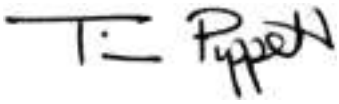
Other ASEG Issues

The ASEG Federal Executive continues to keep a very watchful eye on the finances of the society. Over the last two years we have been able to bring the costs of publications to a sustainable point with no small effort from Andrew Mutton and the Publications Committee. The cost of publications is still a considerable part of the ASEG's budget and we are open to discussion on ways in which to encourage advertising in both Preview and Exploration Geophysics as this has a major impact on the cost of the journals.

I look forward to meeting with as many of you as possible at the conference and would like to hear your comments on the society so that we together can grow the society. We are very interested in hearing from people who would like to assist the society on one of the many committees at either a State of Federal level. If you have time and energy to assist, please let me or one of the other Federal Executive members (who can be identified by their lapel badges) know and we will do our best to link you with the most appropriate person.

On behalf of all the members of the society, I would like to express our thanks to the Conference Committee and in particular the co-chairpeople Jenny Bauer and Nick Sheard who have undertaken a great job in providing a very successful conference. It is only because of the huge commitment of time and energy that the chairpeople and committee members have put in, that has allowed the conference to be so successful in both technically and financially.

I wish you all a very worthwhile and successful conference.



Tim Pippett
President of the Australian Society of Exploration Geophysicists

SEGJ President

At the occasion of the ASEG's 15th Geophysical Conference and Exhibition, at Brisbane, we will complete an agreement between ASEG and SEGJ, by which SEGJ will become an Associated Society of ASEG. I sincerely hope that good collaboration will be established between our two societies.

The Society of Exploration Geophysicists of Japan (SEGJ) was established in 1948 with the objectives of promoting the science and technology of geophysical and geochemical exploration as well as to encouraging the mutual exchange of knowledge and experiences among members. With 52 years of history, SEGJ has grown with development of geophysical technologies in Japan, and currently consists of 1602 individual members and 160 corporate members.

SEGJ publishes its official journal, holds meetings, and leads other activities. Butsuri-Tansa (Geophysical Exploration), which is the official journal, is published bi-monthly and contains original papers, lectures, reviews, and news and announcements of the society. Spring and Fall technical meetings are held every year. A meeting consists of approximately 80 - 100 oral and poster presentations together with invited lectures.

A continuing education program has been held every year since 1985.

International relationships are well developed and the SEGJ International Symposium has been periodically held jointly with SEG and other foreign societies every two years.

The geology of Japan is unique, and the application of geophysical exploration techniques is needed to understand the geological and geographical condition of Japan. Geophysical exploration in Japan has been mainly employed in near surface, civil and environmental engineering oriented, because there are few natural resources such as oil and gas in and

around the Japanese islands. Geophysics in civil and environmental engineering and earthquake-disaster prevention will become increasingly important. Such special experiences will be useful not only in Japan but also in SouthEast Asia, Australia and their vicinity.

In such circumstances, we hope the establishment of association agreements between our two societies will prompt the cooperative activities on geophysics in the region.

Satoru Ohya
President of the Society Exploration Geophysicists of Japan

SEG President

It is a great pleasure to extend my best wishes for the success of ASEG 2001 - A Geophysical Odyssey on behalf of the Society of Exploration Geophysicists. These societies, formally affiliated since 1970, will become even more extensively linked in the future because of the dramatic changes in where the world's applied geophysicists live and work.

In recent years, SEG's membership has grown about 10% per year. The striking fact is that geophysicists living and working outside the U.S. represent more than 100% of the increase. In other words, the overall SEG membership has grown but the number of U.S. members has declined in this period.

SEG's leadership noted the trend quite early and reacted quickly to the Society's increasing 'internationalization.' SEG currently sponsors professional meetings, distinguished lectures, and continuing education courses in all parts of the world. Our Global Affairs Committee is now the largest of our standing committees. It was recently reorganized so that services could be more efficiently provided to members living outside the U.S.

Most recent SEG Executive Committees have included representation from countries outside the U.S. This list includes two noted Australian geophysicists, Norm Uren in 1995-96 and the current ASEG past-President Brian Spies in 1996-97. Norm and Brian and 534 of their countrymen are SEG members. Only three countries have more. This is a very impressive number and strong evidence in and of itself that ASEG 2001 represents the state-of-the-art of our science.

Sally G. Zinke
President of the Society of Exploration Geophysicists

EAGE

Thank you for the opportunity to present this address to the ASEG on behalf of the EAGE.

Let me begin on a personal note by saying how delighted I am to be back in Australia and in particular Brisbane. I first came to Brisbane some 16 years ago and have always enjoyed my visits here ever since.

This is the 11th ASEG conference that I have attended which may be a record for a visitor from overseas. However, it is the first at which I have officially represented the EAGE. It might seem obvious to question why have I been to so many ASEG conferences and also why does the EAGE sponsor such an event. After all, for much of the last 16 years I have lived and worked in Europe and the EAGE is a European organisation. However, there are good reasons for this situation.

First, the EAGE has a worldwide membership with members in over 90 countries; in Australia alone we have over 150 members and it is important that we provide a service to them.

Second, the exploration business is a global one and our European members have worldwide interests so again it is important that we provide a global service to those members. On both these counts, it is natural and correct that we co-ordinate our efforts with the ASEG.

Thirdly, the hydrocarbon exploration business has improved somewhat over the last year or so, but many of the service companies still operate in a tough economic climate. Indeed, there is already speculation that the seismic industry has 'missed' the market upturn of the last two years and that another squeeze on spending will be upon us soon! I do not yet know if this is true, but consolidation among oil companies and contractors is still ongoing. In such an environment, it is important that societies such as ours continue to work together to foster both scientific and business relationships in a cost-effective manner.

Finally, and from a more personal point of view, the science of geophysics is not confined to one geographic region. The geological problems we encounter vary from region to region, but lessons learnt in one part of the world may often be applied elsewhere as well. Indeed, this is one of the fascinations of our work, at least for me. A good example might be multiple suppression. Offshore Australia provides some geological environments that make multiple suppression very challenging. Consequently, there is always a considerable effort within Australia focussed on this topic and it behoves the rest of the world to watch and learn. Conversely, new techniques developed elsewhere need to be tested in these same areas to learn more about their range of applicability. I see that some good examples of papers in this vein are included in the program this week.

In conclusion, on behalf of the whole of the EAGE, and in particular our president Dr. Helmut Gaertner, may I convey our warmest best wishes to the ASEG. I look forward to an interesting conference and also, I hope, to meeting many of you during the next few days.

Gareth Williams
Chairman Geophysical Division

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Floreat W.A. 6014 Australia
Tel: 08 9273 6400
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Email: b.johnson@fugroairborne.com.au
Contact Person: Brett Johnson, Manager Airborne Geophysics

Fugro Airborne Surveys is a leader in airborne geophysical survey contracting, specialising in low level remote sensing technologies for mineral, petroleum and groundwater exploration and for geological mapping and environmental monitoring.

The company offers the most comprehensive range of airborne technologies available and carries out airborne surveys in a variety of terrains in locations all over the world.

With a long term commitment to research and development Fugro Airborne Surveys provides innovative, cost effective solutions for natural resource exploration and environmental management.

WOODSIDE ENERGY

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Perth WA 6000 Australia
Tel: 08 9348 4000
Fax: 08 9348 5539
Email: CompanyInfo@woodside.com.au
Website: www.woodside.com.au
Contact: New Ventures/External Affairs

Woodside Energy is pleased to be a Gold sponsor of this the 15th ASEG conference. Woodside Energy considers it important to support the local geophysical society and its efforts to promote geophysics, a tool that Woodside Energy considers a significant contributor to its exploration and production success. The history of Woodside Energy is a remarkable success story. The company has grown from a humble beginning as a small onshore explorer in the early 1950s, to operator of Australia's largest ever resource project and a position today as Australia's largest and independent oil and gas producer. The future is looking even brighter for the Perth based company, which is now ready to take its greatest Australian success story to some of the most prospective oil and gas regions in the world.

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Santos • Chevron Australia

Workshop Sponsorship

Reeves Wireline Services

General Conference Information

Conference Venue

Brisbane Convention and Exhibition Centre
Cnr Merivale and Glenelg Streets
South Brisbane Qld 4101 AUSTRALIA
Tel: 07 3308 3000
Fax: 07 3308 3500

Conference Office

Registration will be at the conference office located on the ground floor of the Brisbane Convention and Exhibition Centre. The office will be staffed at the following times:

Sunday 5 August 2001	1600 - 1930 hours
Monday 6 August 2001	0800 - 1700 hours
Tuesday 7 August 2001	0800 - 1700 hours
Wednesday 8 August 2001	0800 - 1630 hours

Speakers Audiovisual Testing Room

The speakers' audiovisual testing room is located on the ground floor of the Brisbane Convention and Exhibition Centre in Great Hall Secretariat 2. If you require urgent access to the speakers' testing room outside the times listed below, please see staff at the registration desk. Opening hours are:

Sunday 5 August 2001	1600 - 1800 hours
Monday 6 August 2001	0800 - 1700 hours
Tuesday 7 August 2001	0800 - 1700 hours
Wednesday 8 August 2001	0800 - 1630 hours

Name Badges

Please wear your name badge at all times. It is your admission pass to sessions and morning and afternoon teas. If you misplace your name badge, please ask the conference staff for a replacement.

Ribbons

Please note that ribbons on name badges signify:

Dark blue: Conference committee member
Burgundy: Keynote Speakers

Tickets

Attendance at social functions is by ticket only. These tickets are in your registration envelope. If tickets are misplaced or you do not have tickets for the function, please advise conference office staff.

Lunch

Lunch can be purchased from servery/kiosks in the trade exhibition area.

Special Diet

Delegates who have advised the secretariat of special dietary requirements should identify themselves to the service staff at functions.

Messages

A message board will be located outside the conference office. Please advise potential callers to contact the Brisbane Convention and Exhibition Centre on +61 (0)7 3308 3000 and ask for the 15th Geophysical Conference and Exhibition office. No guarantee can be given to deliver messages personally.

Personal Mail

The conference secretariat does not accept responsibility for personal mail. Please have mail sent to your accommodation address.

Parking

Parking is available at the convention centre for AUD$7 (includes GST) per day.

Smoking

Smoking is not permitted anywhere within the Brisbane Convention and Exhibition Centre.

Cancellation Policy

Regrettably, optional or additional social function tickets will not be refunded if participation is cancelled less than 48 hours prior to the activity.

Disclaimer

The conference host body, organising committee and Intermedia Convention & Event Management Pty Ltd and their agents act only as organisers of these activities and do not accept responsibility for any act or omission on the part of the service providers. No liability is accepted for inaccuracy, misdescription, delay, damage, personal injury or death.

Travel

Ansett Australia is the official domestic conference airline. For reservations and ticketing, telephone 13 13 00 and quote association profile number MC 07049.

Dress

A light jacket may be required in air-conditioned meeting rooms during sessions. Business attire is appropriate for conference sessions and all other social functions, excluding the conference dinner. Dress for the conference dinner is semi-formal.

Climate

Brisbane's subtropical climate affords sunshine for an average of 300 days a year and is recognised as one of the most desirable climates in the world. Average August weather for Brisbane typically has maximum daytime temperatures of 22°C, with minimum evening temperatures of 10°C. Days are generally clear, with an average of 24 rain-free days during August.

Accommodation

Rydges South Bank
Tel: 07 3255 0822 or 07 3255 0899
Conrad International Brisbane
Tel: 07 3306 8888 or 07 3306 8880
Mercure Hotel
Tel: 07 3236 3300 or 07 3236 3891
Hotel Ibis
Tel: 07 3237 2333 or 07 3236 3891
Carlton Crest
Tel: 07 3229 9111 or 07 3229 9618
Explorers Inn
Tel: 07 3211 3488 or 07 3211 3499

City Tours

The following tours are an excellent way to see Brisbane's sights. The tours can be booked by calling Brisbane Transinfo 13 12 30.

City Sights Tour
Enjoy tram-style bus travel while viewing Brisbane's historical and cultural attractions. Alight at any of the 19 stops on the 80 minute tour. Tours leave every 40 minutes between 0900 hours and 1220 hours and between 1340 hours and 1620 hours.
Tickets AUD$18 adults, AUD$12 concession.

City Night Tour
This tour departs daily from City Hall at 1800 hours and includes a complimentary drink at the Mt Coot-tha Lookout. Travel along the Brisbane River and enjoy the glittering lights from a number of excellent vantage points. The tour also includes a trip on one of the popular Citycat river ferries. Tickets AUD$18 adults, AUD$12 concession.

Things to do in Brisbane

While you are in Brisbane for the conference, take some time to explore Australia's third largest city. Brisbane offers delegates a superb sub-tropical climate, friendly people and a myriad of attractions.

The following sights and attractions are a short walk or taxi ride from most city hotels. Ask your hotel concierge for details.

- Chinatown
- City Botanic Gardens
- City Hall (King George Square)
- Conrad Treasury Casino
- Parliament House
- Queensland Art Gallery
- Queensland Museum
- Riverside Markets (weekends only)
- Queensland Sciencentre
- South Bank markets (Friday nights and weekends only)
- South Bank Parklands
- Lone Pine Sanctuary

Shopping in Brisbane

Brisbane City Shopping Centre
The Queen Street Mall has over 500 shops to explore. Some of Australia's most stylish shopping arcades and galleries lead off the Mall, including the Myer Centre, Queen Adelaide Building, Broadway on the Mall, Wintergarden and Brisbane Arcade (where the city's best designers are showcased). Shops in the CBD are open 0900 to 1700 hrs Mondays to Saturdays, until 2100 hours on Friday nights, and most open from 1030 to 1600 hrs on Sundays.

Brisbane Markets
Brisbane also offers a host of markets, where bargains and one-off items by local art and craft workers are available for the discerning shopper. Outdoor markets operate around the city every weekend. Markets worth checking out include:

Fridays South Bank Lantern Markets, South Bank Parklands, 1700 to 2200 hrs

Saturdays South Bank Craft Village Markets, South Bank Parklands, 1100 to 1700 hrs

Brunswick St Markets
Brunswick St Mall, Fortitude Valley, 0800 to 1400 hrs
Sundays South Bank Craft Village Markets, South Bank Parklands, 0900 to 1700 hrs

Riverside/Eagle Street Pier Art & Craft Markets,
Brisbane City, 0800 to 1500 hrs

High School Student Day

Proudly supported by Chevron Australia and Santos.
Tuesday 7 August 2001
Room P6 - Plaza level

A special session for secondary students and teachers will be held during the conference. The session will include presentations on the importance of the resource industry to Australia's economy, an overview of geophysical techniques, and possible career paths in geophysics. The students will be taken on tours of the exhibition hall while conference delegates are in technical sessions.

Career management Seminar

(Co-hosted by AIG)
Sunday 5 August, 1400hours
Room M7&8 - Mezzanine level

A free seminar will be given for geophysicists, who are: in career transition; concerned about job security; considering a change of career; and interested in the job market. Presenters at the career management seminar are from various backgrounds including government, employers, geophysical consultants, recruiters, financial analysts and career advisors, and four past presidents of ASEG

The topics include:
Exploration outlook and job creation - a government's perspective; exploration managers' view - how to start and run a successful consultancy; financial advice for geophysicists; advice in career management; advice on job searching, etc.

Several recruiting agents are expected to attend the seminar and there will be an opportunity for you to register with them.

Conference Secretariat

Intermedia Convention and
Event Management Pty Ltd
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Email: aseg2001@aseg.org.au
Web page: www.aseg.org.au

Intermedia is a multi-award winning event management company with over 21 year's experience in managing a wide range of events, especially the scientific sector.

Sunday 5 August 2001

1800 - 1930
Welcome Reception Trade Exhibition - Exhibition Hall 1
Sponsored by Fugro Airborne Surveys

After registering, join fellow delegates for a warm Queensland welcome to the conference. Canapés and beverages will be served.

Included for fulltime delegates.

Additional tickets: AUD$45

Monday 6 August 2001

1700 - 1800
Happy Hour, Trade Exhibition - Exhibition Hall 1
Sponsored by CSIRO

View the latest technological advances in the industry during a relaxed happy hour in the trade exhibition.

Included for fulltime delegates.

Additional tickets: AUD$11

Restaurant Evening
Optional at additional cost

Vino's Cellar Bar and Café
First Floor Eagle Street Pier 1 Eagle Street Brisbane. Phone: 07 3221 0811
The venue is perfect for a leisurely lunch or dinner on the balcony overlooking the Brisbane River. The cuisine is Australian Mediterranean. Vino's are offering a 10% discount per table booking, please advise upon booking and show your delegate name badge.

Baan Thai
Shop 1 Savoir Faire 20 Park Road Milton. Phone: 07 3367 2318
Authentic Thai cuisine. 10% discount for diners. Please advise you will be taking advantage of this offer when booking.

Oxley's On The River
330 Coronation Drive Milton. Phone: 07 3368 1866
Sitting on the Brisbane River, this award-winning restaurant features the freshest international cuisine with superb views. 25% discount off a la carte menu (food only) on presentation of the voucher in your delegate satchel and subject to conditions on voucher.

Mt Coot-tha Summit Restaurant
Sir Samuel Griffith Drive Mt Coot-tha Lookout. Phone: 07 3369 9922
One of Brisbane's oldest continuously operating restaurants and one of Brisbane's best, the Summit offers a sensational dining experience of truly international cuisine, blending Italian, French and Asian with modern Australia. 2 for 1 main course when purchasing another main course of equal or greater value. Please show your delegate name badge.

Mondo
166 Hargrave Road West End. Phone: 07 3844 1132
Award-winning organic cuisine first in Australia, specialize in organic wines, beers and beef etc. Three minutes from Southbank. 10% discount for group bookings over 10 people. Please show your delegate name badge.

River Canteen
The Boardwalk South Bank Brisbane. Phone: 07 3846 1880
River Canteen is situated on the river's edge with sweeping views of the CBD. Modern Australian Cuisine, featured in Gourmet Traveller 10% discount on food only. Please show your delegate name badge.

The Brasserie On The River Stamford Plaza Hotel
Corner Edward and Margaret Street Brisbane. Phone: 07 3221 1999
Mohammed Maaqoul The Brasserie is one of Brisbane's most popular buffet and a la carte restaurants offering both indoor and alfresco dining. 10% discount food only upon presentation of delegate name badge.

Gianni Vintage Cellar Bar
12 Edward Street Brisbane. Phone: 07 3221 7655
Fine dining, Mediterranean with a touch of Californian influence. Outdoor relaxed courtyard and air-conditioned mezzanine. A glass of sparkling wine with our compliments. Please show your delegate name badge.

1700-1800
University Student Function, Merivales Restaurant, ground floor, Brisbane Convention and Exhibition Centre
Sponsored by WMC Resources

Meet fellow student delegates for a social drink and bar snack at Merivales, located on the main foyer level of the Brisbane Convention & Exhibition Centre. Senior industry representatives will be attending to share their experiences in, and vision for, careers in geophysics. Included for fulltime student delegates only.

Tuesday 7 August 2001

1700 - 1800
Happy Hour, Trade Exhibition - Exhibition Hall 1

Wind down for the day over a few drinks with fellow delegates in the trade exhibition. Included for fulltime delegates.

Additional tickets: AUD$11

1930
Conference Dinner, Room P6 - Plaza level
Sponsored by Woodside Energy

This highlight of the conference social program provides an opportunity for extended networking over a fine evening meal at the Brisbane Convention & Exhibition Centre. The dinner includes a three course meal, beverages and a special presentation by after-dinner speaker, the famous Dr Karl Kruszelnicki, sponsored by WesternGeco.

Dr Krulszelnicki has degrees in physics, maths, biomedical engineering, medicine and surgery and has worked as a physicist, tutor, film-maker, car mechanic and doctor. He has been a presenter and guest on television programs such as Quantum, Midday Show, Good Morning Australia, and Second Opinion.

Optional function at additional cost

Tickets: AUD$85

Wednesday 8 August 2001

1700 - 1800
Conference Farewell, Mezzanine level foyer
Sponsored by Fugro Airborne Surveys

At the conclusion of technical sessions, farewell friends at an informal and relaxed closing function. Included for fulltime delegates.

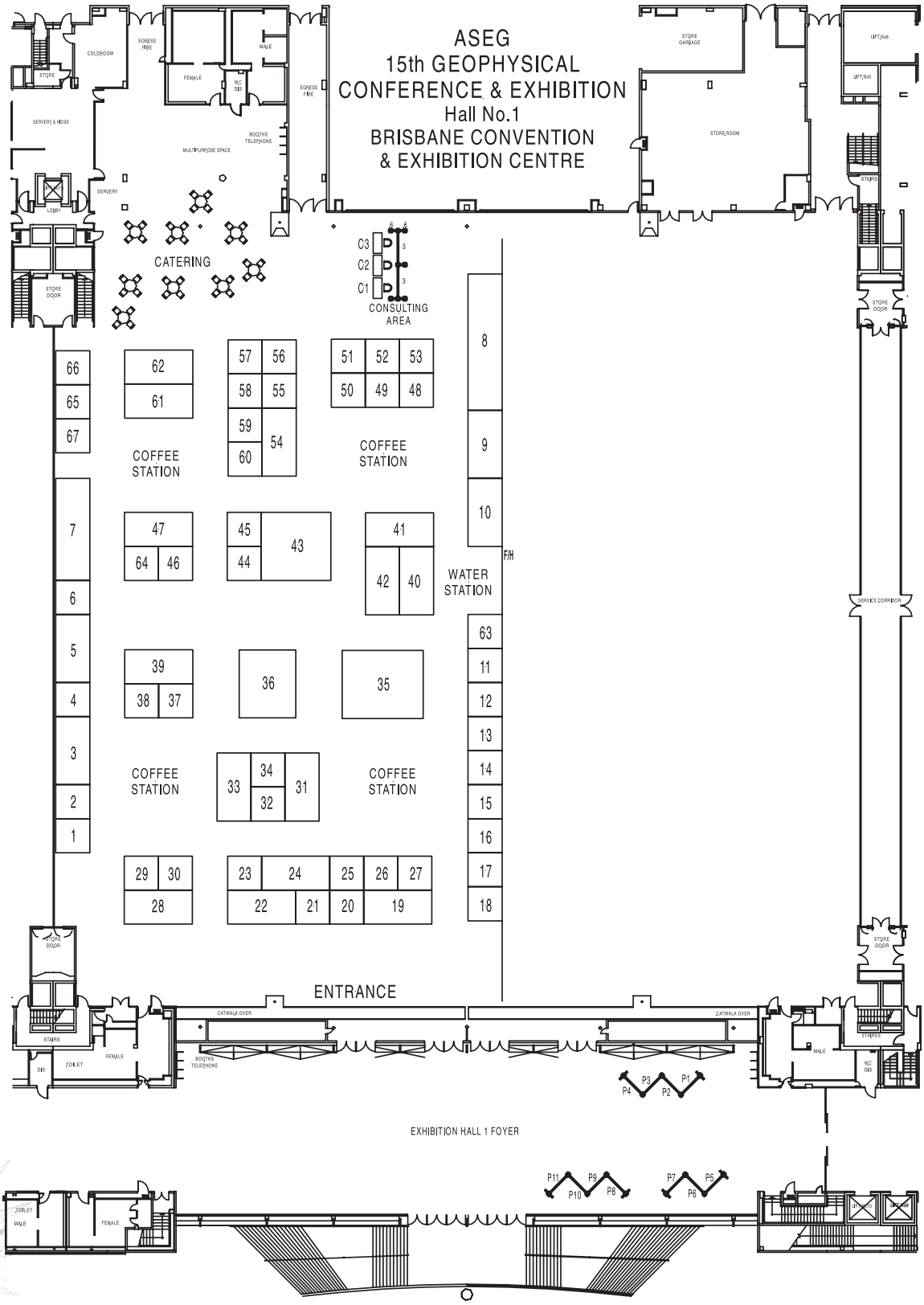
Additional tickets: AUD$20

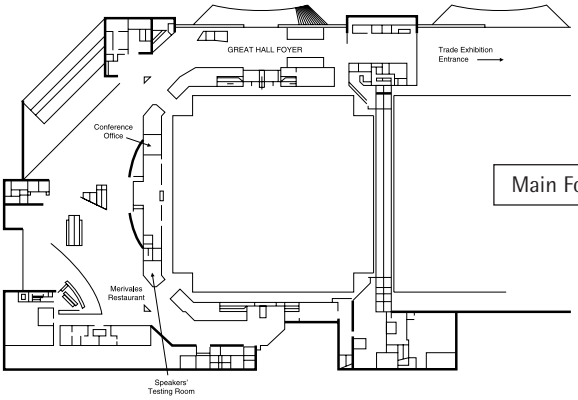
Thursday 9 August, Friday 10 August 2001

Golf Days
In association with Queensland Petroleum Exploration Association (QUPEX)

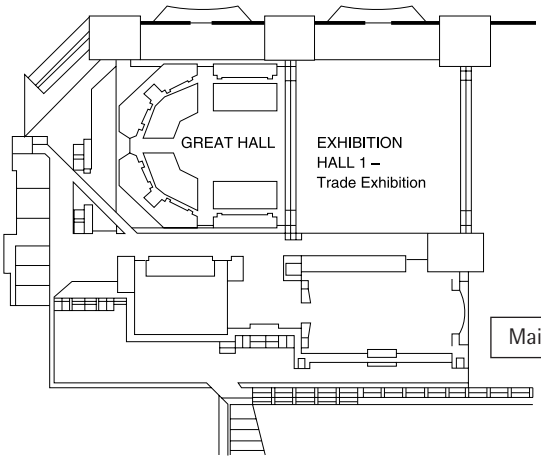
ASEG delegates and friends are invited to join QUPEX for two days of golf at the St Lucia Golf Course. The program will be a Stroke day on Thursday and Ambrose on Friday. A dinner will be held on the Friday evening. For information about attending these days, club hire or other details, please contact Cath McMurchy on 07 3630 3446.

Venue Floor Plan

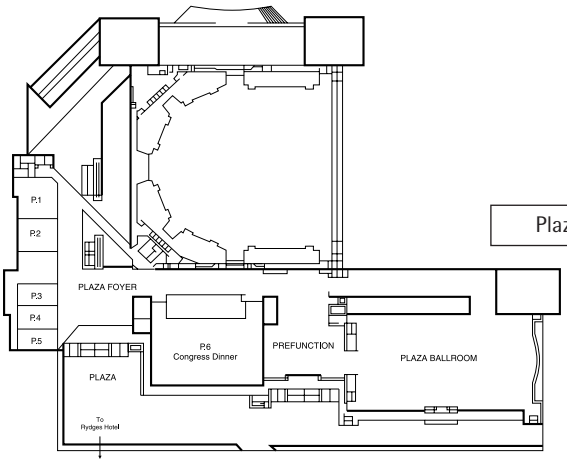




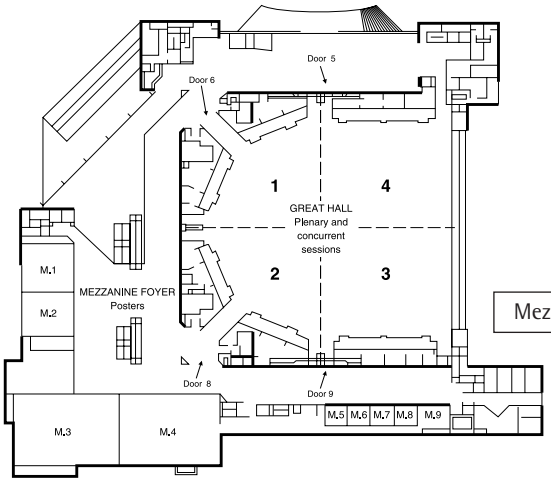
Main Foyer Level



Main Foyer Level



Plaza Level



Mezzanine Level

SUNDAY 5 AUGUST 2001

1400 Career Management Seminar

1600 Conference Registration

1800 WELCOME RECEPTION SPONSORED BY FUGRO AIRBORNE SURVEYS

MONDAY 6 AUGUST 2001

0800 Registration

0830 Opening Ceremony

0900 *The need to find more metal* **Mr Vincent Gauci** MIM Holdings,Qld

0930 *Australias oil and gas industry - where to from here* **Dr Agu Kantsler** Woodside Energy, WA

1000 MORNING TEA SPONSORED BY ORIGIN ENERGY

Theme	QUANTITATIVE SEISMIC INTERPRETATION	COAL GEOPHYSICS	AIRBORNE PROCESSING 1	PETROPHYSICS
1030	*Geostatistical lithology modelling* **Mark Sams** Jason Geosystems Asia, Malaysia	*Automated geotechnical characterisation from geophysical logs: examples from Southern Colliery, Central Queensland* **Binzhong Zhou** CSIRO Exploration and Mining, Qld	*Tracking the transmitting-receiving offset in fixed-wing transient EM systems: methodology and application* **Richard Smith** Fugro Airborne Surveys, Canada	*Electrical properties of porphyry mineralisation at the Cadia Ridgeway gold-copper deposit, NSW - implications for exploration* **David Close** and **Michael Roach** University Of Tasmania, Tas
1100	*Reservoir tracking in 3-D - an inversion case study* **Chris Lewis** IKODA, WA	*Borehole to borehole electromagnetic tomography at Trap Gully Callide Mine, East Central Queensland* **Craig Miller** Geophysics Australia, New Zealand	*Automated anomaly modelling of AEM data with magnetic dipoles buried inside a layered earth* **Daniel Sattel** Fugro Airborne Surveys, WA	*Petrophysical properties of the Goonumbla Volcanic Complex, NSW: implications for magnetic and gravity signatures of porphyry Cu-Au mineralisation* **David Clark** CSIRO Exploration & Mining, NSW
1130	*Quantitative seismic reservior characterisation: a model-based approach for the Sampang Production Sharing Contract (PSC), East Java, Indonesia* **Darren Rutley** Santos Asia Pacific, Qld	*Microseismic monitoring of highwall mining stability at Moura Mine, Australia* **Xun Luo** CSIRO Exploration & Mining, Qld	*Subsurface conductivity structure as approximated by conductivity-depth transforms* **Don Hunter** CSIRO - Exploration and Mining, WA	*Can sphalerite be a polarisable mineral? An example from the Century Zn-Pb deposit* **Philip Hawke**, University of Western Australia, WA
1200	*The integration of surface seismic and borehole data using artificial neural network clustering methods* **Richard Cooper** Rock Solid Images, USA	*A new instrument to remotely monitor rock mass deformation* **Ross Gwyther** CSIRO Exploration & Mining, Qld	*Spectral methods for reducing noise in gamma-ray spectrometry* **Brian Minty** ACT	*Relationships between regolith materials, petrophysical properties, hydrologeology and supergene Ni enrichment at the Cawse Ni-laterite deposits, Western Australia: Implications for exploring with AEM* **Timothy Munday** CSIRO Exploration & Mining, WA

1230	LUNCH			
Theme	HIGH-RESOLUTION SEISMIC	SEISMIC MULTIPLE ATTENUATION	INNOVATIVE AIRBOURNE GEOPHYSICS	RADIO AND RESISTIVITY TOMOGRAPHY
1330	*The influence of coal-mine geology on seismic data quality in the Bowen Basin* **Troy Peters** Velseis Processing, Qld	*High-resolution radon demultiple* **Neil Hargreaves** Veritas DGC, United Kingdom	*Falcon gravity gradiometer technology* **James Lee** BHP Minerals Technology, NSW	*Radio tomography (RTFEM), practical image fidelity or resolution* **Grant Roberts** and **Eric Wederpohl** Subsurface Imaging, NSW
1400	*Bandwidth requirements for shallow, high-resolution seismic reflection* **Steve Hearn** Velseis and University of Queensland, Qld	*Surface-related multiple elimination - applications to an offshore Australia data set* **Andrew Long** PGS Research, WA	*FALCON test results from the Bathurst Mining camp* **Mark Dransfield** BHP Minerals, Vic	*Determination of ore body continuity by a 2.5-D resistivity tomograph method* **Jingping Zhe** University Of Adelaide, SA
1430	*Estimating coal quality from seismic data - is it possible? A case study from the Bowen Basin* **Henk van Paridon** GeoSolve, Qld	*Quantifying multiple suppression of stacking* **John Parrish Periseis** Company, USA	Normandy heli-borne time domain EM system **Graham Boyd** Normandy Exploration, SA	
1500	AFTERNOON TEA			
Theme	LAND SEISMIC ACQUISITION	SEISMIC MULTIPLE ATTENUATION	AIRBORNE PROCESSING 2	MINERAL EXPLORATION APPLICATIONS
1530	*Mini-SOSIE - successful shallow 3D seismic data acquisition in an environmentally sensitive area* **Karel Driml** Velseis Processing, Qld	*Seismic Processing and Attribute Analysis Estimating residual statics using prestack migration* **John Bancroft** University of Calgary, Canada	*New advances in the analysis of potential field data by multiscale edges* **Fabio Boschetti** CSIRO Exploration & Mining, WA	*The geophysics of the Anjing Hitam Deposit: from mapping shales to a major discovery* **Jovan Silic** Flagstaff Geoconsultants, Vic
1600	*Sweeping changes for vibroseis operations* **Brent O'Brien** Veritas DGC, United Kingdom	*Effect of smoothing radius on refraction statics corrections in hard rock terrains* **Leonie Jones** Australian Geological Survey Organisation, ACT	*Designing matched bandpass and azimuthal filters for the separation of potential-field anomalies by source region and source type* **Jeffrey Phillips** United States Geological Survey, USA	*Exploration drillhole targeting with Gocad: recent advances in 3D model construction, query and visualisation* **Jennifer Levett** Mira Geoscience Limited, Canada
1630	*Quantitative source testing - a comparison between an 60'000lbs vibrator and an 80'000lbs vibrator* **Peter van Baaren** WesternGeco, WA	*A new technique for mapping fractures using 3-D seismic data* **Mu Luo** Curtin University Of Technology, WA	*Improving the quality of aerial gamma-ray surveys* **Bruce Dickson** CSIRO, NSW	*Recovering IP information from broadband EM measurements* **Andrew Lockwood** University of Western Australia, WA

1700 Sessions conclude

1700 HAPPY HOUR SPONSRED BY CSIRO

1730 UNIVERSITY STUDENT FUNCTION SPONSORED BY WMC RESOURCES

TUESDAY 7 AUGUST 2001

0800	Conference Registration			
Theme	ENVIRONMENTAL EM	PSDM & DEPTH CONVERSION	AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES SPONSORED BY MIM	DOWNHOLE APPLICATIONS
0830	*Geophysical characteristics of Salinisation at Cape Portland, NE Tasmania* **Ashley Howlett** University of Tasmania, Tas	*The success of PSDM over the Anama Structure in the Papuan Foreland basin, PNG - a case study* **Maki Petkovski** Oil Search, NSW	*Overview of geophysical successes* **Tom Whiting** BHP Minerals, Qld (to be confirmed)	*Borehole EM and MMR methods for weak conductors - a project review* **Michael Asten** Monash University, Vic
0900	*Filling in the gaps - validation and integration of airborne EM data with surface and subsurface observations for catchment management - an example from Bendigo, Victoria,* **Australia Richard Lane** Fugro Airborne Surveys, WA	*Horizon velocity analysis for depth conversion, a case study* **Randall Taylor** Origin Energy Resources, Qld	*Zinc exploration: looking to the past and the Future* **Tom Eadie** Pasminco Exploration, Vic	*Noise reduction for down-hole three-component TEM probes* **James Cull** Monash University, Vic
0930	*Application of the EM-31 terrain conductivity meter in highly-conductive regimes* **James Reid** University of Tasmania, Tas	*Buffalo Oil Field: geophysical success under Big* Bank Brenton Oke BHP Petroleum, WA	*King George: measured and modelled AGG response over an IOCG terrane* **Asmita Mansi** Mahanta BHP Minerals, Vic	*Galvanic excitation of theCadjebut Pb-Zn ore body* John Theodoridis Monash University, Vic
1000	MORNING TEA			
Theme	HIGH-RESOLUTION GEOPHYSICS	AVO	AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES SPONSORED BY MIM	DEVELOPMENTS IN PROCESSING
1030	*Measurement of rock fabric in shallow refraction seismology* **Derecke Palmer** University of New South Wales, NSW	*The AVO modelling volume* **Brian Russell** Hampson-Russell Software Services, Canada	The geophysical characteristics of the trilogy massive sulphide deposit, Ravensthorpe, Western Australia Lee Sampson Homestake Gold of Australia, WA	*The application of Zohdy's method to AEM data* **Daniel Sattel** Fugro Airborne Surveys, WA
1100	*Using high-resolution aeromagnetic surveys to map subsurface hydrogeology in sediment-filled basins: a case study over Rio GrandeRift, Central New Mexico USA* **VJS (Tien) Grauch** US Geological Survey, USA		Comparison of airborne and ground TEM systems for a conductor beneath conductive cover - an example from north-west Queensland, Australia John Hart BHP Minerals Discovery Group	*Extraction of principal component shapes from grids* **Roger Clifton** Northern Territory Geological Survey, NT
1130	*Rapid portable gamma ray spectrometer surveying* **Bob Grasty** Gamma-Bob, Canada	*Numerical and physical modelling of P-wave AVO response for fractured media* **Fatkhan Fatkhan** Curtin University of Technology, WA	Of detritals, derivatives and determination - an example of detrital iron discovery Amanda Butt Hamersley Iron, WA	*Reducing cross-profile aliasing in aeromagnetic data* **Duncan Cowan** Cowan Geodata Services, WA
1200	*Detection of cavities and tunnels from gravity data using a neutral network* **Eslam Ahmed Elawadi** Kyushi University, Japan	*A case study on using AVO walkaway VP data - Barrow Sub-basin, Western Australia* **Volker Dirks** CGG Borehole Services, United Kingdom	Airborne EM applied to sulphide nickel - examples and analysis Peter Wolfgram Fugro Airborne Surveys, NSW	*A heuristic method of removing micro-pulsations from airborne magnetic data* **Michael O'Connell** Fugro Airborne Surveys, Canada

1230	LUNCH			
Theme	PETROLEUM INTERPRETATION TECHNOLOGIES	SEISMIC MODELLING OF NEAR-SURFACE EFFECTS	AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES SPONSORED BY MIM	EM INTERPRETATION
1330	*Integrated interpretation of well logs and surface seismic* **Henry Cao** Schlumberger Oilfield Services, WA	*Topographic scattering effects on seismic data: from seismic numerical modeling to field data* **Yu Duan** Geophysical Consulting, WA	*2-D and 3-D IP/resistivity inversion for the interpretation of Isa-style targets* **Andrea Rutley** MIM Exploration, Qld	*The moments of a sphere in a uniform field, a versatile model* **Richard Smith** Fugro Airborne Surveys, Canada
1400	*Acoustic analysis of overpressure: from modeling to wireline observation* **Li-Yun Fu** CSIRO Petroleum, WA	*Numerical modelling of seismic reflection in basalt terrains* **Eric Battig** University Of Queensland, Qld	*The application of electrical geophysics to gold exploration at Mt Wright, North Queensland* **Derek Webb** MIM Exploration, Qld	*Emax conductivity-depth transformation of airborne TEM data* **Peter Fullagar** Fullagar Geophysics, Qld
1430	*Cascade inversion for tilt data* **Toshifumi Matsuoka** Kyoto University, Japan	*Effects of the traction-free surface with a rugged topography on seismic wave propogation: numerical modelling* **Xiuming Wang** and **Li-Yun Fu** CSIRO Petroleum, WA	*Falcon airborne gravity gradiometer survey results over theCannington Ag-Pb-Zn deposit* **Asbjorn Christensen** BHP Minerals, Vic	*Airborne EM survey over the Groote Eylandt manganese mine* **Richard Irvine** Condor Consulting, USA
1500	AFTERNOON TEA			
Theme	SEISMIC MIGRATION	DATA MANAGEMENT AND RISK REDUCTION IN RESOURCE EXPLORATION	AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES SPONSORED BY MIM	REGIONAL APPLICATIONS
1530	*Prestack kirchhoff migration and amplitude accuracy* **Carl Notfors** Veritas DGC Asia Pacific, Singapore	*Approaches to visualising and interpreting geoscientific data* **Alan Anderson** BHP Petroleum, USA	*Tritton Copper Deposit, Girilambone NSW. A geophysical discovery* **Steve Collins** Arctan Services, NSW	*Regional gravity and regolith geochemistry as an integrated tool for mineral exploration* **Sergey Shevchenko** Geological Survey of Western Australian, WA
1600	*The limitations of time migration and trace stretch in the presence of lateral velocity gradients* **Steve Kelly** PGS Seres Inc, USA	*Managing the volume and maximising its value - the benefits of an automated seismic data management system* **Terrence Folkers** Woodside Petroleum, WA	*Geophysics and the discovery of the Cadia gold-copper system* **Campbell Mackey** Newcrest Mining, Qld	*Spectral depth analysis of the Merlinleigh sub-basin using potential field data* **Ian Stewart** Stewart Geophysical Consultants,SA
1630	*Implicit noise reduction and trace interpolation in wavefield depth extrapolation* **How-Wei Chen** National Chung Cheng University, Taiwan	*Portfolio risk reduction: optimising selection of resources projects by application of financial industry techniques* **Noll Moriarty** Noll Moriarty & Associates, Qld	*Case history: the search for opal at Lightning Ridge* **Dave Robson** Department of Mineral Resources, NSW	*Mapping basement relief with airborne gravity gradiometry* **Clive Foss** Encom Technology, NSW
1700	Sessions conclude			
1700	Happy Hour			
1930	Conference Dinner sponsored by **Woodside Energy**, Dinner Speaker - **Dr Karl Kruszelnicki** sponsored by **WesternGeco**			

WESNESDAY 8 AUGUST 2001

0800	Conference Registration			
Theme	SEISMIC CASE HISTORIES	NEAR-SURFACE GEOPHYSICS	REGIONAL PERSPECTIVES	INVERSION
0900	*Seismic reprocessing contributes to development success at the Elang Field, Northern Bonaparte Basin* **Ian Young** QId	*Shallow refraction seismology for the new millennium* **Derecke Palmer**, University of NSW, NSW	*Progress of the Northern Territory exploration initiative* **Richard Brescianini** Northern Territory Geological Survey, NT	*Three-dimensional inversion of magnetotelluric data with static shifts* **Yutaka Sasaki** Kyushu University, Japan
0930	*Elastic modelling of reflectivity and AVO at the Elang Formation, Laminaria East* **Greg Beresford** On-Line Geophysics, NT	*Interpretation of bedrock topography within the Port Jackson (Sydney Harbour) region using marine seismic reflection* **Glenn Harris**, University of Sydney, NSW	*The geophysical characteristics of the granites - Tanami Goldfields: a regional perspective* **Kerry Slater** QId	*A comparison of smooth and blocky inversion methods in 2-D electrical imaging surveys* **Meng Heng Loke** Universiti Sains Malaysia, Malayasia
1000	*Seismic stratigraphy of the late permian tinowon formation, Surat Basin, Australia : new opportunities in a mature basin* **Koya Suto** Origin Energy Resources, QId	*An integrated approach with DighemV to groundwater exploration - Tsabong, Botswana* **Prue Leeming**, Fugro Airborne Surveys, Botswana	*3D gravity modelling and interpretation for the 1:250,000 Boulia map sheet, Queensland* **Glenn Pears** Quantec Geoscience, QId	*Using the ASVI to invert for remanently magnetised bodies* **John Paine** Scientific Computing & Applications, SA
1030	MORNING TEA			
Theme	SEISMIC ANISOTROPY AND RAY-PATH ANALYSIS	SEISMIC ACQUISITION METHODOLOGIES	ELECTRICAL METHODS	MAGNETIC MODELLING
1100	*Filtered dense n picking for non-hyperbolic movement* **David Le Meur** Compagnie Generale De Geophysique, France	*Understanding elastic wavefield recording by detailed 3D survey planning and simulation* **Andrew Long** PGS Research, WA	*A new survey design for 3D IP inversion modelling at Copper Hill* **Rebecca Denne** Arctan Services, NSW	*Magnetometer calibration: a joint initiative of defence and AGSO* **Malcolm Gamlen** Australian Geological Survey Organisation, ACT
1130	*Explicit anisotropic P-wave ray velocity functions* **Fanmin Zhang** Curtin University of Technology, WA	*Long offset towed streamer recording - a cheaper alternative to multi-component OBC for exploration?* **Gareth Williams** Veritas DGC, United Kingdom	*Borehole MMR at Marvel Loch gold mine - solving for the conductive overburden* **John Jackson** Sons of Gwalia, WA	*Iterative forward magnetic modelling with corrections for self-demagnetisation* **Matthew Purss** Monash University, Vic
1200	*Generalised ray parameters for vertically inhomogeneous and anisotropic media* **Paul Webster** Woodside Energy, WA	*Perturbations in 4D marine seismic* **Tim Brice** Schlumberger Reservoir Evaluation, WA	Application of spectral time domain induced polarisation method to resolve orebody characterisation Nader Fathianpour Isfahan University Of Technology, Iran	*A user guided expert system approach to 3D interpretation of magnetic anomalies* **David Pratt** and **Clive Foss** Encom Technology, NSW

LUNCH

Theme	REGIONAL GEOPHYSICS	SEISMIC TOMOGRAPHY	ELECTROMAGNETIC INTERPRETATION	EXPLORING THROUGH COVER
1330	*Integrated geophysical appraisal of crustal architecture in the Eastern Lachlan Orogen* **Nick Direen** AGSO, ACT	*Tomostatics applications for basalt-outcrop land and OBC multi-component surveys* **Xianhuai Zhu** PGS, USA	*EM target response in complex hosts* **Art Raiche** CSIRO Exploration & Mining, NSW	*Exploring through cover - the integrated interpretation of high resolution aeromagnetic, airborne electromagnetic and ground gravity data from the Grant's Patch area, Eastern Goldfields Province, Archaean Yilgarn Craton Part A* **Lisa Worrall** Australian Geological Survey Organisation, ACT
1400	*The application of curie depth effective elastic thickness seismic tomography and seismicity in regional exploration area selection* **Lisa Vella** WMC Resources, Qld, and **Chris Swain** WA	*A comparative study of 2D and 3D crosswell tomography* **Zhiyi Zhang** Baker Atlas, USA	*Step and impulse calculations from pulse-type electromagnetic data* **Neil Hughes** Crone Geophysics & Exploration, Canada	*Exploring through cover - the integrated interpretation of high resolution aeromagnetic, airborne electromagnetic and ground gravity data from the Grant's Patch area, Eastern Goldfields Province Archaean Yilgarn Craton Part B: Gravity invers* **Benjamin Bell** Australian Geological Survey Organisation, ACT
1430	*Lithospheric boundaries on the eastern Siberian platform* **Yvette Poudjom Djomani** GEMOC - Macquarie University, NSW	*Spatially limited tomographic inversion for time-lapse oil reservoir monitoring* **Toshiyuki Yokota** Geological Survey of Japan Institute For Geo-Resources & Environment, JAPAN	*TEM models for a conductive host and filament migration* **Ashley Grant,** Geological Survey Of Victoria, Vic	*Exploring through cover - the integrated interpretation of high resolution aeromagnetic airborne electromagnetic and ground gravity data from the Grant's Patch area, Eastern Goldfields Province Archaean Yilgarn Craton Part C: combining geo* **Jayson Meyers** AWI Administration Services, Vic
1500	AFTERNOON TEA			
1520	*Something old and something new, something borrowed and something blue* **Dr Ken McCracken Jellore** Technologies, NSW			
1600	CLOSING CEREMONY			
1700	Conference concludes			
1700	CONFERENCE FAREWELL SPONSORED BY FUGRO AIRBOURNE SURVEYS			

Posters

Interactive inversion of geophysical problems
Fabio Boschetti, CSIRO Exploration & Mining WA

Acquisition and processing of single sensor seismic data
Timonthy Brice, Western Geco, WA

Detailed geophysical and geological investigation of the layered, mafic/ultramafic Black Hill Gabbroic Complex, Black Hill, South Australia
Andrew Burtt, Primary Industries & Resources South Australia, SA

Target exploration initiative South Australia (TEiSA) - musgrave block uncovered
Domenic Calandro, Minerals & Energy Resources South Australia, SA

A simplified form for nonhyperbolic equation in a TIM
Chih-Hsiung Chang, National Chiayi University, Taiwan

Geological interpretation of the aeromagnetic survey Las Petas district Republic of Bolivia
Jorge Chernicoff, University of Buenos Aires - CONICET, Argentina

Simulation of Terra satellite data over Rum Jungle, NT
Roger Clifton, Northern Territory Geological Survey, NT

Statistical and wavelet analysis of detailed physical property measurements on the Bellevue drillcore, Northern Lobe, Bushveld Igneous Complex, South Africa
Gordon Cooper, University Of The Witwatersrand, South Africa

Polynomial fitting + narrow reject-band f-k filtering for seismic coherent noise elimination
Yu Duan,Inderpendent Geophysical Consulting, WA

Geophysical signatures over copper porphyries on the Pacific rim
Peter Elliott, Elliott Geophysics International, Indonesia

Development of a new rapid inversion scheme for total field magnetometric resistivity (TFMMR) data
Nader Fathianpour, Isfahan University Of Technology, Iran

Polynomial fitting + narrow reject-band f-k filtering for seismic coherent noise elimination
Li-Yun Fu, CSIRO Petroleum, WA

Micro-gravity for mineral exploration
Eric Gozlan, Monash Univesity, Vic

Seismic attenuation in a heterogeneous porous rock
Boris Gurevich, Curtin University, WA

Waves in alternating solid and viscous fluid layers
Boris Gurevich, Curtin University, WA

Natural resource geophysics in the Northern Territory - new tools or new ideas?
Gary Humphreys, Dept of Lands Planning & Environment, NT

Basement interpretation of the Tennant Creek region
Andrew Johnstone, Northern Territory Geological Survey, NT

Detecting kimberlite pipes at Ekati with airborne gravity gradiometry
Guimin Liu, BHP Minerals, Vic

The magnetization vector became important in surface geology and chromite prospecting within ultramaphic massifs
Arben Lulo, Center Of Geophysics Tirana, Albania

Numerical simulation of fractured media
Mu Luo, Curtin University Of Technology, WA

Migration velocity analysis using seismic multiples
Chris Manuel, Curtin University, WA

Robust digital differentiation with application to coal mining
Nigel McGinty, Defence Science & Technology Organisation, SA

Mapping boulders using 2-D resistivity imaging technique for site investigation in Penang, Malaysia
Mohd Nawawi, Universit Sains Malaysia, Malaysia

Generalized bouguer gravity anomaly (1): formulation of spherical Bouguer anomaly reduced onto an arbitrary equi-potential surface
Kyozo Nozaki, OYO Corporation, Japan

Generalized bouguer gravity anomaly (2): possibility of constructing bouguer gravity anomaly distribution with no gravitational effect due to topographic undulation
Kyozo Nozaki, OYO Corporation, Japan

Apache energy: A case study in real-time database integration
Karen O'Donahoo, Integrated Solutions Australasia WA

A simple approach to 3D shallow refraction seismology
Derecke Palmer, University of New South Wales, NSW

Amplitude 'statics' in shallow refraction seismology
Derecke Palmer, University of New South Wales, NSW

Potential field and bathymetry grids of australia's margins
Peter Petkovic, Australian Geological Survey Organisation, ACT

Modelling the magnetic induced polarisation (MIP) response from the down-hole magnetometric resistivity (DHMMR) method
Matthew Purss, Monash University, Vic

Operation treasure hunt - does the Ontario model work for you?
Stephen Reford, Paterson Grant & Watson, Canada

Antarctic sea ice thickness measurements using a ship-borne electromagnetic induction device
James Reid, University of Tasmania, Tas

Estimating parameters and uncertainty in geophysical inversion: a new approach using the neighbourhood algorithm
Malcolm Sambridge, Australian National University, ACT

Accuracy of interpolation for 3D contour mapping from 2D seismic sections
Alexander Shepherd, Curtin University Of Technology, WA

Constructing high resolution DEMs from airborne laser scanner data
Peter Stone, BHP Minerals - Development Technologies, VIC

Forward and inverse modelling methods for electromagnetic surface impedance
David Thiel, Griffith University, Qld

Time domain airborne electromagnetic reconnaissance for seadepth measurement and shipwreck localisation
Julian Vrbancich, Defence Science & Technology Organisation, NSW

Forward and inverse modelling methods for electromagnetic surface impedance
Glenn Wilson, Griffith University, Qld

Keynote Speakers

The need to find more metal
Mr Vincent Gauci MIM Holdings, Qld

Australia's oil and gas industry - where to from here
Dr Agu Kantsler Woodside Energy, WA

Something old and something new, something borrowed and something blue
Dr Ken McCracken Jellore Technologies, NSW

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ASEG 2001 A Geophysical Odyssey

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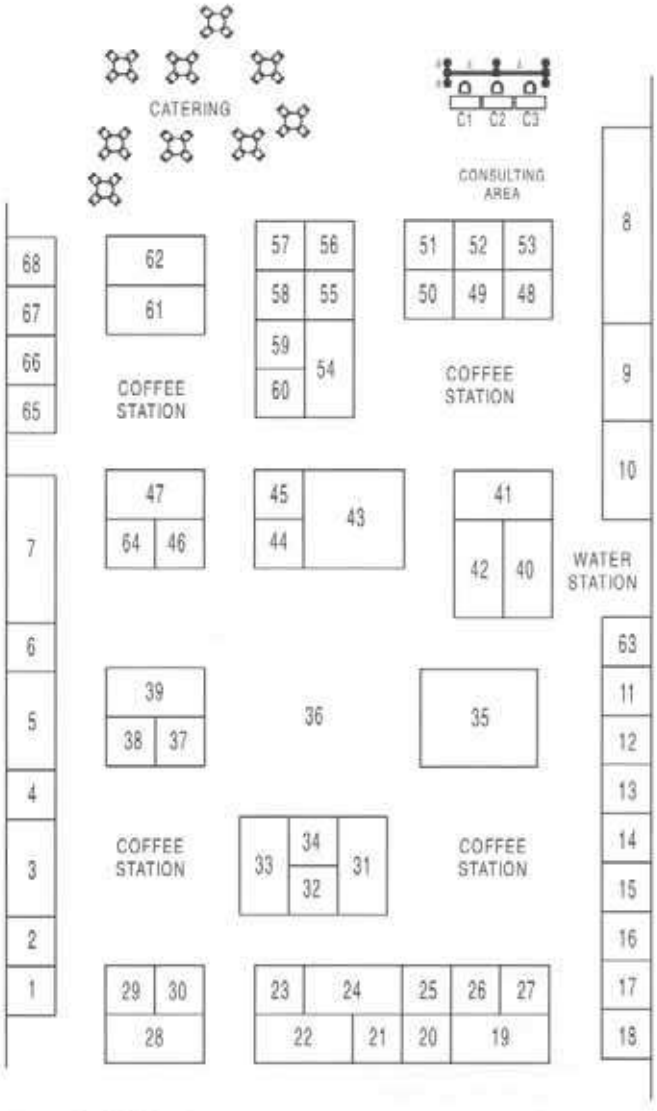

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Sunday 5 August 2001	1800 - 1930 hours (Welcome Reception)
Monday 6 August 2001	0800 - 1800 hours
Tuesday 7 August 2001	0800 - 1800 hours
Wednesday 8 August 2001	0800 - 1530 hours

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Contact person: Ms Alana Birchall

The BHP Billiton booth features the FALCON™ airborne gravity gradiometer. Two systems are deployed in Cessna Grand Caravan aircraft that also acquire aeromagnetics, radiometrics and detailed digital terrain mapping. The AGG results so far have exceeded expectations.

A number of papers about FALCON™ feature at the ASEG conference and demonstrate the capability of the technology. A whole new perspective on the gravity technique and its application to mineral exploration and geological mapping is demonstrated.

BHP Billiton is making the FALCON™ technology available to the global exploration industry through joint ventures and alliances.

CSIRO — STAND 62

PO Box 218
Linfield NSW 2070 Australia

CSIRO is working with the mining and petroleum industries developing new and innovative ways to lead these industries to be the world's most efficient and profitable. CSIRO is developing new geophysical techniques and interpretation methods designed to increase exploration success rates and the efficiency and safety of mining operations, while lowering their environmental impact. CSIRO is demonstrating new superconducting technologies for improved exploration. CSIRO offers a range of petroleum research activities from fluid migration and charge history to reservoir characterization, rock properties and their geophysical response. The booth will provide information on current and planned research programs including in reservoir characterization, laboratory validation of pore pressure prediction, geophysical simulation of saturated reservoir rocks and its elastic response within the context of the broader range of research, basin dynamics, fluid migration and drilling systems.

MINERALS & ENERGY RESOURCES SA — STAND 57

Mineral Promotions
Mineral Resources Group
4th floor 101 Grenfell St. Adelaide
GPO Box 1671 Adelaide, SA 5000 Australia
Tel: 08 8463 3037
Fax: 08 8226 3177
Website: www.minerals.pir.sa.gov.au
Contact Person: Dr Andrew Rowett

The Mineral Resources Group of the Office of Minerals & Energy Resources, PIRSA is responsible for the delivery of quality programs and policy for the mineral resources sectors and the community of South Australia. 2001/2 programs will focus on key prospective areas identified in the Resources Task Force and the MRG strategic planning process, ie. the Gawler Craton, Musgrave Block and Curnamona Province. Activities to be undertaken in these areas will include bedrock drilling, airborne geophysical surveys, regolith and palaeochannel studies and geological mapping at 1:100 000 scale.

A significant recent advancement in MRG website capabilities has been the South Australian Resource Information Geoserver (SARIG) application. Released in June, 2001 SARIG will be a major benefit to the minerals industry providing explorers the opportunity to do business online. Potential explorers will now be able to access high quality geoscientific data over the Internet, with which they can use to identify potential prospective areas for exploration. They can also review current mineral tenements, and apply and pay for exploration licence applications electronically.

VERITAS DGC INC. — STAND 35

38 Ord Street
West Perth WA 6005 Australia
Tel: 08 9214 6200
Fax: 08 9214 6222
Email: Sami_Khan@veritasdgc.com
John_Boldock@veritasdgc.com
Bryan_Robertson@veritasdgc.com

VERITAS DGC Inc. offers the petroleum industry a comprehensive suite of integrated geophysical services designed to enhance drilling and production success. These include seismic survey planning and design, seismic data acquisition in all environments, data processing, data visualization, data transcription, data management and an explorationist's toolbox of interpretive and reservoir characterisation services. The 3,000 people at Veritas are committed to the principles of *'geophysical integrity'*, which means we strive to deliver value and consistent, accurate results to our customers on every project we undertake.

Veritas is a company that aggressively pursues innovative new technologies through ongoing research and development efforts, both internally and externally. The continued growth of Veritas will be achieved by adhering to our core strategy of providing customers with greater value through quality products and services, based on the company's stated promise *"to deliver and do what we say"*.

Bronze Sponsors

DYNAMIC SATELLITE SURVEYS — STAND 56

PO Box 713
Yeppoon QLD 4703 Australia
Tel: 07 4939 2866
Fax: 07 4939 2867
E-mail: yeppoon@dss.com.au
Contact Person: Tim McCall, Director

Dynamic Satellite Surveys (DSS) is an Australian based Global Positioning System (GPS) specialist company offering surveying services. DSS has pioneered the development of GPS in exploration from the initial planning stages, the setout and survey of 2D and 3D seismic, through to pipeline construction and asset management. DSS has been involved in more than 80% of the seismic exploration in Australia since 1989, and has extensive projects in the Middle East, Asia and the South Pacific.

GEOSOFT AUSTRALIA PTY LTD — STAND 41

32 Richardson Street
West Perth, WA 6005 Australia
Tel: 08 9214 3905
Fax: 08 9322 8133
Mobile: 0408 640 132
Contact Person: Mark Russell

Geosoft delivers a one-stop, industry-standard software solution for potential field data processing and interpretation based on Oasis montaj(tm) – a powerful technology for working with large volume spatial data. Using a combination of Geosoft's Oasis montaj core technology and NGA's integrated modeling software, exploration professionals can optimize survey planning and enhance exploration results from offshore and onshore environments. Key applications include structural mapping and geologic modeling using gravity and magnetic data.

GREEN MOUNTAIN GEOPHYSICS — STAND 20

361 Centennial Parkway
Suite 220, Louisville, CO 80027 USA
US Tel: 303 444-6925
US Fax: 303 444-8632
UK Tel: +44 0 1603 664823
Email: marketing@gmg.com
Website: www.gmg.com
Contact person: Paul Brettwood

Green Mountain Geophysics develops high quality geophysical software applications for 3D and multi-component acquisition planning and modeling, acquisition project tracking and pre-processing operations, including geometry and near surface velocity calculations. These advanced tools make it possible to thoroughly understand the benefits associated with state-of-the-art 3D or 3C acquisition design and its appropriateness for a given seismic setting.

In 1997, GMG became an Input/Output, Inc. company, merging with a world leader in seismic acquisition imaging technology for land, transition zone and marine exploration and production. The company specialises in bringing to market technology that creates value for the energy industry in the areas of 2D, 3D, 4D and multi-component seismic data.

Call on GMG for:

- 3D Seismic Survey Planning (MESA®)
- Model-based Survey Design (MESA® GRIP)
- Acquisition Project Management (Alpine™)
- Field QC and Refraction Statics Solutions (Millennium®)
- 3D Survey Design Consulting/Training (GMG Energy Services)

NATURAL RESOURCES AND MINES (QLD) — STAND 1

Department of Natural Resources and Mines
GPO Box 194, Brisbane Qld 4001 Australia
Tel: 07 3237 1434
Fax: 07 3229 7770
Email: enquiries@dme.qld.gov.au
Website: www.dme.qld.gov.au

Natural Resources and Mines (NREtM), formed in 2001, plays a critical role in the stewardship of Queensland's natural resources. The department manages and allocates the State's land, water, mineral and petroleum resources, and manages native vegetation and the control of pest plants and animals. It delivers a range of services including land dealings and registrations, valuations and community titles matters. Broadly, these management activities and services underpin the economic and social well-being of the State, and complement the department's broader responsibilities of providing quality information, planning and advice for sustainable natural resource management.

NSW DEPARTMENT OF MINERAL RESOURCES — STAND 17

PO Box 536
St. Leonards NSW 1590 Australia
Tel: 02 9901 8342
Fax: 02 9901 8256
Email: robsond@minerals.nsw.gov.au
Website: www.minerals.nsw.gov.au
Contact Person: David Robson, Chief Geophysicist

The NSW Department of Mineral Resources is now in the second year of the "Exploration NSW" 7-year $30 million exploration initiative being funded by the NSW Government. It builds on the previous Discovery 2000 initiative in turbo-charging the acquisition and distribution of geoscience data to attract mineral and petroleum exploration in NSW.

Currently, 60% of New South Wales is covered with high resolution airborne geophysical data. The Discovery 2000 and Exploration NSW airborne data is available at approximately 1 cent/km with gravity data available at approximately 50 cents/station. New surveys cover Moree, Tamworth, Braidwood, Lightning Ridge and Tibooburra.

NORTHERN TERRITORY GEOLOGICAL SURVEY — STAND 50

Centrepoint Building, Smith Street Mall
GPO Box 2901, Darwin, NT 0801 Australia
Tel: 08 8999-5313
Fax: 08 8999-6824
Email: reference.geologist@nt.gov.au
Website: www.dme.nt.gov.au/ntgs
Contact Person: Richard Brescianini

The role of NTGS is to collect, interpret, synthesise and disseminate geoscientific data to attract and render more effective mineral and on shore petroleum exploration, and also to provide geoscientific advice in the formulation of resource policies. It proactively undertakes regional geoscience programs, mineral resource assessments, metalliferous deposit and petroleum system studies, exploration reviews and airborne geophysical surveys.

QUANTEC GEOSCIENCE PLTY LTD — STAND 45

128 Waterworks Road
PO Box 276
Ashgrove 4060 QLD Australia
Tel: 07 3366 8022
Fax: 07 3366 8030
Mobile: 0408 737 410
Email: quantecgeo@ozemail.com.au
Contact Person: Phil Andrews

Quantec Geoscience provides the exploration and mining community with the most advanced technologies and experience in the world. Quantec specialises in data acquisition, petro-physics and earth modelling. Advanced array technologies improve targeting by seeing deeper and more clearly into the earth. Integrating this improved data with all other 3D spatial data into constrained 'common earth models', maximises return on exploration dollar spent and Reduce Exploration Risk. Quantec operates globally from offices in Australia, Canada, USA, Chile, Brazil, Argentina, Peru, Mexico and Botswana.

THE VELSEIS GROUP — STAND 54

Velseis Processing
PO Box 1528
Coorparoo QLD 4151 Australia
Tel: 07 3391 3001
Fax: 07 3391 3021
Website: www.velpro.com.au
Contact Person: Karel Driml, Managing Director

The four members of the Velseis Group provide complementary services to the earth resources industry. The group offers a complete service in Australia and internationally. This service encompasses survey design and planning, data acquisition (2D, swath, 3D and Shear Wave), data processing and interpretation.

Velseis Pty Ltd is an Australian company, incorporated in 1974, which has specialised in high-resolution reflection data acquisition since 1979. Velseis is now recognised as the leading Australian contractor in this field. Velseis Processing Pty Ltd was established to provide seismic data processing services to the Oil & Gas and Coal industries. The company is capable of processing and interpreting both land and marine data and is Australia's leader in processing and interpreting both 2D and 3D high-resolution data.

PT Velseis Geofisika, an Indonesian company incorporated in 1996, is a seismic and geophysical logging contractor based in Balikpapan. PTVG provides seismic exploration programme management, high resolution seismic data acquisition, data processing, interpretation and geophysical logging services.

Velseis Niugini was incorporated in Papua New Guinea in early 2001. This entity provides seismic services to the Oil and Gas industry in PNG and continues the three years of service provided by Velseis Pty Ltd.

Exhibitors

ABEM INSTRUMENT — STAND 44

Hamngatan 27
172 66 Sundbyberg Sweden
Tel: +46 8 764 60 60
Fax: +46 8 28 11 09
Website: www.abem.se

ABEM manufactures field worthy, portable instruments for shallow applications under difficult environmental conditions. The instruments are used for geotechnical investigations, education, prospecting of oil, groundwater, minerals and also to detect polluted ground. The instruments are Terrameter SAS 1000 / 4000 resistivity system, the LUND Imaging System, Terraloc MK 6 seismograph, RAS-24 distributed seismograph and WADI VLF. ABEM has distributors in more then 70 countries.

AGSO - GEOSCIENCE AUSTRALIA — STAND 8

Cnr Jerrabomberra Avenue & Hindmarsh Drive,
Symonston ACT 2609
GPO Box 378, Canberra ACT 2601 Australia
Tel: 02 6249 9111
Fax: 02 6249 9990
Email: sales@agso.gov.au
Website: www.agso.gov.au

AGSO is Australia's national geoscience research and information organisation. It is a prescribed agency within the Federal Industry, Science and Resources portfolio.

AGSO provides independent geoscientific information to support decision-making for the economically and ecologically sustainable management of Australia's natural resources and environment.

Our booths will feature projects using 3D visualisation derived from geology and geophysics. These technologies are currently being developed and used by AGSO. Our displays will include data from current research areas such as Kalgoorlie-Ora Banda and Grant's Patch in the Eastern Goldfields Region.

ALPHA GEOSCIENCE PTY LTD — STAND 58

Suite 7, 852 Princes Highway
Sutherland NSW 2232 Australia
Tel: 02 9542 5266
Fax: 02 9542 5263
Email: sales@alpha-geo.com
Website: www.alpha-geo.com
Contact Person: Timothy Pippett

Alpha Geoscience was established in 1997 to offer high sensitivity geophysical tools and expertise to the environmental industry, the ordnance clearance market, the near surface mineral explorationist and the engineering market, as an alternative to intrusive investigations.

Alpha Geoscience has been appointed an agent for the following manufacturers of geophysical tools:

- Geonics Limited (Toronto, Canada) range of environmental and engineering instrumentation for sales and also there is available for rental the EM61.
- Mala Geoscience (Mala, Sweden) range of Ground Penetrating Radar (GPR) systems with frequencies from 25 MHz. to 1000 MHz. A system is available for rental and demonstration.

AUSTRALIAN MINERAL FOUNDATION — STAND 60

63 Conyngham Street
Glenside SA 5065 Australia
Tel: 08 8130 6311
Email: mblake@amf.com.au
Website: www.amf.com.au
Contact Person: Maureen Blake

Unlock valuable industry information - AMF provides a single point of contact for the resources sector by offering:

- Specialist Library Facilities
- AESIS - the national geoscience database
- The AMF Bookshop - Australia's largest industry bookshop
- Professional Development Courses and Conferences

- International Study Tours to the world's significant deposits
- The Data Metallogenica ore deposit collection on-line

AMF Membership offers priority and/or exclusive access to these services. Visit us at the 15th ASEG or our Website at www.mineralsinfo.org for details on the benefits of Membership.

BAIGENT GEOSCIENCES PTY LTD — STAND 2

174 Cape Three Points Road
Avoca Beach NSW 2251 Australia
Tel: 02 4382 6079
Fax: 02 4383 6089
Email: mark@bgs.net.au
Contact Person: Mark Baigent

Baigent Geosciences specialises in the processing of airborne geophysical data. The company is devoted to high quality results and services in the processing of magnetic, radiometric, dtm and helicopter EM data sets. The company has an extensive knowledge base in processing of both fixed wing and helicopter acquired data. The company also has the ability to incorporate horizontal magnetic gradients in the magnetic total field to enhance structural resolution.

In house software development keeps abreast of industry innovation to make sure that only the best processing solutions are used to maximise the usefulness and interpretability of the data. Baigent Geosciences ensures the highest possible quality and rapid turn around of data.

CEANET — STAND 51

Tel: 1800 628 320
Fax: www.ceanet.com.au
Email: info@ceanet.com.au

Established in 1969, ceanet has a solid reputation as the premier supplier and developer of technical computing software for research, product design and development in industry and education. ceanet is the exclusive Australian distributor for a number of market-leaders, including MATLAB, Simulink, Maple, dSPACE, MINITAB and GenStat. In support of these products, ceanet provides its customers excellent training, technical and customer service. Clients come from a wide range of industries including electronics, mining, communications, power, defence, aerospace, automotive, finance and medicine.
For more information

CGG AUSTRALIA SERVICES — STAND 26

PO Box 1014
Morley WA 6943 Australia
Tel: 08 9377 2028
Fax: 08 9377 2737
Email: dthorne@cgg.com
Contact Person: David Thorne, Manager - Borehole Services Division

The Compagnie General of Geophysique is a global participant in the oilfield services industry, providing a wide range of seismic data acquisition, processing and geoscience services and software to clients in the oil and gas exploration and production business. It is also a global manufacturer of geophysical equipment with SERCEL.

CGG Australia Services Pty Ltd is providing acquisition and processing services in surface and borehole seismic (BSD) data.

CURTIN GEOPHYSICS — STAND 59

Curtin University of Technology
GPO Box U1987
Perth WA 6845 Australia
Tel: 08 9266 3565 / 3408
Fax: 08 9266 3407
Email: deirdre@geophy.curtin.edu.au or enq@geophy.curtin.edu.au
Website: www.geophysics.curtin.edu.au
Contact Person: Deirdre Hollingsworth

The department of exploration geophysics specialises in education and research in Minerals, Groundwater and Petroleum Geophysics. In 2001 the Department has 14 Staff and 90 Students. Since the inception of a geophysics program at Curtin, over 500 persons have been awarded degrees at all levels. The Department is a member of three CRCs; APCRC, CRCLEME, CMTE and has recently been chosen as a Centre of Excellence for Exploration and Production Geophysics. The annual operating budget of the Department is approx. $2 million, most of which is received via research grants.

DAISHSAT PTY LTD — STAND 15

14 Carter Road
PO Box 766,
Murray Bridge, SA 5253 Australia
Tel: 08 85310349
Fax: 08 85310684
Mobile: 0418 800122
Website: www.daishsat.com

Daishsat is the leading provider of GPS positioned gravity surveys in Australia, having surveyed in excess of 200,000 gravity stations over the last 10 years since the introduction of precision GPS techniques to the exploration industry. We also offer precision GPS surveys, magnetic surveys, image processing and modelling.

EAGE — STAND 24

European Association of Geoscientists & Engineers
PO Box 59
3990 DB Houten
The Netherlands
Tel: +31 30 6354055
Fax: +31 30 6343524
Email: eage@eage.nl
Website: www.eage.nl
Contact Person: Danielle Vaillant

With more than 5500 members worldwide, EAGE is the leading European based international organisation of geoscientists and engineers. Members receive the EAGE journals, and enjoy other benefits such as reduced registration fees for the Annual Conference. For more information please our visit our stand or contact the EAGE Business Office.

EARTH RESOURCE MAPPING — STAND 30

65 Hume Street
Crows Nest NSW 2065 Australia
Tel: 02 8437 6202
Fax: 02 8437 6223
Website: www.EarthEtc.com
Contact Person: Tong Lim, Australasian Business Manager

Earth Resource Mapping is proud to be the leading image processing and Internet distribution software developer. Earth Resource Mapping produce a suite of imaging solutions for the processing, display and serving of digital raster imagery. The flagship product ER Mapper has gained considerable usage amongst the remote sensing community of the world. It features the innovative dynamic algorithm compiler allowing the easy handling of very large image datasets. Research into wavelet compression methods has lead

to the development of the ECW (enhanced compressed wavelet) format and associated Image Web Server product. This enables the delivery of large processed datasets over the Internet or secure intranets.

ELECTROMAGNETIC IMAGING TECHNOLOGY PTY LTD

41 Reserve Street
Wembley WA 6104 Australia
Tel: 08 9387 6465
Fax: 08 9383 7890
Email: info@emit.iinet.net.au
Website: www.emit.iinet.net.au
Contact Person: Andrew Duncan

ElectroMagnetic Imaging Technology (EMIT) develops instrumentation and software for electrical geophysics. The EMIT SMARTem receiver system is now in widespread use, especially in surveys suffering from electrical interference. SMARTem is a PC-based 8-channel system with Windows OS and the capability to do any type of electrical geophysics including EM and IP, with full time-series recording, many processing options and graphic interface. EMIT's Maxwell is Windows software for the visualisation, processing, modelling and plotting of EM data of any type - time or frequency domain, airborne, ground, borehole.

ENCOM TECHNOLOGY — STAND 47

Level 2, 118 Alfred Street
Milsons Point NSW 2061 Australia

Encom Technology Pty Ltd has provided innovative software solutions, consulting services and training for the petroleum and mineral exploration industries for 17 years.

Pre-release demonstrations of the latest expert magnetic interpretation system, QuickMag, and of the new interpretation assistant, Profile Analyst, will be presented at Encom's booth.

QuickMag will reduce interpretation time and deliver the results of sophisticated 3D magnetic modelling directly into the user's working environment.

Profile Analyst provides users of OASIS and Intrepid data bases with virtually unlimited capability to view and layout their geophysical or geological profile and map data for interpretation and anomaly prioritisation.

ESRI AUSTRALIA — STAND 65

Level 4
441 St Kilda Road
Melbourne VIC 3004 Australia

ESRI Australia is the largest supplier of Geographic Information Systems (GIS) software and services in Australia, with seven offices nationwide. The company business consists of sales, support, consulting and training of the leading GIS software, ranging from desktop right through to enterprise GIS and Internet mapping solutions. ESRI Australia continues to set the standard for high quality GIS systems implementation projects and is backed by staff with a wide range of both industry and technical experience. Industry groups already using ESRI software solutions include; Utilities,Telecommunications, Defence, Mining, Facilities Management, Transport, Resource Management, Business, Local Government and Environmental Management.

EXPLORANIUM — STAND 11

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Mississauga, Ontario
Canada L5T 2V7
Tel: +1 905 670 7071
Fax: +1 905 670 7072
Email: mcgovern@exploranium.com
Website: www.exploranium.com

Exploranium designs and manufactures radiation detection instruments for the Geophysical, Environmental, Nuclear and Industrial applications.

The Geophysical radiation products include the widely used GR-820 Airborne Gamma-Ray Spectrometer, the GR-660 series of integrated airborne and carborne systems, the GR-320 Portable Spectrometer, the GR-130 series of Handheld Spectrometers and the model GR-110G Scintillometer. In addition, the company also produces the KT-9 Susceptibility Meter.

FUGRO GROUND GEOPHYSICS (FGG) — STAND 37

7 - 9 George Place
Artamon NSW 2064 Australia
Tel: 02 9418 8077
Fax: 02 9418 8581
Email: postmaster@fugroground.com

With over 28 years of experience within Australia and around the world, FGG (previously Geoterrex) offers a full range of ground geophysical data acquisition and processing services including GPS/Gravity, Electromagnetics and Induced Polarisation. FGG also acts as agents for ABEM, Geonics, Iris Instruments and Mala equipment with full sales and service support.

GEO INSTRUMENTS PTY LTD — STAND 7

348 Rocky Point Road
Ramsgate Sydney NSW 2217 Australia
Tel: 02 9529 2355
Fax: 02 9529 9726
Email: info@geoinstruments.com.au
Website: www.geoinstruments.com.au
Contact Person: Roger Henderson

Geo Instruments is a leading supplier of high-quality earth science products and services to the geophysical, geotechnical, engineering, & environmental sectors. We promote Australian-made instruments and services internationally, and also represent major North American & European suppliers in the Australasia-Pacific regions. Geo Instruments offers sales, rental & servicing of ground systems & software, as well as high-resolution helicopter & fixed-wing surveys. Recent innovations include our revolutionary ARTEMIS TEM System and the MIDAS-750 fixed-wing FEM System

GEOIMAGE PTY LTD — STAND 34

13/180 Moggill Rd Taringa
Brisbane QLD 4068
PO Box 789
Indooroopilly QLD 4068 Australia
Tel: 07 3871 0088
Fax: 07 3871 0042
Website: www.geoimage.com.au

Geoimage Pty Ltd is an independent image processing consultancy specialising in the production and sales of satellite and geophysical imagery, and the processing and analysis of remotely sensed data for natural resource applications. Since the company was founded in 1988 we have been providing quality spatial products and services to our clients. A wholly owned

Australian, private and independent company. Geoimage's client base includes the Mineral and Petroleum Exploration and Mining Sectors, and the Natural Resources and Geographical Information Systems Sectors. With offices in Brisbane, Darwin and Perth, we service a client base that extends throughout Australia, SE Asia, Africa, the USA and South America.

GEOLOGICAL SURVEY OF NAMIBIA — STAND 27

P O Box 2168
Windhoek Namibia
Tel: +264 61-2085111
Fax: +264 61-249146
Email: secretary@mme.gov.na.

The Government of the Republic of Namibia has, since Independence in 1990, created a modern and enabling environment within which exploration and mining companies may operate. Support to the Exploration Industry is clearly demonstrated by many government funded initiatives which included the financing of a purpose built Geological Survey equipped with modern technologically advanced laboratories, research facilities, library, museum and exploration data archives supported by modern computer technology. A key element in the initiatives is a programme of high resolution airborne geophysical surveys which aims to obtain complete coverage of the country by the year 2008. To date nearly 50% of the country is covered with over 2 million line-kms of high quality data available to the exploration industry.

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA — STAND 55

(a Division of the Department of Minerals and Petroleum Resources)
100 Plain Street
East Perth WA 6004 Australia
Tel: 08 9222 3168
Fax: 08 9222 3633
Email: geological_survey@dme.wa.gov.au
Website: www.dme.wa.gov.au/geology
Contact Person: Dr Tim Griffin, Director

The Geological Survey's role in promoting and enhancing the prospectivity of Western Australia is of crucial importance to the State's economy. The maps, publications and datasets produced by the Survey provide explorers with the basic tools for the design of successful exploration programs. These lead to mineral and petroleum discoveries, which in turn generate royalties, create jobs, and make other important contributions to the economy of the State.

GEOPHYSICAL TECHNOLOGY — STAND 25

Geophysical Technology Exploration Services
183 Hilder Road
The Gap QLD 4061 Australia
Tel: 07 3300 0779
Fax: 07 3862 3418

GTL is a technology company supplying world-leading, technologically advanced, sub-surface detection and mapping to the mineral exploration, mining, engineering and environmental markets. While proficient in most methods, GTL has specialised in-house technologies such as Sub-Audio Magnetics (SAM) and many of these may be operated from cost-effective array platforms including hand-held, vehicle-towed, helicopter mounted and fixed wing. GTL has offices in Brisbane, Armidale and Sydney and its current operations span Australia, Asia, Europe, Nth America and the Pacific Rim.

GEOSCIENCE ASSOCIATES — STAND 66

P.O Box 697
20 Oborn Road
Mt Barker SA 5251 Australia
Tel: 08 8391 2865
Fax: 08 8398 2411
Mobile: 0407 394 938
Email: gaa@olis.net.au
Website: www.geosciencewireline.com
Contact Person: Dennis Stevens, Managing Director

Unit AL22
3 Littlefield Street
Blackwater QLD 4717 Australia
Tel: 07 4982 7002
Mobile: 0428 788 425
Contact Person: Steve Webb

Geoscience Associates (Australia) Pty Ltd is a major Australian designer, manufacturer and service contractor of slim-hole digital logging systems for the oil/gas, coal, and minerals industries. Geoscience operates a fleet of 4WD, air-conditioned, self-contained, computerised Borehole Logging Units, with a full range of down-hole services available on each unit.

From bases located in South Australia and Queensland, the Company has the ability to mobilise plant to any location in Australia and overseas. The Company prides itself on its ability and willingness to undertake unusual, difficult and challenging assignments. Operational diversity, and a hands-on approach to projects are characteristic of the Company's philosophy.

GNS — STAND 68

Institute Of Geological & Nuclear Sciences
PO Box 30-233
LOWER HUTT NEW ZEALAND

GNS, New Zealand's leading exploration consulting group, combines a long established reputation in geoscience research with industry standard software and experienced professionals. GNS utilises multi-disciplinary teams with expertise in reservoir sedimentology, basin modelling, seismic analysis and biostratigraphy to provide innovative solutions for exploration and development problems in the Asia Pacific region.

GPX AIRBORNE PTY LTD — STAND 64

Locked Bag 3
Applecross WA Australia
Tel: 08 9316 8111
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Email: gpx@gpx.com.au
Website: www.gpx.com.au

GPX Airborne Pty Ltd offers fixed wing and helicopter borne geophysics and remote sensing to the mining, oil and environmental industries and government agencies. Technologies offered include Hoistem Time Domain Helicopter borne Electromagnetics, Potassium Vapour, Caesium Vapour and Overhauser Effect Magnetics, AGIS Data Acquisition System incorporating the award winning Picoenvirotec Gamma Ray Spectrometer and the ARA Trispectral Colour Scanner. GPX and Airborne Research Australia Pty Ltd have formed an alliance to jointly service the geophysical market.

HAINES SURVEYS — STAND 18

PO Box 196
Aldgate SA 5154, Australia
Tel: 08 83708779
Fax: 08 83708758
Email: hainsurv@ozemail.com.au
Contact Person: Graeme Haines

PO Box 483
Scarborough WA 6922 Australia
Tel: 08 9245 2025
Fax: 08 9245 3682
Email: wa_haines@compuserve.com
Contact Person: Richard Haines

Haines Surveys are specialists in the acquisition of high resolution gravity data using the latest satellite positioning technology. The Company commenced operations in 1991 and introduced high precision geodetic and GPS based gravity surveys to the exploration industry. Haines Surveys have successfully completed a wide variety of gravity projects in all parts of Australia, North America, Europe, West Africa and South East Asia. Clients are provided with a highly automated, reliable and cost effective gravity service.

Haines Surveys use the latest state-of-the-art GPS satellite positioning equipment and digital gravity meters. Their gravity crews can access a variety of terrains because the equipment is rugged, light-weight, battery powered and can be carried in backpacks. Their licensed geodetic surveyors ensure that gravity surveys are accurately positioned and meet modern geodetic surveying standards. In addition, Haines surveys maintains a database of the different geodetic datums and mapping systems used in various countries to ensure that surveys are accurately integrated into local mapping systems. Gravity results are derived from modern data processing and are presented using the latest mapping software.

HAMPSON-RUSSELL SOFTWARE SERVICES LTD — STAND 38

PT Chandra Bumi Sakti
Jl. Taman Matraman Timur 9
Jakarta 10320 Indonesia.
Tel: 62 21 3190 5940
Fax: 62 21 310 6295
Email: martin@hampson-russell.com
Contact Person: Martin Brewer, General Manager, SE Asia Region

Hampson-Russell Software Services Ltd is a seismic software and consultant services company with head office in Calgary, regional offices in Houston, London, Jakarta, and representatives in Perth, Kuala Lumpur, and India. Our major products include AVO, for AVO modelling and analysis, STRATA, for post-stack inversion and analysis, EMERGE, for multi-attribute analysis, PRO4D, for time-lapse seismic analysis, ISMap, for geostatistical mapping, and GLI3D, for seismic refraction analysis. Advanced exploration services work is available through all of our regional offices.

INTREPID GEOPHYSICS — STAND 16

Intrepid V3.6 Magnetic - Radiometric - Marine & Land Gravity
Intrepid Geophysics
Unit 2, 1 Male Street,
Brighton VIC 3186 Australia
Tel: 03 9593 1077 / 08 9244 9313
Fax: 03 9592 4142
Email: info@dfa.com.au
Website: www.intrepid-geophysics.com / www.dfa.com.au
Contact Person: Desmond FitzGerald

Intrepid Geophysics specialises in geophysical processing and interpretation software and services.

- Acquisition through to regional interpretation and modelling.
- Best Algorithms over the Greatest Spread of the Geophysics Discipline.
- Powerful, easy-to-use software, runs on Windows, Unix and Linux.
- Advanced integration with ERMapper, GIS & Modelling Software provides geo-located vector and image data interchange.
- Interoperability & Plug-ins.
- Web enabled geophysical sales, data archiving and distribution system - 'GDADS'.

INDIGOPOOL.COM — STAND 46

(a Schlumberger company)
Level 4, 150 Albert Road
South Melbourne VIC 3205 Australia
Tel: 03 9696 6266
Direct: 03 9697 1212
Mobile: 0411 484 282
Fax: 03 9690 0309
Email: rsingh@indigopool.com
Website: www.indigopool.com/www.slb.com
Contact Person: Rob Singh
Business Development Manager - IndigoPool Australasia
& Data Sales Manager - IndigoPool Asia Pacific
C/- Schlumberger Oilfield Australia Pty. Limited

IndigoPool.com provides a proven enterprise-class e-commerce platform and associated business solutions to the global resources industry and related financial institutions.

The IndigoPool.com e-marketplace is a secure, neutral, collaborative workspace for resources property acquisition and divestiture, company portfolio administration, and E&P data marketing. In addition, the IndigoPool.com site markets relevant industry information and online services to registered site users. Offices are located in resources and business centers around the world.

IndigoPool enables buyers and sellers of resources properties and associated data to reach global markets and make informed decisions with greater speed, ease and effectiveness. As a result, IndigoPool.com users are able to reduce costs and manage portfolios more profitably while ensuring the highest levels of privacy and security. The result is increased corporate and market liquidity.

IPS RADIO AND SPACE SERVICES — STAND 53

Level 6, North Wing
477 Pitt St
Sydney NSW 2000 Australia
PO Box 1386
Haymarket NSW 1240 Australia
Tel: 02 9213 8000
Fax: 02 9213 8060
Email: office@ips.gov.au
Website: www.ips.gov.au

IPS Radio and Space Services provides the Australian national space weather information and radio propagation service. Geophysical operations supported by IPS, and affected by space weather, include aeromagnetic surveys, power systems protection and cathodic protection of long-distance pipelines.

Relevant services provided by IPS include:
- alerts and forecasts of geomagnetic storm activity
- regional estimated magnetic indices
- pc3 micro-pulsation information
- near real-time variometer data.

These services are available via the Internet, fax, and mobile phone.

JASON GEOSYSTEMS AUSTRALIA — STAND 39

Level 23, St Martins Tower
44 St Georges Terrace
Perth WA 6000 Australia
Tel: 08 9268 2484
Mobile: 0402 326 945
Fax: 08 9268 2550
Email: mvermaas@jasongeo.com
Website: www.jasongeo.com

Jason is a fast growing company that provides innovative solutions for reservoir modeling and characterisation. Using our core product, the 'Workbench', we provide tailored solutions based on an integrated approach. Quantitative analysis techniques employed include seismic inversion, elastic inversion, simultaneous inversion, geological modeling, velocity modeling, stochastic modeling and combined stochastic modeling with inversion. Included in the product line are unique interpretation, reservoir characterisation and analysis tools.

KEVRON GEOPHYSICS — STAND 6

Hangar 106, 10 Compass Road
Jandakot Airport,
Jandakot WA 6164 Australia
Tel: 08 9417 3188
Fax: 08 9417 3558
Email: geophysics@kevron.com.au
Website: www.kevron.com.au
Contact person: Rod Gardner

Kevron Geophysics, based at Jandakot Airport in Perth, was established in 1986, although the Kevron Group has been flying aeromagnetic and radiometric surveys since 1968.

The company operates six survey aircraft, four Aerocommander Shrikes, for mag/hor grad mag/spec/DTM, a Cresco 750 single engine turbine, for the development of the new Midas multi-frequency EM system and a Cessna 404 for offshore magnetics.

Recently, Kevron has flown surveys for the Geological Surveys of South Australia, Northern Territory, New South Wales and Tasmania and overseas in India and Mali. The Mali survey (200 000 line km) is financed by the European Union and covers all the Birrimian in western and south western Mali.

LANDMARK GRAPHICS — STAND 29

PO Box 7779
Cloister Square WA 6850 Australia
Tel: 08 9481 0277
Fax: 08 9481 1580
Email: jhollis@lgc.com
Website: www.lgc.com

Landmark is the leading supplier of integrated E&P technical and economic software and services to support decision making about finding, drilling and producing oil and gas. Knowledge-based E&P companies now are turning to Landmark for T2B technical-to-business process integration for improving returns on their investments. Visit the Landmark Web Site at www.lgc.com.

Founded in 1919, Halliburton Company is a diversified energy services, engineering, energy equipment, construction and maintenance company. The company's World Wide Web Site can be accessed at www.halliburton.com.

LSI LOGIC STORAGE SYSTEMS — STAND 12

2001 Danfield Court
FT COLLINS CO USA 80525
Tel: +1 888 638 2786
Email: energy@lsilogicstorage.com
Website: www.lsilogicstorage.com/energy

LSI Logic Storage Systems, Inc., a subsidiary of LSI Logic Corporation, is a leader in delivering high-performance, highly scalable, open storage solutions for the enterprise. Companies throughout the energy industry relyon LSI Logic technology to store and manage critical data. Four of the six leading server manufacturers deliver LSI Logic components and systems as part of their own branded storage solutions. LSI Logic offers a complete line of robust server-, SAN- and network-attached storage products integrated with centralized storage management software. These products are available through a worldwide network of channel partners under the MetaStor brand name and also through leading OEM suppliers. LSI Logic is headquartered in Milpitas, California.

MALÅ GEOSCIENCE — STAND 58

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930 70 MALÅ Sweden
Tel: +46 953 345 50
Fax: +46 953 345 67
Email: sales@malags.se
Website: www.malags.com
Contact Person: Ms Marlene Bergstrom

MALÅ GeoScience provides products and specialists services within the geoscience sector based on a range of radar and related products, its RAMAC/GPR products. These units cover application areas ranging from shallow archaeology to deep glacial studies.

The radar systems manufactured today cover the whole spectrum from GHz-systems for shallow layer analysis, utility detection systems and deep geological mapping systems all based on the concept of a light-weight, portable, high-speed data acquisition system. New developments include a range of Windows TM based software for acquisition and post processing of radar data. A new RAMAC/GPR cart and improved GPS survey tools are also available.

At the ASEG show in Brisbane, MALÅ GeoScience will be releasing the new RAMAC X3M for the Australian market.

MINERALS & PETROLEUM VICTORIA — STAND 23

Tel: (03) 9412 5131
Fax: (03) 9412 5155
Contact Person: Alan Willocks, Manager Geophysics

Minerals and Petroleum Victoria (MPV) is responsible for the promotion and regulation of the extractive, oil and gas and minerals exploration and mining industries in Victoria. Industry specific facilitation and development are provided, along with the maintenance of the State's historical geological database and the development of additional state-of-the-art regional geological data. These high quality products aim to generate wealth through the sustainable development of earth resources by attracting minerals explorers to Victoria. The geoscientific information provided by MPV include geological maps and accompanying reports, airborne geophysical surveys and GIS data packages covering mineral commodities and regions across Victoria.

OPENSPIRIT CORPORATION — STAND 5

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Houston Texas 77079 USA
Tel: +1 281 940 0200
Fax: +1 281 940 0201
Email: info@openspirit.com
Website: www.openspirit.com

OpenSpirit is an application integration framework focused on improving workflows by enabling 'plug-and-play' integration of applications from a variety of software vendors. OpenSpirit currently provides data access support on Unix, PC and the Web for Landmark OpenWorks™ 98.5 and GeoQuest GeoFrame® 3.8 servers.

OpenSpirit benefits for E&P companies include:
- Selection of 'best-in-class' applications independent of data management solution
- Cross-platform integration (PC&UNIX)
- True 'Plug-and-Play'

OpenSpirit benefits for software developers include:
- Write once and deploy on multiple datastores and across platforms
- Increased market potential
- Lower integration cost and increased focus on value-added development.

For information, please go to our website.

PARADIGM GEOPHYSICAL — STAND 43

The Quadrant, 1 William Street
Perth WA 6000 Australia
Tel: 08 9327 1800
Fax: 08 9327 1883
Email: perinfo@ParadigmGeo.com
Website: www.ParadigmGeo.com
Contact Person: David Flett

Paradigm Geophysical delivers Geoscience Software, Geophysical Services and Reservoir Studies Services to companies involved in the exploration and production of oil and gas. Paradigm's comprehensive range of technical software provides cutting edge solutions for Seismic Data Processing and Imaging, Seismic Data Analysis and Quality Control, Integrated Interpretation for Prospect Generation, Quantitative Interpretation for Reservoir Evaluation, Reservoir Characterisation, Petrophysical Analysis, and Well Planning and Drilling. Paradigm have a global network of sales, user support and services through 20 offices in 16 countries, and operate throughout the Asia Pacific Region from 3 sales and service centres - Perth, Jakarta and Kuala Lumpur.

PETROLEUM GEO-SERVICES — STAND 36

4th Floor, IBM Centre
1060 Hay Street
West Perth WA 6005 Australia

Petroleum Geo-Services is a technologically focused oilfield service company principally involved in two businesses: geophysical seismic services and production services. PGS acquires, processes, manages and markets 3D, time-lapse and multi-component seismic data. This data is used by oil and gas companies in the exploration for new reserves, the development of existing reservoirs and the management of producing oil and gas fields. PGS' Petrotrac(TM) suite of advanced geophysical technologies allows oil and gas companies to better characterize and monitor their reservoirs in order to enhance production and ultimate recovery of hydrocarbons. In its production services business, PGS owns four floating production, storage and offloading systems (FPSOs) and operates numerous offshore production facilities for oil and gas companies. FPSOs permit oil and gas companies to produce from offshore fields more cost effectively. PGS operates on a worldwide basis with headquarters in Oslo, Norway, and Houston.

PETROSYS — STAND 31

1st Floor, 69 Fullarton Road
Kent Town SA 5067 Australia

Petrosys has provided software and services to the Petroleum Exploration & Production industry, for clients including Phillips, Santos, Marathon and Woodside, since 1984. Our product suite produces high quality maps and manages, edits, and analyses the underlying data, including the specialized seismic, well and other information used in the quest for oil. Geoscientists and engineers at more than 100 companies worldwide use the Petrosys suite as a natural tool for basin and field interpretation, to assist communication and to make better decisions.

PHOENIX GEOPHYSICS LIMITED — STAND 67

Phoenix Geophysics
Unit 3
3781 Victoria Park Avenue
Toronto ON CANADA M1W 3K5
Tel: +1 416 491 7340
Fax: +1 416 491 7378
Email: mail@phoenix-geophysics.com

Phoenix (founded 1975) specialises in electromagnetic geophysical instrumentation and services, including MT (magnetotellurics) AMT (audio frequency MT); CSAMT (controlled source AMT); TEM (Transient Electromagnetics); Frequency Domain EM; IP (Induced Polarisation) and Resistivity.

Phoenix - the world leader in MT instrumentation - has exported equipment and services to more than 70 countries.

MT application include exploration for:
- Oil and gas in poor-seismic areas (fast carbonates, volcanics, overthrust, poor coupling) or low-cost reconnaissance in new areas
- Metal deposits as deep as 2000m
- Geothermal reservoirs
- Diamonds (kimberlites)
- Groundwater

Other applications include reservoir monitoring systems, deep crustal studies, earthquake prediction research, and MT observatories.

The latest equipment generation - System 2000 - provides 3-D MT data acquisition and imaging; reduces cost, simplifies logistics, and provides higher quality data.

PITT RESEARCH PTY LTD — STAND 52

Airborne geophysics data specialists
Data processing, mapping & GIS, sales and interpretation services
Suite 3, 39 Holland St, Thebarton SA 5031 Australia
PO Box 485, Torrensville Plaza, SA, 5031 Australia
Tel: 08 8152 0422
Fax: 08 8152 0433
Email: mjd@pitt.com.au
Website: www.pitt.com.au
Contact Person: Mark Deuter

Pitt Research Pty Ltd is an independent geophysical data processing company specialising in high-quality airborne geophysical data services to the global exploration community, including:
- Data processing for new helicopter, ultra-detailed and conventional fixed-wing surveys, as well as re-processing for older surveys.
- Mapping, image processing and GIS presentations for airborne surveys

- Data sales and management through the WANT and MAGNet Airborne Geophysics Databases, and as authorised distributors of some Government datasets
- Interpretation projects for both minerals and petroleum exploration using our strong network of specialist consultants.
- Quality control and project management of airborne geophysical surveys from start to completion.

PROFESSIONAL INVESTMENT SERVICES — STAND 49

Tel: 07 3263 3568
Fax: 07 3263 9652
Mobile: 0409 326 335
Website: www.profinvest.com.au
Contact Person: Noll Moriarty, Life Broker Representative
Financial Planning Authorised Representative

Professional Investment Services is one of Australia's largest financial planning groups, operating from over 362 branches. The management, directors and shareholders provide a wealth of experience, accumulated over many years in the accounting and financial planning areas.

Specialist Expertise areas include:
- Wealth creation plans
- Do-it-yourself superannuation Estate planning
- Mortgage Broking & Finance
- Personal Insurance Planning
- Tax minimisation strategies

Noll Moriarty is an Authorised Representative of the company. He combines the better analytical elements of both the resource and financial industries when constructing an individualised investment and personal insurance strategy.

RESOLUTIONS RESOURCE AND ENERGY SERVICES — STAND 4

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Innaloo City WA 6919 Australia
Tel: 08 9446 3039
Fax: 08 9244 3714
Email: brian@oilfield.com.au
Website: www.oilfield.com.au
Contact Person: Brian Wickins

RESolutions Resource and Energy Services provides specialist publishing and marketing services to the Australasian/South East Asian resource industries. Publishers of Preview, Exploration Geophysics and the ASEG Membership Directory, on behalf of the Australian Society of Exploration Geophysicists, and publishers of PESA News, PESA Journal and the PESA Website, www.pesa.com.au on the behalf of Petroleum Exploration Society of Australia.

Representative in Australasia for PetroMin and Hydrocarbon Asia, published by AP Energy, Singapore.

RESolutions also provides the resource industries with quality Corporate Support services, ranging from the design and production of brochures to newsletters, flyers, web design, adverts and writing and editing.

ROBERTSON RESEARCH AUSTRALIA — STAND 48

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West Perth WA 6005
Australia
Tel: 08 9322 2490
Fax: 08 9481 6721
Email: info@robresint.co.uk
Web site: www.robresint.co.uk (parent company)
Contact Persons: Phil Cook, Centre Manager
Kelly Beauglehole, Processing Manager
Robert Fletcher, 3D Manager
Mark Brailey, Interpretive Processing Manager

Robertson Australia has been in Perth since 1980 and specialises in land, marine 2D and 3D data processing services on either an exclusive or non-exclusive basis. Interpretive processing services (AVO, inversion, PSDM and petrophysical log analysis) are also provided. Our Perth office has a long standing and widely held reputation as a quality processing centre. Robertson Australia is part of the Robertson Research International group, the headquarters of which are at Llandudno in North Wales. There are 600 employees in the group worldwide and other offices are in Swanley and Aberdeen (UK), Milan and Jakarta.

SCINTREX PTY LTD — STAND 3

20 Century Road
Malaga WA 6090 Australia
Tel: 08 9248 3511
Fax: 08 9248 4599
Email: glinford@scintrex.aust.com
Contact Person: Dr Graham Linford, Managing Director

Scintrex Pty Ltd provides contract geophysical surveys and services to the mining and mineral exploration industry and operates throughout Australia and the Asia-Pacific region. Our technologies include:
- High -resolution gravity with differential GPS acquisition using conventional ground and helicopter support.
- Induced Polarization/resistivity with a complete range of arrays and software.
- Scintrex developed MIP/MMR for highly conductive areas and/or with resistive surface layers.
- SIROTEM with RVR sensors
- Ground magnetics with proton and cesium sensors and GPS.
- Borehole logging with Scintrex/Auslog equipment.

SCINTREX/AUSLOG — STAND 42

Tel: 07 3376 5188
Fax: 07 3376 6626
Email: auslog@auslog.com.au
Web: www.auslog.com.au

Scintrex / Auslog products include an extensive range of Geophysical Borehole Logging Equipment, Surface Systems, AusWIN Software, Winches from 300 to 3000 metre's, and more than 50 down hole tools, all manufactured in Brisbane, we have built an envied reputation within the Geophysical community both in Australia and the rest of the world.

Scintrex Earth Science Instrumentation enjoys a worldwide reputation as the leading designer and manufacturer of geophysical technology. Geophysical Instrumentation you can trust.

SEG — STAND 24

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Email: jvangundy@seg.org
Website: www.seg.org

The Society of Exploration Geophysicists (SEG) (founded 1930) has 17 000 members in 100 countries. SEG publishes two journals, Geophysics and The Leading Edge, seven technical books per year, and has over 10 000 pages of geophysical material on its Web site: www.seg.org. SEG has hosted international meetings and expositions for explorationists for more than 40 years. Major conferences/expositions in 2000 will be held in New Delhi, Caracas, Bucharest, Bahrain, Bali, and Villa Hermosa, Mexico. For details about SEG's products or services, contact the SEG Business Office, 8801 S. Yale, Tulsa, OK 74137, or phone 918-497-5500, or facsimile 918-497-5557.

SEGJ — STAND 24

Dr Yasukuni Okubo
International Affairs Chairman
Society Of Exploration Geophysicists - Japan
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The Society of Exploration Geophysicists of Japan (SEGJ) was established in 1948 with the objectives to prompt the science and technology of geophysical and geochemical exploration as well as to encourage mutual communication among the members. The society currently consists of 1600 members and 161 corporate members. The society publishes the bi-monthly official journal, Butsuri-Tansa (Geophysical Exploration) and holds two (Spring and Fall) technical meetings a year. The society is now promoting its international activities through holding international symposia and association with geophysical societies in the world.

SEISMIC MICRO-TECHNOLOGY — STAND 32

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Website: sales@seismicmicro.com
Contact Person: Michelle Foster , Convention Coordinator

The KINGDOM Suite+ (TKS+) works where you work - as a standalone in your office, with your laptop on a plane, conducting interpretation in an asset team environment, and/or while developing the big geoscience presentation. TKS+ is structured to share its resources simultaneously, and with 'team interpretation', throughout all its application. Each product draws information from a single set of project data to perform the specific and independent functions for which it was designed. The original project data and newly created information are instantly available for use by any other product in TKS+.

The six modules, which make up The KINGDOM Suite+, include 2d/3dPAK, SynPAK, VuPAK, TracePAK, ModPAK, and its newest module, EarthPAK.

SUBSURFACE IMAGING — STAND 21

Subsufarce Imaging Pty Ltd
P O Box 211
Berowra
NSW 2081
Australia: Tel: 02 94576339 Fax: 02 94576338
New Zealand: Tel: (64) 9 826 0700 Fax: (64) 9 826 0900
Website: subsurfaceimaging.net

Specialists in high resolution subsurface investigations using ground penetrating radar, and radio imaging for mining, geotechnical, environmental and archaeological applications. GPR applications include mapping depth to bedrock, road pavement analysis, UST and UXO detection. Radio Imaging supplies high resolution images for mapping orebodies, faults, intrusions and other geologic hazards both underground and from the surface. Geophysical wireline logging services are also available, along with specialist near surface EM methods. We service Australia, New Zealand, SE Asia and the World.

SYSTEM DEVELOPMENT INC — STAND 13

10500 Westoffice Dr. #100
Houston TEXAS USA
Tel: 1 713 266 5667
Fax: 1 713 974 4911
Email: sales@sdicgm.com
Website: www.sdicgm.com

CGM Graphics Software for: Conversion, Montage, Printing, Plug-in Viewers, Input & Output Libraries, and CGM Testing.

SDI products are available on Windows 2000/NT, SUN, SGI, IBM, & HP. SDI 'Computer Graphics Metaware'

T SURF — STAND 40

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La Reine
VANDOEUVRE-LES-NANCY FRANCE 54500
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Email: taoufik@t-surf.com

TECHNOGUIDE PTY LTD — STAND 61

Australia
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Fax: 08 9325 4299
Email: deborah@technoguide.com
Website: www.technoguide.com
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Email: christian.lenander@technoguide.com
Website: www.technoguide.com
Contact Person: Christian Lenander, Marketing Manager

Technoguide is an innovative provider of advanced software for 3D modeling of oil and gas reservoirs. Our Petrel software is revolutionary, and is contributing to increased profits for oil and gas companies worldwide. Petrel provides geologists, geophysicists and reservoir engineers with the power to model, visualize and understand their reservoirs. The completeness and degree of integration is unique, and the package has

received tremendous recognition in the petroleum industry worldwide. We also provide a full range of reservoir modeling, training, consulting services and expertise from our offices worldwide.

TESLA GEOPHYSICS — STAND 19

41 Kishorn Road
Applecross WA 6153 Australia
Tel: 08 9364 8444
Fax: 08 9364 6575
Email: cmlees@tesla10.com.au
Websites: www.tesla10.com.au
Contact Person: Michael Lees, Marketing Coordinator

Tesla Geophysics is a dynamic group of companies providing geophysical services to exploration and environmental markets worldwide.

With its origins in Perth, Western Australia, in 1983, Tesla10 Pty Ltd offers data processing expertise, using the latest technology and innovative programming algorithms.

The company is complemented by its ground geophysical division and equipment rental service.

Tesla Salinity Surveys provides surface and sub-soil information to the environmental sector using the proprietary GEOLINER and EMLI systems.

Tesla Airborne Geoscience Pty Ltd (TAG) was formed in 1993, with safety, quality and service being the central aims. High quality magnetic, radiometric and digital terrain data as well as accurate GPS positioning are achieved by combining the latest available technology with in house acquisition and processing systems.

In 1996, TAG became the world's first Quality Assured airborne geophysical company, conforming to ISO Standard 9002 and is also an active member of the International Airborne Geophysical Safety Association (IAGSA).

Rapid expansion in both Tesla10 and TAG has seen regional offices open in New South Wales, the United Kingdom (Tesla Exploration Geophysics Ltd) and Namibia.

Today the group of companies (Tesla Geophysics) boasts an enviable track record, having collected over four million line kilometres of airborne data, successfully undertaken the entire spectrum of ground geophysical surveys and continues its commitment to service, quality and innovation.

UTS GEOPHYSICS — STAND 9

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Perth Airport WA 6104 Australia
PO Box 126
Belmont WA 6984 Australia
Tel: 08 9479 4232
Fax: 08 9479 7361
Contact Person: Kirsty Beckett, Geophysicist

UTS Geophysics are specialists in ultra-high resolution geophysical surveys. Incorporating the latest in sensor, data acquisition and navigation technologies with purpose-built slow flying, low-level aircraft, UTS Geophysics are able to safely acquire magnetic, radiometric and digital terrain data from sensor heights of 10 m and line spacings from 15 m separation. And with a survey speed of 50 m/sec that's a sample every 5 m for magnetics and digital terrain and from 25 m for radiometrics.

WESTERNGECO — STAND 10

WesternGeco (A) Pty Ltd
Level 2, Sheraton Court,
207 Adelaide Terrace
East Perth, WA 6004
Australia

Contacts:

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David Palmer
District Manager
PO Box 5205
Brendale QLD Australia 4500
Tel: 07 3881 3170
Fax: 07 3881 3173
Email: d.palmer@brisbane.oilfield.slb.com

WesternGeco provides comprehensive worldwide reservoir imaging, monitoring, and development services, with the most extensive crews and data processing centers in the industry, as well as the world's largest multiclient seismic library. Services range from 2D and 3D surveys, to time-lapse 4D and multi-component surveys for delineating prospects and for reservoir management. A key WesternGeco objective is to move advanced seismic technologies into the reservoir - serving not only explorationists, but also reservoir and petroleum engineers, appraisal and production teams. The company will be deploying the revolutionary Q- technology around the world, providing superior reservoir imaging capabilities. WesternGeco is a joint venture between Schlumberger (70%) and Baker Hughes (30%.)

ZONGE ENGINEERING & RESEARCH ORG. — STAND 28

98 Frederick Street
Welland SA 5007 Australia
Tel: 08 8340 4308
Fax: 08 8340 4309
Email: zonge@ozemail.com.au
Website: www.zonge.com
Contact Person: Michael Hatch

Zonge Engineering specialises in providing field services and equipment for all aspects of electrical geophysics. We also offer a complete line of geophysical equipment for sale or rental, data processing software, training, consulting, custom data processing as well as equipment design and manufacture. Use CSAMT, IP, TEM, NanoTEM, downhole IP, or DHMMR, to help with your exploration or environmental surveys. Please call our office in Adelaide and talk to us about how we may be of service on your next project. Case histories and sample data are available.

Consultants

CONDOR CONSULTING INC. DISPLAY 1

St. 206, 4860 Robb Street
Wheat Ridge CO 80033
Tel: 303.423.8475
Fax: 303.423.9729
Mobile: 303.520.5732
Website: www.condorconsult.com/www.go-i.net

Condor Consulting is a world leader in the innovative application of airborne geophysics to natural resource and environmental mapping. Condor combines a wealth of practical experience with the world's best processing and visualization tools, thereby enabling us to deliver cost effective solutions to a global market. Since Condor is independent of any airborne survey contractor, we can ensure that our client's technical and budgetary needs come first. Condor is a well pleased to be a re-seller of Encom Technology's geophysical modeling software.

GEOPHYSICAL SOFTWARE SOLUTIONS DISPLAY 2

PO Box 31
Gungahlin ACT 2913 Australia
Tel: 02 6241 2407
Fax: 02 6241 2420
Email: ralmond@geoss.com.au
Contact person: Richard Almond, Director

Geophysical Software Solutions (GSS) provides consultancy services in geoscientific software development and detailed interpretation of potential field data. In 1991 GSS developed Potent, an application that is used by mining and exploration companies worldwide for interpreting potential field data. In 2000 GSS launched Potent0, a simplified and streamlined version of Potent that is accessed through Geosoft's Oasis montaj interface. GSS has developed effective methods for simultaneously modelling multi-component down-hole magnetic data and ground or airborne TMI data.

NEW WAVE GEOPHYSICAL PTY LTD DISPLAY 3

2 Romford Road
Frenchs Forest NSW 2086 Australia
Tel: 02 9453 2534
Fax: 02 9453 2015
Email: sales@newwavegeo.com.au
Website: newwavegeo.com.au
Contact Person: Dave Kirkham

New Wave Geophysical was formed in 1998, with the main focus of business being the conversion of hard copy seismic sections to digital SEGY format by scanning and trace reconstruction. A wide range of post-stack processing, including migration, may also be applied.

New Wave maintains an extensive database related to Australian exploration, including seismic navigation, and incorporates line locations together with wells and permit boundaries in a user-friendly GIS product.

Preview

Section 3

ASEG 2001
A Geophysical Odyssey

ASEG's 15th International Conference and Exhibition

Welcome to ASEG's 15th International Conference and Exhibition, and particularly to our overseas visitors. This meeting is very important to the wealth of Australia, by contributing to the research capabilities of its resource industries.

The impact of geophysics on mineral and petroleum exploration, as well as its impact on land management and land degradation issues is continuing to increase. The mineral and petroleum industries are the main export earners for Australia; minerals and energy underpin our wealth. For example, the value of these exports is expected to rise from $44 billion in 1999/00 to about $54 billion in 2000/01, comparable to the combined exports from the farming and the manufacturing sectors.

Exploration is the lifeblood of the minerals and petroleum resource industries; without exploration these industries cannot be sustained. Furthermore, as the easier-to-find orebodies and petroleum reservoirs are developed, we need more sophisticated methods to find the prizes hidden beneath the regolith or under the deep offshore areas of our continent.

The technical presentations at this conference, and the services and products on display at the exhibition exemplify the range and skills available in Australia.

A quick look through the abstracts of the papers to be given, and the biographies of the presenters, shows the scope and depth of talent. We are indeed very fortunate to have these, and we must be vigilant to ensure these skills continue to remain in this country, and are not transferred overseas to Head or Branch offices of major multinationals.

Preview

This issue of Preview focuses on the conference and exhibition. My contributions were made from my mother-in law's house in Leamington Spa through the Internet. This did cause some problems because of the time differences between UK and Australia, but it eventually worked out. I would like to acknowledge the efforts of Andrew Mutton and the staff at RESolutions in coping with these challenges, particularly when I did not have email access.

During the conference, I will be searching the exhibition and the lecture rooms for future contributors who can provide articles of general interest to our members, particularly case histories or review papers. If anyone has any ideas, or can identify someone else who has, please let me know.

Enjoy Brisbane, and have a rewarding Conference.

David Denham

Contents

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

Material published in Preview 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. Therfore, the deadline for October 2001 is September 15th 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 October 2001 edition is the September 22nd 2001.

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New Members

We welcome the following new members to the ASEG. Membership was approved by the Federal Executive at its May and June meetings.

Name	Affliation	State
Brian Edward Barrett	Adelaide University	SA
Alan Barry	Reid Geophysics	UK
Edwin David Wilson Belcher	WesternGeco	NZ
Sarah Clay	Adelaide University	SA
Brendan J. J. Coleman	Normandy	SA
Anthony Murray Collings	University Tasmania	Tas
Luisa D'Andrea	University Tasmania	Tas
Tania Dhu	Adelaide University	SA
Cameron Geoffrey Dinning	Kuwait Oil Co	WA
Selina Maria Donnelley	Adelaide University	SA
Robert Michael Gill	Adelaide University	SA
Kate Elizabeth Godber	University Tasmania	Tas
Phil Heath	Adelaide University	SA
D. Greg Hodges	Fugro	Canada
Samuel George Howman	University WA	WA
Gregory Francis Patrick Irwin	Magellan Petroleum	Qld
Tomasz Kivior	NCPGG	SA
Amy Elizabeth Lockheed	Adelaide University	SA
Moo Young Song	Chununam National University	Korea
Andrew David Tyson	University Tasmania	Tas
Cherlotte Kinross White	Western Geco	Qld

ASEG Silver Certificates

ASEG Silver Certificates for 25 years of membership are awarded to the following four members this year:

Name	Affliation	State
Patrick Hillsdon	ECS International Pty Ltd	NSW
Salvatore Coniglio		WA
William McLellan	Fugro Ground Geophysics (Pty) Ltd	Botswana
Barry Smith	Mosaic Oil NL	NSW

With the addition of the above awardees, 195 members have now been awarded ASEG Silver Certificates.

Will members who believe they are eligible for a Silver Certificate please contact the Secretariat. It is possible to miss some eligible members, as the old membership records were started on a pre-computer database and there may be errors in the current database. If your name has been changed by marriage or for other reasons, it is also likely to have been missed.

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Dear Sir,

I was surprised to find the author of the article on page 43 of the June 2001 issue of Preview was not 'watch(ing) with interest' as they lead us to believe. If he/she was they would have surely noticed the ASX release on the 30th of April, 16 days prior to the deadline for the June edition, which had further information.

Maybe an article following up this public domain information would be 'of general interest to your membership' or maybe you could highlight the ASX website in the 'Web Waves' section of your magazine as a place to get up to date information if we do want to 'watch with interest'.

Yours sincerely,
Andrew Boyd
30 Fifth Ave
Bassendean WA 6054
Australia

Events for 2001/2002

2001

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

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

September 24-28
4th International Archaean Symposium, University of Western Australia, Perth
Convenor: Susan Ho
Tel: (61 8) 9332 7350
Email susanho@geol.uwa.edu.au

October 9-12
The South African Geophysical Association (SAGA) Biennial Technical Meeting and Exhibition, in association with SEG and EAGE.
Theme: Geophysical Odyssey 2001
Venue: Drakensberg Mountains of South Africa
Website: www.sagaonline.co.za
Conference organizers: ACMH Corporate Consultants
Tel: +27 83 4588984
Email: saga2001rsa@mweb.co.za

November 25-28
Eastern Australasian Basins Symposium 2001 - New Guinea, East Australia, New Zealand
Theme: A refocussed 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 26-27
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: www.NewGenGold.com

December 10-14
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
Website: www.agu.org/meetings/

2002

April 15-18
International Geophysical Conference and Exposition
Yogyakarta, Indonesia
Theme: Geophysics for Human Kind
Sponsors: The Indonesian Association of Geophysicists (HAGI), and the Society of Exploration Geophysicists (SEG)
Abstract Deadline: mid-August, 2001
Contact: Dr Wally Waluyo
Tel: 62 21 350 2150, ext.1434
Fax. 62 21 350 8032/351 0992
Email: wallywaluyo@pertamina.co.id

April 22-26
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
Website: www.copernicus.org/EGS/

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

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

May 28 - June 1
2002 AGU Spring Meeting, Washington, DC, USA
Sponsor: AGU
Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 USA
Tel: +1 202 462 6900
Fax: +1 202 328 0566
Email: meetinginfo@agu.org
Website: www.agu.org/meetings

June 30-5 July
16th Australian Geological Convention
Theme: Geoscience 2002: Expanding Horizons
Adelaide Convention Centre, Adelaide SA
Contact: info@16thagc.gsa.org.au
Website: www.16agc.gsa.org.au

ACT Branch - by David Robinson

The ACT Branch has been meeting monthly to hear the tales of a guest presenters. All meetings are followed by nibbles and a local wine tasting. Members and guests are always welcome.

We recently discovered that our traditional Thursday meetings clash with weekly seminars at the Research School of Earth Sciences (ANU) and have decided to avoid Thursdays in the future. We are hoping that this will allow more members to attend.

On May 24th Trevor Dhu (AGSO) gave a presentation titled The use of fractal dimension for texture-based enhancement of aeromagnetic data, based on his PhD research at the National Centre for Petroleum Geology & Geophysics (Adelaide University). Twelve members and guests in attendance had a "smashing" time.

On June 13th Ray Tracey (AGSO) presented a talk titled *AbFab Grav: AGSO's new absolute gravimeter, and the BollyStolly upgrade of the Fundamental Gravity Network* (see Preview 91). As part of his talk, Ray demonstrated the operation of the new meter. Unfortunately technical problems prevented an actual measurement, but 25 members and guests were appreciative of the opportunity to view this impressive instrument.

Our next meeting on July 19th will be an afternoon workshop for presenters at ASEG 2001. This will provide speakers with the chance to present their talks to a friendly audience, to garner feedback and suggestions for fine-tuning. The workshop will be held in the AGSO main conference room from 1:30-4:30 pm

There will be no August meeting, due to the ASEG Conference. September's meeting date and topic TBA.

Western Australia - 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 starts). Admission is free for ASEG members and is $10 for non-members.

For information on upcoming meetings/events/agendas, please see our website at: http://www.aseg.org.au/wa

Technical meetings since April 2001
The May 2001 meeting was a joint meeting of Australian Society of Exploration Geophysicists (ASEG) and the Formation Evaluation Society of Western Australia (FESWA). This was an opportunity to draw the geoscience communities represented by these two societies together for a technical and social evening.

The first talk was given by Dave Dewhurst, CSIRO Petroleum, and entitled: *Petrophysical Properties of Muderong Shale as a function of Effective Stress Path.*

The second talk was given by Tony Siggins, also of CSIRO Petroleum; it was entitled: *Ultrasonic Geophysical Properties of Overpressured Sandstones and Shales.*

The June 2001 meeting focussed on Mineral Exploration and was very well attended.

The first talk was given by Daniel Sattel, Fugro Airborne Surveys and entitled: *Modelling of AEM Anomalies with Electric and Magnetic Dipoles Buried inside a Layered Earth. The second talk was entitled: A Study into the End of the World or Geophysical Signatures of Australian Meteorite Impact Structures* and was given by Phil Hawke, University of Western Australia.

Business meeting
The Business Meeting minutes for the SEGJ, among SEG, ASEG, EAGE, KSEG and SEGJ, are available from John McDonald at Curtin University.
The main highlights are:

- SEGJ will hold a technical meeting every two years
- the next meeting is proposed for Korea
- the KSEG and SEGJ has a focus on groundwater, engineering and earthquake geophysics, and
- KSEG is working to publish a manual of geophysics for civil engineering.

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

Employment Service
Our Employment Service is still 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
Our Website: http://www.aseg.org.au/wa

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Tasmania - by James Reid

On 3rd July 2001, Mike Asten of Flagstaff Geoconsultants and Monash University gave a presentation entitled: *Borehole EM and MMR methods for weak conductors - a project review.* This was followed by a well-attended dinner at a local restaurant.

On 27th July, David Close, Michael Roach and James Reid gave exclusive previews of their presentations for the 15th

ASEG Conference, respectively entitled:

- *Electrical properties of porphyry mineralisation at the Cadia Ridgeway Cu-Au deposit, NSW - implications for exploration,*
- *Geophysical characteristics of salinisation at Cape Portland, NE Tasmania, and*
- *Application of the EM-31 terrain conductivity meter in conductive regimes.*

New South Wales (a year in review) - by Steve Webster

The first year of the new millennium has presented some interesting challenges for the NSW Branch Committee with declining employment of members (either through retirement or retrenchment) and the reduction in the number of exploration companies contrasting with the enthusiasm of the Olympics and all being compounded by the GST. Fortunately for the Branch President, the latter problem could be delegated to the Treasurer who had to answer to the Federal Executive. We all owe many thanks to Phil Schmidt for rising to the GST challenge.

Alan Willmore was our capable Secretary for the first half of the year until he deserted the mining industry for a new career. Mike Moore has volunteered to replace Alan.

The branch finances are still in a strong position, as one can see from the Balance Sheet. Our main activity is the monthly meeting with the occasional social event, such as the Annual Dinner, and we run at a slight loss every year. We have obviously saved on postage costs by moving to email for notices and most of the committee meetings are also done this modern way.

Next year we hope to supplement the finances by running a one-day conference in association with SMEDG. Discussions are continuing, with the proposed theme of the meeting to be 'In-mine and near-mine exploration' including presentations on the latest geophysical applications to be supplemented by multi-discipline case histories.

When we took over the branch committee in April last year one of the issues we tried to address was the lack of attendance of 'soft-rock' members at the regular meetings. Discussions with some of these members revealed an impression that the branch was oriented just to mining types and there was more to be offered by PESA. In an attempt to encourage them back to the fold, we held a joint meeting with PESA (addressed by the visiting ESSO Lecturer) and invited speakers at monthly meetings who may have a broad audience appeal. I notice from the annual report of the South Australia Branch that they have the opposite problem, in that their presentations have a predominantly petroleum and seismic bias and see few mineral geophysicists at their meetings. We will continue to try to encourage the 'soft-rockers' to again be involved with the branch.

Branch Meetings	Speaker	Topic
2000		
May	Dr. Phil Schmidt	Magnetic Petrophysics
June	Bruce Hooper	Joint meeting with SMEDG
11th July	Dr Craig Beasley	Joint luncheon with PESA
28th July	Annual Dinner	Different Drummer @ Glebe
August	Glenn Jones (LIC)	The change of Australia's geodetic datum
September	no meeting due to Olympics	
October	Ken Witherly	Comparative study of airborne EM systems
November	Students night	
December	Derecke Palmer	Seismic refraction methods for the new millenium
2001		
January	no meeting	
February	Dr. Peter Hatherly	Seismicity of the Appin area
March	Tim Pippett	Geophysics in the shallow regime
April	Dr. Don Emerson	Quo Vadis Explorator

Australian Geoscience Council's Election Policies

With a Federal election due some time later this year, the Australian Geoscience Council has put together a series of objectives for the next Australian Government. These are currently in draft form and will be fine-tuned for official release before the FASTS Science Meets Parliament day on August 22nd this year.

The policies have been generated to develop:

- The growth of healthy and competitive resource industries in Australia, because of their vital contribution to the wealth of the nation, and
- National plans and remedial actions to address land degradation and deteriorating water quality, to ensure that our land and water management practices will sustain productive and profitable land and water uses, as well as our natural environments.

Specifically the AGC recommends the following Government actions:

- Convene meetings with stakeholders to simplify the complex processes currently involved with land access for mineral and petroleum exploration and resource development.

- Provide appropriate financial incentives to encourage mineral and petroleum exploration, particularly in greenfield areas and by smaller companies.

- Build on the present Innovation Action Plan to create a blueprint for long term national investment in our science and technology base.

- Strengthen the teaching and research infrastructure in tertiary institutions so that the R & D capacity and capability are available to use our natural resources in a responsible manner.

- Develop and implement a national plan, based on the key scientific evidence, to address land degradation and water quality issues.

- Rejuvenate AGSO as Australia's national geoscience institution by:
  - increasing its resources so that it can cooperate fully with the State & Territory Governments on regional onshore programs and increase its programs on geoscience research;
  - coordinating national geoscience programs on groundwater and land degradation; and
  - instituting a Research Advisory Board, responsible to the Minister, comprising its key stakeholders and clients to provide formal feedback/advice on its programs.

- Implement the Productivity Commission's Report on Cost Recovery so that 'core' information in 'Information' Government agencies such as AGSO, ABS and ABARE are not subject to cost recovery.

- Increase the funding to CSIRO so that it is less dependent on external earnings and is able to concentrate more on longer-term strategic research.

- Repeal Section 17 of the Australian Citizenship Act 1948, to make it easier for Australian scientists who have taken out foreign citizenship to return home and work in Australia.

The full text of the document can be viewed on the AGC web site (http://www.aig.asn.au/agc/index.htm), and as this is still a draft document the AGC would welcome any comments and suggestions.

PMSEIC considers Mineral Exploration in Australia

The 7th meeting of the Prime Minister's Science, Engineering and Innovation Council was held in Canberra on June 28th 2001. Mineral Exploration, along with Commercialisation of Public Sector Research and Child Health and Wellbeing, was considered at the meeting.

According to the PMSEIC website, the Mineral Exploration item focussed on 'the importance of Australia's mineral sector and its global significance, emphasising continued exploration is vital for its future prospects. Australia leads the world in many aspects of exploration, and government-industry collaboration is an important element. Responses to the challenges facing the industry in the 21st century, including the difficulty of locating major new ore bodies under deep ground cover and innovation in exploration, will be the key to future success.'

At the time of writing I have not had access to the papers presented, but I understand it was argued that every dollar invested in pre-competitive research and data generates returns to the government $22 in taxation and $27 in royalties and therefore that government should take a stronger leadership role in this sector.

Shortcomings in Natural Heritage Trust funding

The Federal Auditor-General released its report on 'Performance Information for Commonwealth Financial Assistance under the Natural Heritage Trust' on June 1st this year. It presents a picture of poor accountability in the government's $1.5 billion, five year environment spending program.

The Natural Heritage Trust (NHT) is authorised under the Natural Heritage Trust of Australia Act 1997. Currently, the NHT consists of a suite of 23 environmental and natural resource management. To date, some $1.1 billion has been allocated to 9877 projects involving State and Territory agencies, local government and non-government bodies.

The purpose of the audit was very clear, namely to examine and report on:

- The performance information used to support the administration of $1.5 billion in Commonwealth financial assistance under the Natural Heritage Trust; and
- compliance with legislative requirements for performance monitoring and reporting.

Essentially what the Audit Office found was an absence of a core set of performance indicators, and a performance information system has fallen substantially short of what was originally intended.

In other words there was no proper system in place to assess whether the taxpayers money was well spent. The report recommends that 'A core set of performance indicators be finalised and linked to sufficient resources for effective monitoring and reporting'.

Reading between the lines, it seems there has been very weak links between the desired outcomes, the science needed to achieve these outcomes, and the resources needed to develop appropriate action plans.

In fairness to the Commonwealth Departments administering the Act, it is not a simple matter to get agreements between the States and the Commonwealth on matters dealing with land and water, and while the trust is set-up the way it is, by being managed by a Ministerial Board comprising the two environment and the agriculture ministers it is easy to see how serious problems could arise.

Eristicus June 30th 2001

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)

It is important for all of us, as scientists, to master the art of technical writing. A successful scientist is one who not only has exceptional scientific skills, but who can also effectively communicate to a range of audiences via written reports, proposals, journal papers and other publications. It seemed fitting that, as we gather in Brisbane for the 15th ASEG Conference - Australia's largest showcase for geophysical research and development, Web Waves should highlight web resources to help geophysicists improve their written communication skills.

Useful Online Articles

The Science of Scientific Writing
(www.research.att.com/~andreas/sci.html)

Scrutiny of the Abstract
(sepwww.stanford.edu/sep/prof/abscrut.html)

Scrutiny of the Introduction
(sepwww.stanford.edu/sep/prof/Intro.html)

Notes on the Structure of a Scientific Paper
(aerg.canberra.edu.au/pub/aerg/edupaper.htm)

How to Write Right
(www.ee.ed.ac.uk/~gerard/Management/art4.html)

Tips for Scientific Writing
(www.srh.noaa.gov/ftproot/ssd/html/writetip.htm)

Writing a Paper or Lab Report in Scientific Format
(duke.usask.ca/~Kaminsky/writing.html)

Guidelines for Writing a Scientific Poster
(www.niehs.nih.gov/nta/LabManual/Poster.html)
Technical Writing
techwriting.miningco.com/careers/techwriting/

This site covers the essentials of report writing - aims, writing style, format, research, and how to deal with abstracts and introductions. The webpage also contains guides to, among other topics, desktop publishing, e-publishing and creating illustrations.

Online Technical Writing
www.io.com/~hcexres/tcm1603/acchtml/acctoc.html

This site is a text book use by students enrolled at the Austin Community College, Texas, USA. Topics covered by the text include applications of technical writing, document design, and processes and guidelines in technical writing. Of particular interest is the information on proposals, progress reports, abstracts, introductions, conclusions, audience analysis, and common grammar and word usage problems.

Technical Writing Resource
www.eamonn.com/sitemap.html

Eamonn Fitzgerald's Technical Writing Resource provides advice on language, grammar and the mechanics of writing in English, HTML and JavaScript. From this site you can also find comprehensive lists of references that cover the theory and practice of technical writing.

Understanding Scientific Writing
www.belin.qc.ca/~sdrouin/rions/scientific.html

Just for a laugh ... if you've ever had trouble getting your head around a scientific article, this may help you understand what it is all about!

Geophysics in the Surveys

Geological Survey of Victoria

Publication of Palaeozoic Geology of Victoria

The Tasman Fold Belt System in Victoria is the culmination of a decade of geological work by the Geological Survey of Victoria that has, for the first time, been supported by high quality airborne geophysical data. It describes the evolution of Victoria through time, from the Neoproterozoic through to the Permian, and covers the development of the Victorian part of the Lachlan Fold Belt as part of the Tasman Fold Belt System. The different styles, timing and controls on mineralisation that developed in Victoria during this period are described, and links to similar styles of mineralisation in both Tasmania and New South Wales are made.

Three new maps are now available:

- Surface geology map
- Pre-Permian geology map that shows the interpreted geology of Victoria, with the Permian and younger units stripped off
- Mineralisation map of metallic and major industrial minerals

Reviews of this volume are available on the Minerals and Petroleum website at http://www.nre.vic.gov.au/minpet.

The volume is available from the Minerals and Petroleum Business Centre for $110. Phone +61 3 9412 5020.

Geophysical and GIS data

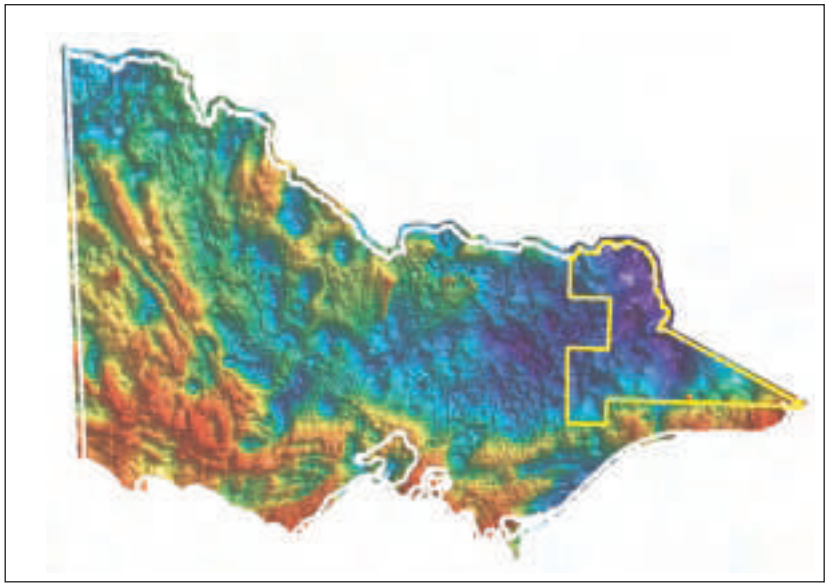
The airborne survey data, gravity and GIS data collected under the Victorian Initiative for Minerals and Petroleum is free. The data can be ordered on line at www.nre.vic.gov.au/minpet or by order forms that are also downloadable at this site. These forms will be available at our booth at ASEG in Brisbane along with displays of some of the recent data.

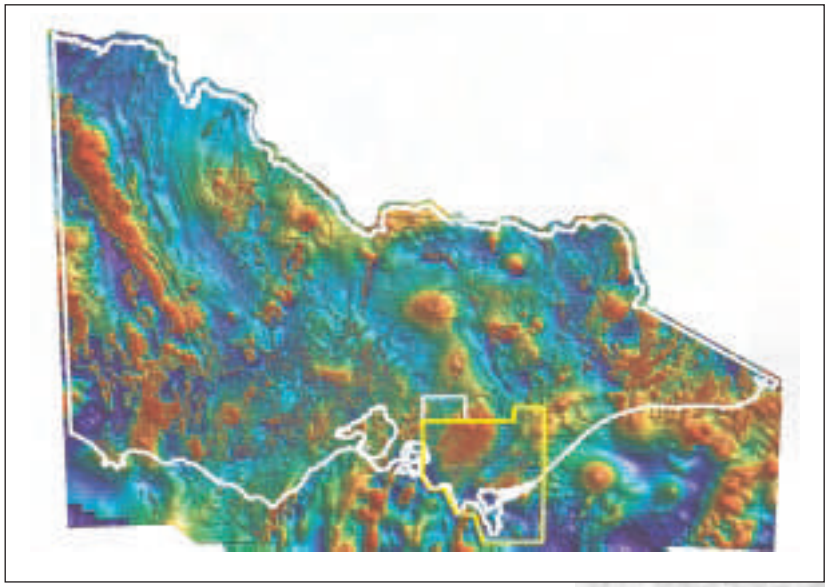
For further information on the geophysics program contact Alan Willocks on +61 3 9412 5131 or by email at alan.willocks@nre.vic.gov.au.

Airborne magnetic and radiometric surveys

The Victorian Initiative for Minerals and Petroleum (VIMP) program, and joint projects with the Australian Geological Survey Organisation (AGSO) and a few large industry surveys, has enabled the collection of industry standard magnetic and radiometric data covering 95% of the state. These data have been collected at line spacings between 200 and 400 m. (see Figure 1).

Two airborne surveys have been conducted under the Victorian Initiative for Minerals and Petroleum (VIMP) for 2001. The larger of the surveys covers the Warragul - Sale area over the western Gippsland Basin. The work has been contracted to Tesla Geophysics. It has been flown with a 250 m line spacing and 80 m height and is about 68 200 line-km.





A small helicopter survey of about 5 800 line-km has been flown by Geo Instruments around the Warburton area. This survey now completes the magnetic and radiometric coverage of the Warburton 1:250 000 mapsheet area.

Data from these surveys will be released in November 2001 during the Mining 2001 Convention. For further information on these surveys contact David Bibby +61 3 9412 5017 or by email at david.bibby@nre.vic.gov.au

Gravity surveys

Gravity surveys are being done in the eastern Victorian highlands by Geological Survey of Victoria (GSV) staff and contractors. The GSV is continuing to collect data on geological project specific map areas, and in some instances infilling gaps that were inaccessible at the time of previous contract work. Tesla Geophysics is doing surveys for GSV under contract. The program is expected to deliver results for seven 1:100 000 sheet areas by July 2001 (see Figure 2).

Fig.1. (Top) Airborne survey data release November 2001. Fixed wing magnetic/radiometric survey around Warragul SE Victoria (yellow outline). Helicopter magnetic/radiometric survey around Healesville SE Victoria (white outline)

Fig. 2. (Above) Gravity survey data release November 2001. Ground gravity data in NE Victoria (yellow outline Fig. 2) Statewide (onshore and offshore) terrain/bathymetry corrected gravity data

For further information on these surveys contact Paul McDonald 03 9412 5077 or by email at paul.a.mcdonald@nre.vic.gov.au

2001 Acreage Release

In April 2001, the Commonwealth of Australia and the State of Victoria Joint Authority released four offshore areas adjacent to Victoria. Three of these blocks are in the Otway Basin and one in the Gippsland Basin. At the same time, Natural Resources & Environment (NRE) will be releasing three onshore Otway Basin areas. Minerals & Petroleum Victoria (MPV) has prepared three reports on the hydrocarbon prospectivity and potential of the 2001 released areas.

For further information on gazetted blocks, conditions and criteria for selection and submission of applications, can be seen on: -Commonwealth (ISR) web-site: http://www.isr.gov.au/resources/petr_exploration/index.html or the State of Victoria (NRE) web-site http://www nre.vic.gov.au /minpet/pet/pet.htm. Contact Maher Megallaa on 03-9412 5081 or maher.megallaa@nre.vic.gov.au

AGSO

AGSO has released the following geophysical data in the last few weeks:

The 2001 edition of the Australian National Gravity Database which contains data from more than 900 000 point gravity observations on the Australian mainland is now available. These data have been collected from nearly 1 000 gravity surveys dating back to 1937, in an area extending from 8° S to 48° S and 108° E to 162° E. All data will be provided with GDA94 coordinates and have accuracy estimates for each station.

A new gridded gravity dataset of the Australian Region combining an accurate onshore gravity measurements, a sub-sample of the levelled offshore marine gravity traverses with satellite data used in areas where there is no marine data has been produced. The cell values represent simple Bouguer anomalies at a density of 2.67 tm-3 onshore and free-air anomalies offshore. The grid covers the area extending from 8° S to 48° S and 108° E to 162° E. The grid cell size is 0.5 minutes of arc, which is equivalent to about 800 m.

A new 1:250 000 scale colour airborne gamma-ray spectrometric ternary image map for the Broken Hill area has been released by AGSO and NSWDMR. The area covers six 1:100 000 sheet areas as indicated below. The map contains high resolution data acquired by AGSO and the NSW Department of Mineral Resources in parts of the Broken Hill and Menindee 1:250 000 sheet areas. The data for most of the map area were acquired with a 33 litre detector at 60 m height on lines spaced either 100 m or 200 m apart. Infill areas in the north-east of the map area were flown at 80 m height on flight lines spaced 250 m apart. The pixel map provides a useful overview of the radiometric character of the Broken Hill region.

The Fifth Edition of the Index of Australian (AGSO/BMR and State) Government airborne geophysical surveys has been released in both hardcopy and digital format. This edition of the Index contains a more comprehensive coverage of surveys than the previous version. Information on older surveys prior to 2000 has been updated and additional surveys have been included from various State and Federal exploration initiatives and the ongoing regional work of Government bodies. Specifications of several open file surveys are also included in this release.

The hardcopy version contains a summary of the major specifications of over 850 airborne surveys.

The digital version includes a copy of AEROMAP, a Windows program (NT compatible) which allows the user to selectively access a database of information for each survey. This is achieved by interactively querying a map of Australia upon which the polygonal boundaries of individual surveys are plotted. AEROMAP requires no software other than a Windows operating system installed on a PC. It is supplied on a single 3.5 inch high-density floppy disk.

A preliminary on-line version of the index can be viewed at http://www.agso.gov.au/map/

Digital point located gravity data from the Laverton and adjoining 1:250 000 Sheet areas in the Eastern Goldfields area of Western Australia has been released.

The data set comprises 3055 new gravity stations spaced on a regular 4 x 4 km grid over an area of about 47 800 sq km on the Youanmi, Leonora, Laverton, Rason, Barlee, Menzies, Edjudina, Minigwal 1:250 000 Sheet areas.

Data were acquired over the period September to December 2000.

AGSO and GSWA announce the release of airborne magnetic and gamma-ray spectrometric data from the Sandstone 1:250 000 Sheet area in Western Australia. The Sandstone Sheet area is in the northern Southern Cross province of the Yilgarn Craton. The Archaean basement consists of greenstones, gneiss and granite and is overlain by extensive shallow regolith cover. The aeromagnetic data provides details of distinct greenstone belts which are separated by large regions of granitoid. Numerous faults and shears cut these belts and the region is prospective for gold mineralisation. Calcrete hosted uranium occurs in paleochannels such as at Yeelirrie.

The Sandstone Sheet coverage is made up of 4 surveys and consists of over 71 600 line-km of data.

AGSO and the Geological Survey of Western Australian (GSWA) have released a gravity anomaly map of Western Australia. This map combines 230 000 onshore gravity observations, spaced between 11 km and 50 m, with 1.9 million levelled offshore values along ship traverses. In areas which are not covered by the marine surveys satellite, derived anomalies were used.

The image displayed on the map shows Bouguer gravity anomalies calculated at a density of 2.67 tm-3 onshore and free-air gravity anomalies offshore. The pixel colour hue is the rainbow palette with transparent artificial sun shading to give a sense of relief. The map projection is Albers Equal Area with a central meridian at 121°E and standard parallels at 17°30' and 31°30'S. The data were gridded onto an 800 m mesh in a two pass process.
This map complements the Magnetic Anomaly Map of WA and the State Geological Map at the same scale.

For further information on these products and details of prices, please contact the AGSO website http://www.agso.gov.au/minerals.

Fugro Continues to Grow

According to a media release issued by Fugro, an agreement has been signed for the sale of the Robertson Research Holdings Ltd group of companies to Fugro Holdings Ltd, a subsidiary of Fugro NV, a company trading on the Amsterdam Stock Exchange.

This agreement is subject to approval by the shareholders of Simon Group, a publicly-traded company that owns 49.9% of Robertson. The transaction is expected to be completed around the end of July 2001.

Fugro has fully endorsed Robertson's present business strategy and has made it clear that it will encourage and support growth to help Robertson develop an even stronger position in the petroleum service sector.

Fugro is an organisation of over 6 000 employees with offices in over 50 countries. Its businesses are generally dominant in the speciality market segments in which they operate. More information is available through the Fugro website: http://fugro.com.

In addition to Robertson Research, Fugro has, through the acquisition of six companies within its existing divisions and some major capital expenditure, further implemented its growth strategy. The acquisition of Robertson Research Holdings Limited, Geoid SARL, Marsco, Inc., Kevron Pty Ltd., Tesla 10 Pty Ltd. and certain of the activities of LaCoste Romberg-Scintrex, Inc. with combined sales of about EUR 75 million will require a total investment of EUR 133 million.

Furthermore, Fugro is investing a total amount of EUR 30 million in the purchase and conversion of a new vessel for geotechnical activities (the Fugro Explorer) and in the acquisition of real estate in Houston (USA).

Summaries of the companies being acquired are given below:

Robertson Research Holdings Limited (UK)
Robertson is one of the world's leading geoscience companies providing services to the oil and gas industry with headquarters in North Wales (United Kingdom) and overseas offices in Italy and Australia. Its activities include geological and geophysical services, reservoir engineering, data management and laboratory services.

The company employs around 500 people. Fugro anticipates a full year turnover from Robertson for 2001 of £31.7 million (A$90.6 million). Robertson is a debt-free company and will be consolidated into the accounts as per July 1st 2001. The purchase consideration of £59 million (A$168.6 million) is expected to be settled in cash and loan notes. After selling its interest in the company's equity its senior management will continue to work within the company.

Geoid SARL
Geoid SARL (Geoid), with its offices in Montpellier (France), has an annual turnover of about FFR 24 million (circa EUR 3.7 million) and employs 30 staff. The company was established in 1986 and is now one of the largest French surveys organisations specialising in onshore and offshore survey. Geoid will be consolidated as per January 1st 2001.

Marsco, Inc.
An agreement has been signed with the shareholders of Marsco, Inc. whereby Fugro will acquire the entire share capital and debt obligations of the company, which presently provides offshore geotechnical services in the Gulf of Mexico. Marsco employs a staff of 15 people and its annual turnover is about US$3 million (A$5.9 million). Marsco will be consolidated per July 1st 2001.

LaCoste Romberg-Scintrex, Inc.
A letter of intent has been signed with the shareholders of LaCoste Romberg-Scintrex, a Canadian airborne survey company, by which Fugro will acquire its geophysical survey activities and its Australian subsidiary. In addition Fugro will take a 10% shareholding in LRS together with a seat on its board of directors. LRS manufactures equipment required for geophysical and gravity surveys and has a substantial share of the world market for this equipment. The activities will be integrated with the existing Fugro Airborne Surveys companies per July 1st 2001. A staff of 25 employees will join Fugro and the annual turnover of the acquired activities is about $C3.9 million (A$4.9 million).

Kevron Pty Ltd.
Fugro has signed an agreement with the owners of the Kevron Group of Companies, to purchase all the shares in Kevron Pty Ltd, Kevron Aerial Surveys Pty Ltd, Kevron Geophysics Pty Ltd, Geo Instruments Pty Ltd, Kevron Aviation Pty Ltd and Kevron NT Pty Ltd. (together Kevron). These Australian companies provide airborne geophysical, aerial photography and mapping services.

Kevron has its head office in Perth (Australia), a separate operation in Sydney (Australia), an annual turnover of $A14 million (EUR 9 million), over 70 staff and 10 aircraft. They operate throughout Australia, South East Asia and Asia Pacific and Africa.

Tesla 10 Pty Ltd.
The shareholders of Tesla 10 Pty Ltd. and Tesla Airborne Geoscience Pty Ltd have been circulated with share sales agreements for their consideration and approval for the acquisition by Fugro of these Australian airborne survey companies.

These two companies operate as a group (Tesla Geophysics) with head office in Perth (Australia). The group has a combined annual turnover of about $A8 million (EUR 4.8 million), over 50 staff, five aircraft and two data processing centres. The companies are predominantly active in Australia, but also operate in Africa and Europe.

With Kevron and Tesla Geophysics, Fugro acquires good quality and internationally active companies that strengthen Fugro's presence particularly in Australia, Southeast Asia, Africa and Europe.

Further acquisitions

Fugro remains in discussion with several other companies throughout the world, which may lead to further acquisitions in existing divisions in the second half of this year.

Major capital expenditure program

In order to maintain its ongoing capital expenditure policy of remaining at the forefront of technical development, Fugro has committed expenditure to purchase a vessel for geotechnical activities in the Gulf of Mexico and the Atlantic Ocean. This ship, the Fugro Explorer, will be equipped with dynamic positioning, state-of-the-art drilling, sampling and in situ testing equipment and will have the capability of conducting geotechnical investigations in water depths of 3000 m whilst retaining the flexibility of working on standard projects in shallow waters. The vessel has a length of 78 m and can accommodate a total of 58 people. The vessel will be operational early in 2002. The purchase price for the vessel plus the conversion for geotechnical services will amount to an investment of $US16 million (EUR 18 million).

Launch of new survey vessel

16 June 2001 saw the launching of Fugro's new survey vessel, Skandi Carla, in Molde (Norway). The vessel, commissioned by Fugro-UDI Ltd. for offshore survey services by way of a five year charter, already has a backlog of 84 days. Being a multi purpose-vessel, the Skandi Carla can be used for both ROV surveys and construction support and is equipped to work in water depths of up to 3,000 m. The 84 m long vessel is equipped with a fuel efficient diesel electric propulsion system, a 640 m2 main deck, a 50 ton/15 m heave-compensated deck crane, integrated ROV support, dynamic positioning and Fugro Seastar DGPS and it can accommodate 80 persons.

Largest airborne geophysical project

Fugro-Suhaimi Ltd. of Saudi Arabia has signed a contract with Saudi Aramco's exploration division for an aeromagnetic data acquisition survey in the central and eastern provinces of the Kingdom of Saudi Arabia. The total value of the contract is approximately $US18 million (A$35.3 million).

Scheduled to start in the second half of 2001, the survey will acquire 1.8 million line-km of TRIAX magnetic gradiometer data, making it the largest airborne geophysical project ever awarded. The survey will be conducted by Fugro-Suhaimi Ltd., Fugro Airborne Surveys and an associate Canadian company, SGI, and will utilise a fleet of eight aircraft. The project will take two years to complete, including the time required for the training of Saudi Aramco designated personnel to use the data.

Finance

To finance the acquisitions, possible other acquisitions in the near future, and the capital expenditure program, Fugro is considering issuing new shares to a maximum of 9.9% of the issued capital.

Good Discoveries of Petroleum in 2001 March Quarter

Australia's petroleum exploration industry achieved a record number of oil and gas discoveries in the first quarter of this year according to the latest figures released by the Australian Geological Survey Organisation.

According to the report, *Australian Petroleum Exploration Development and Activity January 1st to March 31st 2001*, 12 discoveries were made in the first three months of 2001. These are summarised in the table below.

The Parliamentary Secretary to the Minister for Industry, Science and Resources, Warren Entsch said, "This number of discoveries represents the highest number of petroleum discoveries in a single quarter of any year and is an outstanding effort by the industry at a time when some uncertainty regarding exploration budgets has been expressed by the industry".

Operator	Basin	Field	Nature of discovery	State
		Offshore		
Tap Oil	Carnarvon	Lindsay	Oil & Gas	WA
OMV	Bonaparte	Audacious	Oil	NT
Apache	Carnarvon	South Plato	Oil	WA
Apache	Carnarvon	Gibson	Oil	WA
Woodside	Bonaparte	Kuda Tasi	Oil	ZOCA
		Onshore		
Santos	Cooper/Ero	Coonaberry	Gas	Qld
Santos	Cooper/Ero	Raworth	Gas	Qld
Santos	Cooper/Ero	Tarrango	Gas	SA
Santos	Otway	McIntee	Gas	Vic
Santos	Otway	Tregony	Gas	Vic
Santos	Cooper/Ero	Moona	Gas	SA
Santos	Cooper/Ero	Quasar	Gas, Cond.	Qld

Interest in WMC Pushes Up Share Price

Takeover talk is never far away these days as far as Western Mining is concerned.

The latest speculation is that both Rio Tinto and the South African mining giant Anglo American are chasing WMC.

With Anglo being beaten to the punch for Ashton and North they are probably well cashed up to make an attractive bid. In fact there is renewed speculation that it is trying to win the support of Alcoa of the US for a $12-a-share takeover bid for WMC.

Alcoa, which was the largest minerals resource company before the merger of BHP and Billiton, is the manager and 60% partner in AWAC, the global alumina alliance with WMC (40%) that accounts for more than 50 per cent of WMC's asset value.

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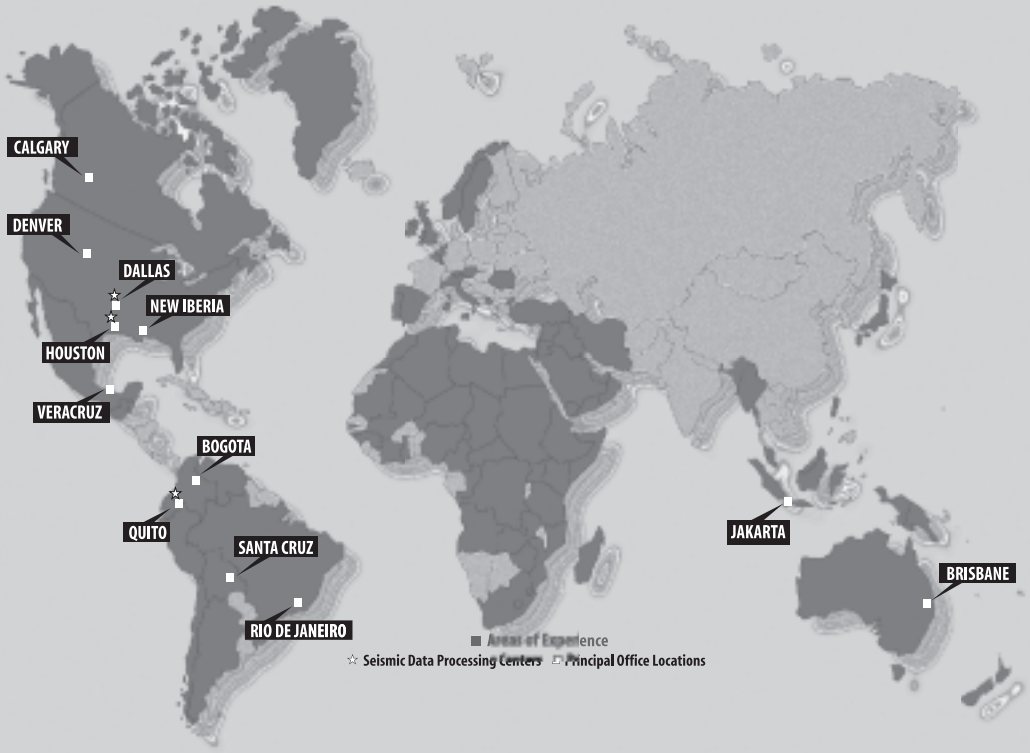

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Are the Good Times Coming Back: Both Petroleum and Mineral Exploration Continues to Grow

Charts provided with permission of the Australian Bureau of Statistics

Minerals exploration increases

Figures released in June by the Australian Bureau of Statistics showed that for the March 2001 quarter, in seasonally adjusted terms, the expenditure on mineral exploration continued to increase. The Bureau estimated a seasonally adjusted expenditure of $202 million for that quarter, which is 14% higher than the estimate of $177 million for the December 2000 quarter, and an increase of 24% ($39 million) over the March quarter for 2000.

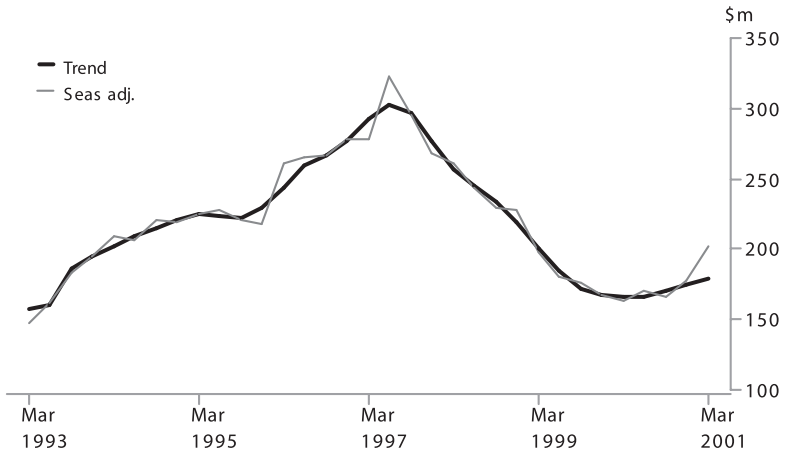
Figure 1 shows the trends for the last eight years.

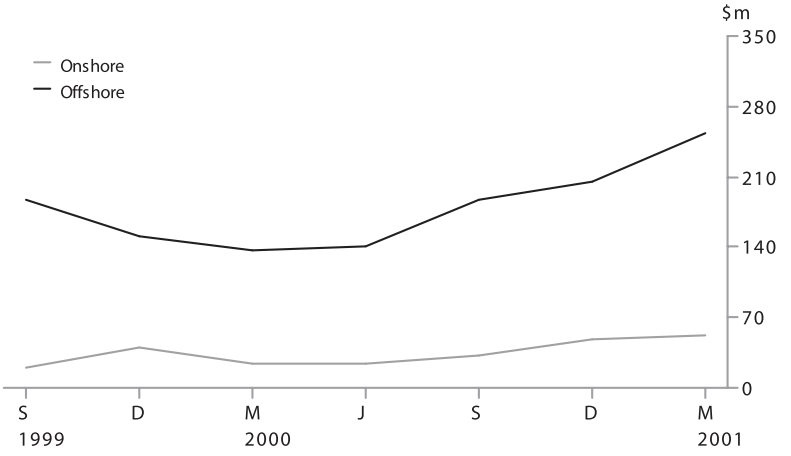
The largest increase was in Queensland, where the seasonally adjusted numbers increased from $22 million in March 2000 to $48 million in March 2001. However, Western Australia at $111 million still attracted close to 55% of the national total.

In the March quarter 2001 exploration expenditure for gold fell by 11% ($11 million), diamonds by 58% ($6 million) and iron ore by 54% ($4 million). The majority of the decreases for these commodities were in Western Australia and the Northern Territory.

Fig. 1. (Below) Mineral exploration expenditure, March 1993 to March 2001

Fig. 2. (Bottom) Petroleum exploration expenditure, September 1999 to March 2001





By comparison, between the December quarter 2000 and the March quarter 2001; exploration expenditure for base metals (copper, silver-lead-zinc, nickel and cobalt) increased 13% ($6 million) to $55 million. The rise in base metals was due to a significant one-off expenditure in Queensland.

The good news is that, in seasonally adjusted terms, the 'green field'/'brown field' ratio increased from ~3 to ~4 from the December to the March quarter. In other words, a higher proportion of expenditure was allocated to searching in new areas. The statistics on the metres drilled also indicate a trend away from production leases. Since the September quarter for 1999 this has hovered at around 1500 km per quarter, and of course, most of this would have occurred on production leases.

Petroleum Exploration Expenditure rises strongly

Reported expenditure on petroleum exploration in the March quarter 2001 was $305 million, 20% ($51 million) higher than the December quarter 2000, and 89% ($144 million) higher than the March quarter 2000.

Total petroleum exploration expenditure for the March quarter 2001 was the highest reported since June quarter 1998.

The increase in total petroleum exploration expenditure for the March quarter 2001 occurred mainly as a result of a 51% ($53 million) increase in offshore drilling expenditure. Between the December quarter 2000 and the March quarter 2001, expenditure for petroleum exploration on 'all other areas' rose 27% ($51 million), while exploration on 'production leases' fell only slightly (down $0.3 million) to $60 million. This is a very encouraging sign because it means that companies are looking in 'new' areas.

Figure 2 gives an indication of the trends in the last two years.

Victoria, Queensland and Western Australia combined, to contribute 81% to total exploration expenditure in the 2001 March quarter.

Once again Western Australia was the main contributor, with a reported $216 million expenditure on petroleum exploration, an increase of 30% ($50 million). This is the highest reported figure for Western Australia since September quarter 1994, when the ABS began collecting petroleum exploration expenditure by state/territory.

Is Pasminco in Trouble?

At the time of writing, it appears that Pasminco may be having real difficulties in maintaining its profitability.

At the beginning of June, after a disappointing forecast on its second-half profit its share price fell by 9c to 82c, its lowest level in 10 years (it was at $2.5 four years ago in 1997).

The zinc and lead miner said that 'although its full-year result would be an improvement on 1998-99's $8.3 million net loss, a seven-week shutdown at the Cockle Creek zinc smelter and underperformance at the Broken Hill and Elura mines had hurt second-half earnings'.

While Pasminco's revenue base has benefited from the weaker dollar, the June-half result would also be affected by higher debt servicing costs and foreign exchange losses incurred through loan repayments and the company's $US225 million currency hedging program.

Pasminco has also failed to find a buyer for its 49% share in the Ernest Henry copper mine, inherited from last year's takeover of Savage Resources, despite having said previously it had several serious bidders.

In the third week in June the share price fell to 22c, however the company hit back with a statement that:

'it is not aware of any issues that might have prompted today's fall in the company's share price. The recent decline in metals prices and zinc in particular, adversely impacted the Pasminco share price earlier this week.

Pasminco continues to deliver its Business Improvement Program and the ramp-up in production at the Century Mine. The previously announced asset review is also proceeding to plan.

The Business Improvement Program is delivering sustainable improvement in costs and production.'

As a result of the dramatic fall in its share price the ASX instigated an inquiry into the issue and Pasminco, in response issued, another statement saying that:

'it has no new information which might affect the value of, or could explain the recent trading in its shares.
As has already been announced, the company's revenue stream has been adversely impacted by the decline in metal prices. Notwithstanding this impact, Pasminco is able to meet all of its commitments as and when they fall due. The company has already completed all principal loan repayments due this calendar year and is not in breach of any banking covenants. It currently has undrawn facilities of $125 million.

The company is well advanced with a Business Improvement Program announced last December which is delivering substantial cost reductions and production improvement. This initiative will deliver a sustainable improvement in the underlying performance of the business at the rate of $ 100 million per annum by the end of calendar 2001. This plan is already delivering benefits ahead of internal targets. It is unfortunate that the decline in metal prices is distracting from these gains.

Pasminco reported a loss after tax of $37.3 million for the first half, and as flagged to the market in its last quarterly report on April 26th 2001, does not expect to be profitable this financial year. The second half loss is likely to be similar to that of the first half despite the deterioration in the metal process.

The company has already announced a review of each asset in its portfolio with a view to disposing of those that are not capable of generating an adequate return on funds employed. This review is also well advanced and discussions are underway with various parties who have indicated an interest in acquiring some assets from Pasminco. In particular negotiations for the sale of the Broken Hill Mine have already commenced.

The company continues to concentrate its efforts towards delivering improved production and reduced costs. The Century Mine is presently operating above 90% of capacity and the production ramp-up continues on schedule for completion by December 2001.'

Let us hope the company will pull through and prosper.

Records and Reminiscences: Geosciences at the University of Adelaide 1875–2000

Compiled by John Cooper

Published by the Department of Geology and Geophysics, University of Adelaide

ISBN 0 8639 66861, Price, $20 plus $2 GST (if applicable) plus $7 p&h, from Yvonne.Philip@adelaide.edu.au

This 254-page volume was written to celebrate the 125th anniversary of the birth of Geosciences at the University of Adelaide. Indeed, as noted in the introduction, geology has been offered as a field of study at Adelaide University over its entire history, a situation possibly unique in Australia. There are 15 chapters arranged chronologically, with between two and 13 sections per chapter. Each section has separate authorship. This compilation by John Cooper and colleagues must have been an immense task. It was launched at the December 2000 graduation dinner, which in itself was a major achievement because the graduation was brought forward from the usual date of March/April 2001. Sadly, Robin Oliver, who gave considerable assistance in the preparation of the volume, died early in 2001.

This book is one of the few such large scale 'histories' of geology departments in Australia. The only other of comparable scale of which I am aware is the 1973 Sydney University publication *Rocks/Fossils/Profs* and its successor *More Rocks/Fossils/Profs* (early 1990s) both produced under the guidance of David Branagan. There is also a smaller volume on the Geology Department at New England written by Alan Voisey. There is clearly an enormous amount of dedicated effort required to produce such a volume but the final product is full of interest, particularly to the graduates of the institution involved.

As the title suggests the book is not a formal history, but rather a record of the department's activities by means of reminiscences in the form of anecdotes and reflections. This is both a strength and a weakness in that many of these anecdotes provide interesting insights into personalities and happenings of the past. However, the same incident may be mentioned in more than one section and it is difficult to relocate a particular anecdote, especially as there is no index.

The book covers the exploits of such geologists as Ralph Tate, Walter Howchin, Douglas Mawson, Cecil Madigan, Eric Rudd and Martin Glaessner. The remarkable Professor Ralph Tate (1875-1901) was the initial Professor of Natural Science, which covered botany and zoology as well as geology. Walter Howchin, Methodist clergyman and geologist, undertook much of the teaching and administrative duties of geology in the period 1901-1920 (between the ages of 55 and 75!), due to the prolonged absences of Mawson both in Antarctica and on military service. Although largely forgotten now, Howchin's 1918 book *The Geology of South Australia* remained a student text for 40 years. Mawson's Antarctic exploits are deservedly very well known. What is less well known is that Mawson and Madigan were responsible for most of the teaching of geology between the wars, with some assistance from Arthur Alderman (Professor of Geology 1953-66) after 1930. If the present Federal Government has its way we will be reduced again to geoscience departments with only two or three academic staff in the not too distant future. Almost throughout Mawson's tenure as Professor, and despite numerous submissions, the Geology Department was housed in a series of unsatisfactory 'temporary' accommodations until the completion of present Mawson Laboratories in 1952, ironically the same year in which Mawson retired. There is a substantial section on Cecil Madigan whose major contribution to Australian geology has been overshadowed by Mawson's exploits.

The 1949 appointment of Eric Rudd as the first Professor in Economic Geology in Australia was a landmark event. Prior to that time most Australian universities had dealt with classical academic geology with only limited recognition of the mining industry. The appointment of Martin Glaessner in 1950, as Senior Lecturer in palaeontology, balanced the traditional hard rock approach of Adelaide. Apart from a formidable reputation in micropalaeontology, Glaessner also had a top class understanding of alpine mountain belts. At Adelaide he became best known for his classic work on the Ediacara fauna. One other staff member of special significance is Maud McBriar, who ran many of the undergraduate practical classes, particularly in petrology, in the period 1956-1987. In my opinion, Maud's value to the department both as an organiser and teacher of practical classes and field camps cannot be overemphasised.

The most enjoyable parts of the book are the numerous anecdotes and short reminiscences. One of these by Keith Johns concerns the famous moon rocks hoax at the August

1969 ANZAAS Conference. In that era ANZAAS Conferences were the major geological gatherings rather than the current series of Australian Geological Conventions. The first moon landing had been on July 21st, 1969 and there were rumours that some moon rocks would be displayed at the conference, particularly as it was known that Australian geologists were to be involved in the study of the rocks collected by Neil Armstrong and 'Buzz' Aldrin. At the end of the August 18th morning session it was announced that the moon rocks had indeed arrived and if we wished to view them (and who would not?) they would be on display outside. There was an enormously long queue as we all snaked past and gazed at a well-lit glass case protected by one-armed security guard. Inside the glass case were what looked like vesicular basalt and glass beads. Various profound statements were made to the effect that this is just what would be expected etc. I remember sitting next to a prominent Australian geologist at a lecture that evening and asking him what he thought of the specimens. "Most interesting" was the reply. A photo and story in the *Advertiser* the following day revealed the truth, i.e. certain Ph. D. students had arranged a display of Mt Gambier basalt and glass beads produced by the melting of basalt for XRF buttons. According to Keith Johns the culprits included Peter Fleming, Malcolm Walter, Alan Goode and Alan Moore.

In addition to the well-known figures mentioned above there is a short piece on almost all the academic staff who have performed at Adelaide. There are numerous excellent photos of both staff and students, although most of these date from the 1930s through to the present era. At the end of the volume there are appendices listing all geoscience academic and support staff plus lists of all DSc, PhD, MSc and Honours graduates. Unfortunately there are several omissions in these lists as well as inclusions of University of South Australia graduates who did their honours and postgraduate programs through the National Centre of Petroleum Geology and Geophysics, a joint venture between the University of Adelaide and the University of South Australia. There are also a few typographical errors. However, these are minor problems that can be corrected in a later edition.

In summary this is a very readable, enjoyable and very reasonably priced volume that should be of interest not only to all University of Adelaide geoscience graduates but also to geoscientists in general.

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Beneath Our Feet
The Rocks of Planet Earth

Reviewed by Sandy Paine

By Ron Vernon

Cambridge University Press, 2000, Hardback, viii+216pp, rrp$59.95

Physically, this book is practical and most attractive. At a fairly compact 260 x 210 mm it is a pleasure to handle and refer to, and the binding is robust.

From Emeritus Professor Vernon's opening sentence, "What on Earth are you standing on?", to his epilogue beginning, "I hope that I have convinced you that Earth rocks are as fascinating in their variety as they are beautiful", this is a book to delight would-be students of geology, together with non-geologists who want to learn about rocks, and plenty of professional geologists too.

The chapters cover the following: *Looking at Rocks and Minerals; Juggling Plates; Anything Flows* (including how solids flow, and the difference between flow and fracture); *A Mantle of Green* (what is known about the mantle); *Hot Stuff* (magma and its many manifestations); Breaking Point (faults and fault fillings); *All Washed Up* (weathering, erosion, sedimentary rocks, fossils); *Turning up the Heat* (deep-Earth processes); *In Hot Water* (water in magma; hot springs; water, faults and ore deposits; 'black smokers'); *A Tight Squeeze* (changing the shapes of solid rocks); and *From Outer Space* (identified flying objects). There is a useful glossary, divided up into mineral names, rock names and other terms.

It is a rare pleasure to review this book, which is lavishly and beautifully illustrated with colour plates. The areas occupied by text and plates are about equal. Several clear, coloured diagrams in *Juggling Plates* show the Earth's interior and how subduction operates. There are many photomicrographs with spectacular interference colours, which non-geologists could find quite startling. Of more practical interest to them, though, will be the many superb photos of outcrops and other geological features from around the world, like the picture on page 89 of Mount St Helens, taken by Lyn Topinka (USGS) on a cloudless day during the May 1982 eruption: a 'puff' of ash rises vertically 1000 metres above the small black lava dome, framed symmetrically between the towering, snow-mantled 'shoulders' of the breached crater formed by the catastrophic eruption of 1980.

'Beneath Our Feet' is written in easy-to-read, non-technical language. At present I can't think of a better, more appealing introduction to geology than this book, which has a huge potential readership, from students embarking on the subject (both at school and beginning university), to those living with a geologist in the house, and to other non- geologists who often wonder how rocks have formed. Although earth scientists will also find much pleasure in its pages, it should not be marketed to them but to those whose interest in the subject has yet to be awakened.

Gold: Forgotten Histories and Lost Objects of Australia

By P. A. Malone Edited by Iain McCalman, Alexander Cook and Andrew Reeves

Cambridge University Press, 2001, A$49.95, ISBN 0 521 80595 3 Hardback

This book was produced with assistance from the National Museum of Australia, Canberra, and its publication coincides with the 150th anniversary of the discovery of gold in Australia, as well as the exhibition on gold at the NMA.

The contributors to the book are historians and curators. Thus the volume is clearly slanted towards the history of gold in Australia, rather than its geology. Even so, it contains much of interest to earth scientists wishing to learn more about the social and political impact of the gold rush and the way of life of prospectors and their families.

The book is divided into five parts: 1 Gold and Modernity: The Impact of the Gold Rushes on the Development of the Australian Colonies; 2 Immigrants and Ethnic Relations; 3 White Gold/Black Gold: Settler and Indigenous Histories of Goldmining; 4 Daily Life and Domestic Culture; and 5 Art, Visuality and Material Culture.

As each of the 20 chapters is self-contained, it would be easy to dip into the book, reading only those sections of greatest personal interest. But to do so would detract from the strengths of the volume, which presents a broad picture of the life and times of those involved with the gold rush, mainly in Australia, but also with a chapter on New Guinea.

Part 1 includes chapters on the moral dilemmas raised by the gold discoveries; a study of early trade unionism in the Bendigo diggings; environmental degradation resulting from alluvial prospecting, as well as the population growth in Sydney and Melbourne following on from the discovery of gold in those colonies.

Part 2 looks at the extent of racism among the miners of New South Wales and Western Australia, and outlines the differing view points about Chinese prospectors held by Squatters (searching for cheap agricultural labour) and prospectors (competing with the Chinese for limited quantities of the precious metal).

Part 3 is possibly the most varied section of the book. It contains a chapter on gold exploration in New Guinea, as well as chapters on individuals associated with gold, such as Lasseter, and a lesser-known figure, an aboriginal boy called Oscar, whose sketchbook was acquired by the National Museum of Australia. Oscar was about nine or ten years old when the Manager of a cattle station in the far north-west Queensland obtained him (presumably to work on the station). Noticing the child's interest in drawing, the Manager gave Oscar a lined exercise book and some pencils and the child drew pictures, depicting among other things, the Native Police and their methods of dispersing traditional aboriginals from their traditional lands.

Part 4, on daily life and domestic culture in the goldfields, is among the most coherent sections the book, since all the contributions deal with the clearly allotted topic, whereas some of the chapters in Part 3 sit uneasily in that section and could have either been placed in Part 5, Art, Visuality and Material Culture, or omitted from the collection.

As is to be expected in a book with twenty-five contributors, the readability of the prose varies, with some writers presenting the reader with a vivid picture of the times, while others cloud the picture with turgid prose.

Throughout the volume, the written word is enhanced with numerous illustrations. These include sketches by contemporary artists working at the diggings and photographs of goldfield jewelry. The illustrations make an important contribution to the book. However, there are only two maps, one of which is illegible. The lack of clear maps is particularly frustrating in chapters such as those about Lasseter and New Guinea where the text refers to locations not necessarily known to the reader.

Additionally, the volume would have benefited from a clear map of Australia and New Guinea, showing the locations of the gold discoveries, together with key dates. A table indicating the approximate amounts of gold obtained from the major fields would also have improved the book.

Those wishing to learn about current gold production will be disappointed since the book largely focuses on the nineteenth and early twentieth centuries, giving little attention to recent gold history.

Abstracts

Section 4

ASEG 2001
A Geophysical Odyssey

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List of Abstracts by Session

Alphabetical Index of Speakers

Alphabetical Index of Speakers

KEY NOTE SPEAKERS

The need to find more metal

Mr Vincent Gauci MIM Holdings, Qld

Australia's oil and gas industry - where to from here

Dr Agu Kantsler, Woodside Energy, WA

QUANTITATIVE SEISMIC INTERPRETATION

Geostatistical lithology modelling

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Lithology modelling is an essential part of quantitative reservoir characterisation. Seismic data as well as geological information should be used to constrain the construction of lithology models. Geostatistics offers a number of tools to combine seismic and well-log data with geological knowledge for the generation of detailed lithology models in association with other important reservoir parameters such as porosity and permeability.

Simultaneous lithology and impedance simulation combined with geostatistical inversion gives excellent results but is computationally expensive. Cheaper techniques, where the lithology models are simulated before or after impedance modelling, do not produce equivalent results. Results from a carbonate reservoir show that all methods produce approximately the same total pore volume within the hydrocarbon interval. However, the simultaneous simulation with inversion produces models of the reservoir, which have a much higher degree of heterogeneity. The lower connectivity between high porosity sweet spots has implications for field development.

Reservoir tracking in 3D: an inversion case study

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Acoustic impedance inversion (AI) of 3D seismic data has resulted in the identification of low impedance bodies that can be correlated to sandstone reservoirs on the Talbot-Anson Horst, Timor Sea. Calibration of the impedance values within the bodies with nearby well control, including the Talbot-1 oil well, suggests that the anomalous units are hydrocarbon bearing. Further evidence for the occurrence of hydrocarbons lays in the fact that low impedance anomalies exist in the bodies above a possible hydrocarbon-water contact, whereas higher impedances exist below. AI inversion in 3D has reduced the perceived risk associated with reservoir and trap for the Anson West prospect and increased the potential volume of this hydrocarbon prospect.

Quantitative seismic reservior characterisation: a model-based approach for the Sampang Production Sharing Contract (PSC), East Java, Indonesia

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A model-based approach for quantifying post-stack seismic amplitudes was conducted for the Alpha and Omega prospects within the Sampang PSC, East Java, Indonesia.

Deterministic tuning curves were generated by analysing the effects of porosity variations, fluid content and reservoir thickness, on the seismic wavelet for various siliciclastic and limestone units for the prospects. The tuning curves generated are able to assist with prediction of reservoir parameters at undrilled prospects.

The results of this modelling study suggest the high amplitude seismic anomalies observed over the Alpha and Omega prospects are bright in response to the presence of gas.

The integration of surface seismic and borehole data using artificial neural network clustering methods

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We present a new method for calibrating a classification of a 3D seismic volume.

The classification process employs Kohonen self-organizing maps; the subsequent calibration is performed using one of more sets of borehole logs.

The method is described in some detail, and a case-study is presented using data from the North Sea.

The method shows promise as an alternative to current techniques for integrating seismic and log data, for seismic reservoir characterisation.

COAL GEOPHYSICS

Automated geotechnical characterisation from geophysical logs: examples from Southern Colliery, Central Queensland

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Conventionally, geotechnical information comes from cored drill holes. However, coring is expensive and most boreholes are drilled without or with very limited coring. Alternative ways of obtaining geotechnical information need to be found. One approach is by geophysical logging. Borehole geophysical logging is carried out routinely at coal mines. It measures various in-situ petrophysical parameters, which are usually correlated with rock types and can be used for rock mass characterisation, litho-stratigraphic interpretation, orebody delineation and grade estimation.

This paper presents examples of automated geotechnical characterisation from geophysical logs to identify the key strata responsible for caving behaviours during longwall coal mining at Southern Colliery in Central Queensland. The method is based on computer program LogTrans. Conventional logs such as density, natural gamma and UCS (derived from sonic transit time) logs and full wave sonic data are examined. The geotechnical units predicted from the geophysical logs are well matched with the original strata classification and core photographs. A 3D geotechnical model has been established based on the LogTrans geotechnical interpretation. The results could assist site geologists, planning and production engineers predict and manage mining conditions on an ongoing basis.

Borehole to borehole electromagnetic tomography at Trap Gully Callide Mine, East Central Queensland

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Borehole to borehole electromagnetic tomography, also known as the Radio Imaging Method (RIM2), has been used at Callide Coal Mine since 1996 for mapping fault structures behind high walls. The RIM2 system has been used at frequencies from 12.5 kHz to 302.5 kHz at borehole separations of 50 to 120 m. A high level of correlation with the logged geology is obtained by using close spaced transmitter and receiver spacings and by the choice of the highest frequency at which signal penetration still produces a good dynamic range. The use of RIM2 was instrumental in improving the geologic model of the structures behind the highwalls at Trap Gully. The RIM2 system has imaged a range of structures including reverse faulting and monoclinal folding with seam offsets of less than 5 m to greater than 20 m. The tomographic images produced have since been confirmed by the use of other geophysical methods and geotechnical drilling.

Microseismic monitoring of highwall mining stability at Moura Mine, Australia

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In this paper we present results obtained from a microseismic monitoring at Pit 20DU at Moura Mine in central Queensland. The objective of this study was to investigate the feasibility of using the microseismic method to map roof fracturing associated with highwall mining for highwall mining stability assessment. 14 triaxial geophones were installed in seven boreholes across the highwall bench, covering an area of 300 m by 400 m. The experiment was carried out from Jun 12th to Jul 25th, 1999. More than 7000 events were recorded.

Generally, the recorded events were weak in seismic energy. Many of the events only triggered the nearest one or two geophones. The events were classified into three types on the basis of their frequency content and seismic duration. Each type appears to be associated with different fracturing mechanisms.

The first type consisted of two groupings of events. One was located in the main sandstone roof and constrained by existing faults. They may be caused by the release of a localised stress concentration. The second group was dominated by events located in the floor of the DU Seam near the highwall bench. They appear to be controlled by the fault and floor stress concentration near the highwall face.

The second type of events occurred across the mining area and followed the general sequence of the mining. These are inferred to represent a general ground response to the mining. Events of the third group were located mainly in the immediate roof of the DU Seam. They were found to be associated with minor fracturing near the mine entries.

During the monitoring period, about 30 entries were mined and no significant entry or pit stability problems were encountered. Therefore, the fracturing giving rise to the microseismic activity observed at 20DU did not have an adverse impact on the highwall mining stability.

A new instrument to remotely monitor rock mass deformation

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A new system for precise monitoring of surface and underground deformations in rock mass surrounding a mining operation has been developed and successfully deployed by CSIRO Exploration and Mining since 1993. The new system is based on a borehole strainmeter, which has the sensitivity to enable measurements remote (for example at distances of 1-5 km) from the mining operation, and long-term stability to provide accurate measurements over periods of years.

Strainmeters traditionally used for deformation measurement have neither the long-term stability nor the high sensitivity to perform measurements in these applications. This paper describes the new precision borehole strain monitoring system (GTS) currently deployed by CSIRO Exploration and Mining, which has the potential to solve these new issues in rock mass deformation monitoring. This technology was originally developed for use in hard rock mines (Gladwin 1977) and refined considerably for earthquake research (Gladwin et al. 1994, Gwyther et al., 1992). A case study of the use of the GTS in monitoring longwall coal mining over the period 1993-1999 is presented.

Accurate measurement of rock mass response during the mining of massive underground ore-bodies is essential as mines become larger and deeper. The CSIRO GTS system is immediately applicable in circumstances such as: provision of quantitative data for optimal pit slope design and engineering; measurement of the stability of deep pit slopes, monitoring the long term integrity of shafts, large scale underground infrastructure and surface infrastructure, and long term measurements of deformation or rock mass creep following the mining process to provide data for environmental management.

AIRBORNE PROCESSING 1

Tracking the transmitting-receiving offset in fixed-wing transient EM systems: methodology and application

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Fixed-wing transient airborne electromagnetic methods are now capable of measuring the on-time response and accurately estimating the three components of the primary field. Using the primary fields as the input to an inversion algorithm, it is possible to determine the offset of the receiver sensor (bird) from the transmitting loop. The result is a dynamic and continuing measure of system geometry that can be used to augment data processing and interpretation schemes.

Independent estimates of the offsets using a laser range finder show that the primary-field estimates are accurate at high altitudes away from any ground effect. Because laser range finders cannot be employed practically at survey altitude, the primary-field method can also be used to obtain a dynamic estimate of the bird position close to the ground. Typically, the bird position is confined to within a few metres of the mean position when using a bird and/or tow cable with reasonably high coefficients of drag. Empirical observation suggests that the estimated positions are not significantly effected by the ground response, and are therefore good estimates.

In one example, the dynamic positions are used as input to a conductivity/depth estimation algorithm and compared with the results obtained when using only the nominal bird position. The results are comparable.

Automated anomaly modelling of AEM data with magnetic dipoles buried inside a layered earth

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An algorithm is described that determines, models and classifies spatially discrete anomalies in airborne EM (AEM) data sets. The first module scans segments of EM profiles for anomalies wide enough to have their origin in the subsurface and narrow enough to be caused by a discrete conductor. Next, background conductivity models are determined with layered-earth inversions from the spatially smoothed EM data. Finally, the identified EM anomalies are modelled first with rectangular current filaments in free-space and then with magnetic dipoles buried inside a layered-earth. The approach used takes into account the effect of overburden blanking and is applicable for discrete, sheet-like conductors inside a resistive host, i.e. in scenarios where vortex currents dominate. Computing the current-excitation ratio for each solution monitors the validity of this assumption. The model parameters determined from each data segment include the target conductor position, depth, dip, size and conductance. The method is fully automated with the filament start model being determined by curve matching from a digital look-up table. Results from synthetic data indicate the efficiency and reliability of the method. Automated anomaly modelling of TEMPEST data acquired across the Bull Creek prospect, Queensland, provides a sensible description of the main mineralisation and indicates the presence of other minor conductors.

Subsurface conductivity structure as approximated by conductivity-depth transforms

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Conductivity-depth transforms (CDTs) are widely used as a means of quickly approximating the subsurface conductivity structure as sampled by electromagnetic systems. Using synthetic data from forward modelled layered-earths, the behaviour of CDT profiles with changing conductivity structure is explored to assess how approximate these methods are.

It is shown that CDT profiles exhibit a characteristic behaviour that prevents literal interpretation. Specifically, profiles show a propensity to 'bulge'. The depth, size and shape of this bulge is directly related to conductivity structure encountered with depth but does not mimic it. Consequently, CDT products (sections, interval conductivities or volumes) have variable levels of accuracy with depth, dependent on what part of the bulge is being examined. Accurate interpretation of CDT products then requires that the interpreter be mindful of CDT behaviour.

Alternatively, new products based on profile characteristics, can be generated and interpreted in terms of CDT behaviour. To this end, an algorithm has been developed to automatically provide a quasi 3-layer simplification of CDT profiles. The algorithm shows promise as a means of finding depth to base of the conductive sequence and depth to the top of the first significant conductive layer.

Spectral methods for reducing noise in gamma-ray spectrometry

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Statistical methods for removing noise from multichannel spectra are now routinely applied in gamma-ray spectrometry. The two methods in common use are the Maximum Noise Fraction (MNF) method and the Noise Adjusted Singular Value Decomposition (NASVD) method. These methods use a principal component (PC) type analysis to extract the dominant spectral shapes from a dataset. These PCs are then used to construct smooth spectra. The purpose of this paper is to evaluate current spectral smoothing methods in terms of both their accuracy and precision.

We develop a methodology based on the use of a synthetic spectra dataset where the true spectrum channel count rates (in the absence of noise) are known. By repeatedly processing the same synthetic data using different synthesised noise, and because the true values of the synthetic data are known, we derive estimates of both the precision and accuracy of the processed data.

Our tests using synthetic data show that the MNF and NASVD methods produce almost identical results. However, the MNF method produces results that are fractionally better in terms of both precision and accuracy. This may be a function of the robustness of the numerical algorithms we used to implement these methods.

PETROPHYSICS

Electrical properties of porphyry mineralisation at the Cadia Ridgeway gold-copper deposit, NSW - implications for exploration

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The Cadia Ridgeway Au-Cu deposit is a deep (> 500 m) gold-rich porphyry copper system located in central NSW. A chargeability anomaly, recognised within a prospective NW-SE mineralised corridor motivated the drilling program, which led to the discovery of the deposit.

In-situ and laboratory electrical tests were conducted to characterise the petrophysical properties of the deposit and host sequences. The ore is both chargeable and relatively conductive, although not sufficiently conductive for EM methods.

Significant scale variation of apparent resistivity was observed with in-situ measurements using electrode spacing of one metre or more up to two orders of magnitude lower than values determined from laboratory measurements.

Forward modelling of measured induced polarisation and apparent resistivity data was conducted using petrophysical properties determined primarily from in-situ testing. The chargeability anomaly identified over the Ridgeway ore body is due largely to discontinuous halos of pyrite alteration above the economic mineralisation, but a highly chargeable source component associated with the economic mineralisation at Ridgeway is also inferred.

The contrast in conductivity between ore and host rocks suggests that Ridgeway-style mineralisation may represent a target for magnetometric resistivity (MMR) surveying. Three-dimensional numerical modelling of the expected MMR response indicates that the Ridgeway deposit would be detectable by both surface and down-hole MMR surveys.

Petrophysical properties of the Goonumbla Volcanic Complex, NSW: implications for magnetic and gravity signatures of porphyry Cu-Au mineralisation

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Petrophysical data are important for constraining the geophysical signatures of the Endeavour Cu-Au deposits within the Goonumbla Volcanic Complex (GVC). Susceptibilities vary systematically with lithology and, particularly, with alteration. Remanence tends to be subordinate to

induced magnetisation in the GVC. Densities are predictably related to composition, Alteration effects on densities are generally minor, although rocks with particularly strong development of secondary magnetite, hematite or sulphides have higher densities.

Modelling of magnetic and gravity profiles over the Goonumbla Volcanic Belt and the GVC, constrained by geological information and petrophysical properties, suggests that the GVC is underlain by a large zoned intrusion, representing the parent magma chamber, which has a substantial low density, weakly to moderately magnetic, core of alkali feldspar granite to monzonite composition, enclosed by marginal mafic monzonite and monzodiorite phases. The mafic roof zone and marginal phases of the GVC have high susceptibilities (> 0.08 SI, > 2.5 vol % magnetite).

A prominent ridge of low-density material occurs along the eastern margin of the mother intrusion. A zone of lower susceptibility occurs above the felsic ridge, probably representing magnetite-destructive alteration due to fluids emanating from inferred underlying felsic intrusion. This zone appears to be related to the Endeavour Lineament, which is thought to control the emplacement of many of the mineralising intrusions in the GVC. Magnetic signatures of deposits tend to be obscured by the heterogeneous magnetic environment, but reflect variably developed halos of enhanced magnetite content, associated with early potassic alteration, surrounding a core of reduced magnetite content, which represents the combined effect of felsic mineralising intrusives, mineralising phase (K-feldspar dominated) alteration and phyllic overprinting. Different signatures can be expected for lava-dominated wall rock sequences (weak to moderate annular high with well-developed central low) and volcaniclastic-dominated sequences (unimodal weak to moderate high).

Can sphalerite be a polarisable mineral? An example from the Century Zn-Pb deposit

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While sphalerite is an important ore-forming mineral, the difficulties of exploring for this mineral target due to its low petrophysical contrast with gangue material have been well documented. Fortunately, many large zinc deposits also contain dense and conductive secondary sulphide minerals, which are good targets for standard geophysical tools.

The low-grade metamorphic, sediment hosted Century deposit of northwest Queensland represents a style of mineralisation rich in zinc, but with relatively few accessory sulphide minerals. Mineralisation is generally stratiform, consisting of fine-grained laminae of sphalerite, pyrite and galena cross cut by veins of sphalerite and galena in the upper layers of the deposit. Pyrite replaces sphalerite as the main sulphide mineral at the base of the deposit. Of the wide range of techniques applied to detect the deposit, including the gravity, magnetic and electromagnetic methods, only the induced polarisation technique shows a clear anomaly.

Conventional wisdom would suggest this induced polarisation anomaly was sourced from galena in the upper part of the deposit or pyrite enrichment in the footwall shales. The authors suggest that sphalerite may be a significant contributor to the observed chargeability response. Further study of the electrical properties of this mineral is required to assess the potential for using induced polarisation as direct targeting tool for zinc-rich orebodies with a low content of secondary sulphides.

Relationships between regolith materials, petrophysical properties, hydrologeology and supergene Ni enrichment at the Cawse Ni-laterite deposits, Western Australia: implications for exploring with AEM

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In the Eastern Goldfields of Western Australia, airborne electromagnetic (AEM) data have been acquired over areas prospective for nickeliferous laterite deposits, although their application in exploring for this style of mineralisation is not well understood. In part, this can be attributed to a lack of detail concerning relationships between supergene Ni enrichment and the petrophysical, particularly electrical, properties associated with prospective regolith materials and settings.

This issue was addressed using a combination of multi-parameter borehole geophysical techniques and lab analysis of mineralogy, geochemistry and soluble salt content for 24 drill holes in a zone of known mineralisation associated with the Cawse lateritic Ni deposits, located in the Eastern Goldfields, WA.

The regolith associated with supergene Ni enrichment exhibited a complex vertical conductivity structure. In places, elevated conductivities were coincident with Ni-Mn-Co mineralisation. These correlations were noted to occur at hydromorphic barriers associated with structural discontinuities or in places where regolith textural changes were marked. The observed regolith electrical structure was indicative of contemporary groundwater processes, with higher conductivities associated with concentrations of soluble salts.

Results suggest that AEM data could be used as an exploration tool particularly to locate structurally controlled conductivity contrasts that may be associated with Ni enrichment.

HIGH RESOLUTION SEISMIC

The influence of coal-mine geology on seismic data quality in the Bowen Basin

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Over the past two decades numerous seismic surveys have been undertaken to assist with exploration over Australian coal mines. More recently this has been extended to assist with mine design and coal extraction. This latter application is placing increasing demands on the quality and resolution achievable with the seismic method.

We present a number of examples of seismic surveys conducted in the Central and Northern Bowen Basin which illustrate that seismic data quality is strongly influenced by localised mine geology. Unfavourable near-surface conditions including variable weathering and the presence of basalt or other high-velocity layers can drastically impact on image quality. The stratigraphy of the target coal seams also affects the definition of the target seam.

We comment on various ways of reducing the adverse effects of unfavourable mine geology. By incorporating knowledge of mine geology in the acquisition design and by utilising appropriate processing solution, it is possible to obtain high quality seismic imagery.

Bandwidth requirements for shallow, high-resolution seismic reflection

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The optimum bandwidth for shallow, high-resolution seismic reflection differs from that required for conventional petroleum reflection. An understanding of this issue is essential for correct choice of acquisition instrumentation. Numerical modelling of simple Bowen Basin coal structures illustrates that, for high-resolution imaging, it is important to accurately record all frequencies up to the limit imposed by earth scattering. On the contrary, the seismic image is much less dependent on frequencies at the lower end of the spectrum. These quantitative observations support the use of specialised high-frequency geophones for high-resolution seismic imaging. Synthetic seismic inversion trials demonstrate that, irrespective of the bandwidth of the seismic data, additional low-frequency impedance control is essential for accurate inversion. Inversion provides no compelling argument for the use of conventional petroleum geophones in the high-resolution arena.

Estimating coal quality from seismic data - is it possible? A case study from the Bowen Basin

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This paper is a case study from the Newlands Colliery, Bowen Basin, Queensland, Australia. Stratigraphic information from high quality 3D seismic data was used to estimate the ash content for coal quality. A variety of seismic attributes were used, including impedance and facies analysis. Hard data from geophysical logs and core based ash content determinations have been correlated with these attributes. The application and limits of the methods are discussed.

SEISMIC MULTIPLE ATTENTUATION

High-resolution radon demultiple

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It is well known that the conventional Radon demultiple may fail when there is limited differential moveout between primaries and multiples or when the input data contain aliased events. These limitations can be overcome by an extension of the conventional Radon transform, which uses data-derived constraints to enhance the focusing of energy in the transform domain. This leads to better separation of primaries and multiples and an improved resistance to errors due to noise and aliasing. Data examples show the benefits that result in practice from this high-resolution version of the transform:

a) Better multiple removal and signal preservation when primaries and multiples have small differential moveout;
b) Removal of aliased multiples without the need for pre-interpolation, and;
c) Removal of aliased noise in the course of demultiple processing.

Surface-Related Multiple Elimination: applications to an offshore Australia data set

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The presence of free-surface-related wave phenomena is a classic problem in marine seismic data processing. Over the years, the industry has relied heavily on conventional multiple suppression methods such as predictive deconvolution and differential move-out filtering to remove surface-related multiples from marine seismic data. These methods are based on rather specific assumptions about the subsurface and characteristic differences between primaries and multiples. Since these assumptions are often not met in the field, the effectiveness of these methods may be limited. Surface-Related Multiple Elimination (SRME) is a relatively new method that removes all surface-related multiples, without using any additional information about the subsurface. Application of SRME to offshore Australia data sets results in much improved results, where relatively weak primary reflections become more interpretable.

Quantifying multiple suppression of stacking

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The motivation for this study was a 1989 request by Shell Oil Company's Pecten Syria Petroleum Company to evaluate several 3D acquisition proposals in the light of suspected multiple interference. Even with proper 3D imaging, could the prospect be obscured by multiple interference evident in prior 2D seismic data?

Seismic geophysicists need a quantitative way to quickly evaluate and compare seismic data sets with respect to multiple suppression. A new dimensionless-frequency response curve has been developed to quickly quantify the multiple suppression capabilities of stacking within a single CMP. When there are a large number of diverse CMPs within a 3D acquisition, the mean-squared-amplitude of the dimensionless-frequency response curves can be used to quantify the average multiple suppression within an entire unit-cell of coverage.

Quickly recognizing and quantifying multiple interference can be very cost effective. Merely, reducing the acquisition costs without quantifying known multiple interference in seismic data can lead to wasted man-hours, wasted money, and ultimately poor quality seismic interpretations.

Potentially poor 3D acquisition designs can be quickly and inexpensively eliminated by proper application of this new tool. The best alternatives can be selected without field-testing, computational overload, or display overload. More cost effective acquisition and processing can be chosen with respect to multiple suppression. In addition, some more robust rules-of-thumb were developed for 3D seismic acquisition and processing design.

INNOVATIVE AIRBORNE GEOPHYSICS

Falcon gravity gradiometer technology

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The BHP FALCON gravity gradiometer is a derivative of the Gravity Gradient Instrument (GGI) developed by Bell Aerospace (now Lockheed Martin) between 1975 and 1990. The basis of the GGI design is an accelerometer complement consisting of four accelerometers equi-spaced on a circle with their sensitive axes tangential to the circle. This configuration rejects both common mode acceleration and rotations about the axis perpendicular to the plane of the complement. The complement remains intrinsically sensitive to rotation rates about axes in the plane of the complement and is sensitive to the acceleration environment to the extent that there is imbalance in the accelerometer sensitivities. Rotation of the complement moves the gradient signal to twice the rotation frequency, away from the effects of low frequency accelerometer bias changes. The GGI is mounted in a high performance inertial stabilised platform to reduce rotation of the instrument so that its sensitivity to this motion does not represent a significant noise source.

The GGI accelerometers are designed for very low noise, requiring hard evacuation, high pendulosity, low spring constant and attention to the constrainment loop. Accelerometer pairs are aligned with precision and their sensitivities and frequency responses are matched. The scale factor (sensitivity) and alignment of the sensitive axis of each accelerometer can be adjusted. These adjustments are made to minimise accelerometer imbalance by monitoring the response of the system to specific stimuli through compensation loops.

Survey logistics were considered during development of the system and the result is a system which requires limited preparation, is largely automated during surveys, places few restrictions on flight planning and has been operated in harsh ambient conditions. Data processing is streamlined and data quality can be checked immediately after a flight.

FALCON test results from the Bathurst mining camp

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BHP commenced exploration surveying with the world's first fully operational, airborne gravity gradiometer in October 1999. This gradiometer (called Einstein), together with a later one called Newton, was developed in conjunction with Lockheed Martin by BHP's FALCON project. Falcon data are acquired by Sander Geophysics Ltd., flying a Cessna Grand Caravan to survey specifications typical of aeromagnetic surveys.

The first FALCON survey was flown over a portion of the Bathurst mining camp in New Brunswick, Canada in order to compare system performance with existing extensive and detailed ground-gravity data.

The ground-gravity data, supplied courtesy of Noranda Minerals Exploration Ltd., were upward continued to the flying height and vertically differentiated to provide vertical gravity gradient data suitable for comparison with the airborne data.

The two data sets compare very well and the results demonstrate that the FALCON airborne gravity gradiometer is capable of detecting sources with a vertical gravity gradient signal of greater than 10 Eö and a full-width at half-maximum of 500 m.

Normandy heli-borne time domain

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In April 1998 Normandy successfully flew a new helicopter-borne TDEM system. This system has been in constant use and data comparing ground and airborne TDEM are presented.

In December 2000 a new non-metallic version of the system was flown which allows a combined transmitter and receiver to be flown at 30 m terrain clearance. Data comparing the Mk I and Mk II versions are presented.

RADIO AND RESISTIVITY TOMOGRAPHY

Radio tomography (RTFEM), practical image fidelity or resolution

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Radio Tomography (RTFEM) is applied in mine to define geological hazards in advance of coal mining, outline ore bodies in base metal exploration and a range of geotechnical and environmental applications.

This paper ranks the dominant sources of image degradation in terms of significance, so as to provide guidelines on the practical applicability of the technique.

RTFEM appears to have niche rather than general applicability:

- It cannot accurately image features oriented parallel to the survey line;
- It will not generally be able to probe the interior of targets unless the attenuation is such that signal is observable through the strongly attenuated zone (i.e. above noise level), and;
- The resolution perpendicular to the access lines will always be relatively poor.

A realistic version of the actual conductivity (or attenuation) image can be achieved by using robust imaging inversion methods. For base metal imaging, it would also be desirable to develop algorithms which can deal better with signal attenuated below the noise level at the receiver, and which can take better account of the variation in antenna coupling. The current approaches still have significant limitations.

The technique is applicable for coal seam imaging, but resolution parallel to data collection lines is two to three times less. In these cases usually the only feature observable is a step in image level and not the outline of a structure.

The technique is well suited for delineating the external geometry of base metal deposits when the host rock is relatively homogeneous and resistive. This precludes working in areas where the host rock is pervasively altered or pervasively mineralised with disseminated sulphides.

Determination of ore body continuity by a 2.5D resistivity tomograph method

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The electrical resistivity method has been used in the exploration industry for many years. However, it is mainly used on surface surveys and has not been applied extensively in crosshole situations. Two reasons for this are that there is not a very good inversion technique developed for crosshole geometries and there is not a good way to display crosshole survey data like pseudosections in surface surveys. But the need for detecting geological structures between two boreholes in the mining industry is urgent.

Here we present a few examples for detecting ore body continuity with the 2.5D resistivity tomography method. Firstly, we produce a few sets of borehole numerical modelling data for different models, with our 2.5D FEM resistivity modelling program. Then, our 2.5D FEM resistivity inversion program is used to invert the model data to obtain the resistivity distribution between the two boreholes. The three examples show that 2.5D resistivity inversion can clearly detect the ore body continuity between two boreholes from simple bipole bipole scanning data. The technique can be very easily used in exploration and is most useful for mining purposes to delineate the structure between boreholes.

LAND SEISMIC ACQUISITION

Mini-SOSIE – successful shallow 3D seismic data acquisition in an environmentally sensitive area

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Environmental and cultural restrictions are increasingly impacting exploration efforts for mineral and energy resources. It is almost impossible to gather seismic data without being constrained by these factors. 3D land seismic data acquisition requires intense source and receiver sampling particularly for high resolution work where shot and receiver line intervals can be as little as 45 m. Consequently, the acquisition method chosen is extremely important, as it will govern the degree of environmental impact imposed by the survey.

In the case of the Onley 3D survey, traditional sources such as dynamite and vibrator were deemed to be unacceptable, on environmental grounds. Mini-SOSIE, which utilises a light, portable surface compactor (Rammer) as a source was an acceptable alternative. After comparing the results from the 'Rammer' source with dynamite and vibrator sources, the Mini-SOSIE system proved to have the penetration and resolution needed to acquire useful 3D data. However, as could be expected, the signal bandwidth of the Mini-SOSIE (and vibrator) data was not as high as that of the dynamite data.

After extensive software and hardware development aimed primarily at increasing recording channels and receiver line numbers, a pilot 3D seismic survey was recorded. The aim of this survey was to delineate small faults and other geological features, to assist in mine planning. The Mini-SOSIE 3D data were of high quality. From the interpreted data volume it was possible to resolve a seam split as well as a likely small fault – critical information for mine planning.

The environmental impact imposed by the survey was minimal, with no negative feedback from relevant landholders.

Sweeping changes for vibroseis operations

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This paper reviews current slip-sweep and High Fidelity Vibratory Seismic (HFVS) operations and tracks their evolution over the past three to five years. Projecting the technological advances and operational experience over this period, high-productivity and high-resolution vibroseis surveys may become a future standard in the oil industry.

Such surveys utilising simultaneous sweep technology are designed to use increased vibroseis production to explore large areas with suitable fold and resolution, or improved seismic data quality through increased fold and denser surface sampling.

Further improvement in seismic data quality in all forms of vibroseis acquisition is achievable by real-time processing of actual vibrator ground motion with the uncorrelated field record. Perhaps vibroseis signal correlation with a synthetic pilot sweep will become an outdated standard?

Quantitative source testing : a comparison between an 60 000lb vibrator and an 80 000lb vibrator

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The Quantitative Quality Analysis (QQA) method provides an alternative to subjective analysis of source tests by using analytical measurements on the seismic signal. This is achieved by measuring a number of wavelet attributes of the seismic signal to determine seismic quality. This provides an objective method to determine quality. The QQA method is demonstrated on a vibratory source test where a 60 000lb M26 vibrator is compared with an 80 000lb M30 vibrator on a prospect in Australia. The combination of these attributes shows the QQA method can clearly differentiates between 60 000lb and 80 000lb vibratory sources in a manner, which is consistent with expert subjective analysis.

SEISMIC PROCESSING AND ATTRIBUTE ANALYSIS

Estimating residual statics using prestack migration

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A method is presented for estimating residual statics that are computed prior to normal moveout correction. No velocity information is required, and the offset and structure terms are eliminated from the decomposition. Model source (shot) records are formed using the EOM method of prestack migration to provide a one-to-one trace for cross-correlation. After cross-correlation, the estimated time shifts are decomposed directly into source and receiver statics.

The method is stable for ling time windows that are input to the cross-correlation, and provides solutions for structured data where other methods fail.

Effect of smoothing radius on refraction statics corrections in hard rock terrains

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The sensitivity of refraction statics to choice of smoothing radius has been investigated for a deep crustal seismic line across part of the Lachlan Fold Belt. The effective smoothing radius depends on the size of the Fresnel zone for the refractor and we demonstrate that choice of smoothing radius is critical to the quality of the final stack where the refractor varies rapidly along the line. If too severe a smoothing is carried out, the quality of the final stack is severely degraded, although it can be partially recovered with automatic residual statics. In this case, automatic statics calculated for a deep gate between 3 and 5 s TWT were able to sharpen features in the upper 2 s. However, the implication for areas without good reflector continuity is that determination of the optimum smoothing in calculation of refraction statics is crucial.

A new technique for mapping fractures using 3D seismic data

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We developed and tested an attribute mapping technique, which was found very useful in aiding fracture detection. It requires a transform of binned CMP trace data from the original Cartesian spatial coordinates to a Polar system and displays the important seismic attributes in a polar-plot form. Data lineations within the map are direct indicators of the orientation of fracturing. The technique utilises all available azimuths and

offsets in a super bin and can operate on any 3D seismic data with wide azimuthal and offset distributions.

We demonstrate the application using real field data and physical modelling data.

AIRBORNE PROCESSING 2

New advances in the analysis of potential field data by multiscale edges

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Given a gravity profile, the location and size of a block-like approximation to the source can be found with the use of simple formulas that do not involve any searching. This allows for a very fast algorithm and real-time results. The approach has proven robust when tested against different irregular sources and under noisy conditions. An application to real data is also presented.

Designing matched bandpass and azimuthal filters for the separation of potential-field anomalies by source region and source type.

Designing matched bandpass and azimuthal filters for the separation of potential-field anomalies by source region and source type

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Matched bandpass filtering of potential-field data, based on a multi-layer equivalent source model, provides a useful way to separate short-wavelength anomalies that originate at shallow depths from long-wavelength anomalies that generally originate at greater depths. Matched azimuthal filtering is a new concept that can be used in conjunction with the bandpass filtering to suppress directional noise or to enhance directional signal. An implementation of matched bandpass and azimuthal filtering using multiple equivalent-source layers is demonstrated on aeromagnetic data collected over the Albuquerque Basin, New Mexico, USA.

Improving the quality of aerial gamma-ray surveys

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A review of the parameters used in processing aerial gamma-ray survey data from a number of recent surveys showed that many surveys were processed with incorrect values. Many of the problems arise from unrecognised variations in concentrations of airborne radon during the collection of the calibration data. These problems may be overcome by:

- Testing values against expected values to flag potential problems,
- Deriving the height attenuation coefficient for U from the average values for K and Th if the value does not fall between those for K and Th, and,
- Calculating the sensitivity coefficients at various heights and plotting the K/U and K/Th ratios to reveal any radon effects.

If necessary, a U sensitivity value can be obtained by appropriately scaling the Th value.

MINERAL EXPLORATION APPLICATIONS

The geophysics of the Anjing Hitam Deposit: from mapping shales to a major discovery

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The Anjing Hitam sedex lead/zinc/silver deposit, currently estimated to contain 10 million tonnes at approximately 25% Pb/Zn combined, is one of the most significant new basemetal discoveries in the world during the last ten years. The deposit, still open at its deeper southern extremity, is located at Sopokomil Northern Sumatra, Indonesia some 250 km SW from the city of Medan. It is in an area of high mountainous relief and was only recently recognised as having the potential to host significant basemetal deposits. In July 1999 some two years after the start of the Sopokomil exploration program a major ground EM survey was commissioned using the UTEM system. Before the EM survey, and over a period of three years, the prospective shale and carbonate horizons had been drilled at sixteen different locations and failed to identify a 'substantial' deposit in the area. During the UTEM survey, with every line of data containing at least two to three anomalies, it became obvious that a number of innovative interpretation procedures would need to be introduced to recognise (and compensate for):

- Topographical effects;
- The geometry of the conductive source;
- Structural disruptions to the shale unit, and;
- Localised conductivity increases within the shale unit whose response may be dominated by local current gathering effects.

Introduction of these new interpretation techniques resulted in a number of changes to the initial EM program and identification of a number of targets. The first drillhole of the new drilling program explored one of the EM/geological targets and revealed an intersection of 17 m at 18.8% Zn and 12.4% Pb in what is now recognised as the Anjing Hitam deposit.

Subsequent DHEM surveys confirmed that the massive sulphides, which characterise the deposit and which is concealed beneath the topography, are the cause of the initial UTEM response attributed to the orebody .The initial ground EM response however is now known to have been largely dominated by a current gathering response. Other geological /geophysical targets are currently being pursued on the property, with two of the three drilled targets associated with massive sulphides hosting sedex lead/zinc mineralisation.

Exploration drillhole targeting with gocad: recent advances in 3D model construction, query and visualisation

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The work described here summarises an early experiment in multidisciplinary, integrated 3D GIS for exploration drillhole targeting using the Gocad technology. The objective of the project was to prove the feasibility of 3D model construction and multi-layer spatial data query and analysis using a typically incomplete and inconsistent property-scale mineral exploration data set. The data are from a junior mining company exploring for gold on the south Carlin Trend, Nevada, U.S.A.

A 3D 'topological' structural model of fault blocks and horizons was constructed based on surface fault and contact mapping, and sections interpreted from sparse drilling. The resulting 3D representation corresponds to the vector geological map layer in 2D GIS. A 3D grid was superimposed on the model volume, corresponding to a raster grid in 2D GIS, in which each grid cell 'knows' to which fault block and formation it

belongs. Several more layers of geophysical, geochemical, and spatial-topological data were added to the 3D grid model, which was then used as a basis for query and analysis using Boolean and numerical operations. 3D spatial queries, like their counterpart in 2D GIS, correspond to conventional exploration reasoning for highlighting model sub-volumes favourable to mineral occurrence, and thus likely drillhole targets. They may also be used in developing an understanding of the multidisciplinary data relationships that define mineral occurrence.

Results of this case study demonstrate that a trained user of the technology can construct an advanced 3D topological model of a property containing several formations, multiple fault blocks, drilling, geophysical and geochemical data within a time frame (approximately 10-15 days in this case) that is very short in comparison to project cycle times and data acquisition costs. The value of the model to the exploration team in this case study was regarded as very high, and is now being used as a framework for guiding ongoing exploration decisions.

Recovering IP information from broadband EM measurements

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Fast electromagnetic (EM) inverse techniques can be applied to induced polarisation (IP) data, especially when induction effects complicate the interpretation of IP measurements. The EM inverse modelling algorithm automatically compensates for induction effects and can be used to solve for complex conductivity. A synthetic example is initially presented that demonstrates the successful recovery of dispersion information from an interpretation problem containing EM coupling effects. A pole dipole array operating from 0.01 Hz to 10 kHz is chosen as the system to be studied over a layered, conducting Earth. The results show the deterioration in sensitivity to deep conductors at high frequencies which limits the success of this method at frequencies over 100 Hz. Below this limit, relatively good information is recovered. The procedure is found to be relatively insensitive to the amount of regularisation employed to stabilise the inverse problem. It is also noted that good estimates of the dispersion can be made even when the conductivity structure is poorly defined by the inverse modelling.

ENVIRONMENTAL EM

Geophysical characteristics of salinisation at Cape Portland, NE Tasmania

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An integrated geophysical study of salinisation at Cape Portland, NE Tasmania, has mapped the distribution of saline areas, and has identified constrictions in the hydrogeologic basement and a possible source and transport mechanism for the salt.

EM-31 data collected in the area not only clearly delineate the extent of salt scalds, but also highlight areas of elevated conductivity not visibly affected by salt. EM-31 data has enabled the distribution of the salt to be mapped at a much higher resolution than was previously possible using shallow drilling.

Results from time-domain electromagnetic surveys confirm the responses seen in the EM-31 data and provide additional information about the subsurface distribution of saline material. Conductivity depth pseudosections and layered earth inversions indicate depressions of up to 140 m in the resistive basement are infilled with more conductive material. Ground magnetic data show the distribution of shallow Jurassic dolerite basement features and define a major negative amplitude anomaly, which transects the study area. This feature is coincident with depressions identified from the time-domain electromagnetics and with a negative Bouguer gravity anomaly.

The electromagnetic and potential field interpretations are consistent and indicate the presence of a major palaeochannel infilled with more conductive material. This feature is inferred to be the major control on salinisation in the study area.

Filling in the gaps - validation and integration of airborne EM data with surface and subsurface observations for catchment management - an example from Bendigo, Victoria, Australia

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An airborne electromagnetic (AEM) survey was flown with the TEMPEST System over the Kamarooka study area north of Bendigo.

Conductivity values derived from AEM measurements were compared with borehole conductivity values obtained with an EM39 induction probe, indicating an approximately 1:1 relationship between the two quantities when taking into account the vertical (several metres) and horizontal (100 m) resolution of the AEM values.

The thickness of Tertiary and Quaternary cover overlying Paleozoic basement was mapped as the transition from moderately conductive cover to resistive basement. Palaeodrainage lines were mapped in the lower parts of the survey area using the topography of this interface, and in the upper portions of these buried valleys by tracing low amplitude magnetic trends associated with the valley infill material.

The lateral extent and depth to a shallow (0 to 15 m), highly conductive layer was mapped. This layer was interpreted to correspond to high salt concentrations at the groundwater table. Areas where this layer intersects the land surface correlate with mapped areas of saline discharge.

The conductivity values derived from TEMPEST AEM data provided a regularly sampled 3D framework into which surface observations and sparsely distributed sub-surface observations were incorporated as part of an integrated hydrogeological investigation.

Application of the EM-31 terrain conductivity meter in highly-conductive regimes

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Over highly-conductive earths, the maximum effective depth of investigation of the EM-31 terrain conductivity meter is reduced from its theoretical value of 6 m at low induction numbers. In extreme cases, depths of investigation may be as small as ~2.5 m and ~4 m for the vertical coplanar and horizontal coplanar coil configurations respectively. Sensitivity of the instrument to the depth of the overburden-basement boundary in two-layered earth models is highly dependent on the geoelectric structure. Over highly-conductive earths, the in-phase component of the response is depends strongly on the subsurface electrical conductivity. The restricted measuring range of the EM-31 instrument is however a severe limitation on the usefulness of in-phase measurements in such cases.

PSDM AND DEPTH CONVERSION

The success of PSDM over the Anama Structure in the Papuan Foreland basin, PNG – a case study

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The successful application of Pre-Stack Depth Migration (PreSDM) over the Anama structure has been demonstrated by the recent drilling of the Anama-1 well. The effectiveness of traditional depth conversion methodologies is limited in the Papuan Gulf Area due to significant lateral velocity variations introduced by thick Tertiary carbonates, channelling and shallow gas accumulations in Pliocene-Recent sediments. As a result the validity of Mesozoic structural closures previously drilled in the offshore Papuan Foreland Basin is highly questionable.

Sparse well control, and stacking velocities significantly affected by raypath distortions, hinders the definition of accurate velocity fields. In an attempt to resolve these limitations and improve the accuracy of the interpreted velocity fields, PreSDM was applied to a modern 2D seismic grid acquired in 1998. Detailed velocity interpretation was conducted using coherency inversion across the seismic grid over the entire Anama structure. The resultant velocity model was tied across the seismic data set prior to generating the PreSDM sections. The final depth interpretation was completed on a workstation using the PreSDM sections.

The PreSDM based depth map was used to locate the Anama-1 well. A depth closure was identified with the interpretation of the PreSDM sections where no valid closure was present in the time domain. Drilling results from Anama-1 showed the maximum error for predicted tops based on the PreSDM processing was within 1.2%, while the error for the predicted top target sand was less than 0.5%.

PreSDM processing is principally aimed at improving imaging and lateral continuity. However, by tying the velocity model used in the PreSDM processing across a seismic grid it was possible to improve the accuracy of absolute depths without detrimentally affecting both imaging and lateral continuity. In this case history it was possible to use PreSDM as a predictive tool for absolute depths.

Horizon velocity analysis for depth conversion, a case study

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This case study compares three methods of deriving velocity information from seismic data for the purposes of depth conversion. Horizon Stacking Velocity Analysis (HSVA) and Interval Velocity Analysis (IVA) have been used to derive average and interval velocity data over the Yolla structure in the Bass Basin, approximately 120 km north of Tasmania. The resultant velocity maps are compared with those derived from (more commonly used) vertical function stacking velocities generated during processing.

As HSVA and IVA are both horizon-based approaches to velocity picking, lateral velocity trends can be more readily identified and interpreted to be consistent with the geological structure, than regular stacking velocities. A velocity gradient between the two wells in the survey area is known to exist from check-shot data. This gradient is shown to be more accurately determined from the horizon velocity analysis than from the stacking velocity vertical functions. This supports the conclusion that HSVA and IVA (in this case, and perhaps in general) are a more accurate source of velocity control for depth conversion than more routinely used regular stacking velocities. In this example, the relative accuracy of HSVA and IVA velocities is shown to be within 10 m/s of check-shot data, compared to several tens of m/s for velocity derived from stacking velocity vertical functions.

Buffalo Oil Field: geophysical success under Big Bank

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The Buffalo Oil Field is located in Production Licences WA-19-L and WA-21-L in the Bonaparte Basin, approximately 300 km off the coast of northern Western Australia. The discovery well, Buffalo-1, was drilled in September 1996 and encountered a 45 m oil column within sandstone reservoirs of the Callovian Elang Formation.

The Top Elang boundary is typically very difficult to interpret on seismic data. Modelling has shown this boundary to have a Class II AVO response, i.e. where a polarity reversal of the seismic event occurs across the CMP gather, resulting in attenuation of the event during stacking.

In addition to this fundamental geophysical problem, the Buffalo field underlies a seafloor carbonate bank ('Big Bank'), which rises from the seafloor, 300 m below sea level, up to a depth of 27 m below sea level. Interpretation of the underlying geology on conventionally processed seismic data is made very difficult by severe ray-path distortion from the steep sides of this bank and the large velocity contrast with the surrounding water. At top reservoir level the very poor seismic data quality is a consequence of poor signal penetration, poor reflectivity, faulting, multiples and severe imaging problems, which also give the reservoir section the appearance of being highly faulted.

A 3D seismic survey was acquired in 1996 over the field, and a vast improvement in data quality and reliability was obtained through advanced processing techniques incorporating Wave Equation Datumming (WED). The remaining depth-structure uncertainty was quantified by a geological-model-based interpretation and mapping process to provide a range of realistic possible structural outcomes. A key assumption – that velocity changes across the field would be a relatively minor contributor to the depth uncertainty – was confirmed by development drilling results, which demonstrated the success of the WED method in removing most of the undesirable effects of the carbonate bank.

This paper focuses on the WED processing and interpretation process which reduced the uncertainty of oil-in-place calculations for Buffalo to an acceptable level and allowed development of the field to proceed.

AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES *Sponsored by MIM*

King George: measured and modelled AGG response over an IOCG terrane

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King George is a high priority magnetic anomaly that was identified within regional aeromagnetic data. The anomaly is located in 20-30 m of water in the Spencer Gulf, South Australia, adjacent to the Moonta-Wallaroo mining field. Regional geology indicates that this area is highly prospective for Iron Oxide Copper-Gold (IOCG) style deposits.

IOCG deposits are expected to have a high gravity signature with possible association of magnetic anomalism, the latter being dependent on magnetite content. In March 2000, the Falcon airborne gravity gradiometer (AGG) system was flown over the King George anomaly, previously inaccessible to conventional gravity measurement techniques. The survey showed a 7 mGal gravity anomaly coincident with the 10 000 nT magnetic anomaly, making the anomaly to a high-priority drill target.

Modelling of the airborne gravity and magnetic data indicated that two closely spaced bodies 200 m below the surface produced the observed anomaly. Vertical gravity gD was used during the modelling exercise. The Falcon AGG system measures the quantities GNE and GUV from which vertical gravity gradient GDD and vertical gravity gD are derived. To verify the gravity model, the GNE and GUV responses were also computed and compared with actual quantities measured by the Falcon AGG system. A good match between the measured and the modelled components was obtained.

DOWNHOLE APPLICATIONS

Borehole EM and MMR methods for weak conductors – a project review

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This paper reviews a 3-year research project targetted towards processing and interpretation methodologies for borehole EM methods in the search for weak electrical conductors. Weak conductors are best energised by current-channelling methods, which include both MMR, and inductive loops off-set from the hole collar. The following results have been achieved:

- Recognition of the importance of using current-channelling energisation of weak conductors; a sphalerite-rich conductor is frequently too poor a conductor to support an inductive EM response of vortex currents, but any conductor showing a conductivity contrast relative to host rock, can produce an EM response from currents channelled through the conductor from the conducting host rock.
- Recognition of the equivalence of MMR and long-offset TEM data, in terms of information and interpretation of current-channelling energisation of conductors.
- Comparison of numerical modelling techniques for inductive and current-channelling responses in TEM surveys using state-of-art software (MARCO and LEROI); identification of instabilities in multiple-plate modelling in LEROI .
- Development of an algorithm for modelling the three-component MMR or current-channelling EM response of multiple 3D conductors.
- Recognition of the importance of correct modelling of the MMR response of a layered earth as a precursor to stripping background and modelling of residual MMR anomalies.
- Development of a software package for processing three-component MMR field data (calibration, stripping of wire field and layered-earth background field) and for modelling the data in 3 components, and with multiple 3D conductive bodies.
- Development of a 3D rotatable screen viewer for an arbitrary number of boreholes, transmitters and dipping tabular conductors (incorporated in the above software package).
- Numerical modelling of an MMR phase response.
- A comparison of noise characteristics of different receivers and borehole EM probes.

Noise reduction for down-hole three-component TEM probes

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Three-component downhole TEM probes can provide a unique service for mineral exploration surveys. Apart from assisting with target recognition the individual vectors can be used to resolve rotational ambiguities associated with filament inversion routines. However, noise levels in the crosshole components are often considered to be extreme compared to data obtained with the more common axial probes.

Substantial improvements in data quality are unlikely in view of the physical limitations relating to probe construction. In particular core materials are relatively ineffective in the short crosshole sections and consequently there is no substantial gain in effective physical area. In addition background noise levels in the horizontal EM field may be 5 times larger than for the vertical field. Consequently digital filters and advanced numerical techniques are required to improve data quality in post survey processing.

Deconvolution involving exponential basis functions can provide substantial improvements in crosshole data assuming consistent decay curves scaled for variations in coupling. Apart from reductions in noise the verification of a uniform decay can eliminate the possibility of spurious axial anomalies associated with an extreme core response. More complex scaling factors are required for complex conductors with several iterations to establish the extent of coupling for each source.

Galvanic excitation of the cadjebut Pb-Zn ore body

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Numerical modelling was used to investigate the results from a downhole transient electromagnetic (DHTEM) test survey, which was performed over the Cadjebut lead-zinc ore body in 1987. Unexpectedly, the response due to the inductively well-coupled near-loop contained no signature of the known ore-body, whilst the response due to the offset loop contained a prominent negative intersection anomaly.

A dual-slab block model representing the known mineralisation was constructed using a 3D integral equation program MARCO. This algorithm was used because it permitted modelling of both inductive and galvanic effects. The response generated from this model for both the near and far loops contained a weak and strong single-signed galvanic anomaly, respectively. Current channelling was recognised as the primary excitation mechanism after consideration of the anomaly sign and verification with decay analysis. Specifically, decay analysis of the anomaly within the offset loop data yielded decay indices a= -3.27 and a= -3.47 for the field and model data, respectively. These results are in agreement with the decay index identifiable with current channelling, namely a=-7/2.

The modelling has demonstrated the importance of offset loops in the production of detectable current channelling effects, which in turn enables the detection of weakly conducting targets which may otherwise be invisible to traditional inductive exploration methods.

HIGH RESOLUTION GEOPHYSICS

Measurement of rock fabric in shallow refraction seismology

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A three-dimensional (3D) seismic refraction survey was carried out across a shear zone. The data were processed with the generalized reciprocal method (GRM) rather than with tomographic inversion because of the relatively small volume of data, the occurrence of large variations in depth and wavespeeds within the main refractor, and the presence of azimuthal anisotropy.

The amplitude products of the refracted signals are approximately proportional to the square of the ratio of the specific acoustic impedances between the upper layer and the refractor. The ratios of these amplitude products for different azimuths of shot pairs for a given set of geophones provide a convenient and detailed measure of apparent azimuthal anisotropy or rock fabric.

Qualitative measures of azimuthal anisotropy are obtained from the wavespeeds and the time-depths computed from the traveltime data with the GRM algorithms and from the amplitudes. These three methods give similar consistent results, with the direction of the greater wavespeed being approximately parallel to the direction of the dominant geological strike. Furthermore, all three methods show that the direction of the greater wavespeed is approximately orthogonal to the direction of the dominant geological strike in one region adjacent to the shear zone.

Using high-resolution aeromagnetic surveys to map subsurface hyrogeology in sediment-filled basins: a case study over Rio Grande rift central New Mexico USA

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High-resolution aeromagnetic surveys were acquired for the Albuquerque Basin in the central Rio Grande rift, a basin filled with poorly consolidated sediments. The surveys proved successful in efficiently and economically mapping previously unknown hydrogeologic features of the shallow subsurface. This success suggests that aeromagnetic methods may be useful in hydrogeologic studies of other sediment-filled basins.

The aeromagnetic surveys were used primarily to delineate buried igneous rocks and to locate faults within the basin fill, both important for understanding the subsurface hydrogeology. Buried igneous rocks were recognized from their high-frequency, high-amplitude anomalies and anomaly patterns. The horizontal-gradient and local wavenumber methods were applied to these anomalies to obtain estimates of their source depths. The aeromagnetic surveys were also successfully used to locate faults within the basin fill. Anomalies associated with faults are produced by the juxtaposition of sediments having differing magnetic properties, contradicting the traditional belief that magnetization of poorly consolidated sediments is negligible. Expression of faults is abundant throughout the basin, revealing patterns that cannot be mapped at the surface due to widespread cover.

A fault signature recognized in the high-resolution data that has multiple inflection points is best explained by a fault with a thin magnetic layer on the upthrown block and thick magnetic layer on the downthrown block, called the thin-thick layers model. Geologically, this signature indicates erosion of the upthrown block or a growth-faulting scenario: fault-controlled sedimentation for faults that offset sediments, and successive accumulation of basalt on the downthrown block for faults that offset volcanic rocks.

Rapid portable gamma ray spectrometer surveying

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Spectral component analysis is commonly applied to airborne gamma ray spectral data to reduce statistical noise in the measurements of potassium, uranium and thorium. This technique has been applied to continuous 5-second ground measurements with a portable gamma ray spectrometer using a 7.6 cm x 7.6 cm (3 inch x 3 inch) sodium iodide detector. The results have shown that the reduction in statistical noise is much greater than for large airborne detectors. Even with a short sampling time of 5-seconds, continuous ground measurements have practical significance for both geological mapping and mineral exploration.

Detection of cavities and tunnels from gravity data using a neutral network

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We have developed a simple approach to determine the depth and radius of subsurface cavities from the microgravity data. Horizontal location of the cavity centre is picked up by an algorithm as the projection of the minimum of gravity anomaly. Depth to the cavity centre is determined using back propagation neural network. The cavity radius can be then calculated using the determined parameters if the density contrast between the host rock and the cavity filling materials is known or assumed according to the geological background. The present method is tested by several synthetic data sets and showed high ability to determine the cavity parameters in presence of natural noise. Applying the method to field data from Medford cavity site, Florida, the estimated cavity parameters are coincident the boring results. The method is proved to be fast and robust and can be used in field situation.

AVO

The AVO modelling volume

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An AVO modelling scheme is proposed in which we create a 3D volume of modelled CDP gathers by varying two physical parameters, one in the in-line direction, and one in the cross-line direction. This 3D volume is then processed using conventional AVO analysis techniques, and the results are interpreted using time or structure slices. Two examples are presented. The first involves P-wave velocity change in one direction versus S-wave velocity change in the other. In the second, we change porosity in one direction against water saturation in the other, using the Biot-Gassmann equations to perform the modelling. In the first example, an excellent fit is obtained between actual and expected results. In the second example, the fit is encouraging, but far from perfect. This study has therefore motivated future research into the use of multi-attribute statistical methods on this problem.

Integrated AVO analysis in offshore south eastern Australia

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Integration of sequence stratigraphy, amplitude mapping and AVO analysis was used within an offshore lease area to reduce uncertainty for a field development and to improve understanding of prospects on the northern flank of the Gippsland Basin in offshore Victoria.

Sequence stratigraphic mapping was confined to identification of reservoir-seal pairs of significance with subsequent horizon-based analysis at those interfaces. Post-stack amplitude mapping at the events was ambiguous. Pre-stack reconnaissance indicated that the ambiguity arose largely from a Type 2 AVO response. Further scanning of the pre-stack gathers lead to a method for identification of a gas response.

Good matching was obtained between half space modelling and the actual response using four wells as input. The gas-reservoir AVO response within the field area was found to include both Type 3 and Type 2 responses across a wide range of Acoustic Impedance contrasts. The wet reservoir response shows a clear separation from the gas response and in the Intercept versus Gradient domain both can be mapped across the 3D volume.

Noise analysis shows that at moderate depths the AVO gas and water trends can be used to infer similar responses in locations beyond the area of immediate well control but at depth the method adds little value.

The results have lead to a much tighter estimation of risk within both the development area and adjacent prospects.

Numerical and physical modelling of P-wave AVO response for fractured media

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In this study we investigate variations of P-wave reflection coefficients with offset (AVO) and with azimuth (AVA) for a transversely isotropic medium with a horizontal axis of symmetry (HTI) in contact with water, and also with another HTI medium. Aligned, equidistant, vertical fractures, imbedded in an isotropic background, were used to represent a HTI medium. To grasp the effect of fractures their contribution was computed separately and then added to the isotropic background. The total response of a medium is then obtained by adding the two.

An approximate equation is used to compute partitioning of seismic energy at layer interfaces. The solution compares well to the results obtained in physical modelling experiments. To analyse AVO and AVA effects we used 3D multi-azimuth transmission and reflection surveys. The results show that AVA effects are significant even at moderate angles whilst they are dominant for large incident angles. Routine 2D AVO analysis, as commonly performed, is clearly unsuitable for HTI media.

A case study on using AVO walkaway VSP data: Barrow Sub-basin, Western Australia

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In December 1999 the TL/1 JV partners acquired a 2D walkaway VSP survey in the Monty-2 well in the Barrow Sub-basin, Western Australia. The survey was designed to analyse AVO effects and possible later calibration of surface seismic data. The survey was recorded using CGG's 12 level array tool, the SST-500, and comprised a total of four walkaway lines, with two azimuths at each of two array positions. Each of the four walkaway lines had a length of 6000 m. Walkaway VSP data were acquired by positioning the array tool just above the two target reflectors, the North Rankin and the Mungaroo 'B' sandstone formations.

The VSP data were processed using an 'isotropic' sequence, which allowed for a perfect preservation of the amplitude and phase relationships between the three receiver components. AVO estimates were computed from the reflected P-wavefield after shaping deconvolution, derived from the down going P-wavefield. P-wave polarisation information was used to compute reflection angles at the target horizon and the local reflector dip. Finally, synthetic P-wave reflectivity curves were computed for the North Rankin and the Mungaroo 'B' sandstone formation and compared with the borehole seismic measurements.

The AVO/AVA response at the top North Rankin reflection was found to be strongly affected by a thin overlaying carbonate layer. The best match between measured AVO curves and isotropic modelling therefore was found for a shale/carbonate model rather than a carbonate/sandstone model. In contrast, the AVO response of the Mungaroo 'B' reflection was found to be in very good agreement with isotropic modelling results.

AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES *Sponsored by MIM*

The geophysical characteristics of the Trilogy massive sulphide deposit, Ravensthorpe, Western Australia

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The Trilogy deposit is a polymetallic massive sulphide deposit hosted within the conductive graphitic phyllites of the Proterozoic Mount Barren metasediments. There are two different styles of mineralisation, Pb-Zn massive style mineralisation and Cu-Au stringer style mineralisation, contained within a silicified envelope that hosts the mineralisation.

Petrophysical samples were taken and geophysical surveys conducted to characterise the response of the massive sulphide system to help define an exploration model.

Gravity, ultra-detailed airborne magnetics and radiometrics, airborne time domain electromagnetics (EM) and ground time domain EM have all been conducted over the deposit. The gravity outlined the position of the massive Pb-Zn mineralisation. A radiometric low around the surface projection of the silicified zone was evident in the airborne radiometrics. There was no response from the deposit recorded in the airborne magnetics. There is a subtle airborne EM anomaly over the known mineralisation, but the ground EM better defines its location and EM response. The airborne EM anomaly produced by the deposit was small compared with the response of the conductive phyllites elsewhere in the region.

Geophysical exploration may aid in the search for additional sulphide mineralisation in the area. The combination of airborne EM with followup detailed gravity and ground EM have proven to be the most effective geophysical methods in locating Trilogy style mineralisation in the Mount Barren basin.

Comparison of airborne and ground TEM systems for a conductor beneath conductive cover: an example from north-west Queensland, Australia

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Magnetite-pyrrhotite mineralisation at the Bull Creek Prospect in North-West Queensland is both magnetic and conductive. The mineralisation of Proterozoic age is buried beneath 30-50 m of conductive younger cover. Overburden conductance values of 10 to 30 S make this a challenging area for airborne electromagnetic systems. The presence of this conductive cover and availability of ground EM and drilling information make this a valuable case study for evaluating the performance of airborne electromagnetic systems.

This paper presents data from both ground and airborne time domain electromagnetic systems and compares conductivity sections derived from the data with drilling information.

The moving loop ground EM system produced a very clear response from the basement conductor. This conductor was also detected by the 25 Hz GEOTEM and TEMPEST systems flown over the prospect in 1997 and 1998 respectively. Conductivity sections derived from measured response data were useful for visualising the response variations. Due to the width of the discrete conductor and the continuity of the conductive cover, conductivity sections based on a 1-dimensional approximation provided reasonable quantitative estimates for the thickness of conductive cover and the depth to the conductor.

Of detritals, derivatives and determination: an example of detrital iron discovery

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The Hamersley Basin of Western Australia holds significant tonnages of detrital iron deposits. Formed by a cyclic weathering and eroding sequence of nominally barren banded iron formation, they may form rich proximal accumulations of iron-cemented gravels distal from any obvious hard-rock iron mineralisation. While generally small, they nonetheless represent excellent economic targets, as they are near-surface and easy to mine. The relatively high density of iron detritals, as compared with their sedimentary hosts, makes the gravity method the primary method of exploring for these blind deposits. Identification of possible trap sites is used as a precursor to gravity surveying, with magnetics used as an ancillary method prior to drilling.

Application of the gravity method in this terrain is not straightforward. Detrital trap sites are best developed next to the spectacular cliffs that form the range fronts to the Hamersley Ranges. Precise terrain corrections and use of first vertical derivatives are routinely applied to gravity data in an effort to map every possible gravity high that may reflect the presence of a detrital accumulation. Extensions to Hamersley Iron Pty. Ltd's BS2D deposit were discovered by the routine application of gravity. It has been used to create a model by which exploration for detrital deposits continue to the present day.

Airborne EM Applied to Sulphide Nickel: Examples and Analysis

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Exploration for nickel sulphides has often involved the application of airborne electromagnetic data. Some of the early successes of the technique were in Canada in the 1950s, detecting shallow massive sulphides in highly resistive host stratigraphies. As exploration for deeper deposits under cover proliferates, a comparison of different systems and an analysis of the depth of penetration of these systems are required.

An examination of field data from known nickel sulphide deposits shows that the target anomalies are all above the noise level except where shielded by a flat-lying conductor. Using the geological models for each deposit, forward modelling was applied to determine that the ore bodies chosen for this study could be buried deeper before the system used would cease to be an effective exploration tool. A forward modelling exercise shows that all methods examined are able to identify the target. Systems with the lower base frequency give the best results.

DEVELOPMENTS IN PROCESSING

The application of Zohdy's method to AEM data

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Zohdy's method for modelling DC-resistivity data has been adapted to the modelling of airborne electromagnetic (AEM) data. AEM responses are first transformed into apparent conductivity – depth profiles, followed by an iterative adjustment of layer thicknesses and interval conductivities. The method is faster than layered-earth inversions, while offering the main advantages of Occam's inversions. The starting model, including the number of layers, is determined from the data, which optimises model flexibility without the need of parameter regularisation. While Zohdy's method models abrupt vertical conductivity changes smoother than they are, results from synthetic and field data indicate that for some conductivity scenarios up to five distinct layers can be resolved from TEMPEST data. Modelled conductivity sections of TEMPEST data acquired across the Bull Creek prospect in Queensland clearly indicate the mineralisation beneath 30 m of conductive overburden.

Extraction of principal component shapes from grids

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The country's increasing collection of data sets and increasing resolution of instruments creates an opportunity to put the redundant data to work. The shape of the grid on fine scales may not be evident to the eye. However, if a vector of shape components at each point is available, images and quantities may be extracted.This paper shows how to extract such a multiband dataset using shape filters in the locality of each point in the original grid, and then characterise it by constructing the principal component shapes.

The basis components are obtained by running basis filters composed of orthonormal functions across the grid. The functions are on the scale of the locality of interest, so that each characterisation is on the scale selected.

Consequently the shapes associated with each of the principal components for an area can readily be extracted. Apart from mapping, the principal component shapes are expected to be of value for numerical modeling and for automated searching in GIS.

Reducing cross-profile aliasing in aeromagnetic data

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Image processing of high-resolution aeromagnetic data is an essential tool in mineral exploration and is finding increasing application in petroleum exploration. However, interpolation of the flight line data onto a regular grid can lead to loss of high frequency information and introduction of gridding artifacts, which can obscure subtle anomalies of interest. There is a high degree of anisotropy in sampling with closely spaced measurements along flight lines and much wider spacing between flight lines. For surveys conducted over shallow magnetic basement, there is significant high frequency information in the located total magnetic field data profiles, which is lost or distorted in gridding. Gridding of line data is always a compromise between honouring closely spaced data along line and producing smooth and continuous interline interpolation between widely spaced flight lines. Cross-line aliasing is a minimum when flight lines are perpendicular to the geological strike but where multiple trends are present or where we have local trends, aliasing is directional and cross profile aliasing may be severe. A problem, common to all gridding methods, is that linear trends at an acute angle to lines tend to produce 'bull's-eyes' at line intersections. Linear and curvilinear anomalies appear as stepladder or string of beads effects. This paper examines methods of improving line to line correlation and concludes that gradient enhanced gridding using measured transverse gradient provides the best solution to interpolating between flight lines as this provides direct information on magnetic anomaly variation between flight lines. However, when measured gradients are not available it is still possible to use calculated gradients or other search techniques to improve line-to-line correlation and reduce stepladder and string of beads effects to an acceptable level.

An heuristic method of removing micro-pulsations from airborne magnetic data

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An automatic, heuristic method has been developed for the removal of micro-pulsations from airborne magnetic data to improve the geological integrity of data. This method was applied to data collected in a high-sensitivity survey flown off the coast of Nova Scotia, Canada from September to October, 2000. This method permitted the diurnal data measured on land to be used to subtract micropulsation variations from the airborne data. Small differences in the variations are allowed between the data acquired at the base station and on the airborne platform. This is because conductivity contrasts between the land and sea water will change the amplitude and phase of the micropulsation.

The new method adjusted the land based diurnal data to match the phase and amplitude of the micropulsations measured in the airborne data. These adjusted micropulsations were then removed from the data. This improved the final levelled data so that obvious micropulsations are not evident. This noise reduction is critical, as any filtering which may be applied, cannot remove diurnal events from the airborne data without possibly removing geological signal.

The procedure will produce higher quality data that better show weaker features and patterns than the standard processing produces, such as subtraction of the base station data.

PETROLEUM INTERPRETATION TECHNOLOGIES

Integrated interpretation of well logs and surface seismic

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Formation properties such as mineral composition, fluid contents, porosity, permeability and etc are accurately obtained from the petrophysical interpretation of well logs. After calibrating the petrophysical interpretation with well testing results, the net pay zone is quantified.

Different seismic attributes (facies) are associated with different subsurface formation properties in different ways. These distinguishing relationships are used to map the areal distribution of formation properties, particularly reservoir fluids.

The integrated interpretation of well logs and surface seismic adds value to the process of reservoir optimisation. The in-situ measurements of the logs are the ultimate ground truth and are linked to surface seismic via the transformation from logs to seismic waves. This transformation is the vital link to the integrated interpretation of well logs and seismic attributes.

Acoustic analysis of overpressure: from modeling to wireline observation

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A comparison between acousto-elastic modelling, surface seismic, and wireline responses to overpressure suggests that acoustic responses to overpressure are not uniform among the data of different sources. Acousto-elastic modelling underestimates the effect of the in-situ formation pressures on acoustic properties of waves. That seismic energy decreases with increasing pore pressure is evident for either very low overpressure or extremely high overpressure, but becomes less definite for moderate overpressure. Sonic logs in conjunction with wireline pressure measurements in a number of wells are used to establish a common understanding of acoustic-pressure relationship in the Muderong Shale of the northern Carnarvon Basin. The velocity-pressure relationship in the Muderong Shale seems to be controlled by stratigraphic factors. In the same stratigraphic category, acoustic velocity changes across wells are found to be consistent with pore-pressure variations in our examples. Investigation of velocity-pressure relationships for the Muderong Shale indicates that pore-pressure prediction should be based on the detailed lithologic classification.

Cascade inversion for tilt data

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We investigate an inverse problem for mapping hydraulic fracture geometry using surface tiltmeter data. It is well known that this problem becomes a non-linear inverse problem. If the inversion algorithm can be separated into two stages as: (1) the identification of the fracture plane and (2) the estimation of the fracture aperture distribution, the computation scheme becomes robust and stable. We call this methodology a cascade inversion scheme for tilt data.

In the first stage of the inversion, the fracture plane is estimated by the Nelder-Mead simplex method whereby we obtain the volume of the hydraulic fracture. The fracture aperture distribution is then determined by the successive linear inversion stage. In this second stage, the fracture plane is divided into small rectangular pieces and each piece has a different fracture aperture. The normal equation, where the fracture apertures are unknowns, can be solved by the least squared method with two constraints, which are the smoothness and non-negative values of the fracture apertures.

The proposed methodology was applied to synthetic and field data. The inversion results are quite acceptable and we conclude that this cascade inversion scheme is a robust method and easy to apply to field data.

SEISMIC MODELLING OF NEAR-SURFACE EFFECTS

Topographic scattering effects on seismic data: from seismic numerical modeling to field data

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Using synthetic seismograms, we study the influence of the widely observed strong scattered noises in complex near-surface areas. Our studies show that an intense scattering occurs in near surface regions, especially in the near-source and near-receiver regions. The scattering is dominated by rugged topography. These strong near-surface scatterings can seriously decrease the energy of valid signals and significantly increase noise levels that mask the interesting reflections. The study of simulating wave scattering by a low-velocity topographic structure in the western areas of China shows that the topographic effect is the most important factor to degrade the quality of seismic data in these areas.

Numerical modelling of seismic reflection in basalt terrains

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We have used numerical modelling to improve understanding of seismic reflection in basalt-covered regions. Our models are based on hydrocarbon prospects in the Denison Trough, Queensland, Australia.

Reflectivity modelling has been used to assess the influence of a range of model and source parameters. Models that include a single near-surface

basalt layer generally result in relatively noise-free reflection signals, provided the basalt is reasonably attenuative. Reflection quality is poorest for models with buried high-velocity basalts, or for multi-layered basalts interspersed with lower-velocity material. Such models result in strong reverberatory noise, apparently propagating between the surface and basalt, or within the multi-layered basalts. In these situations, reflection strength is significantly improved if the source can be positioned below the basalt.

Finite-difference modelling permits analysis of models incorporating lateral variations in basalt geometry. Shot records generated with this approach exhibit basalt-related features seen routinely in real field data. Simple stacking of the finite-difference records indicates that reasonable sections can be obtained in areas of near-surface, or thin, basalts. Poorer stack quality is associated with thicker, buried basalts although deeper reflectors may be imaged by undershooting the basalt.

Effects of the traction-free surface with a rugged topography on seismic wave propogation: numerical modelling

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Understanding the impact of rugged topography on seismic data provides a means to design strategy to reduce or eliminate these effects from the seismic data. In this paper, the effect of rugged topography on synthetic seismic data is studied by using a finite-difference method with a velocity-stress staggered algorithm. Based on the FD algorithm, the imaging and vacuum methods are used to simulate the elastic wave propagation in flat and rugged traction-free interfaces for both acoustic and elastic models. Seismic waves in heterogeneous media with a rugged topography are numerically simulated, and the properties of the P-wave, S-wave, and Rayleigh wave along the topography are discussed. Shear waves, surface waves and their scattered events along the topographic surface are major contributions to the scattered energy propagating with slow velocities. Furthermore, effects of the topography on the synthetic seismic data are eliminated effectively by employing our proposed method based on full elastic wave theory. For removing the scattered waves from a near surface topography, the numerical simulation demonstrated that our method, taking into account shear and surface waves such as Rayleigh and Love waves, as well as P-waves, is very effective for synthetic data, provided the properties of the near surface with a rugged topography are known.

AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES *Sponsored by MIM*

2D and 3D IP/resistivity inversion for the interpretation of Isa-style targets

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A total of 20 line-km of IP, DC resistivity and MT data has been acquired using MIMDAS, (MIM's Distributed Acquisition System), over the Cluny prospect, south of Mt Isa. The utilisation of 2D and 3D inversion programs has provided a significant advantage in the interpretation of these data.

The integration of geology and geophysics through the use of inversion, particularly 3D inversions, has greatly improved the geological understanding of the Cluny region. It has enabled the identification of variations along linear conductors, and anomalous chargeable zones. This has implications for the ability of geophysics to provide discrimination for mineralisation along linearly extensive stratigraphy.

The application of electrical geophysics to gold exploration at Mt Wright North Queensland

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The gold resource at Mt Wright, located approximately 10 km to the northwest of Ravenswood North Queensland, is uneconomic due to its depth. Definition of a shallower resource of similar grade would have a profound effect on the current Ravenswood operation. Recent exploration at and around Mt Wright has been directed toward this end.

Early IP surveys at Mt Wright showed that the mineralised system produced a low resistivity anomaly with moderate chargeability. Trial MIMDAS (MIM Distributed Acquisition System – MIM owned technology), using the pole-dipole/dipole-pole configuration, and CSAMT surveys proved that both techniques have much greater depth of investigation than conventional IP in the Mt Wright area. More than 25 km^2 have since been 'screened', using MIMDAS and CSAMT, to >400 m depth for systems similar to Mt Wright. Infill surveys around Mt Wright have mapped the extent of the alteration system and highlighted anomalous zones away from Mt Wright itself. Some of these have been drill tested.

MIMDAS and CSAMT have proven to be effective exploration tools in the Mt Wright area.

Falcon airborne gravity gradiometer survey results over the Cannington Ag-Pb-Zn deposit

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In April 2000 BHP conducted six FALCON airborne gravity gradiometer (AGG) test surveys over the Cannington Ag-Pb-Zn ore body in NW Queensland, Australia.

The purpose of the test surveys was to demonstrate the capabilities of the AGG instrument by comparison with known detailed ground gravity data, to investigate the effects of source distance on signal strength by flying surveys at various altitudes, and to estimate AGG instrument noise levels in survey conditions.

The processed FALCON gD data compare very favourably with the upward-continued residual ground gravity data, capturing most geological features and clearly delineating the Cannington ore body.

Analysis of the effects of source distance on signal strength indicates that with a nominal flying height of 120 m, the FALCON AGG instrument can detect the gravity anomaly from a deposit with the size and geometry of Cannington through 130 m overburden.

By repeating a survey using the same acquisition parameters we can make an estimate of the RMS noise of the instrument under survey conditions. Analysis of repeat survey readings show that the FALCON AGG instrument attained a noise level of 10 Eötvös RMS in the bandwidth from 0.0 Hz to 0.125 Hz during the Cannington test flights.

EM INTERPRETATION

The moments of a sphere in a uniform field, a versatile model

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The moments of a sphere in a uniform field can be used to approximately model the moments of a sphere in a dipolar field. The numerical computations are trivial and the approximation is especially good for higher-order moments. The greatest discrepancy is seen on the zeroth-order moment at large radii, however, the zeroth-order moment is not commonly used for interpreting airborne electromagnetic data.

The sphere in a uniform field can also be used to approximate the response of a body that has its currents constrained to flow in a specific dip plane. This means that plate-like bodies or anisotropic spheres can also be modelled.

The third-order moment of MEGATEMTM data acquired over the Reid-Mahaffy test site shows an anomalous response than can be modelled by a sphere at 170 m depth with a conductivity of 15 S/m and a radius of 40 m. The currents flowing in the sphere are constrained to flow in a vertical plane. This model is consistent with the geology of the area and a hole drilled to test the anomalous zone.

Emax conductivity-depth transformation of airborne TEM data

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Conductivity-depth imaging is a convenient form of presentation for preliminary interpretation of ground and airborne EM data. This paper describes the airborne EM adaptation of the Emax conductivity-depth transformation, originally developed for ground TEM. The transformation proceeds in two stages: first the apparent conductivity is determined at a given delay time; then the depth of the current maximum in a half-space with conductivity equal to the apparent conductivity is adopted as the apparent depth at that time.

The advantage of the Emax transformation is that it is readily adaptable to a wide variety of TEM data. The disadvantage is that apparent conductivity is not unique, nor always defined. In practice this does not usually pose difficulties for transformation of airborne EM.

The utility of the Emax transformation to airborne data is illustrated via application to GEOTEM_DEEP total field data. The total field provides a degree of immunity to receiver mis-orientation.

Airborne EM survey over the Groote Eylandt manganese mine

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A Geotem® airborne electromagnetic (AEM) survey was flown over the Groote Eylandt manganese mine in May 1991 to characterize the conductivity and magnetic properties of the manganese ore and host rocks, in order to assess if AEM was viable in exploration for such a deposit type. Strong EM responses correlated with most of the known manganese ore zones. Subsequent drill hole EM surveys confirmed the conductive nature of most of the different types of ore. These results demonstrate that AEM is a cost-effective method of reconnaissance exploration for Groote Eylandt style manganese, providing the host rocks are comparatively resistive.

SEISMIC MIGRATION

Prestack kirchhoff migration and amplitude accuracy

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Prestack Kirchhoff migration is a successful seismic imaging method, commonly used in exploration seismology. Amplitude analysis and AVO attributes are also a common part of exploration seismology; hence the amplitude integrity of prestack Kirchhoff migration is an important issue. Accurate amplitudes do not naturally fall out of Kirchhoff migration. Three corrections must be computed and applied to the migration operator to ensure accurate amplitudes.

First, an anti-alias filter must be applied to ensure that residual operator noise is not created. The anti-alias filter can affect the amplitudes of both flat and dipping events. Next, a derivative filter is applied to ensure that the wavelet phase and frequency content are preserved after migration; this filter does not affect the migrated amplitudes. Finally, most of the amplitude corrections come from 'true-amplitude' weights that are applied to the migration operator.

Accurate true-amplitude weights are costly to compute and may even not be worth the effort because of potential instability. In practice, various approximate weights are normally applied, resulting in migrated amplitudes that are usually more accurate than those obtained from conventional processing.

The limitations of time migration and trace stretch in the presence of lateral velocity gradients

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This paper quantifies the imaging errors that result from the assumptions of time migration and a preliminary, laterally-variable 'stretch' of the data, in the presence of lateral velocity gradients. The analysis is restricted to media that are approximately homogeneous in the vertical direction, with dip in the same direction as for the velocity gradient. It is shown that a time migration that explicitly recognizes the lateral variation in velocity results in underestimation of steep dips by only a few degrees, even for large gradients of 0.1 s^{-1}. A preliminary stretch of the data, followed by time migration and stretch removal, however, results in a net overestimation of moderate dips by a few degrees and overestimation of steep dips by 15° or more. The errors increase with increasing gradient and decreasing average velocity.

Implicit noise reduction and trace interpolation in wavefield depth extrapolation

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Various types of noise can obscure reflections and refractions on deep crustal seismic data. This study presents a simple but elegant approach to true wavefield processing where noise reduction and trace interpolations are applied implicitly during depth extrapolation. No velocity and source/receiver information is required and the proposed approach can be combined with conventional or available processing algorithms. Prestack processing is successfully applied to a complicated OBS data set, demonstrating an improvement in noise reduction and effective trace interpolation.

Data Management and Risk Reduction in Resource Exploration: approaches to visualising and interpreting geoscientific data

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3D Visualisation of the subsurface of the earth is a relatively new but already proven technology for enhanced understanding and presentation of large datasets thus enabling rapid decision-making. This is the story of one company's efforts to understand and implement these tools. BHP first became involved in 3D visualisation in the mid 1990s through a research initiative that recognized this technology as having great potential to maximize our business. Several years of concerted effort raised our level of knowledge, as we became involved in university and industry consortia. Various types of visualization technologies, for example, 'CAVES', 'HIVES' 'REALITY CENTERS amongst others were trialled. A prototype interactive workbench was built which allowed our geoscientists to view a 3D image of seismic volumes and to interact with the displays. Collaboration rooms were built in our Melbourne and Houston offices. The very positive feedback received from the users of these rooms has led us to our current situation of having 'Smart Workrooms' for most resource teams and a 'Visualisation Room' available for larger teams or for when 3D immersion environments are required. These rooms are already having a powerful impact on the way we do business.

Managing the volume and maximising its value - the benefits of an automated seismic data management system

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Over the past 10 years there has been an exponential growth in the amount of seismic data being acquired, processed and interpreted within the Australian region. The data management techniques used to handle this growing volume however, continue to use technology from the 1970s. Woodside identified this as a major stumbling block in its drive to remain a world-class exploration company. The manual system in use was close to breaking point and it was concluded that an external automated data management system was needed.

The system we have implemented is called SeisLIB and we hope to integrate it into a national on-line data repository.

The major benefits of this system are that it reduces the overall management costs, improves work practices, greatly improves the quality of the archived data and helps to unlock its interpretative potential.

SeisLIB is a comprehensive data management system where all navigation, poststack seismic data and seismic support data is stored online, while the prestack data is catalogued and stored offline. There is direct access from the workstation to SeisLIB via a fibre optic link. GIS maps can be built and data delivered directly to the workstation in a number of formats ready for loading.

It is cost effective, flexible, quick and accurate.

Portfolio risk reduction: optimising selection of resources projects by application of financial industry techniques

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We seek to forecast accurately the likely outcome of an exploration program - in particular minimum and maximum and average size of a success; also the chance of achieving a success.

Commonly such predictions are employed in the resource industry, but only on a project-by-project basis. When a group of projects are combined in a portfolio, a higher level of evaluation is possible by quantifying the correlation coefficients among the projects. The outcome is that the result is not necessarily the sum of the parts.

The approach in this paper draws on financial portfolio theory, and is routinely employed in the financial industry. It faces a similar challenge of forecasting outcomes (from investments).

Analysing projects within a portfolio structure has the advantage of reducing the uncertainty for the resultant range of deposit sizes that may be encountered after a success. It allows selection of the most efficient group of projects that maximises the expected NPV value for the total portfolio, while at the same time minimising the uncertainty in the range of NPVs that could be expected.

Furthermore, if projects are selected with low correlation coefficients with each other ('diversification'), then the chance of obtaining one success is increased, compared to projects that are more positively correlated.

AUSTRALIAN MINERAL EXPLORATION CASE HISTORIES *Sponsored by MIM*

Tritton Copper Deposit, Girilambone NSW: a geophysical discovery

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The Tritton massive sulphide copper deposit was discovered using systematic moving loop surface EM surveys. The use of this technique was based on previous experience around the Girilambone copper mine. The deposit consists of an upper and lower lens, both of which are highly conducting. The lower lens was discovered through the use of downhole EM techniques.

The upper lens lies at a depth in excess of 160 m below the surface and the lower lens is at a depth of greater than 400 m. Both these lenses have EM time constants of about 10 mS.

Apart from having a minor associated magnetic anomaly, the Tritton deposit has not been seen from the surface by any other geological, geochemical or geophysical technique.

Approximately 1 km north of Tritton is the uneconomic sulphide deposit, Budgerygar. This has similar geometry to the Tritton deposit but lies at the shallower depth of 60 m. The Budgerygar deposit is readily detectable by a variety of geochemical and geophysical techniques. The Tritton and Budgerygar deposits are interesting test sites for the development of new exploration technology, due to the similarity in their form but difference in depth and hence detectability.

Geophysics and the discovery of the Cadia gold-copper system

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The Cadia Gold Copper system in Central West NSW is a world-class porphyry gold copper system, where geophysics has helped to discover or define some of the resources.

Initial drilling at Cadia Hill employed ground magnetic data to help optimise drillhole direction.

A ground magnetic target was drilled at Cadia East, and showed increasing copper grades with depth. Follow up drilling discovered the Cadia East mineralisation under Silurian sedimentary cover.

Ground magnetic and 200 m dipole-dipole IP data led indirectly to the discovery of the Ridgeway mineralisation under Tertiary basalt cover, by detecting the magnetite and pyrite halo above the mineralisation. The IP drillhole intersected anomalous gold and copper. Deeper follow up drilling intersected the Ridgeway orebody.

Other data acquired across Cadia include heli-magnetics / radiometrics, gravity, downhole EM at Ridgeway, and physical property measurements.

Overall, magnetics and IP have been the most successful methods used to date.

Case History: the search for opal at Lightning Ridge

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Opal at Lightning Ridge typically occurs at the interface between the electrically resistive Wallangulla Sandstone and the deeper conductive Finch clay facies. The best quality opal is generally found beneath thicker portions of the Wallangulla Sandstone and associated with local jointing, faults and breccia zones.

Electrical, electromagnetic, magnetic, induced polarisation and seismic reflection surveys have all been trialled by the New South Wales Department of Mineral Resources at Lightning Ridge. The electrical and electromagnetic methods appear to provide a means to define the conductive Finch clay facies (or 'opal level'), the overlying and moderately resistive Wallangulla Sandstone and the highly resistive surface gravel and silcrete (or 'shincracker') layers. Localised linear features appear to be well-defined in both TEM and high-definition ground magnetic data as electrically resistive and high frequency magnetic anomalies. Results indicate that an ultra-detailed airborne electromagnetic survey may assist in the future search for opal at Lightning Ridge.

REGIONAL APPLICATIONS

Regional gravity and regolith geochemistry as an integrated tool for mineral exploration

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The Geological Survey of Western Australia has carried out helicopter-supported regional regolith sampling and gravity capture, based on a 4*4 km sampling grid. Started initially as a regolith-sampling program in 1994, gravity capture was added in 1998 with little increase in cost or time.

Each survey targets a 1:250 000 scale map sheet in less extensively explored parts of Western Australia, which invariably have poor gravity coverage. The gravity data provide valuable information on regional-scale structures and help in the interpretation of regolith chemistry. In conjunction with regional aeromagnetic surveys, the gravity data are also of use in regional mapping.

In an area of Proterozoic and Archaean rocks in central Western Australia, areas of potential mineralization have been identified by combining gravity data with regolith chemistry and bedrock mapping to indicate where regional faults and shear zones have probably acted as conduits for mineralising fluids.

The simultaneous capture of gravity data and regolith samples in the same field program is an effective approach to regional mineral exploration.

Spectral depth analysis of the Merlinleigh Sub-basin using potential field data

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Two-dimensional spectral analysis has been applied as an automated interpretation method to potential field data from the Merlinleigh Sub-basin. This has enabled a comprehensive idea of the main variations in basement depth to be obtained rapidly across the region as an aid to further exploration. The results suggest that the basin contains several fault-bounded troughs, which reach about 7 km in sedimentary thickness.

Mapping basement relief with airborne gravity gradiometry

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Airborne measurement of gravity tensor components provides a new means of high-resolution mapping of the gravity field. The tensor components attenuate more rapidly with increase in source depth than does gravity, so these methods are best suited to the investigation of shallow sources. A primary use of gravity studies in both petroleum and mineral exploration is the mapping of basement relief.

In this study gravity tensor variations have been computed over a complex model representing a horizontally and vertically faulted basement surface. Simulated measurement noise was added to the model output to create synthetic data sets. This synthetic data were then inverted to investigate the limitations of recovering basement structure from the data.

The model results presented in this study show that gravity gradients over wide and extensive vertical steps in a 0.4 t/m^3 interface with amplitude +/- 10% of depth can be reasonably inverted up to noise levels of approximately 10 E.u rms. Multi-profile inversions substantially outperformed single profile inversions, indicating their value in suppressing random profile-to-profile noise.

SEISMIC CASE HISTORIES

Seismic reprocessing contributes to development success at the Elang Field, Northern Bonaparte Basin

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The 3D data set over the Elang Field, Northern Bonaparte Basin, was reprocessed to provide greater confidence in mapping the structural configuration of the field and to investigate infield development opportunities. The original (1994) data set, which was acquired and processed in the inline (strike) direction, suffered from poor resolution and reflection coherency and multiple contamination at the reservoir level.

The reprocessing strategy included rebinning and HVA analysis in the dip direction followed by radon demultiple applied close to the HVA velocities. The result was a significant improvement in resolution of reservoir horizons and faults. Interpretation of the reprocessed data yielded a simpler structural picture of the Elang Field with the crestal area interpreted as a simple rollover with little or no erosion of the reservoir section. The interpretation also confirmed significant attic oil potential in vicinity of Elang-1. This potential was tested in January 2000 by Elang-1/ST1, which intersected the reservoir 28 m up dip of Elang-1 and close to the prognosed depth. Production from the well has exceeded pre-drill predictions and added substantial incremental reserves to the field. This has increased value to the project and extended the life of the Elang production facility.

Elastic modelling of reflectivity and AVO at the Elang Formation, Laminaria East

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The Elang formation produces a weak event, which is virtually impossible to pick on conventionally processed seismic sections. Its top is difficult to define on wireline logs. A rigorous approach to modelling its reflectivity is as a superposition of reflections from a sequence of layers at $\leq$ 2 m thickness. This *formation response* verifies that AVO can be derived for interfaces near the top of the Elang if V_p,V_s and ρ are averaged over at least 10 m above and 10 m below this interface. Using a depth of 3264 m for Top Elang this method predicts a polarity reversal at ray parameter, p=0.105 s/km (about mid-streamer).

However, at near-to-mid streamer offsets ($p < 0.105$ s/km) the reflectivity is too sensitive to depth to derive an AVO representative of the Elang. At Laminaria East, the full depth model predicts a peak/trough wavelet at the TWT near top Elang (3215 ms), which is grossly influenced by the sidelobes of boundaries beneath the reservoir.

At far offsets ($p > 0.105$ s/km) a consistent trough develops in the τ-p formation response, which extends out to an equivalent 8 km source/receiver offset. This trough is clear on the full model seismogram when multiples and guided waves are suppressed. It may provide the basis for defining a more interpretable signature for the Elang by weighting far offset traces and perhaps acquiring data out to very long offsets.

Seismic stratigraphy of the late permian tinowon formation, Surat Basin, Australia: new opportunities in a mature basin

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The Myall Creek and Riverside gas fields were recently discovered in the Surat Basin. These fields were only 2 km apart, yet are contained in two separate sand units within the Late Permian Tinowon Formation: the Upper Tinowon Sandstone and Mid Wallabella Sandstone. The DST data of the discovery well of the Myall Creek Field suggest the reserves are greater than the mapped structure could hold invoking a strong stratigraphic trapping mechanism.

A post-drill interpretation of the reprocessed seismic data has resolved each sand unit. The distribution of the channel sand, which hosts the Riverside Field, has been mapped and the extent of the stratigraphic trap of the Myall Creek Field is delineated. Both cases open new opportunities for prospects of their respective play types.

NEAR-SURFACE GEOPHYSICS

Shallow refraction seismology for the new millennium

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In the last 50 years, the advances in shallow refraction seismology have been very modest. There have been few developments comparable to CMP, digital processing, or the 3D methods of reflection seismology.

The most critical requirement is the development of an efficacious method for digital processing using the complete seismic refraction trace. Digital processing is an essential requirement for deriving more information from existing data as well as for efficient handling of the increased volumes of data typical of most 3D surveys.

The refraction convolution section (RCS) is a new method for the digital processing of seismic refraction data. It can result in more detailed geological models of the subsurface through the convenient use of amplitudes as well as traveltimes. It also facilitates the examination of important issues such as signal-to-noise ratios, the resolution of ambiguities in refractor models, 3D refraction methods and azimuthal anisotropy, signal processing to enhance second and later events and stacking data in a manner similar to CMP reflection methods.

The RCS provides an effective domain for the advancement of shallow refraction seismology using the model provided by seismic reflection technology.

Interpretation of Bedrock Topography within the Port Jackson (Sydney Harbour) Region using Marine Seismic Reflection

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An interpretation of the bedrock topography of virtually the whole of Sydney Harbour has been undertaken to estimate the bedrock configuration, identify paleochannels, and determine the nature and thickness of overlying sediment layers. The interpretations are based on an extensive series of marine seismic reflection data recorded in 1975 covering the harbour entrance and tributaries, and data recorded in August 2000 covering the harbour entrance and adjacent areas.

Sydney Harbour has a bedrock configuration defined as a meandering channel that follows a generally deepening path as it reaches the harbour entrance with the bedrock configuration deepening to 85 m below sea level (b.s.l.) at the harbour entrance. Within the harbour, the paleochannel maintains a depth of about 30-40 m b.s.l. in the southern region near Point Piper and in Middle Harbour, and a depth of about 40-70 m b.s.l. in the middle region around the Sow and Pigs reef. In the northern survey area, paleochannel depths of 40-50 m b.s.l. were found in the Manly region. In Parramatta River, bedrock depths occur between 20-30 m b.s.l. in upstream sections of the channel and 40-45 m b.s.l. in downstream sections of the channel. In Lane Cove River, the depth of the paleochannel extends to 20-35 m b.s.l.

Meandering paleochannels occur throughout Sydney Harbour with tributary paleochannels clearly defined. Sydney Harbour sediments interpreted as Holocene marine sand were found to be thickest (65 m) near the harbour entrance. Average estimated sediment thicknesses were 17.4, 10.8, 14.3 and 13.6 m in Port Jackson, Parramatta River, Middle Harbour and Lane Cove River respectively.

An integrated approach with DighemV to groundwater exploration - Tsabong, Botswana

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Exploration for potable groundwater to supply settlements in the southern Kalahari Desert of southwestern Botswana is currently in progress. A DighemV survey was flown over outcrops of Precambrian rocks after target areas were selected in an initial desktop study. The study included some preliminary ground geophysics, reviewed all available information in the area and completed an interpretation of remotely sensed (Landsat TM and SPOT) and aeromagnetic data. Two target areas were recommended for DighemV airborne electromagnetic (AEM) surveying near outcropping basement. The DighemV survey was designed to map faults and fractures intersecting resistive quartzite of the Olifantshoek Sequence, the most productive groundwater host in the area. Outcrop geological mapping,

ground geophysical traverses to test previous successful boreholes and to locate new ones, exploration drilling and borehole logging were then used to follow up and refine targets generated from the AEM survey.

Airborne and ground geophysical survey data were carefully integrated with outcrop geology and borehole information. An improved understanding of the geology and structure in Precambrian Olifantshoek quartzite was based on interpretation of the DighemV and aeromagnetic data. Exploration drilling success is attributed to an integrated multidisciplinary approach, which is strongly recommended for other potential groundwater projects in the Kalahari Desert.

REGIONAL PERSPECTIVES

Progress of the Northern Territory exploration initiative

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During 1999-2003, significant additional funding is being made available to the Northern Territory Geological Survey through the Northern Territory Exploration Initiative. Airborne geophysics is the cornerstone of the Initiative. The allocation of substantial expenditure to this activity recognises its importance to the early exploration protocols of project generation and area selection. The adoption of semi-regional airborne survey specifications is considered adequate for qualitative district-scale geological interpretation.

In its desire to attract and maintain global client contact, NTGS is focused on developing efficient mechanisms for access to and delivery of its spatial data and information over the Internet. Excellent early progress has been made using located geophysical imagery with the implementation of an image web server.

The production of Territory-wide geological and magnetic maps was a key output achieved early in the life of the Initiative. The establishment of the Interpreted Geology map series, initially focused on poorly exposed mineralised terrains, provides explorers with basement geology derived largely from airborne geophysical data as part of the integrated multidisciplinary approach adopted by all NTGS regional geoscientific studies.

The geophysical characteristics of the granites - Tanami Goldfields: a regional perspective

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3D gravity modelling and interpretation for the 1:250,000 Boulia map sheet, Queensland

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Sedimentary cover thickness strongly affects area selection for exploration in Proterozoic and Archean basement. Depth-to-basement is often inferred from gravity data. Interpretation of gravity is, however, fraught with ambiguity. The uncertainty can be minimised if all available information is exploited. In this paper drill logs, aeromagnetic depth-to-basement and basement geology interpretations, and a compilation of density values, as well as gravity data, are used to constrain a 3D density model of the Boulia 1: 250 000 map area, Queensland. Four recent events triggered this work:

1. Acquisition of 4 km-spaced gravity data by the Queensland Department of Mines and Energy;
2. Publication of an aeromagnetic interpretation by AGSO;
3. Development of a computer program for constrained 3D inversion of gravity, and;
4. Availability of sophisticated 3D geological modelling and visualisation software.

A 3D starting model was constructed, with basement topography, lithology, and density conforming to drill hole data and aeromagnetic interpretations. Palaeozoic cover was represented as a layer of uniform density. The calculated gravity response of the starting model resembled the observed gravity in gross terms, but did not provide a satisfactory fit. Shallow magnetic basement correlated with low gravity. Denser basement units tended to be deeply buried.

The basement densities and elevations have been adjusted via inversion, to achieve a close fit to the data. In the areas of shallow basement (less than 1 km), basement depths have changed by up to 300 m. In the NW corner and the central south of the map sheet, the interpreted depth of undivided granite basement has in places been reduced to 100 m and 200 m respectively.

The Boulia 3D density model represents a starting point for future refinement as additional holes are drilled and as new gravity and density data are collected. In particular, the gravity contribution from limestones in the cover sequence is not well understood. Additionally, combined magnetic and gravity inversion could further advance geological understanding of the area.

INVERSION

Three-dimensional inversion of magnetotelluric data with static shifts

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The static shifts caused by small-scale shallow resistivity anomalies hamper the interpretation of magnetotelluric (MT) data. In this paper, an approximate three-dimensional inversion scheme is developed that inverts jointly for resistivities and static-shift values. The unknown static-shift parameters are incorporated into the inverse problem based upon an assumption that they are Gaussianly distributed. A staggered-grid finite-difference method is used to calculate the MT responses in 3D. The sensitivities of the MT responses to subsurface resistivity changes are calculated from the analytic solutions of the electric field for a homogeneous half-space model using the adjoint-equation approach. These approximate sensitivities are used throughout iterations, which results in a substantial saving in the computation time over the full inversions. A synthetic example indicates that the inversion scheme recovers the resistivity structure from the data contaminated heavily with static shifts.

A comparison of smooth and blocky inversion methods in 2D electrical imaging surveys

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2D electrical imaging surveys are now widely used in engineering and environmental surveys to map moderately complex structures. In order to adequately resolve such structures with arbitrary resistivity distributions, the regularised least-squares optimisation method with a cell-based model is frequently used in the inversion of the electrical imaging data. The l_2 norm or smoothness-constrained optimisation method that attempts to minimise the sum of squares of the spatial changes in the model resistivity is frequently used. The resulting inversion model has a smooth variation in the resistivity values. In cases where the true subsurface resistivity consists

of several regions that are approximately homogenous internally and separated by sharp boundaries, the result obtained by the smooth inversion method is not optimal. It tends to smear out the boundaries and give resistivity values that are too low or too high. The l_1 norm or blocky optimisation method can be used for such situations. This method attempts to minimise the sum of the absolute values of the spatial changes in the model resistivity. It tends to produce models that are piecewise constant. Results from tests with the smooth and blocky inversion methods with several synthetic and field data sets are given to highlight the strengths and weaknesses of both methods. The smooth inversion method gives better results for areas where the subsurface resistivity changes in a gradual manner, while the blocky inversion method gives significantly better results where there are sharp boundaries. While fast computers and software have made the task of interpreting data from electrical imaging surveys much easier, it still remains the responsibility of the interpreter to choose the appropriate tool for the task based on the available geological information.

Using the ASVI to invert for remanently magnetised bodies

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Magnetic inversion programs such as mag3d from UBC have proven to be very useful for generating realistic 3D susceptibility models from surface Total Magnetic Intensity (TMI) data.

However, these programs do not perform well when the observed data include the response of bodies which are strongly remanently magnetised. This failure occurs because the forward model algorithm used in the inversion only generates the induced response, so the remanent component in the TMI has to be modelled using the induced response for an unrealistic distribution of susceptibility.

In this paper we investigate the effectiveness of inverting the analytic signal of the vertical integral (ASVI) for synthetic and real TMI data using mag3d. For both data sets we find that the inversion of the ASVI data produces a model which is much more realistic than that obtained by inverting the original data.

SEISMIC ANISOTROPY AND RAY-PATH ANALYSIS

Filtered dense η picking for non-hyperbolic movement

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The focusing quality of far-offset volumes is strongly dependent on the density of the Non-Hyperbolic Normal Move Out (NHNMO) parameter estimation. The automatic picking of the residual time-shift due to the non-hyperbolic behaviour of the reflection curve attempts to achieve this goal. The anellipticity η field containing many errors related to mis-picks and artifacts is replaced by anelliptic velocity, which is related to the asymptote of the reflection curve. This new NHNMO parameter field, thanks to the short spread curvature weighting, suggests a more reliable attribute for geostatistical filtering. Standard geostatistical techniques such as factorial kriging are successfully applied to perform the filtering of the anelliptic velocity as well as the filtering of NMO velocities. The real data example shows that filtering of anelliptic velocity instead of anellipticity η itself increases the reliability of effective η field, therefore improving the focusing of the far-offset data.

Explicit anisotropic P-wave ray velocity functions

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Sedimentary rocks encountered in seismic exploration frequently exhibit directional seismic wave velocity dependence. These anisotropic rocks often can be regarded as transversely isotropic (TI) media in which the ray velocity surface of SH-waves is elliptical, while those of P- and SV-waves are non-elliptical. Transversely isotropic phase velocity expressions exist for P-, SH- and SV-waves. Unfortunately, until now no explicit exact analytical ray velocity functions exist for P- or SV-waves propagating in TI media. In exploration seismology, explicit ray velocity functions are needed for efficient migration, velocity analysis and other seismic processing procedures.

Approximate explicit analytical P-wave ray velocity functions in transversely isotropic media have now been developed. These ray velocity functions include a new dimensionless constant, A, which depends on elastic parameters C_{11}, C_{33}, C_{44}, and C_{13}, or Thomsen's parameters ε, δ, $\alpha 0$, and b0. The accuracy of the functions has been tested for all the materials published by Thomsen (1986). From these ray velocity functions, the travel time between any two points in homogeneous transversely isotropic media may be calculated. Reflection travel times from a single horizontal reflector overlain by transversely isotropic media with vertical symmetrical axis (VTI) are also calculated and compared with those obtained by Tsvankin (1996). The results show that the proposed explicit ray velocity functions have high accuracy.

Generalised ray parameters for vertically inhomogeneous and anisotropic media

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In this presentation we derive a concise equation for a generalised ray parameter in inhomogeneous and anisotropic media. We illustrate the direct application of this conserved quantity by several examples, involving anisotropic parameters and linear velocity fields.

The ray parameter, or raypath parameter, p, is a conserved quantity, which plays an important role in both exploration and global seismology. The constancy of the ray parameter contributes to convenient methods of raytracing and imaging. The standard form of p in a homogeneous isotropic medium is the horizontal component of the slowless, expressed in terms of the angle measured from the normal to the interface between media, θ, and the velocity, v. This ray parameter, p, is a conserved quantity, i.e. the *first integral* of the *Euler-Lagrange* equation.

Increased interest in anisotropic characteristics of sedimentary rocks motivated this work, which provides an exact form of the ray parameter for vertically inhomogeneous and anisotropic media. We use the mathematical tools provided by calculus of variations, in particular the Euler-Lagrange equation with its first integrals, to arrive at this new form of the ray parameter.

There always exists a conserved quantity, such as the ray parameter for arbitrarily complex velocity fields. For exploration seismology in sedimentary basins, a relevant form would account for vertical inhomogeneity and anisotropy. In such a case, the ray parameter resembles the standard form mentioned above with an additional term due to the anisotropy.

The results allow for convenient modelling and raytracing. They permit certain investigations of the influence of anisotropy on ray trajectories and traveltimes, which play an important role in AVO analysis. Furthermore, presented results could be incorporated in data-processing applications.

SEISMIC ACQUISITION METHODOLOGIES

Understanding elastic wavefield recording by detailed 3D survey planning and simulation

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Elastic modelling of seismic wave propagation must be pursued with different algorithms to fully understand all aspects of the recorded information. Modern seismic survey planning will utilise a suite of modelling tools, each incorporating the full acquisition system response for any given survey. Therefore, the user can discriminate between acquisition and Earth effects upon the data. Survey planning no longer simply estimates the basic configuration of the acquisition equipment. Every facet of the seismic method must be replicated and understood. Then the data implications of any given acquisition approach (streamer, land, ocean bottom sensor, vertical cable) can be understood and treated throughout the entire processing and interpretation workflow. In particular, the ability to accurately model the Earth reflectivity sequence is critical for AVO, reservoir characterisation and time-lapse studies.

After summarising the main modelling algorithms, we describe their integrated use within survey planning exercises, with emphasis upon addressing the elastic properties of the recorded seismic wavefield.

Long offset towed streamer recording - a cheaper alternative to multi-component OBC for exploration?

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Multi-component OBC data relies on mode conversion from p-wave to S-wave in the subsurface to obtain information about the elastic properties of the earth. Since the energy converted to S-wave is now missing from the p-wave an alternative to recording OBC multi-component data is to examine P-wave data for the missing energy. Since the conversion is dependent upon the incident angle and occurs most at wider angles of incidence, long offset p-wave data is necessary for this technique.

A non-linear, wide angle (including post critical) AVO inversion has been developed that allows elastic properties to be extracted from long offset p-wave data. In order to extract amplitudes at long offsets for this inversion it is necessary to image the data correctly, including correcting for higher order moveout.

The higher order moveout may itself be inverted to yield additional information about the anisotropy of the sub-surface.

Perturbations in 4D marine seismic

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A new concept for acquiring calibrated towed streamer seismic data is introduced through a new acquisition and processing system. The specification of the new system has been defined by rigorous analysis of the factors that limit the sensitivity of seismic data in 4D studies and imaging. New sensor and streamer technology, new source technology and advances in positioning techniques and data processing have addressed these limitations.

Sensitivity analysis revealed that the most significant perturbations to the seismic signal are swell noise and sensor sensitivity variations. Conventional analog groups of hydrophones are designed to suppress swell noise however, a new technique for data-adaptive coherent noise attenuation delivers even greater noise suppression for densely spatially sampled single-sensor data.

Although modern source controllers provide accurate airgun firing control the signature of an airgun array may vary from shot to shot. This can be due to factors such as changes in the array geometry, air pressure variations, depth variations and wave action. A method for estimating the far-field signature of a source array is the Notional Source Method (proprietary to Schlumberger), which has been steadily refined since its first disclosure. A recent development compensates for variation in source array geometry by monitoring the position and azimuth of each subarray using GPS receivers mounted on the floats.

New calibrated positioning and streamer control systems are part of the new acquisition system. Active vertical and lateral streamer control is achieved using steerable birds and positioning uncertainty is reduced through an in-built fully braced acoustic ranging system.

Calibrated marine seismic data are achieved through quantifying the source output, the sensor responses and positioning uncertainty. The consequential improvements in seismic fidelity result in better imaging and more reliable 4D analysis.

ELECTRICAL METHODS

A new survey design for 3D IP inversion modelling at Copper Hill

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The Copper Hill prospect is a well-known porphyry copper/gold system. Investigation of geochemical assay data and gradient array IP data suggests that grid northwest and grid northeast structural directions have considerable control over mineralisation. Previous drilling has been oblique to these directions.

The sulphide rich mineralisation zones have moderate to strong IP responses. The intention of Golden Cross Resources Ltd, as tenement holders, was to verify the main trends and locations of possible extensions to mineralisation. A 3D inversion of IP data is a suitable approach to the problem of mapping the sulphide horizons in detail.

The primary aim of the survey was to gather sufficient IP/resistivity data over an area 1.2 km by 1 km to generate a reasonably detailed 3D-inversion model for Copper Hill.

Based on the knowledge that the data was to be processed in a 3D-inversion program, a modification of the pole-dipole IP survey geometry was used. The new array design resulted in fast collection of a large quantity of data. The high data redundancy inherent in the design allowed for editing prior to inversion.

3D inversion results highlighted the three dimensionality of sulphides zones at Copper Hill. Zones of high IP response are concentrated along northwest and north trending structures forming an annular zone terminating at depth.

A cost effective broad scale and detailed IP survey was successfully accomplished.

Borehole MMR at Marvel Loch gold mine - solving for the conductive overburden

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Multi-parameter logging at Marvel Loch gold mine in the Yilgarn Craton of Western Australia indicated that the mineralisation was more conductive than the host rocks and thus potentially targeted using downhole electrical methods. Borehole MMR was the preferred to borehole EM due to the lack of large zones of consistently conductive mineralisation and the lack of conductive features within the surrounding host rock.
The drilling program consisted of a parent hole with a number of wedges. Two of these wedge holes were surveyed with borehole MMR however the upper portion of the hole through the overburden/regolith (i.e. the parent hole) could not be surveyed due to steel casing and thus the nature of the conductive overburden could not be readily determined. Hence, an empirical approach was initially taken whereby stripping the raw total MMR field with a layered-earth field was computed for a range of different overburden conductivities until a credible background to the axial component of the anomalous MMR response is obtained. TEM soundings acquired post survey in the vicinity of the drillhole collar to assist in determining the overburden characteristics and improved the stripping process.

The results of the two wedge holes were similar with subtle negative axial anomalies related to the upper and lower mineralised zones and thus attributable to conductors below the drillholes. The modelling indicates a southerly plunge to the lower conductive zone, which is consistent with the southerly plunge of the mineralisation within the pit. The adjacent pit has been modelled as conductor carrying current in the reverse direction to simulate a resistor producing a minimum at around 150 m and influences the shape and amplitude of the anomaly due to the upper alteration zone.

Application of spectral time domain induced polarisation method to resolve orebody characterisation

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One of the most important issues in searching for metallic ores is to discriminate between different types and textures of mineralisations. One of the methods capable of deriving such information is the spectral induced polarisation (SIP). With advances in the time domain IP receivers it is possible to get SIP data with no more additional costs. Therefore using the Cole-Cole impedance model for the subsurface it is possible to calculate the apparent Cole-Cole parameters by a curve matching technique in a least squares sense. In the current study, SIP measurements have been obtained using six chargeability slices of the transient decay curve after a two seconds square wave current on time at the Irankuh lead and zinc ore deposit complex. It is shown that the SIP measurements will give additional valuable textural and structural information, which can be of great help in determining and delineating ore blocks for a systematic exploration program. It was found that the increase in time constant is associated with the ore zones with continuous and greater grain size of IP sources. The average frequency exponent for the vein type ores was found to be about three times larger than that of the disseminated ore zones. Also from the true chargeabilities obtained from SIP analysis, the location of the vein type ores was delineated with a higher resolution.

Finally, due to its cost efficiency and faster field operation it is suggested that SIP data be collected for exploration targets where the textural information can play a very important role in dividing ore to the blocks with similar characteristics.

MAGNETIC MODELLING

Magnetometer calibration: a joint initiative of Defence and AGSO

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The Australian Department of Defence and AGSO aimed to provide a calibration facility for three-component (vector) magnetometers and thereby a cost-effective service for defence and geoscientific purposes. DSTO was the main provider of funding and would be spared the expensive and long-winded process of sending its instruments overseas for calibration. Australia would gain from having a world-class facility available to all magnetometer users.

Three sets each of four coils are mounted orthogonally and connected to programmable current sources enabling the creation of magnetic fields between 0 μT and 100 μT in any direction. A sequence of field values is generated and compared with the corresponding outputs of the magnetometer under test. The system computer then automatically prints the main parameters describing the instrument's sensor angles, sensitivities, linearities, and test conditions. Background field variations over the measurement period are subtracted.

Our system is capable of generating fields to a magnitude accuracy of 20 ppm and a directional precision of about 10 seconds of arc assured by checking the generated fields with a standard scalar (proton) magnetometer.

The Defence Department's needs and its policy of encouraging general use have enabled AGSO, in close collaboration with its suppliers, to create a unique facility for terrestrial and space exploration, for general scientific research, and a foundation for future client needs. Already AGSO is developing, with funds from the CRC for Satellite Systems, the capacity to magnetically characterise FedSat, which will carry a three-component fluxgate magnetometer into polar orbit early next year. FedSat is an Australian Government Centenary of Federation project.

Iterative forward magnetic modelling with corrections for self-demagnetisation

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Self-demagnetisation is commonly ignored in magnetic modelling of geometrically complex mineral exploration targets. With conventional methods, the level of accepted mismatch between the observed magnetic field and the calculated magnetic field governs the degree of modelled complexity. Where the target bodies possess low magnetic susceptibilities, the effect of self-demagnetisation is negligible and as such conventional numerical calculation methods give satisfactory results even with geometrically complex models. However, in cases where target bodies possess high magnetic susceptibilities, self-demagnetisation effects have a significant influence on the observed magnetic field. If the geometry of the modelled body is complex, the fact that the self-demagnetising field can only be calculated exactly for an equivalent ellipsoid may lead to significant errors in its numerical interpretation.

This paper proposes a new generalised iterative 3D numerical modelling routine that allows for detailed modelling of geometrically complex target bodies possessing high magnetic susceptibilities. The modelling routine also allows for a magnetic field that varies spatially due to the effects of self-demagnetisation. This is done by segmenting the model into a 3D matrix of spheres and repeatedly calculating the magnetic field at the centre of each sphere. Each iteration of the modelling routine consists of

a two-pass calculation of the magnetic field for each sphere. The first pass calculates the magnetic field at the centre of each sphere for a given inducing magnetic field (e.g. IGRF) with respect to the surrounding spheres. The second pass calculates the magnetic field at the centre of each sphere (using the resultant magnetic field from the first pass), where the sphere is considered to be in free-space. Each iteration uses the resultant magnetic field from the previous iteration as the inducing magnetic field. For simple models the added contribution from magnetic interaction with the surrounding voxels becomes negligible after approximately four (4) iterations. The number of iterations required for convergence increases with increasing complexity of the model.

A user guided expert system approach to 3D interpretation of magnetic anomalies

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Research into the development of an expert computer system for 3D magnetic modelling has yielded a methodology that can be applied to a wide range of magnetic exploration problems. The research focussed on the development of a semi-automated method for realistic 3D modelling of magnetic units truncated by an unconformity. Using the models produced by this process it is possible to map depth variations at the unconformity surface, map irregular geological boundaries of magnetic units and estimate magnetic susceptibility values.

The objective of the research was the development of an interactive tool that would allow an interpreter to select a magnetic anomaly with a mouse and have the expert system produce a complete 3D model of the magnetic source distribution. In addition, the interpreter is required to select a geological constraint that biases the model creation in a geologically plausible manner.

The research required the development of an expert system that emulates the procedures used by an experienced interpreter and an inversion methodology that could resolve complex 3D objects with fuzzy geological constraints. The system had to be suitable for inclusion in popular mapping systems.

For appropriate anomalies, this process replaces innumerable individual steps that are normally required to manually construct a complex 3D magnetic model. As a result it is possible to replace a lengthy manual process that may take hours with one that can take less than a minute on a desktop PC.

REGIONAL GEOPHYSICS

Integrated geophysical appraisal of crustal architecture in the Eastern Lachlan Orogen

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Forward modelling of potential field data, combined with new geological mapping and deep seismic reflection transects acquired by the Australian Geodynamics Cooperative Research Centre (AGCRC), has led to testing of robust crustal-architectural models for the eastern Lachlan Orogen of New South Wales. This integrated analysis has led to new subsurface inferences unlikely to be deduced solely from any of the individual datasets used.

The overall Palaeozoic history of the eastern Lachlan Orogen implied by the integrated analysis of geophysical and geological datasets, involves:

- Formation of an Ordovician oceanic island arc;
- Early Silurian thin-skinned east-directed overthrusting of a continental backarc basin over the arc;
- Generation of Silurian granites due to crustal thickening;
- Early Silurian to early Devonian rifting, resulting in the dismemberment of the deformed arc-basin complex, and formation of a series of arc fragments with intervening thin basins;
- Tight, asymmetric folding of these basins during the Early to Mid Devonian, with some granite magmatism;
- Extensive Carboniferous thin-skinned thrust stacking involving both east-, and west-directed transport;
- Slicing of the upper structural level of earlier antiformal stacks, together with granite roof zones, and;
- Final granitic arc magmatism during amalgamation with the New England Orogen.

The application of curie depth effective elastic thickness seismic tomography and seismicity in regional exploration area selection

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When selecting geological provinces prospective for giant ore deposits, knowledge of the location of deep lithospheric structures and craton margins, and an understanding of the temperature distribution of the Earth, are all-important. Curie depth, effective elastic thickness, seismic tomography and seismicity are techniques with the potential to provide this information.

Curie depth depends on the geothermal gradient and may, in principle, be derived from aeromagnetic data. However, it is concluded here that such Curie depth maps may have little value in many shield areas.

Effective elastic thickness (TE) is a measure of the strength of the lithosphere. Methods for estimating TE are described and, as an example, a new TE map of Brazil is presented. TE gradients correlate well with province boundaries and seismicity, implying that they map major lithospheric structures.

Seismic tomography uses the travel times of earthquake P- and S-waves to map velocity variations within the Earth. Many new tomographic velocity models are now becoming available, with resolution <100 km in some cases. It appears that temperature is the major control on velocity, at least in the upper mantle.

Global seismicity information may be analysed in terms of the distribution of earthquakes, their magnitudes and their focal depths. A correlation between seismicity and large mineral deposits has been observed in certain regions, which motivates the use of this data. Possible reasons for the correlation are discussed here.

As the different maps - TE, seismic velocity and seismicity - respond to different physical properties (or the same physical properties in different ways), it is most beneficial to interpret all three together.

Lithospheric boundaries on the eastern Siberian platform

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The regional mapping of large lithospheric blocks can provide guidance for mineral exploration, because such large-scale structures, and particularly the boundaries between them, may control the emplacement of several types of large ore bodies. This study uses a combined analysis of potential-field geophysical data and mantle petrology, to map major lithospheric

structures on the eastern part of the Siberian platform. Garnet and chromite concentrates from a chain of Paleozoic to Mesozoic kimberlites across the platform have been used to construct mantle sections. These sections reveal that the lithospheric mantle shows significant differences, corresponding to tectonic terranes mapped at the surface, and indicating that the terrane boundaries are translithospheric. Furthermore, the Archean terranes are underlain by typical depleted Archean lithosphere > 200km thick, while the Proterozoic terranes are underlain by thinner and less depleted lithosphere.

We inverted gravity and topography data from the Siberian platform to determine the flexural rigidity or elastic plate thickness (Te), which is a measure of the mechanical strength of the lithosphere. The results of this inversion reveal a major zone, ~ 150 km wide, of very weak lithosphere (Te < 10 km) running N-S across the western part of the craton. This zone coincides with thicker lithosphere, lower surface heat flow and abnormally high sub-Moho P-wave velocities suggesting an anisotropy in the upper mantle. The kimberlite fields in the Archaean part of the platform are localised on the western flank of this zone of weak lithosphere. We suggest that the low Te reflects a mantle shear zone, which has been a preferred conduit for fluids (e.g. magmas) into the lower crust, and has controlled the location of kimberlite emplacement in the area.

SEISMIC TOMOGRAPHY

Tomostatics applications for basalt-outcrop land and OBC multi-component surveys

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Tomostatics has been recently applied to two types of data sets. The first is from the Middle East region where the near surface layer is exhibiting high-velocity basalt outcrops and the second is a multi-component (4C) OBC data set containing low-velocity gas clouds. Near-surface velocities estimated from turning-ray tomography provide useful information for geological interpretation and structural imaging. Tomostatics has advantages over traditional refraction statics in regions where 1) no refractors can be easily identified, and 2) high velocity materials (e.g. basalt) are overlaid on top of the low velocity sediments immediately below the topography.

P-wave velocities that estimated from turning-ray tomography could be used to calculate the traveltime contours. Correlating P-wave and converted-wave traveltimes would allow us to estimate Vp/Vs ratios, leading to a practical approach for converted-wave long-wavelength statics solution.

A comparative study of 2D and 3D crosswell tomography

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Crosswell tomography can generate high-resolution velocity images that can be used directly in interpretation or as inputs to migration processing. Two-dimensional tomography is computationally efficient and has been widely used to invert crosswell data. Real geological structures, however, are usually 3D, and it is important to assess 3D effects on first arrival traveltimes and account for these effects in traveltime tomography.

In this paper, we investigate how 3D structures affect first arrival traveltime data in crosswell surveys, and present a 3D tomography algorithm that minimizes a model objective function consisting of the second order directional derivatives of the model parameters. Our 3D forward modelling results show that 3D effects can become significant in a 2D crosswell survey when the 3D structure is close to the 2D survey plane. Furthermore, the 3D effects in the data can be propagated to the final inversion results. Three-dimensional tomography counts for off-plane ray-paths and hence can produce better velocity images over 2D inversion in 3D environments. Because of the restriction from the geometry, 3D tomography of crosswell data from 2D surveys cannot provide any lateral resolution.

Spatially limited tomographic inversion for time-lapse oil reservoir monitoring

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In this paper, we discuss time-lapse reservoir fluid monitoring of the real oil-reservoir circumstances using the seismic travel-time tomography. We use a reservoir where fluid injection has been carried out for enhanced oil recovery (EOR).

In order to evaluate the applicability of seismic tomography to fluid injection EOR monitoring, a numerical experiment was carried out. As ordinary tomography inversion failed to obtain a good result, an inversion technique was developed under the assumption that 'velocity change occurs mainly in the reservoir' during the EOR process.

A velocity calibration method for the direct imaging of injected fluid front was also developed. The results of the calibration suggest the advanced usage of the seismic tomography for the fluid injection EOR monitoring.

ELECTROMAGNETIC INTERPRETATION

EM target response in complex hosts

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Electromagnetic exploration methods are only useful if they give the user an enhanced likelihood of finding economic targets or at least decrease the probability of drilling false targets. Given reasonably clean data, many schemes exist to identify simple targets in uniform hosts. However, the EM responses of potential economic targets are often obscured by those from heterogeneities in the host as well as a number of structural factors like topography and unconformities. The AEM response is further complicated by system factors such as airframe currents, plus variations in bird position and flight path.

This paper examines the changes in response of a simple target as its environment becomes increasingly more complicated. We start with a 1 km long conducting dipping dyke and then add overburden, topography, a paleochannel, heterogeneities, faults and then put it at the boundary between two rock units. We also look at system factors such as transmitter angle, airframe currents and non-level flight as well as the effect of different flight paths. Although CDIs do not yield an accurate picture of the subsurface geoelectric structure, they nonetheless represent a useful transform on the data that can be used for pattern recognition studies.

Step and impulse calculations from pulse-type electromagnetic data

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It has been shown by others working in the field of time-domain electromagnetic induction, that the late-time step response of the ground can be very useful for the detection of large, slowly decaying secondary fields. A simple method is outlined here to calculate the step response from pulse-type time-domain EM data. Pulse-type systems are often described as impulse systems, but a measured impulse response cannot be used to derive the step response. These systems would better be described as hybrid systems - lying somewhere between a pure impulse and pure step -

because their current termination is of short duration, but not instantaneous. By taking at least one measurement during the current turn-off time, and by ensuring that the turn-off is a very linear, controlled ramp, a simple step response calculation can be made.

It can also be important to determine the impulse response of the ground since many interpretation schemes are based on this measurement. It is shown that with a few additional calculations while the step response is being calculated, the impulse response can also be easily determined.

TEM models for a conductive host and filament migration

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Simple planar filaments can be used to provide a reasonable approximation to compound TEM eddy current decay systems. An optimum solution can be found using inversion theory to constrain the location and physical dimensions of these filaments in order to duplicate any spatial anomalies observed with fixed loop surveys.

Multiple filament solutions are possible for any traverse using different windows in the total decay curve. Any systematic migration or progression in the results as a function of time can provide an indication of target or host configuration.

Filament tracking techniques are developed here to provide a basis for data stripping designed to isolate a target response from the effects of highly conductive host materials. The results can provide for more complex geological constraints in place of a simple half-space model.

EXPLORING THROUGH COVER

Exploring through cover - the integrated interpretation of high resolution aeromagnetic, airborne electromagnetic and ground gravity data from the Grant's Patch area, Eastern Goldfields Province, Archaean Yilgarn Craton, Part A

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Conductivity values derived from TEMPEST AEM data were compared with conductivity values derived from ground EM data and borehole induction logs. The high degree of correlation at scales of around 100 m laterally and less than 10 m vertically allow the conductivity data derived from AEM data to be interpreted with confidence.

An extensive drilling database was used to interpret the conductivity distribution. This showed that the conductivity variations at Grant's Patch are principally associated with the regolith, specifically with in situ saprolite. The fresh bedrock in this area is uniformly resistive in comparison to the regolith, which attains a maximum conductance of around 50 S. The regolith conductivity variations can be used to infer basement lithology because the regolith is largely in-situ and the thickness and conductivity of the regolith materials is demonstrably litho-dependent.

Information derived from the AEM data has lead to a significantly improved understanding of the geology (lithology, structure, alteration and weathering) in the Grant's Patch Area.

Exploring through cover - Part B: Gravity inversion as a bedrock and regolith mapping tool

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The cost and risk associated with mineral exploration in Australia increases significantly as companies move into deeper regolith covered terrain. The ability to map the bedrock and the depth of weathering within an area has the potential to decrease this risk and increase the effectiveness of exploration programs. This paper is the second in a trilogy concerning the Grant's Patch area of the Eastern Goldfields. The recent development of the graVI³ potential field inversion program in conjunction with the acquisition of high-resolution gravity data over an area with extensive drilling provided an opportunity to evaluate three-dimensional gravity inversion as a bedrock and regolith mapping tool.

An apparent density model of the study area was constructed, with the ground represented as adjoining 200 m by 200 m vertical rectangular prisms. During inversion graVI³ incrementally adjusted the density of each prism until the free-air gravity response of the model replicated the observed data. For the Grant's Patch study area, this model proved easier to interpret than the Bouguer gravity.

A regolith layer was introduced into the apparent density model and realistic fresh-rock densities assigned to each basement prism according to its interpreted lithology. With the basement and regolith densities fixed, the graVI³ inversion algorithm adjusted the depth to fresh basement until the misfit between the calculated and observed gravity response was minimised. The resulting geometry of the bedrock/regolith contact largely replicated the base of weathering indicated by drilling with predicted depth of weathering values from gravity inversion typically within 30% of those logged during RAB and RC drilling.

Exploring through cover - Part C: Combining geophysical methods for a holistic exploration model

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Archaean lode gold deposits usually follow narrow structures, such as lithological contacts, ductile shears and brittle cross-faults. These features cannot be identified directly in covered areas and are often impossible to correlate between exploration drillholes. High-resolution geophysical methods provide dense, regularly spaced coverage for mapping continuity of structure and the geometry of the regolith at depth. Such geophysical 'pattern mapping' contrasts to direct anomaly targeting in that it requires image processing and integration of geological and geochemical data to produce 'holistic' regolith and bedrock geology maps used for targeting gold bearing structures.

Grant's Patch is a semi-mature lode gold corridor located 45 km NW of Kalgoorlie in Western Australia. The southern part of this corridor is covered by high-resolution aeromagnetic, airborne electromagnetic and gravity data, has uniform exploration drillhole coverage to non-weathered bedrock, and has very little surface disturbance from mining infrastructure. These geophysical methods are shown to produce effective results, yet no method is superior as they each provide complementary information.

At Grant's Patch, aeromagnetics identifies magnetic greenstone units, such as mafic to ultramafic sills and dolerite horizons, faults as disruptions crossing magnetic units, and paleochannels containing ferruginous gravel. Gravity maps density differences between greenstone rock units, identifies buried granitic intrusions, and identifies large paleochannels. High-pass filtered grids of gravity data reveal differential weathering between rock

units and along faults zones, even where no pattern is revealed in the aeromagnetic data. The airborne electromagnetic (AEM) response is dominated by conductive clays, predominately in situ as saprolite, and saline groundwaters in the regolith that usually follow litho-dependant weathering of bedrock units. AEM data can also identify graphitic shale units as bedrock conductors where conductive regolith overburden is thin and allows for penetration. Cross-faults are mapped as disruptions of the conductive units and may themselves be either conductive or resistive.

KEYNOTE SPEAKER

Something old and something new, something borrowed and something blue

Dr Ken McCracken, Jellore Technologies, NSW

POSTERS

Micro-Gravity for Mineral Exploration

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High-definition microgravity surveys have been conducted at Fosterville in an attempt to delineate major fault structures associated with gold mineralisation in Central Victoria. More specific local gravity anomalies were also anticipated for highly prospective zones of sulphide mineralisation along the margins of the fault.

Long wavelength features in the resulting data appear to be associated with the Fosterville fault but there are no obvious anomalies associated with the high-level oxide zones. This result is consistent with the disseminated nature of the mineralisation within the host material and the subtle nature of any density contrasts close to the surface. However, two distinct gravity anomalies have been detected to the east of the fault-line. These are associated with sulphide zones and estimates of excess mass are consistent with the geological constraints.

In addition to the gravity surveys, high-density magnetic images have been obtained to provide complementary data over the same area. These indicate several linear contacts identified as possible splay faults. However there is no apparent correlation with the previously identified gravity anomalies.

Time domain airborne electromagnetic reconnaissance for seadepth measurement and shipwreck localisation

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An AEM bathymetric survey of a portion of Geographe Bay, WA, was carried out using the QUESTEM 450 system. The area covered includes the decommissioned HMAS Swan divewreck. The survey also included two tie lines skirting Cape Naturaliste, reaching out to the 200 m depth contour in the Indian Ocean. TEM data was interpreted using both layered earth inversion and conductivity-depth imaging methods. The maximum depth of investigation for bathymetric mapping to within 10% of chart soundings was estimated to be 60 m with the QUESTEM system. The EM interpretation methods gave similar results in Geographe Bay. The divewreck was readily detected and appears as an anomaly in the estimated water depth derived from inverted in-line component data. Preliminary numerical modelling results are presented for the EM response of a '+' cross-section thin sheet high conductivity-contrast conductor, representing a hull, buried 60 m in a 5 S/m host.

Operation Treasure Hunt: does the Ontario model work for you?

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The Ontario Geological Survey is midway through a three-year, C$29 million initiative known as Operation Treasure Hunt. Its main objectives are to collect and disseminate geophysical, geochemical and geological data to industry, to identify exploration targets and to attract investment in mineral exploration of the Province. The geophysical component in the first two years has included the acquisition of nearly 140 000 line-km of magnetic-electromagnetic data over eight survey areas, and the purchase of an additional 105 000 line-km of proprietary data from industry. The Reid-Mahaffy airborne electromagnetic test range was established to facilitate comparison of systems for a variety of geological targets, and has been rapidly adopted by industry. Early impact analysis has shown that the imminent release of geophysical and geochemical data in strategically chosen areas results in a significant increase in claim staking activity and subsequent exploration expenditures in an area. A twinning agreement with the Geological Survey of New South Wales and discussions with other Australian state agencies has allowed the Ontario Geological Survey to optimise its program based on the Australian experience, while adapting it to the local geological and jurisdictional conditions.

Modelling the Magnetic Induced Polarisation (MIP) Response from the Down-Hole Magnetometric Resistivity (DHMMR) Method

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The Down-Hole Magnetometric Resistivity (DHMMR) method, an extension to the surface Magnetometric Resistivity (MMR) method, is an effective technique used for the exploration of massive sulphide deposits. The method is based on the 'in-hole' measurement of low-amplitude, low-frequency magnetic fields associated with galvanic current flow through the earth. To date, the interpretation of DHMMR data has focused on modelling the amplitude component (which reflects changes in resistivity), neglecting the phase component (which reflects changes in induced polarization).

This paper proposes to address the numerical interpretation of decoupled axial component phase data using DHMMR data acquired from the Flying Doctor prospect (near Broken Hill, New South Wales) as a case study. 3D electromagnetic modelling of polarisable tabular bodies in a layered, non-polarisable, half space has provided useful results. In addition to demonstrating a systematic decrease in the size of phase anomalies with increasing distance from the receiver, we have shown that the phase anomaly due to a polarisable body is also dependent on the body's position relative to the transmitter and receiver.

Generalised Bouguer gravity anomaly (1): formulation of spherical Bouguer anomaly reduced onto an arbitrary equi-potential surface

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I have formulated a generalised Bouguer gravity anomaly, taking account of the regional VGG anomaly ($\Delta\beta$: the constant term of the VGG anomaly), the degree of freedom of the datum level of gravity corrections (h_1), and the scheme of truncated spherical shell system of gravity correction. Also, I have presented the basic ideas of the formulation and have pointed out the differences between the new formula and the conventional one. The new formula thus obtained can be considered to have some advantages

over the conventional one. Firstly, one can treat wide ranges of gravity anomalies from a microgravity survey to a regional gravity survey in a unified manner, whose distance ranges of terrain and Bouguer corrections are from the order of 10 m to several hundred km from each gravity station. Secondly, particularly in the microgravity survey, one is to obtain a receptacle that enables us to evaluate $\Delta\beta$. Thirdly, explicit formulae for the two special datum levels to eliminate the topographic gravitational effects regardless of the Bouguer densities have been shown.

Generalised Bouguer gravity anomaly (2): possibility of constructing Bouguer gravity anomaly distribution with no gravitational effect due to topographic undulation

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Based on the newly defined formula of a spherical Bouguer anomaly, the authors have proposed a new method intending to determine the regional VGG anomaly ($\Delta\beta$) and the Bouguer density (ρ_s) so as to satisfy the condition of eliminating the topographic gravitational effects. For this purpose, we have introduced a new concept of 'the datum level such that the value of the Bouguer anomaly becomes invariant for any Bouguer density', and have shown an approximate equation to be satisfied by $\Delta\beta$ and ρ_s. Also, we have shown an explicit formula to estimate $\Delta\beta$. These two simultaneous equations enable us to estimate both $\Delta\beta$ and ρ_s. These quantities and subsequently conducted gravity corrections will give a new way to construct Bouguer anomaly distribution with no gravitational effect due to topographic undulation.

The Magnetisation Vector became important in Surface Geology and Chromite Prospecting within Ultramaphic Massifs

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A ground-based magnetic survey was performed on two ultramaphic massifs, Albania, mapping magnetic anomalies possibly connected with tectonic and cumulate sections, grade of horst rocks serpentiniation and/or shallow chromite deposits of variable size. The results were contradictory. We have implemented a scheme and computer code for contouring rock surface with abnormal magnetisation utilizing the simplicity of magnetic bell shaped field anomaly with so-called vertical and the analytic signal for the 2-D thin sheet model. Rapid estimations for the edge of the sources, depth, intensity and angle of total magnetisation for the observed shallow anomalies surveyed-line data are obtained. As an alternative of filtering technique we have used the magnetic computed field intensity map of the area with constrained source parameters. The computed magnetic field anomaly map with magnetisation vector collinear within the range revealed from chromite laboratory measurements show characteristic, which hardly notices in the survey magnetic anomaly map. The predicted magnetic data on an area 4 km2 are well correlated with the shallow deposits or surface occurrences or controlled associated structures in the harzburgite host rocks. Image of total magnetisation inclination data derived from ground magnetic survey acquired over a 30 km2 resembles the geology than the total field magnetic anomaly map. These data show that the total magnetisation of thick residual dunites, rich in basaltic impregnation, reveals an opposite direction data against the underlain harzburgite rocks.

Statistical and wavelet analysis of detailed physical property measurements on the Bellevue drillcore, Northern Lobe, Bushveld Igneous Complex, South Africa

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Analysis of susceptibility and density data from a borehole in the Bushveld igneous complex in South Africa was performed using statistical tools such as power spectra, wavelet analysis, and windowed histogram plots. This analysis has revealed significant patterns and cycles that correlate both with rock type and subtle layering within and between units. These results can now be used to test models of layering processes.

Detailed geophysical and geological investigation of the layered, mafic/ultramafic Black Hill Baggroic Complex, Black Hill, South Australia

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A recently acquired aeromagnetic survey over the predominantly Cainozoic covered Black Hill/Murray Bridge region of South Australia (SA) revealed three magnetic bodies that were poorly defined by previous, regional-scale BMR aeromagnetic data. Outcrop and mineral exploration company drilling of the Black Hill gravity and aeromagnetic anomalies indicate that they are layered mafic/ultramafic intrusive bodies that have potential for PGE, chromite and Ni/Cu massive sulphide mineralisation.

The current project of detailed ground geophysical surveys are part of the South Australian Governments phased, regional exploration strategy known as the Targeted Exploration Initiative South Australia (TEISA). The aim of this project and TEISA is to accelerate resource exploration in SA and send a strong message to the mineral industry that the SA Government is prepared to share some of the preliminary exploration costs. The geophysical surveys of this project revealed anomalism within the core of the northern Black Hill Gabbroic Complex intrusive. The data were interpreted and the gravity anomalism modelled, resulting in a proposed diamond drill hole and down-hole geophysical survey to test a layered mafic/ultramafic magmatic mineralisation model.

Detecting kimberlite pipes at Ekati with airborne gravity gradiometry

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From late April to the end of July 2000, a 39,000 line km airborne gravity gradient survey was completed over the EkatiTM mine property in the NWT, Canada. This was the world's first airborne gravity gradient survey for the purpose of detecting kimberlite pipes. Preliminary data processing was done on site at the EkatiTM diamond mine. Subsequent drilling of gravity anomalies in the year 2000 has resulted in the discovery of two new kimberlite pipes. More anomalies will be drilled in 2001.

The AGG data shows that more than half of the known kimberlite pipes have associated gravity anomalies. Some pipes with a diameter as small as 100 m or less can be detected in the AGG data. The AGG data has a 300 m resolution with an average RMS noise of 7.6 Eotvos in the derived vertical gradient. Laser profilometer data and differential GPS data were also acquired in the survey to construct a detailed digital elevation model for terrain correction.

Besides detecting kimberlite pipes, the AGG data is also useful for mapping details of geological structures. This is complementary to the magnetic data acquired simultaneously with the AGG data.

Target Exploration Initiative South Australia (TEiSA) - Musgrave Block uncovered

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Following extensive negotiation and consultation with Anangu Pitjantjatjara (AP) stakeholders, Minerals and Energy Resources South Australia (MER) obtained permission to undertake a regional airborne geophysical program over the Mann, Woodroffe and Alberga 1:250, 000 map sheets within the Musgrave Block.

Commencing with the Woodroffe map sheet the surveys were flown at 400 m line spacing and at a survey height of 80 m.

The surveys provided an excellent opportunity for the AP stakeholders to view first hand the processes and mechanisms required to undertake a large regional airborne survey. As a result MER was further encouraged to continue the survey onto the adjoining map sheets of Mann and Alberga.

The result is a spectacular data set covering approximately 75% of the Giles Complex within the Musgrave Block. The new TEiSA data has provided an excellent insight into the geological structure of the region at a resolution never seen before. There is clear delineation of the mafic bodies and fault systems hidden beneath the shallow cover.

The radiometric 'RGB' ternary image shows the contrasting geology clearly delineating such features as the Woodroffe Thrust Zone.

The digital terrain data provides good terrain detail successfully delineating the ranges and dune systems throughout the region.

Estimating parameters and uncertainty in geophysical inversion: a new approach using the Neighbourhood Algorithm

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The neighbourhood algorithm (NA) is a recently proposed direct search (i.e. derivative free) approach to nonlinear inversion which is finding increasing numbers of applications from problems in earthquake seismology to production uncertainty quantification in oil reservoirs.

An inverse problem occurs whenever data only indirectly constrain some physical, chemical or parameters of interest. For example when seismic data, collected at the Earth's surface is used to constrain structure at depth. Inverse problems occur in many areas of the physical and mathematical sciences.

The NA is applicable in cases where the relationship between unknowns and observations is highly non-linear and simple derivative calculations are undesirable, or impossible. NA is in the same class of technique as Genetic Algorithms (GA) and Simulated Annealing (SA), which are often associated with global optimisation. The NA makes use of simple geometrical concepts, and requires just two tuning parameters, but has been shown to produce a sophisticated 'self-adaptive' search behaviour in multi-dimensional parameter spaces. It also allows a fully nonlinear estimation of uncertainty in unknowns arising from noise, or other uncertainties, in the data.

Constructing high resolution DEMs from airborne laser scanner data

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In processing and interpreting the data collected during FALCON airborne gravity gradiometry surveys it is necessary to carefully compensate for topographic features. So that surveys may be performed even in areas where accurate DEMs (Digital Elevation Maps) are unavailable, the FALCON aircraft have been fitted with laser scanners, providing ground return data across a sufficiently wide swathe so that very adequate DEMs over the whole survey area can be produced. Additionally, in one aircraft, a laser profilometer has been fitted adjacent to the scanner, providing independent data to monitor the scanner integrity throughout a survey.

This paper briefly describes the scanner features and details the post processing of the scanner ground returns through to gridded DEM format.

The intrinsic accuracy of the scanner at low scan angles is demonstrated to be very good, accounting for a ground height error of less than 0.1 m standard deviation. Taking into account that DGPS height errors are about 0.15 m, the resulting ground height error is estimated as 0.2 m standard deviation, which is confirmed by the analysis of height differences in the overlapping areas between adjacent lines. This estimate is characteristic of a lightly vegetated terrain. This level of topographic error will have a negligible impact on our ability to identify target anomalies arising from geological variations.

Natural Resource Geophysics in the Northern Territory : new tools or new ideas?

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In the Northern Territory natural resource assessments are performed before land is released for horticulture or for intensive agriculture.

With the advent of detailed airborne geophysical surveys, funded by the NT Geological Survey, advanced assessment methodologies have been introduced. The new methods combine traditional site assessment skills with advanced image processing and GIS analysis.

The assessment process targets both water and land resources, with the intention of planning and managing development in a sustainable manner.

Initial tests of Enhanced Resource Assessment tools have shown the value of using airborne data to reduce the amount of ground truthing, and have been invaluable in modelling hydrogeological environments.

Development of a new rapid inversion scheme for Total Field Magnetometric Resistivity (TFMMR) data

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A large number of geophysical inversion methods have been published, but there are no published efficient technique applied to either of MMR or TFMMR data. One of the important aspect of inverting TFMMR data is its dependence on all three components of the anomalous magnetic field. In the case of inverting TFMMR data using gradient methods, we propose a preprocessing reduction of data to the pole to overcome the problems of the effect of the geomagnetic field direction and dependency of the TFMMR data on all three components. By doing this, we invert the data only using the sensitivity of the vertical anomalous magnetic field. After

formulating the expressions for computing the Frechet derivatives for the anomalous vertical component on a homogeneous half space model, the Marquart-Levenberg method (damped least squares method) incorporating the quasi-Newton approximation for updating the Jacobian matrix in successive iterations is employed. As the most time consuming task in inversion process is to calculate the Frechet derivatives, therefore employing such scheme will considerably reduce the computing time and improve the stability of the inversion. An analytical solution for calculating the Frechet derivatives in wavenumber domain for all mesh nodes component for a homogeneous half space model is developed first. Next for recovering 2D models, every 4 by 3 element in the x and z directions respectively constitute a resistivity block. This block parametrisation allows for recovering the sharp resistivity contrasts which occur in mineral exploration prospecting or shallow surface experiments. Assuming a linear variation of transformed electric potential and its gradient over the boundary of the elements, we may derive the discretised form of derivative equations. The efficiency and accuracy of the proposed scheme is demonstrated using a set of synthetic data from a double vertical dike model.

Geophysical signatures over copper porphyries on the Pacific Rim

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Geophysical methods have played an important role in the discovery and definition of porphyry copper deposits in the Indonesian Archipelago. Geophysical methods of particular value are aeromagnetics, induced polarisation, and to a lesser degree airborne radiometrics. Some deposits that have recently benefited from the application of geophysical methods, within the Indonesian Archipelago, include Bukit Hijau, Batu Hijau, and Beutong.

Geological interpretation of the aeromagnetic survey, Las Petas District, Republic of Bolivia

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Significant information about the underground continuity of the surface geology of the Las Petas district has been obtained, and it is presented on a solid geology map.

The newly defined lithomagnetic units range from Precambrian basement, largely beneath non-magnetic cover, to Cretaceous sandstones.

The basement comprises three units, i.e. a high magnetic gradient, Lower Proterozoic unit of high-grade metamorphic rocks, a medium magnetic gradient, Middle Proterozoic unit of low- to medium-grade metamorphic rocks and a low magnetic gradient unit of Middle Proterozoic sediments and metasediments. In addition, a unit of Upper Proterozoic sediments is inferred to underlie the Quaternary sediments of the southeastern portion of the district.
Two circular shaped, previously unrecognized Cretaceous alkaline bodies have been identified.

An area of low magnetic gradient and high potassium content identified in the Middle Proterozoic gneisses would correspond to an aureole of hydrothermal alteration.

New data also include structural information, particularly foliation/schistosity of the metamorphic rocks covered by laterite, as well as the positions of faults and fractures of various scales.

Forward and inverse modelling methods for electromagnetic surface impedance

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Low frequency computer modelling of the surface impedance response of subsurface structures is time intensive. Consequently automated three-dimensional inversion remains unrealistic. In this paper, a Genetic Algorithm least squares minimisation routine was applied to a one-dimension model and results used to seed two-dimensional surface impedance data. The Impedance (IM) method is shown to be an efficient numerical solution engine in the inversion method.

Polynomial fitting + narrow reject-band f-k filtering for seismic coherent noise elimination

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The paper presents a f-k filtering method to reduce coherent seismic noise. The method uses and adaptive strategy that the f-k filtering automatically adapts to lateral variations in apparent dip and amplitude of coherent noise events. We first use orthoganal polynomials to fit apparent dip and amplitude of coherent noise events. We then incorporate the instantaneous variations in apparent dip and amplitude into narrow reject-band (NRB) f-k filters which are applied in a spatially and temporally varying way across seismic traces. The method is only applied to the area where coherent noises are located and will not affect the signal that is located outside the area in the same seismic record but has the same regularity as the noise. That is, in a given window, the method removes coherent noises using the differences between noise and signal in three aspects: apparent velocity, frequency, and amplitude. The data outside the window will keep intact. The method can remove any coherent noise in prestack and poststack seismic data, which will favor following seismic processing and modification of seismic sections. The novel method has been applied to field seismic data and shows good attenuation characteristics with minimal distortion of signal.

Acquisition and processing of single sensor seismic data

Guido Baeten, Vincent Belougne, Tim Brice, Leendart Combee, Ed Kragh, Andreas Laake, James Martin, Jacques Orban, Ali Özbek and Peter Vermeer

Surface seismic data are normally acquired using arrays of receivers; each array forms a group, which is recorded into a single seismic channel. Two of the main drawbacks of conventional analog arrays are that the outputs of each receiver element are simply summed without any pre-processing and that the spatial sampling is fixed at the survey design stage. A new acquisition system has been developed which can record up to 30,000 channels so each component of the array can be digitised and recorded individually, this is called single sensor recording. The system consists of the acquisition hardware and a suite of software tools for processing the data. Single sensor data will yield improved data quality as improved noise attenuation results from the process of digital group forming (DGF). In addition, eliminating intra-array static variations retains high frequencies lost when statics are averaged in conventional analog arrays. DGF also allows greater flexibility in the processing centre. Output sampling may be varied during processing so different processing schemes can be employed for different temporal and spatial parts of the survey. In a single survey, shot to image multiple targets, the workflow can be optimised for each target. The new system moves us a step closer to decoupling the geophysics of the imaging process from the acquisition hardware and reduces the levels of noise and distortion, which limit the bandwidth of seismic data

Waves in alternating solid and viscous fluid layers

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Explicit expressions for the frequency dependence of the velocity and attenuation of shear waves in a periodic system of flat solid and viscous fluid layers have been derived by solving exact Rytov's dispersion equation in the long-wavelength approximation. The dispersion and attenuation are related to the well known mechanisms of dissipation in porous media: viscoelastic mechanism (viscous shear relaxation) and visco-inertial Biot's mechanism. The expressions describing the effects of these two mechanisms in a broad frequency range have been derived from the same standpoint. The asymptotic expressions for various limiting cases coincide with the results of previous studies.

Seismic attenuation in a heterogeneous porous rock

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I study the attenuation of an elastic wave propagating in a macroscopic heterogeneous poroelastic medium due to the scattering (conversion) of the passing wave's energy into the highly attenuative Biot's slow wave. This is done by studying two particular geometrical configurations: (1) a thinly-layered porous medium and (2) porous saturated medium with ellipsoidal inclusions. The frequency dependence of the so-called mode-conversion attenuation has the form of a relaxation peak, with the maximum of the dimensionless attenuation (inverse quality factor) at a frequency at which the wavelength of the Biot's slow wave is approximately equal to the characteristic length of the medium (layer thickness or size of the inclusion). The width and the precise shape of this relaxation peak depend on the particular geometrical configuration. Physically, the mode-conversion attenuation is associated with wave-induced flow of the pore fluid across the interfaces between the host medium and the inclusions. The results of our study demonstrate how the local flow (or squirt) attenuation can be effectively modeled within the context of Biot's theory of poroelasticity.

Basement interpretation of the Tennant Creek region

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A basement interpretation of the Tennant Creek region, incorporating modern semi-regional airborne magnetic data and recent geological mapping, is helping to unlock some of the secrets of the Tennant Creek Au-Cu-Bi mineral field. A GIS based environment facilitated the effective integration of several geological and geophysical datasets.

Five different magnetic signatures are associated with mineralised Warramunga Formation. The major deposits of the Tennant Creek mineral field are hosted by the magnetic siltstone dominated lithofacies. Several of these deposits are adjacent to areas with a 'washed out' magnetic response, possibly caused by destruction of magnetite by hydrothermal alteration.

The new magnetic data defines previously unrecognised structures and faults that may be related to mineralisation.

Numerical simulation of fractured media

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Numerical simulations using low order approximations of the full Zoeppritz equations were performed on anisotropic parameters derived from the Sydney basin and the North West Shelf region. The resultant amplitude coefficients were then displayed in full azimuths in which a lineation indicates abnormalities caused by the fractured media. Our studies show that amplitude variations with offset and azimuth (AVAz) depend not only on fracture orientation, but also on impedance differences of P- and S-waves in the fractured media.

Migration Velocity Analysis Using Seismic Multiples

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Migration velocity analysis (MVA) is a powerful tool for determining the interval velocity model in regions of complex geology. It is based on the fact that the migration process is sensitive to changes in the velocity model. Only when the migration velocity is equal to the interval velocity of a layer will that event be horizontally aligned in a migrated common image gather (CIG) (a CIG is a gather containing traces from the same surface location but from different migrated shot gathers). This is equivalent to saying that the image of the subsurface should be in the same location regardless of the source position. Conventional analysis is concerned with utilising primary events and these alone for the determination of interval velocity. However, it has been found that a greater accuracy can be obtained by utilising multiple events which are normally considered as noise and removed prior to MVA. The new technique is based on the fact that any initial error in velocity between the migration and interval velocities will be increased as the distance travelled through the Earth increases. Hence in migration, multiples will be more sensitive than primaries to changes in the velocity model. Two synthetic examples are presented to demonstrate this. Both show that on a coherency plot, multiples will stack in a more localised region. This should result in increased accuracy in determining interval velocity and subsequently interval thickness. It should also reduce the number of migration iterations needed to converge on an accurate solution. This has implications for reducing the time and cost of the MVA process.

Mapping boulders using 2D resistivity imaging technique for site investigation in Penang, Malaysia

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The 2D Electrical Resistivity surveys were carried out in a site in Sungai Nibong, Penang. This technique has proofed to be successful in mapping the depth and location of the boulders buried underground, which are typical features of the area. The results can then be used by civil engineers to design the piling foundation of the proposed buildings.

Apache Energy: a case study in real-time database integration

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All Exploration and Production (E&P) companies have a vested interest in controlling and maintaining subsurface data. The need for managing an information strategy has obvious benefits to the wider goals of

interpretation, 3D reservoir modelling and business decisions based on the technical model.

To the E&P companies, many solutions are available to help them manage and leverage the increasing volume and complexity of their data. It is our intention to show how leading edge technology combined with sound data management practices can deliver a cost effective data management strategy.

Principally, data managers need to be able to find, condition and deliver data to their customers - the interpreters. Our case study from Apache Energy Ltd, (Perth) will highlight the migration from a 'past' state to a 'future' state and how Integrated Solutions Australasia (ISA) deployed GeoBrowse as the integration tool to meet the principal Apache objective of 'Easier Data Access'. We will show evidence of how GeoBrowse allows visual display of spatial data with the unique ability to then query 'non spatial' data. This environment allows geoscientists, data administrators and managers rapid access to their data.

Building on the initial GeoBrowse implementation many queries have been developed by Apache staff and transformed into macros, that users can run 'real-time' against their databases. This results in 'live' reports of the latest data to be stored in those databases.

From this work Apache now view their disparate databases as a single 'virtual' database. Enormous time savings are being made in a) locating data b) comparing data c) quality control and d) reporting of data.

Amplitude 'statics' in shallow refraction seismology

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Increases in refracted amplitudes not related to changes in the head coefficient are usually associated with increases in traveltimes in the near-surface layers, while decreases in amplitudes are associated with decreases in traveltimes. These correlations demonstrate that the amplitude variations are related the variations in the near surface geology, rather than to variations in the coupling of the detectors with the ground.

The change in amplitude can be described with the transmission coefficient of the Zoeppritz equations. Correction factors can be applied for those surface conditions which are sufficiently extensive to permit the measurement of the wavespeed. Where this is not possible, then the lowest amplitude or amplitude product is representative of the head coefficient for the main refractor.

A simple approach to 3D shallow refraction seismology

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A three dimensional (3D) seismic refraction survey was carried out across a shear zone. The data were processed with the generalised reciprocal method (GRM) rather than with tomographic inversion because of the relatively small volume of data, the occurrence of large variations in depth to and wavespeeds within the main refractor and the presence of azimuthal anisotropy.

The results show that there is an increase in the depth of weathering and a decrease in wavespeed in the sub-weathering associated with the shear zone. Although the shear zone is generally considered to be a two dimensional (2D) feature, the significant lateral variations in both depths to and wavespeeds within the refractor in the cross-line direction indicate that it is best treated as a 3D target. These variations are not predictable on the basis of a 2D profile recorded earlier.

The in-line results show that both accurate refractor depths and wavespeeds can be computed with moderate cross-line offsets, say less than 20 m, of shot points. These results demonstrate that swath shooting with a number of parallel recording lines would be adequate for 3D surveys over targets such as highways, damsites and pipelines. Only a modest increase in shot points over the requirements for the normal 2D program would be required in the cross-line direction for measuring azimuthal anisotropy and rock fabric.

Potential Field and Bathymetry Grids of Australia's Margins

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The Australian Geological Survey Organistaion, in co-operation with Desmond Fitzgerald and Associates and the Australian Hydrographic Service, has produced a set of digital bathymetry, gravity and magnetic grids for Australia's continental margin, with resolutions of 250-1000m. They represent a major upgrade of marine ship-track potential field and bathymetry data in Australian waters to assist geological interpretations. In integrating data from many sources, levelling techniques have been developed to correct crossover and other errors, and the ship-track data have been merged with satellite and high-resolution onshore sources.

Antarctic sea ice thickness measurements using a ship-borne electromagnetic induction device

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We perform a theoretical analysis of Antarctic sea ice thickness estimates made using a ship-borne electromagnetic instrument. Inversion of theoretical one-dimensional sea ice models assuming a conductive half-space model has shown that the ship-borne system is able to determine thickness to within 10% for level ice up to ~2 m thick. However, the presence of a thin conducting brine layer within the ice, common during the Antarctic summer, results in a large error in thicknesses estimated assuming perfectly-resistive ice.

An analysis of the effect of system attitude on the electromagnetic response has shown that pitch and roll of up to 10° can result in significant errors in the interpreted ice thickness in areas of thin sea ice.

A preliminary three-dimensional model study of the EM-31 system has shown that it can yield good estimates of maximum sea ice keel thickness. However, sea ice thickness is significantly over- or underestimated near sharp vertical boundaries in the three-dimensional model.

Accuracy of interpolation for 3D contour mapping from 2D seismic sections

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This research examines the accuracy of contour maps sub-sampled from a 3D seismic survey. A 3D seismic dataset was interpreted using Landmark's 'Seisworks-3D' software to build three contour surfaces of stratigraphic horizons at various depths and structural complexities. These horizons were exported and imported to a Geographic Information System (GIS), resampled at various inline and crossline, and point spacings, and interpolated to create 3D surface grids from these sub-samples of the horizons to simulate interpolation from 2D seismic lines.

In the first set of experiments, for both transect and point data structures, map error decreased as a power function of sample size. This systematic

increase in error as sample size decreases allows prediction of the accuracy of interpolation according to sample size and distribution of the data. This relationship facilitates estimation of errors for seismic data interpreters picking a sub-sample of sections for a particular stratigraphic horizon, determination of receiver and line spacings for sufficient survey accuracy for least economic outlay. Another application of this relationship is to determine the accuracy of interpolative contour mapping on a series of parallel 2D seismic lines according to their spacing.

In a second set of experiments on the point data of a set sample size, map error increased with the local structural complexity of strata sampled. This relationship would allow prediction of the relative precision expected in areas of varying complexity. These findings corroborate earlier work on topographic maps and indicate that similar trade offs between map accuracy and both sample size and surface complexity apply to geologic blocks.

Biographies

Section 5

ASEG 2001 A Geophysical Odyssey

Alan Anderson received a BSc (Honours) in Geophysics from the University of Adelaide, South Australia, in 1985. He worked as an Exploration Geophysicist with SANTOS Ltd. on their Cooper/Eromanga, Bonaparte and Timor Sea interests before joining BHP Petroleum in 1990. He has since held a variety of exploration/development and technical positions for BHP in Australia, Malaya and is currently a Senior Geoscientist for BHPP (Americas) in Houston. Alan is a member of the SEG, ASEG, AAPG and GSH.

Yuzuru Ashida is Professor, in Earth Resources Engineering at Kyoto University. He graduated from Kyoto University in 1967 and obtained a Doctorate of Engineering from University of Tokyo in 1985. Between 1967 and 1986 he worked for the Japan Petroleum Exploration Co. Ltd (JAPEX), and has been at Kyoto University since1986. He won Best Paper Award, SEGJ 1980; Best Paper Award, SEGJ 1990; and Best Paper Award, The Society of Materials Science, Japan. 1997. His interests include seismic interpretation and data processing. He is a member of EAGE, SEG and SEG Japan.

Michael Asten is a consulting geophysicist and Partner with Flagstaff Geo-Consultants, and also holds a part-time academic position as Principal Research Fellow at Monash University. He majored in Physics, Geology and Geophysics at the University of Tasmania before entering post-graduate study at Macquarie University in 1972. After excursions into magneto-tellurics and DC electrical methods he gained a PhD in geophysics on the topic of using micro-seismic waves as a tool for studying sedimentary basins. In 1977 he took up a two-year appointment lecturing and coordinating an MSc (geophysics) program at Ahmadu Bello University in Nigeria. He then joined BHP Minerals in 1979 and worked in coal and base-metal exploration in Australia, East Africa and North America, with particular emphasis on geophysical research issues. He has been active in EM research for a decade, initiated the airborne gravity gradiometer project in BHP, and is author of a short Industry course on EM Methods for Geologists and was Visiting Lecturer for the South African Geophysics Association in 1999. He recently completed a research project on "Borehole EM Methods in the search for Weak Conductors" sponsored by four Australian mining companies. He received the ASEG's Laric Hawkins Award in 1988, co-authored the Best Paper at ASEG 1992, was a co-recipient of the BHP Research Innovation Prize in 1996 (for development of airborne EM technology and interpretation tools), and a co-recipient of the CSIRO Medal for External Research in 2000 (for development of the "Falcon" airborne gravity gradiometer). He is a past Vice-President of the ASEG, an Associate Editor for the SEG, Co-Chairman of the ASEG Conference 1998, and Guest Editor for the SEG Special Issue on Mining Geophysics. He is currently collaborating with the SEGJ in translating a book on engineering seismic methods. He is a member of SEG, EAGE, SEG, AGU and a Fellow of the RAS.

Peter van Baaren, a senior project geophysicist, has worked with WesternGeco since 1989. In this period he has mainly been active in seismic data acquisition in a large number of different environments around the world including projects in ecologically highly sensitive areas as well as highly populated areas. Recently, this experience included managing data acquisition projects in Australia. His current projects include investigating geophysical issues related to land and transition zone data acquisition in Australasia and South East Asia. This work includes the design of 3D surveys. He is a graduate of the Delft University of Technology.

Fabio Boschetti obtained his Honours degree in Geological Sciences in Italy and then worked as meteorologist before moving to Australia. He obtained a PhD in Mathematical Geophysics at The University of Western Australia. Afterwards he moved to CSIRO where he has been working mainly in the analysis of potential field data and inversion of geological and geophysical processes.

Richard Brescianini graduated with a BSc (Hons.) in geophysics from the University of Tasmania in 1985 after completing his undergraduate degree in geology and physics at La Trobe University. He joined BHP Minerals in Brisbane as an exploration geophysicist in 1987. Over the next 12 years he worked with BHP on base and precious metal exploration programs whilst based in various locations throughout Australia, Canada and the U.S. He is currently the Chief Geophysicist at the Northern Territory Geological Survey, a position he has held since 1999. His role is to coordinate all geophysical programs within the framework of the Northern Territory Exploration Initiative.

Andrew C. Burtt graduated from University of South Australia with Honours in 1992. He has been employed as a Geologist and Senior Geologist with Primary Industries and Resources (formerly Mines and Energy South Australia) for last eight years. For the last five years he has worked on stratigraphy, structure, geochronology and metallogeny of Cambrian Kanmantoo Trough metasediments, metavolcanics and igneous bodies. For past six years he has been involved in GIS compilation of South Australia geology using Arc/Info.

Amanda Butt graduated from the University of Queensland with a BSc in 1990. From 1990 to 1995, she was employed by Newcrest Mining Limited, exploring for gold, primarily in Queensland and New South Wales. During this time Amanda managed the geophysical program at the newly discovered Cadia Hill gold deposit. In January 1996, she joined Hamersley Iron Pty. Limited as mine geophysicist. She is currently applying high-resolution geophysical techniques to iron ore delineation at Hamersley Iron's mines and evaluation prospects. She is a member of the ASEG.

Domenic Calandro graduated in 1993 with a BSc in Geophysics from the Flinders University of South Australia. He is currently employed as a Senior Geophysicist with the Minerals and Energy Resources South Australia where he manages and coordinates the processing of Airborne Magnetic and Radiometric data acquired through the South Australian Exploration Initiative, Broken Hill Exploration Initiative, Target Exploration Initiative and company surveys. His expertise covers data acquisition, processing and interpretation of both ground and airborne geophysical data. He is currently managing the Mineral Resources - Data Management Group and the Targeted Exploration Initiative South Australia (TEISA).

Henry Cao obtained his BSc in 1985 from the China University of Mining and Technology and his PhD in 1991 from the Australian National University. Both degrees were in Geophysics. Before joining Schlumberger as a Senior Geophysicist in 1997, he worked at Flinders University and the Australian Geological Survey Organisation. He is a member of SEG, ASEG and SPE.

Chih-Hsiung Chang received a BSc (1984) and an MSc (1986) both in Geophysics from the National Central University in Taiwan, and a PhD (1992) in applied geophysics from the University of Houston. He is currently an associate professor in Department of Applied Physics at National Chiayi University, Taiwan. His research interest is focused on seismic modelling and elastic wave propagation, especially in anisotropy. He is a member of SEG.

Carlos J. Chernicoff was born in Buenos Aires, Argentina, in 1957. He graduated from the University of Buenos Aires as a Licentiate in Geological Sciences in 1981, completed his MSc at the Rand Afrikaans University (Johannesburg) in 1985 and his PhD at the University of Buenos Aires in 1994. Both his MSc and PhD theses dealt with Structural Geology. After 1994 his main field of interest changed to the use of airborne geophysics (magnetometry and gamma ray spectrometry) in mineral exploration. Since then he has taken a number of specific courses/guided work, notably at the Geological Surveys of Australia and Canada. At present he is a researcher of the Council for Scientific and Technical Research of Argentina, lectures on a part-time basis at the University of Buenos Aires, and heads the Geophysics Group of the Argentine Geological-Mining

Survey (SEGEMAR). At the SEGEMAR, he is involved in the geological interpretation of the airborne magnetic and gamma ray spectrometric surveys carried out by the latter organization in areas with a mining interest.

Asbjorn N. Christensen received his BSc in Physics and Chemistry (1987) and his MSc in Geophysics (1991) from University of Aarhus, Denmark. He received his PhD in Geophysics from Colorado School of Mines in 1995. He then joined BHP Research working on algorithms for semi-automated interpretation of airborne magnetic and electromagnetic data in mineral exploration. Since 1999 he has been actively involved with processing and interpretation of airborne gravity gradiometry data with BHP Minerals Discovery Technologies. He is a member of the SEG and ASEG.

David Clark graduated in 1974 with a First Class Honours degree in Physics from Sydney University and completed an MSc in Geophysics, also at Sydney, in 1983. Since 1978, he has worked for the CSIRO, carrying out research into applications of rock magnetism to exploration. He is currently a Principal Research Scientist in CSIRO Exploration and Mining, working on magnetic petrology, tensor gradiometry and predictive magnetic exploration models.

Roger Clifton started geophysics in the nickel boom, finding the shear, which became the Karonie gold mine with VLF. He joined BMR and was working in the Observatory Section during the Meckering earthquake. He travelled widely and spent years as the dirt doctor for a brick factory, doing satisfying science. Roger taught at Curtin University while studying Norm Uren's seismic diploma and wrote a Masters Thesis on multichannel radiometric processing in the days before it became fashionable. At the School of Mines in Kalgoorlie he started up the VHF underground communications system, MINECOM. He is now with NTGS. He still goes skydiving and enjoys talking science with total strangers.

David Close completed a BSc (Hons) in Geophysics at the University of Tasmania in 2000 and was awarded a university medal. He will take up a Rhodes Scholarship to undertake a PhD in Geophysics at Oxford University in 2001.

Steve Collins completed his MSc at Macquarie University in 1974. He spent two years as a company geophysicist for Cities Service and eight years with Amoco Minerals. This involved field surveys and interpretation in Australia, New Zealand and Pacific Islands. In 1985 Amoco became Cyrus Minerals. Steve became a consultant but continued a close association with Cyprus. Since then, he has continued as a consultant, working for a variety of clients. His consulting work over the last decade has been mostly in Eastern Australia and Southeast Asia in exploration for copper, gold and base metals. Steve has been closely involved in the discovery of several deposits including Red Dome and the Selwyn copper/gold deposits, the Junction Reefs gold deposits and the Tritton and Larsen's East copper deposits at Girilambone NSW.

Richard Coopper graduated from The University of Liverpool in 1979 with an Honours degree in Geophysics with Geology. He joined Digicon Geophysical the same year (now Veritas-DGC) and spent 13 years with the company in a variety of positions including Processing Geophysicist (UK), Manager, Special Projects (Singapore), Division Geophysicist (Australia), Manager, Technology Transfer (Houston) and Marketing Manager (Singapore). Richard joined CogniSeis Development in 1991 as Manager of EAME Division and returned to Houston in 1996 as General Manager and then President of CogniSeis Development, Inc. Following the sale of CogniSeis in 1998, Cooper joined The Discovery Bay Company as President. Rock Solid Images was formed the same year through the merger of The Discovery Bay Company with Seismic Research Corporation and PetroSoft ®, Inc. He is currently President of Rock Solid Images, based in Houston, Texas.

Duncan Cowan graduated from the University of Nottingham, England with BSc (Hons) in 1963 and a PhD in 1966. He has over 30 years experience in exploration geophysics and geology and has worked on all continents except Antarctica. He works as a consulting geophysicist specializing in interpretation of magnetic, gravity and radiometric data with emphasis on computer techniques for data enhancement, analysis and dataset integration. His research interests include data processing and inversion of potential field data, aeromagnetic gradiometers and kimberlites/lamproites. He lectured at Royal School of Mines, Imperial College, London, from 1979 to 1989 and is currently an adjunct research fellow in the Department of Geology and Geophysics, UWA. He is a member of ASEG, SEG, EAGE, IAMG and IMM.

Jim Cull joined Monash University in 1986 after an extensive career in regional and exploration geophysics primarily with the Bureau of Mineral Resources (now AGSO) and CRA Exploration Pty Ltd. Since joining Monash he has also consulted extensively to the geotechnical and groundwater industries and has been responsible for the introduction of several innovative exploration, NDT and pipeline inspection technologies. Professor Cull is a Fellow of the Australian Institute of Mining and Metallurgy (FAusIMM); a Fellow of the Australian Institute of Energy (FAIE); a Member (and past State President) of the Australian Society of Exploration Geophysics (ASEG); and a Member of the Environmental and Engineering Geophysics Society (EEGS). His specialities include geothermal, EM, GPR, groundwater, remote sensing, and NDT technologies.

Rebecca Denne graduated with an Honours Degree in Geophysics from Macquarie University in 1994. Since 1995 Rebecca has worked as a geophysicist for consultants Arctan Services Pty Ltd. Areas of interest include IP and EM data processing and imaging. Rebecca also has a keen interest in GIS software and geological database management.

Bruce Dickson obtained his MSc from Wellington University, New Zealand, and received a PhD from Imperial College, London in 1973. He moved to Australia where, after a short time at ANU, he joined CSIRO to work on a variety of aspects of application of radiation measurements to exploration. His work has covered aspects of uranium grade control, uranium exploration using ground waters, radioactive disequilibrium in uranium deposits and more recently, the processing and interpretation of aerial gamma-ray surveys.

Jamie Doyle graduated in 1992 with a BSc (Hons. - 1st Class) in Geology from The Queensland University of Technology. He joined Oil Company of Australia Ltd in 1993 and has worked as an exploration geologist in several basins including the Otway, Cooper/Eromanga, Surat/Bowen, Clarence-Moreton and Georgina Basins. He is currently assigned to the Denison Trough asset team as an exploration geologist. Jamie is a member PESA.

Mark Dransfield graduated in 1981 from the University of Western Australia with a BSc (Hons.) in Physics, and joined Seltrust Mining Corporation as a geophysicist. Mark's major interest since 1985 has been in airborne gravity gradiometry. He worked for nine years on the development of an airborne gravity gradiometer at the University of Western Australia including four years on a PhD focussing on the geophysics of airborne gravity gradiometry. In 1995, CRA Exploration employed Mark as a senior geophysicist working in airborne gravity gradient modelling and in airborne EM and radiometrics. In March 1998, Mark joined BHP's Falcon team in the early phase of the airborne testing of their gravity gradiometer. The first Falcon system was delivered in October 1999 and Mark is now project leader of the Falcon deployment and data processing team. The Falcon team, including Mark, was awarded the CSIRO Medal for external research in December 2000.

Karel G. Driml is the Managing Director at Velseis Processing Pty Ltd. He graduated from the University of Queensland in 1980 with a BSc majoring in Physics and Mathematics. After a short period computing refraction statics on a field crew he started processing seismic data at Petty-Ray Geophysical. He moved to Digicon in 1989 where he became land

processing supervisor. In 1992 Karel participated in the formation of Velseis Processing becoming Managing Director. Since that time Karel has been actively involved in developing processing and interpretation methods critical to the adoption of 3D seismic to the coal industry. He has over 15 years experience with high-resolution seismic data.

Yu Duan received a BSc (1984) in Geophysics from Jianghan Petroleum Institute in China. She commenced her geophysical career with the China National Offshore Oil Exploration & Development Research Center doing seismic data interpretation and seismic data processing. From 1992 on she undertook research in developing efficient methods to handle extremely poor signal-to-noise data that are related to seismic exploration in areas of rough topography and complex near-surface velocities. She developed a prestack one-step pre-processing (POP) technique, doing bad-trace editing and filtering, static correction, first arrival muting, amplitude compensation and equalisation, suppression of unwanted waves (random noise, surface waves, multiples, and various coherent noises), and signal reconstruction for irregularly spatial sampling. All of these prestack pre-processing can be done automatically in one step. The POP technique has been widely used to significantly improve the quality of low S/N ratio data from various complex areas. She has authored and co-authored several papers.

Tom Eadie was appointed Executive General Manager - Exploration of Pasminco following the formation of the Exploration division in early 1990. Prior to this he spent eight years in the minerals exploration industry in North America, including three years with Cominco. In 1983 he was transferred to Aberfoyle Limited (then 48% owned by Cominco) in Melbourne as Chief Geophysicist and then manager of Aberfoyle's base metals exploration programs before joining Pasminco in 1990.

Peter Elliott graduated with a BSc (Hons) in Geology and Geophysics from the University of Melbourne (1976). He was later awarded an MSc from the University of Melbourne in 1984, and a PhD from Macquarie University in 1997. He started his profession as a Cadet Geologist with the Geological Survey of Victoria in 1975. He worked as a geologist in Regional Mapping for a couple of years and then as a Geophysicist with the newly formed Geophysics Section in the Dept. of Mines, Victoria (1977-1980). He later joined the Shell Company (Australia) Ltd. in 1981 where he worked as a Regional Geophysicist with the Metals Division (1981-1987). During this time he worked out of Melbourne, Perth, and Adelaide. In 1987, Peter left Shell to set up his own exploration services company. This company is now represented by Elliott Geophysics International Pty. Ltd. and PT Elliott Geophysics Indonesia. Peter Elliott has spent the last nine years working in SE Asia. Most of this time has been spent in Papua New Guinea, Indonesia and the Philippines. Peter has worked in Indonesia since 1992, and established a permanent branch office in Jakarta in 1996. He has given courses in Electrical Geophysics at the University of Adelaide and has published more than 20 scientific papers. Peter currently holds three patents in Canada, USA, and Australia.

Nader Fathianpour is based at the Department of Mining Engineering, Isfahan University of Technology, Iran. He teaches exploration geophysics, ore reserve evaluation, applications of computers in mineral industries and geostatistics. His research interests are in: geomathematics, exploration geophysics (electrical and EM methods), and geostatistics. He is member of the IGS (Iranian Geological Society).

Clive Foss obtained his BSc in Geophysics from Reading University in 1975 and a PhD in palaeomagnetic and rock magnetic studies from the University of Leeds in 1979. From 1979 to 1987 Clive lectured in exploration geophysics at the University of Malaya, before joining the Indonesian/Australian Geological Mapping Program in Bandung, where he was senior geophysicist in charge of regional gravity studies of Irian Jaya and Western Kalimantan. In 1990 Clive returned to Kuala Lumpur where he worked as a potential field consultant in the oil industry, firstly as an independent consultant, then as a senior geophysicist for ARK Geophysics. In 1995 Clive joined Encom Technology in Sydney where he is the principal consultant running the potential field consultancy group. Clive also has responsibilities in development and maintenance of Encom's potential field software packages including ModelVision, AutoMag and QuickMag.

Li-Yun Fu received a BSc (1985) in Geophysics from Chengdu College of Geology, China. He started his research career with the China Offshore Oil Exploration & Development Research Center doing seismic data processing, seismic wavelet analysis, high-resolution data processing, and the application of AVO techniques to reservoir characteristics. Li-Yun subsequently undertook research in wave propagation simulation and obtained an MSc (1992) in Applied Geophysics at the China University of Petroleum. Then he turned to research in reservoir integration strategy and completed a PhD in geophysics from China University of Petroleum in 1995. From 1995 to 1997, he was a postdoctoral fellow in engineering mechanics, at the Tsinghua University, Beijing, developing a velocity-weighted wavefield theory and its application to seismic modeling, seismic migration, and seismic inversion. In 1997 Li-Yun moved to the Institute of Tectonics, University of California, Santa Cruz, investigating Lg phases in the crust and simulating crustal wave propagation. Li-Yun joined CSIRO in Perth in August 1999 and works as a research scientist on geopressure, based on acoustics. He is a member of SEG, ASEG, AGU, and INNS, and has authored and co-authored a number of journal papers and book chapters.

Hirohide Fukamori graduated at Kyoto University with a BSc in 1999 and is currently a post-graduate student at that university in engineering geophysics and inversion. He is a member of SEG.

Peter Fullagar holds an MSc from Monash University, Melbourne, and a PhD in Geophysics from the University of British Columbia. He worked for Western Mining Corporation in Australia for 12 years, serving in a variety of exploration, research, and management roles, including Chief Geophysicist. While with WMC he promoted the application of high-resolution geophysics at Kambalda Nickel Mines. In 1993 he became the inaugural Chair of Borehole Geophysics at Ecole Polytechnique in Montreal. In Canada he initiated research into the application of borehole radar and radio imaging for orebody delineation at Inco mines in Sudbury. He was the leader in Australia in 1995-96 for a CMTE/AMIRA Research Project into mine geophysics, sponsored by seven major mining companies. Later, with Rio Tinto Exploration, he investigated application of geophysics at Freeport's Grasberg Mine in Irian Jaya. In 1998 he established Fullagar Geophysics Pty Ltd, a geophysical consultancy based in Brisbane. He is an Adjunct Professor at the WH Bryan Mining Geology Research Centre, University of Queensland, and is a member of SEG and ASEG.

Malcolm Gamlen has worked in Engineering Services at AGSO since 1974 and is now Deputy Director of that group. He received his BSc in Computer Science and Pure Mathematics from ANU before leaving the employ of the Research School of Earth Sciences at that University. While there he was involved mainly in the technology of solid-source isotope ratio mass spectrometers. He designed a field integrating magnet controller to minimise hysteresis, and a unique calibrator to improve the precision of ratio measurement. During 1977 he attempted to legitimise his practice of engineering by studying final year Engineering Units at the University of New South Wales. He has been involved in the design of equipment for aeromagnetics, EM prospecting, marine seismic data acquisition, magnetic property measurement and geomagnetism. His main professional interests are in metrology, signal processing and the art of providing engineering development and advice to scientific organisations. He is now mainly involved in magnetic measurement and field control, and enjoys the role of a senior technical adviser to Engineering Services, AGSO and its external clients.

Vince Gauci, MIM's Chief Executive since April, was born in Broken Hill where he joined CRA's operations as a young mining engineer and rose to Acting General Manager. Vince moved to Woodlawn Mines as General Manager of Operations, and subsequently Denehurst, and served as

Managing Director of Pancontinental prior to its takeover, before joining MIM in 1995. Initially, his responsibility covered executive operational management of MIM's Australian mining division, extended in 1998 to all Australian operations, including Mt Isa, and again in 2000 to encompass MIM's world-wide interests. Vince has been a Director of MIM since 1999.

Eric Gozlan completed his BSc at Monash University in 1998 majoring in Geology/Geophysics with a mathematics background. He is currently completing his MSc at Monash University in geophysics in the field of gravity and magnetic potential. He is also currently working as a geophysicist for Monash Geoscope concentrating on groundwater and geotechnical projects.

Ashley Grant commenced a BSc Honours project at Monash University at the completion of his undergraduate program in 1999. As part of his research program he was required to provide an interpretation of TEM data for exploration targets contained in a conductive host. Apart from gaining familiarity with industry software standards and numerical models for interpretation, he developed an innovative approach to removing host effects based on filament migration. He gained a H1 award for this project and is now working on a temporary basis for the Geological Survey of Victoria.

Boris Gurevich received his MSc in Exploration Geophysics from Moscow University in 1981, and PhD in Geophysics from the Institute of Geosystems in Moscow in 1988. From 1981 until 1993 he worked as a researcher for the Institute of Geosystems. He was a visiting scientist at the Geophysical Institute of Karlsruhe University (1992-1993) and at Birkbeck College of London University (1993-1994). In 1995-2000 he worked as a research geophysicist at the Geophysical Institute of Israel. He is currently professor of petroleum geophysics at the Department of Exploration Geophysics of the Curtin University of Technology in Perth, Western Australia. His research interests include petrophysics, theory of seismic/acoustic wave propagation in rocks and other porous materials, and seismic imaging. He is a member of SEG, AGU and EAGE.

Ross Gwyther has worked as a research geophysicist with CSIRO Exploration and Mining for nine years, managing a number of earth strain research projects in minescale geophysics. His experience includes development of new borehole strainmeter technologies, and modelling and analysis of observed surface strain data associated with longwall coal mining in the Bulli basin. He has previously worked for 15 years in geophysical investigation of earthquake processes in California, and has authored several publications in international geophysics journals.

Glenn Harris obtained his Honours degree at the University of Sydney (Marine Science). His honours thesis involved an investigation into the bedrock topography of Port Jackson (Sydney Harbour). This project was supported by the Defence Science and Technology Organization Student Vacation Scholarship Program and the Department of Geology and Geophysics. Glenn maintains an active interest in the maritime environment by supporting numerous research projects (which are both geological and ecological in nature) through the provision of SCUBA diving services. He is currently undertaking an MSc in the field of marine geology.

John Hart obtained a BSc Hons in Geology from the University of Western Australia in 1992. He commenced work with BHP Minerals Exploration in 1993. Since then he has been involved in geophysical programs in the Mt Isa Block, W.A. and Northern Territory, Botswana, Rajasthan and South America. He is currently Senior Project Geophysicist with the Australian Discovery Group. During his time with BHP Minerals he has been involved mainly in the interpretation of potential field data and time-domain electromagnetic data.

Philip Hawke graduated from the University of Adelaide with a BSc (Hons) in 1993. He was employed by Rio Tinto from 1994 to 1999 in the exploration for iron ore and base metal deposits. He is currently working towards a PhD at The University of Western Australia researching the geophysical responses associated with meteorite impact craters.

Marc Hendrickx graduated from La Trobe University in 1993 with first class honours in Geology. In his five years with the Geological Survey of Victoria between 1993 and 1998 he made important contributions to the understanding of the eastern Lachlan Fold Belt. Marc supervised mapping in the Tanami and North Arunta provinces between 1998 and 2001 with the Northern Territory Geological Survey resulting in a revision of the understanding of this part of the North Australian Craton. His main interests are regional mapping and geophysical interpretation with a view to reconstructing provincial tectonic histories and the application of structural analysis to mineral systems. Marc is currently employed by the Geological Survey of New South Wales.

Neil A. Hughes graduated with a BSc (Hons) in Geophysics from Queen's University, Ontario, in 1984 and gained an MMET degree from Curtin University of Technology in 2000. He worked as a mud logger on oil rigs in the north sea from 1985 to 1986, as a field geophysicist for JVX Ltd from 1986 to 1989, as a geophysicist for Crone Geophysics from 1989 to 1992, as senior and then principal geophysicist for Pasminco in Melbourne and Broken Hill from 1992 to 2000, and is currently senior geophysicist at Crone Geophysics & Exploration Ltd.

Don Hunter graduated in 1994 from Curtin University with a BSc (Hons) in Computer Science. He joined the Cooperative Research Centre for Mineral Exploration Technologies (CRCAMET) in 1995, compiling GIS databases and developing software for the application of airborne electromagnetic (AEM) methods to mapping geology in regolith dominated terrains. Currently, he is with CSIRO-Exploration and Mining's environmental geoscience group and divides his time between examining the application of AEM to mapping solute dispersion and developing software for airborne hyperspectral instruments.

Richard (Dick) Irvine received a BSc from the University of Sydney in 1964 and an MSc in Geophysics from University of London (UK) in 1968. After working for 4 years in USA and Canada he returned to Australia and worked for Amax and Union Miniere in base metal, gold and nickel exploration. In 1977 he joined BHP Minerals and spent 21 years as a geophysicist in mineral exploration, initially throughout Australia employing a wide range of ground and airborne techniques. Later he was based in Hong Kong managing geophysical programs in challenging geopolitical environments in SE Asia, China, India and Pakistan and Africa and then spent a year in Cape Town on similar programs in Africa. Since 1999 he has been Vice President of Condor Consulting, Inc. in Denver, USA, specializing in value-added processing of airborne EM and magnetic data and integration with geological data applied to mineral, groundwater and environmental programs.

John Jackson is a Senior Geophysicist with Sons of Gwalia Ltd, an Australian mineral exploration and mining company. Current work includes the use of geophysics in exploration and development of Archean gold and tantalum deposits as well as mineral sands deposits and is interested in the integration and visualisation of geological and geophysical data. He is a member of the ASEG.

Andrew Johnstone graduated with an honours degree in Geophysics from the University of Tasmania in 1993. He joined BHP Minerals in Melbourne as an exploration geophysicist in 1994. Over the next five years he worked with BHP on sediment hosted base metal, mesothermal gold, BHT, IOCG and magmatic Ni-Cu exploration programs in Australia and Africa. Two of these years were spent working with BHP's Australian Reconnaissance Group. Andrew is currently employed as an Interpretation Geophysicist at the Northern Territory Geological Survey, a position he has held since 1999.

Leonie Jones has a BSc (Hons) in Physics (1972) from the University of Queensland and a PhD in Geophysics (1976) from the Australian National

University. She has worked as a geophysicist in the petroleum industry, in the academic sector and in government. Her initial research interests in laboratory studies of elastic properties of minerals and rocks at ultrasonic frequencies have evolved into seismic reflection and refraction investigations of the Australian continent from deep crustal to shallow scales. Since 1998, she has been employed at the Australian Geological Survey Organisation, first with the Australian Geodynamic Cooperative Research Centre (AGCRC) and currently as a Research Seismologist with the Australian National Seismic Imaging Resource (ANSIR).

Stefan Kleffmann is a postdoctoral fellow in the Tectonics Special Research Centre at the University of Western Australia. After completion of an MSc in Geophysics and a short period as a processing geophysicist at New Zealand Oil and Gas, he obtained a PhD in Geophysics from Victoria University in Wellington, New Zealand. His research interests are in seismic and gravity methods as applied to engineering, exploration and tectonic studies.

Agu Kantsler graduated with a BSc (Hons) degree in Geology from the University of New South Wales in 1974 and gained a PhD from the University of Wollongong in 1985. He joined Shell Development (Australia) Ltd in 1980 as a team geologist and was subsequently transferred to Shell Petroleum Development Company of Nigeria in 1984 as a team seismologist. He then moved to the Netherlands where he worked as an exploration team leader and subsequently as Head of Prospect, Evaluation and Geological Operations for Nederlandse Aardolie Maatschappij BV, a Shell/Exxon joint venture. This was followed in 1992 by an assignment to Shell Companies in Indonesia, initially as Chief Geologist and then as Exploration Manager. Agu returned to Australia in mid 1995 as Reserves Development Manager for Woodside Offshore Petroleum. His current position is Director New Ventures for Woodside Energy Limited and the Upstream Woodside/Shell Alliance in Australia.

James B. Lee has worked at the BHP research laboratories in Newcastle NSW since 1981. His work related to mineral exploration began in the field of airborne infra-red spectroscopy and included the deployment of the GER Scanner in an Australian mission in 1987. He was later involved in the joint BHP/CSIRO Airborne Imaging Spectroscopy project. In 1991 he began his involvement with CSIRO in development of high temperature SQUID magnetometers and their deployment in airborne TEM. In this project he was leader of the BHP team responsible for implementation of the airborne system and has a particular interest in overcoming the effects of sensor motion in airborne TEM. This project was the first to demonstrate SQUID sensors in ATEM detection of geological conductors. He has most recently led the technical team for BHP's airborne gravity gradiometer development covering all aspects of the system development from the gravity sensor, aircraft systems and dynamics, topographic measurement and data processing algorithms. This system was the first airborne gravity gradiometer to be deployed in mineral exploration, and the first effective airborne gravity technology for this role.

Prue Leeming is currently marketing airborne geophysics for Fugro Airborne Surveys in southern Africa. She moved to Botswana in 1999, after working with Tempest development in Perth. After joining World Geoscience in 1992, she worked with interpretation of airborne geophysical data for salinity mapping and on large mapping projects in Western Australia, India, Oman and Indonesia. Since graduating in 1976 as a geologist, she worked in mineral exploration with Newmont and later in the gold mining industry with Homestake Gold, Freeport and briefly Normandy.

Jennifer Levett received her BSc (Hons) degree in Geophysics from The University of Sydney. From 1994 to 1998 she worked for Placer Dome Exploration in Australia and Canada on properties and projects in Papua New Guinea, the Philippines, Australia and Canada. After travelling in Europe during 2000, she joined Mira Geoscience Limited, a division of Quantec Geoscience, based in Montreal. Mira provides software and services for 3D exploration data integration and analysis to the mineral industry.

Guimin Liu graduated from Chengdu Institute of Geology, PRC with a BSc in Exploration Geophysics in 1982. He obtained his MSc in 1985 and PhD in 1989 in Engineering Geoscience from University of California, Berkeley. He was a Research Fellow from 1989-1991 appointed jointly by Macquarie University, Sydney and the University of California, Berkeley. He joined BHP Research in 1991 in Melbourne and is now a Principal Research Scientist in BHP Minerals Discovery Technologies. Since joining BHP he has been mainly involved in the development and application of electromagnetic data interpretation techniques and airborne gravity gradient data processing and interpretation techniques.

Meng Heng Loke obtained a BSc Hons. and an MSc in Physics from Universiti Sains Malaysia, and a PhD in Earth Sciences from the University of Birmingham (UK) in 1994. He is currently an Associate Professor at the School of Physics, Universiti Sains Malaysia. His current research is on the development of interpretation techniques and computer software for 2D and 3D resistivity, IP and Spectral IP surveys. He has also been involved in resistivity imaging surveys for mapping of ground water pollution, saline water intrusion and engineering site investigations. He has published papers in a number of refereed journals, including Geophysics, Geophysical Prospecting, Journal of Applied Geophysics and Computers & Geosciences. He has served as a reviewer for a number of geophysical journals, including Geophysics, Geophysical Prospecting and Journal of Applied Geophysics. He is also a member of the Editorial Board of the Journal of Applied Geophysics. He is a member of the SEG, EAGE, EEGS and ACM.

Andrew Lockwood received a BSc in Geology from the Queensland University of Technology and later received a bachelor of applied science Hons 1 in Geophysics from the University of Queensland. He then worked for Mt Isa Mines exploration based in Queensland, then Western Australia until 1997. He commenced PhD studies at the University of Western Australia in 1998 and is the recipient of an ASEG Research Foundation Grant and an APAI scholarship. His research interests include geophysical inverse theory and classical electromagnetics.

Arben Lulo obtained a degree in Geophysics at the University of Tirana, Albania, in 1984. He has worked on: Magnetic and electric survey in chrome prospecting, Geological - geophysical complex mapping in an ultramafic massif, Magnetic, electric mapping, drilling works and chromite regional exploration, Magnetic survey and compilation of the Albanian Magnetic Map, and, Magnetic and geochemical correlation methods for tracing of heavy metal contamination in the soils. He is a member of the AGU.

Campbell J. Mackey graduated from Curtin University of Technology, Perth, in 1991 with a BSc (Hons)(Geophysics). After working as a mineral exploration contract geophysicist with Scintrex Pty Ltd, he joined RUST PPK, and was involved in the application of geophysics to ground water and environmental studies. Campbell joined Newcrest Mining Ltd in 1994, and spent two years working for the Telfer exploration group, as well as performing mine-site geophysical work. Since 1996, he has worked from the Newcrest Brisbane office as Project Geophysicist, Eastern Australia. The role has involved the design, supervision, processing and interpretation of airborne and ground geophysical surveys around Cadia, regional NSW, QLD, SA, and Indonesia.

Asmita M. Mahanta received a Master's Degree in Applied Geophysics from the Indian School of Mines, Dhanbad, India in 1997. From 1997 to 2000 she worked for BHP Minerals Discovery on SEDEX Pb-Zn and IOCG projects in Rajasthan, India. She has worked with both ground and airborne EM and magnetic data interpretation. Asmita has experience with ground EM (frequency and time domain), gravity and magnetic data acquisition, processing ad interpretation. Since March 2000 she has been based in Melbourne working as a geophysicist in Discovery Technologies, BHP Minerals. Her present responsibilities mainly include final stage processing and interpretation of Falcon airborne gravity gradiometer data. She is a life member of Indian Geophysical Union.

Chris Manuel graduated from Curtin University of Technology in 1996 with a first class Honours degree in Mineral Geophysics. He then became a crew leader for Scintrex Pty Ltd where he undertook acquisition and processing of various geophysical data from all over Western Australia. In 1998 he graduated again from Curtin University with a Masters of Geoscience degree in Petroleum Geophysics. Currently he is undertaking a PhD with the research being concentrated on multiples and their use in prestack imaging.

Toshifumi Matsuoka is Associate Professor, in Earth Resources Engineering at Kyoto University. He graduated from the Tokyo Science University with a BSc in 1967 and an MSc in 1975. In 1995 he received a PhD from the University of Tokyo. Toshifumi worked for the Japan Petroleum Exploration Co. Ltd (JAPEX) from 1975 to 1998 and he was seconded to the Japan National Oil Corp between 1986 and 1988. He has been at Kyoto University since1998. He won the Best Paper Award, at the 1988 SEG Japan meeting, and the Best Paper Award, Japanese Association for Petroleum Technology in 1999. His interests include tomography, signal processing and engineering geophysics. He is a member of EAGE, SEG and SEG Japan.

Ken McCracken was trained in physics in Tasmania in the 1950s. During the 1960s he worked with NASA and was a principal investigator on seven interplanetary spacecraft. Returning to Australia, he established the minerals geophysics program in CSIRO. Later he established the CSIRO office of Space Science & Applications. Throughout this time he was closely involved in ground EM (e.g. SIROTEM) and remote sensing. Retiring from CSIRO in 1989, he has been closely involved in R&D in many Australian mining companies. Among other projects, he participated in the development of the 'SALTMAP' airborne EM technology, and the Falcon airborne gravity systems. For relaxation he runs an 850-acre cattle farm in the Southern Highlands of New South Wales and names the cows (and bulls) after geophysicists he has known.

Chris Manuel graduated from Curtin University of Technology in 1996 with a first class Honours degree in Mineral Geophysics. He then became a crew leader for Scintrex Pty Ltd where he undertook acquisition and processing of various geophysical data from all over Western Australia. In 1998 he graduated again from Curtin University with a Masters of Geoscience degree in Petroleum Geophysics. Currently he is undertaking a PhD with the research being concentrated on multiples and their use in prestack imaging.

Jayson Meyers holds a BSc in Geology, an MSc in Geochemistry, and a PhD in Geophysics and Tectonics. His interests and experience cover a broad range of geoscientific areas, with the main focus in recent years on mineral commodities, especially lode gold and diamond deposits. He has nine years of industry experience and is currently Manager of Geophysics for the Gutnick group of companies.

Craig Miller graduated in 1996 with an MSc 1st Class Honours from University of Auckland, New Zealand. He started with BHP exploration in Perth, working in NT and WA, exploring for base metals. Made redundant in 1998 (along with everyone else), climbed some peaks in South America for a few months and then joined Geophysics Australia. Has been involved in RIM and GPR surveys in a wide variety of coal and base metal applications for the last two and a half years. Interests include rock climbing and any sport associated with mountains, cycling and landscape gardening.

Brian Minty received a BSc (1976) from Rhodes University, a BSc (Hons) (1977) in Geophysics from the University of the Witwatersrand, an MSc (1982) in Exploration Geophysics from the University of Pretoria, and a PhD (1997) from the Australian National University. He worked for the Geological Survey of South Africa for five years before emigrating to Australia to work for Hunting Geology and Geophysics Ltd. He currently works as a Principal Research Scientist for the Australian Geological Survey Organisation in Canberra, Australia. His research interests relate mainly to the acquisition, processing and interpretation of airborne magnetic and gamma-ray spectrometric data.

Tim Munday graduated from the University of Reading (UK) with a PhD in 1985. After a brief stint in the exploration industry Tim spent several years lecturing in the Dept. of Geology at the University of Durham, UK. He joined Curtin University in Perth, WA in 1988 in a joint position funded by the University and CSIRO. He subsequently joined CSIRO Exploration and Mining where he has been since. In the past year Tim has been directing particular effort to applications of AEM technologies in catchment hydrology and mineral systems mapping under complex regolith cover. The focus of this work has been in the Gilmore region in central-west NSW. Prior to that Tim was involved for seven years with the successful CRCAMET, where he worked on the application of AEM for the mapping of, and exploration through, regolith dominated terrains. In the CRCAMET, Tim headed up the Geological Mapping Program. Current research interests include the application of geophysics to exploring through cover, and their role in better managing salinity.

Mohd Nawawi Mohd Nordin was awarded his PhD in Geophysics in 1993 from University of Birmingham, England, after obtaining a BSc and an MA from Western Michigan University, majoring in Physics. He now works as a lecturer in the Geophysics Program, School of Physics University Sains Malaysia, Penang. His research interests include 2D Electrical Imaging of the subsurface.

Kyozo Nozaki received a BS (1977) in Geodesy and Earth Sciences, and an MS (1980) both from Nagoya University, Japan. In 1981, he joined OYO Corporation's Research Institute in Urawa, Japan, where he worked on data processing of GPR, seismic refraction method. Since 1987, he has been working on the development of the method of microgravity survey, field gravity measurements method, gravity data processing technique. He is a chief researcher at Tsukuba Technical R&D Center of OYO. His research interests include geodetic and geophysical gravity potential field, particularly, microgravimetry for civil engineering and the relevant theory. He is a member of SEG Japan and GS Japan.

Brent O'Brien graduated from Victoria University of Wellington, New Zealand with Geology (1989) and Geophysics degrees (1992). After briefly working with the New Zealand Institute of Geological and Nuclear Sciences as a research scientist, he left for the Sultanate of Oman in early 1996. There he worked for Rees Geophysical (Oman) on 3D vibroseis crews as a QC seismologist. He transferred to the Muscat regional office in 1997 as Area Geophysicist for Oman. He has continued in this position with Veritas DGC, with regional postings in Indonesia and the United Kingdom. Currently he is based in Crawley, UK as Area Geophysicist for the EAME region.

Michael O'Connell is currently with the R&D Department at Fugro Airborne Surveys in Ottawa. He is a graduate of the University of Ottawa, Canada (BSc, MSc). Michael has also worked for Sander Geophysics in Ottawa. His interests are in the acquisition, processing, interpretation and display of airborne geophysical data.

John Paine enjoys life working as a geophysical software consultant in Adelaide. The internet revolution allows him to work with many different groups around the world on a wide variety of projects without having to leave home. Current interests are magnetic, gravity and IP inversions, data presentation and analysis and 3D visualisation. All of which are greatly assisted by his PhD in Numerical Analysis from ANU (1979), his Post Doctoral work with David Boyd at Adelaide University and the many clever people out there doing geophysics in the real world.

Henk van Paridon has 20 years of experience mainly in seismic interpretation. He graduated from the University of Adelaide in 1976 and traveled the world before commencing his professional career. Later he gained postgraduate qualifications in computer technology from the Queensland University of Technology. He worked for Delhi Petroleum for eight years in Adelaide and Brisbane and for Crusader Resources for eight

years in Brisbane. During this time he acted as field geophysicist, seismic interpreter, IT manager and general explorationist in basins worldwide. He formed his own consultancy, GeoSolve, in 1997 and has consulted to the petroleum and coal industry since that time. As a consultant he has had to broaden his outlook and has adapted his skills to new industries including coal. He has a long history of involvement with the ASEG. These roles include President, Preview Editor, Conference Co-chairman and State Branch President. In 1998 he was awarded a Silver Certificate for outstanding contributions to the Society over many years.

Glenn Pears graduated with a BSc (Hons) in Physics from the University of Queensland in 1994. This was followed by a MSc, also carried out at the University of Queensland, which examined the ability to invert cross-hole radio frequency data using approximate inverse mapping (AIM) techniques. In May 1997, Glenn was employed by Fugro Airborne Surveys (formerly World Geoscience Corporation), as an Interpretation Geoscientist and later became actively involved in R&D as a part of the Product Development Division. In September 2000, Glenn was employed by Quantec Geoscience and is primarily involved with 3D Earth modelling using the GOCAD software as well as geophysical interpretation and inversion. Glenn is an associate member of the ASEG with professional interests in all aspects of geology and geophysics.

Troy Peters is the Supervisor of Coal and High Resolution Seismic Services at Velseis Processing Pty Ltd. He graduated from the University of Queensland with a Bachelor of Applied Science Honors, majoring in Geophysics. After graduating he joined Velseis Pty Ltd and was responsible for processing refraction, reflection and velocity surveys. In 1992 Troy participated in the formation of Velseis Processing, which was established to provide expert geophysical services to the Coal industry. Through its expansion Troy became the supervisor of data processing and interpretation services of both 2D and 3D seismic data. Troy has over 10 years experience in this field.

Peter Petkovic received a BSc in Geology, Physics and Mathematics at the ANU, Canberra in 1971. He worked with the Bureau of Mineral Resources in acquisition, processing and interpretation of data from Australia's first continental margins survey in the 70s. In 1978 he completed a Grad Dip Ed and Grad Dip Curric and then taught mathematics for 10 years. Since 1989 he has worked at AGSO on the development of a long-range radio navigation system, management of processing, software and database development for marine gravity, magnetic and bathymetry data, development of processing and modelling systems for refraction data, and image processing.

Jeff Phillips received his MSc (1973) and PhD (1975) in Geophysics from Stanford University. He has been a research geophysicist at the US Geological Survey since 1975, where his current responsibilities include developing the USGS potential-field software package for the PC. His research interests are in potential-field theory and its applications.

David Pratt graduated in 1967 from the University of Sydney with a BSc (Hons) in Geology and Geophysics. While working with the NSW Geological Survey he went on to complete his MSc in 3D electrical modelling. In the early 70s he worked for the Canadian seismic processing company Digitech and Layton Geophysical consultants. In 1975 he started work at the University of Newcastle on remote sensing applications for groundwater exploration and lectured in geophysics to third year Physics and Geology students. In 1979 after completing a PhD in remote sensing and some post-doctoral research he started a geophysical and remote sensing consulting company Geospex Associates. In 1984 he co-founded Encom Technology to develop software and services for the mineral and petroleum exploration industries. David is now Managing Director of Encom Technology and leads the potential fields expert systems development team.

Matthew Brian John Purss graduated from the University of Wollongong with a BSc (Hons) - Class II, Division I in December 1997. Following the completion of his degree he was employed by Kevron Geophysics Pty. Ltd as a geophysical data processor, where he specialised in airborne magnetic, radiometric and Hummingbird EM data processing and map production. In March, 2000 he began studying towards a PhD at Monash University. His PhD research project is involved with the application of three-component down-hole magnetometry to the down-hole magnetometric resistivity method. His collaborators in this work include Richard Almond, of Geophysical Software Solutions, and Michael W. Asten from the Monash University - Department of Earth Sciences.

Art Raiche worked for the US defence industry during the 1960's, on problems associated with anti-submarine warfare, EM compatibility, gas dynamics and other such anti-social topics, whilst pursuing a PhD in theoretical nuclear physics at night. Upon completion of the PhD in 1970, he migrated to Australia, a year later, joining the CSIRO Mineral Physics Division. After reading Stan Ward's superb article on electrical geophysics in Mining Geophysics, Vol 2, he began working on 3D EM modelling and inversion. In 1980, he established an international consortium for EM modelling research through AMIRA. Currently a Chief Research Scientist and research group leader for EM Modelling in the CSIRO Division of Exploration & Mining, he and his EM modelling team have completed seven three year projects and are starting on P223E, their eighth. A former Dobermann breeder, he now studies and plays Japanese honkyoku on the shakuhachi, an end blown bamboo flute.

William Ravenhurst graduated with a BSc (Hons) and MSc in Geophysics from the University of Western Ontario in 1985. He worked briefly for TexasGulf and Kidd Creek Mines before joining Crone Geophysics in 1985. His work as geophysicist and chief geophysicist concentrated on improving the Pulse EM system and TDEM interpretation. Since 1998 he is President of Crone Geophysics & Exploration Ltd.

Grant Roberts graduated from Auckland University in 1980 with an MSc (1st Class Hons.). He worked for several years in geotechnical and ground water companies in both Australia and New Zealand. He established Groundsearch NZ in 1984 and purchased the RIM equipment to form Geophysics Australia Pty Ltd in 1997. His goal was to develop an integrated high resolution geophysical company focused on use of GPR and RIM. He has worked in Engineering Geology, Groundwater exploration and Exploration Geophysics. Recent project work involves RIM, ground radar, and wireline geophysics. He is an enthusiastic supporter of high resolution geophysical methods especially applied to in mine studies. He is a member of ASEG.

David Robson is Chief Geophysicist of the New South Wales Department of Mineral Resources and in this role he is responsible for providing geophysical input into the regional geological/geophysical mapping and coal exploration programs. He also has provided support for the 6-year Discovery 2000 Exploration Initiative just concluded. He is now responsible for the mineral component of the Department's new 7-year $30 million exploration initiative - 'Exploration New South Wales: Mining Beyond 2000'. Over the past six years, David has supervised the collection and added value to over 1.5 million line-km of high-resolution airborne geophysical data. Currently, he is Honorary Federal Secretary of the ASEG.

Brian Russell holds an Honours BSc in Geophysics from the University of Saskatchewan and an MSc in Geophysics from the University of Durham, England. He started his career in 1976 as a seismic interpreter for Chevron Standard in Calgary. He was then transferred to Chevron Geosciences in Houston, where he worked on a variety of acquisition and processing assignments. After transferring back to Calgary in 1981, Brian left Chevron and joined Teknica Resource Development, working with Roy Lindseth on interpretation and software development. He then moved to Veritas, holding positions with both Veritas Seismic Ltd. and Veritas Software Ltd. before leaving in 1987 to help found Hampson-Russell Software, along with Dan Hampson. Brian is currently vice president of that company and, although he is based in Calgary, pays regular visits to Hampson-Russell's offices in Houston, London, Perth, and Jakarta. He is actively involved in

both geophysical research and training, and presents courses on new seismic technology throughout the world. He has written numerous papers, many of them co-authored with Dan Hampson, on various aspects of inversion, AVO, and multiple attribute analysis. Brian has also been very active with both the CSEG and SEG. He was President of the CSEG in 1991, received the CSEG Meritorious Service Award in 1995, the 1999 CSEG Medal, and honorary membership in 2001. With SEG, Brian served as chairman of The Leading Edge editorial board in 1995, technical co-chairman of the 1996 SEG meeting in Denver, and as President of SEG during the 1998-99 term. In 1996, Brian and Dan Hampson were jointly awarded SEG's Enterprise Award. Brian is also registered in the province of Alberta as a Professional Geophysicist, and is currently enrolled in the PhD program at the University of Calgary, where he is researching neural network applications to seismic data analysis.

Darren W. Rutley graduated from the University of Queensland with Honours in a Bachelor of Applied Science (Geophysics) in 1991and a Post Graduate Diploma in Education in 1992. In 1993, he joined MIM Petroleum Exploration Pty Ltd as a Seismic Interpreter and worked extensively in study groups, farmin and gazettal evaluations throughout Australia and New Zealand. Since 1997, he has worked as a Senior Geophysicist, in the Indonesian Team at Santos Asia Pacific Pty Ltd, on regional basin analyses, project geophysics for operated permits in Central Sumatra and East Java and new venture evaluations throughout South East Asia. His main interest is geological and geophysical integration for prospect generation and risk reduction. He is a member of the ASEG, SEG and PESA.

Malcolm Sambridge's research interests are in geophysical inverse theory, theoretical and computational seismology and wave propagation. His PhD (1989) was in Geophysics from the Australian national University. He has held postdoctoral positions at the Department of Terrestrial Magnetism (Carnegie Institution of Washington DC, US), and the Institute of Theoretical Geophysics (University of Cambridge, UK) before returning to the ANU in 1992. He is now on staff in the Seismology Group of the Research School of Earth Sciences (ANU) employed as a mathematical geophysicist. Malcolm is an editor for the Geophysical Journal International and handles papers out of the Pacific Region Office.

Lee Sampson graduated with a BSc in Geophysics from Curtin University of Technology in 1997. He began his career in 1998 with UTS Geophysics processing airborne magnetic and radiometric data. In 1999 he returned to Curtin University and with the assistance of Homestake Gold of Australia Limited (HGAL) and the CRCAMET completed an honours degree entitled 'The Geophysical Characteristics of Shale Hosted Polymetallic and Sulphide Mineralisation in the Mount Barren Basin, Ravensthorpe, Western Australia'. In 2000 he gained employment with HGAL Exploration working mainly in the Northeastern Goldfields of the Yilgarn in Western Australia. Experience gained to date includes exploration for gold (Lawlers/Darlot districts), nickel (Mt Goode/Bellvue) and basemetals (Ravensthorpe). He is a member of the ASEG.

Yutaka Sasaki received a BSc (1974) in Mining Engineering and a PhD (1984) in exploration geophysics from Kyushu University. From 1974-78 he worked with Nittetsu Mining Consultants. In 1979 he joined Kyushu University where he has been working on inversion methods and field applications of electrical and electromagnetic geophysics.

Daniel Sattel received his Vordiplom from Universitaet Karlsruhe, Germany in 1986 and an MSc from Oregon State University, USA in 1990, working on the interpretation of seismic refraction data. He holds a PhD in geophysics from Macquarie University, where he specialized in electromagnetics. He is currently working for Fugro Airborne Surveys in Perth involved in the development of EM software and the interpretation of airborne EM data.

Alex M. Shepherd is presently a PhD student at Curtin University of Technology in Perth, Western Australia. His thesis proposal and ongoing research is entitled, 'Time Lapse 3D Using Legacy Seismic Data' He presented this proposal at the CRGC meeting, Technology Park, Bentley, Perth in August 2000. The research involves improving methods of processing different 3D seismic surveys of the same block taken 6 months to four years apart so they can be differenced to show up movements of hydrocarbons during production. Before this, He studied for his MSc at the University of South Carolina, USA in Geography, Cartography, and Geophysics, graduating in 1999. There, he studied Sequence Stratigraphy including Global eustatic (Haq) sea level changes, analysis of salt diapirs and undertook a 2D seismic project in an Alaskan oil field involving the picking of many stratigraphic horizons in a pro-grading sequence and mapping the direction of deposition and sea level change and palaeo-shoreline movement. My thesis was entitled "Accuracy of Interpolations for Geologic Mapping made from 3D Seismic Models Using a Geographic Information System" on which this poster presentation is based. His BSc at the University of Edinburgh, Scotland was in Geology and he studied for a diploma in Cartography at the University of Wales.

Sergey Shevchenko graduated from Tashkent University (USSR) with BSc (Hons) in 1980 and worked for Tashkentgeologia Exploration Company until 1993 managing, acquiring and interpreting mainly gravity and magnetic surveys for mineral and petroleum industry. He joined Geological Survey of Western Australia (GSWA) in 1994 as geophysicist and worked on potential fields data with the Petroleum Initiative Project in the Officer, Perth and Carnarvon Basins of WA. He is currently a senior geophysicist with Regional Mapping Project of GSWA involved in processing and interpreting gravity and magnetic data as well as responsible for acquisition, processing and interpretation gravity data of regional helicopter geochemistry-gravity surveys for the last three years.

Jovan Silic is a director and principal consulting geophysicist with Jovan Silic and Associates Pty Ltd a member of the Flagstaff Geoconsultants, and has a successful association with a mineral exploration industry over a period of 20 years. He graduated from University of Western Australia BSc (Hons) First Class and has recently been granted a PhD (Geophysics) from Macquarie University, NSW on the topic of interpreting TDEM data from geophysical/geological complex areas. As an exploration/research geophysicist he has introduced a number of geophysical innovations to base metal, epithermal gold, porphyry copper and diamond mineralised discoveries, including the world class Hellyer (Tasmania) and Anjing Hitam (Sopokomil, Indonesia) base/precious metals deposits and some recent promising diamond discoveries in Canada. At both the Hellyer and Anjing Hitam discoveries not only did he introduce new methodology, which lead to the discovery of the orebodies but also played a key role in the integration of multiple data sets within the exploration program which targeted the deposits. His industry experience includes working with government organisations on regional data compilations, major resource companies such as Cominco Ltd (Canada) and 12 years as Chief Geophysicist with Aberfoyle Resources (Australia). In 1998 he left Aberfoyle Resources and since that time as a consulting geophysicist, has worked on major mineral and oil and gas exploration (and research) projects within Australia, Canada, South East Asia, South America and Europe. A number of major resource companies use his consultancy services. He is an active participant within the exploration community and since 1992 has been a member of the Advisory Board to the Co-operative Research Centre for Australian Mineral Exploration Technologies.

Kerry Slater completed a BSc (Hons.) with the University of Sydney in 1993. After one year undertaking industrial and ordnance related surveys in Australia, Germany and the US with Australian Defence Industries she transferred to the Geological Survey of Victoria. As an interpretive geophysicist with GSV between 1994 and 1998 Kerry was involved in detailed interpretation of geophysical datasets through western and central Victoria. In the last two years she has been based in Alice Springs with the Northern Territory Geological Survey during which time she was involved in the Tanami, Musgrave and North Arunta projects. Her work at

NTGS led to major increases in the understanding of these complex geological terrains. She has a strong belief in instilling the benefits of integrating geophysical data with regional mapping programs. Kerry is currently employed at the Geological Survey of New South Wales.

Richard S. Smith is currently R&D Manager at Fugro Airborne Surveys in Ottawa. He is a graduate of the University of Adelaide (BSc, MSc) and the University of Toronto, Canada (MSc, PhD) and has undertaken post-doctoral research at Macquarie University. Richard has also worked for Lamontagne Geophysics in Toronto and Pasminco Exploration in Melbourne. Richard's interests are in the acquisition, processing and interpretation of geophysical data, and electromagnetic data in particular.

Ian C. F. Stewart completed his PhD in Seismology at the University of Adelaide in 1972; he carried out research in aeromagnetic methods in the Department of Economic Geology at Adelaide. In 1974 he took up a faculty appointment in geophysics at Memorial University of Newfoundland in Canada, and in 1982 he left the position of Associate Professor to join Aramco (now Saudi Aramco) in Dhahran, Saudi Arabia. While employed with Aramco until 1996, he was associated with the Geophysical R & D section, and was also supervisor of the gravity and magnetics unit for most of this period. This involved a number of projects using non-seismic methods, as well as considerable software development. In 1996 he returned to Australia, and has been a consultant in potential field techniques for both mineral and petroleum exploration, for which the development of methods and software for data processing and analysis is continuing. He is a member of ASEG, SEG, SSA, AGU, GSA, GAC and IAMG.

Koya Suto graduated from Akita University, Japan (BE, 1974 and ME, 1976) in Geology and Geophysics. He studied at the University of Adelaide between 1975 and 1980. He has worked for Esso Australia, CRA Exploration (Pacific Oil & Gas) and the Oil Company of Australia. He is currently with Origin Energy Resources Ltd. Koya is a member of ASEG, SEG, EAGE, SEGJ AAPG and PESA.

Chris Swain's first exposure to geophysics was reading a Worden gravimeter for an exploration project in Cyprus. Despite this, he went on to do an M Sc in Applied Geophysics at Birmingham University and subsequently worked for Hunting Geology and Geophysics, several Universities (including two in Africa), the British Antarctic Survey, and WMC Exploration. He has a PhD on gravity and seismic measurements in Kenya and is currently a consultant specialising in potential fields.

Randall Taylors's current position is Geophysical Advisor for the Origin/OCA group, providing specialist geophysical analyses and OC services. He transferred to Origin Energy in 2000 after six years with OCA as team leader and interpreter in the Otway and Eromanga Basins. Prior to this Randall was a seismic interpreter for Santos (87-92) in their offshore group. He began his career in geophysics with AAR in 1982, working mainly in the Denison and Surat Basins. Randall's current professional interests are quantitative interpretation and velocity analysis for depth conversion.

David V. Thiel received the BSc degree from the University of Adelaide, Adelaide, Australia, in 1970, and then the MSc and PhD degrees from James Cook University, Townsville, Australia, in 1974 and 1980 respectively. He is currently Professor and Head of the School of Microelectronic Engineering at Griffith University, Queensland, Australia and Director of the Radio Science Laboratory at the same university. He has research interests in switchable antennas, numerical modelling in electromagnetics, electromagnetic geophysics and electronic odour sensing.

John A. Theodoridis received a BSc (Hons.) degree in Applied Mathematics at Monash University in 1997. In 1998 he began his PhD in Geophysics at the Department of Earth sciences, Monash University. His research interests include downhole EM prospecting for weak conductors. He is a member of the ASEG, SEG and EAGE.

Julian Vrbancich joined the Defence Science and Technology Organisation (DSTO) at Pyrmont (Sydney) in late 1984. His interests focus on studying ELF EM emissions and DC electric fields arising from corrosion currents in ships and submarines using undersea instrumentation and geophysical EM numerical modelling methods. This work has expanded to include the use of airborne EM methods to explore marine environments in littoral waters.

Derek Webb completed his BSc at Wollongong University in 1977. He was awarded a Certificate of Equivalent Honours in Geophysics by the University of New England in 1981. From 1982 to 1994 Derek worked for Geopeko/North on their eastern Australian projects, including Goonumbla and Lake Cowal. During this period he was based from Parkes then Brisbane. In early 1995, he joined MIM Exploration (MIMEX) as a Senior Geophysicist working mainly on northeast Queensland projects, particularly Ravenswood. He is currently responsible for the geophysical component of MIMEX' eastern Queensland and New South Wales projects.

Paul Webster completed a degree in Mathematics in 1991 at the University of Loughborough in the UK. He then went on to do a Masters in Mathematical Physics at Kings College, University of London, followed by going to Canada to do a PhD in Theoretical Physics at the University of Calgary. Paul then got a job with Veritas in Perth and joined Woodside about eight months ago, working as a geophysicist.

Peter Wolfgram obtained his geophysical training at the Universities of Munich and Toronto and has specialised in electromagnetic exploration methods. Active in airborne electromagnetics since 1992, his main achievement was the development of the low-frequency GEOTEM system. He is presently R&D Manager for the Australia/Asia Pacific Region of Fugro Airborne Surveys.

Lisa Worrall is a regolith geologist/geomorphologist who has recently moved to Canberra to work in the Minerals Division at the Australian Geological Survey Organisation. Prior to moving to Canberra she was based in Perth where she was deputy Program Leader of CRC AMET's AEM Mapping Program.

Toshiyuki Yokota received a BSc (1989) and an MSc (1991) in Exploration Geophysics at Kyoto University, Japan. From 1991 to 1997 he worked for Geological Survey of Japan (GSJ) as an exploration geophysicist. In 1997, he moved to the Japan National Oil Corporation and returned back GSJ in 1999. His current research interests are borehole seismology and reservoir characterisation. He is working on seismic tomography inversion and its application to geothermal and oil field explorations. He is a member of SEG and SEG Japan.

Fanmin Zhang received a BSc in Physics from Ningxia University, PRC in 1984 and an MSc in Geophysics from Seismological Institute of Lanzhou, PRC in 1992. He was registered as a PhD student studying at the Department of Exploration Geophysics, Curtin University of Technology, Australia, in 2000. From 1984 to 1989, he taught physics in high schools. Between 1992 and 2000, he was a research fellow in geophysics at Seismological Institute of Lanzhou. His research interests include seismic wave field decomposition, seismic signal processing using neural networks, shear wave splitting, numerical modeling, inversion problems and seismic data processing. He is a member of ASEG and SEG.

Jingping Zhe received his BS (1982) in Computer Sciences from Xian Jiaotong University, P. R. China and an MSc (1994) in Earth Sciences from The Flinders University of South Australia. He currently is studying for a PhD at University of Adelaide. He had worked in Xian Geophysical Research Institute for 8 years as a computer programmer for geophysical application software, and worked in Pitt Research Pty Ltd for 2 years as a researcher and computer programmer. His research interests include acoustic and elastic seismic forward-modelling and migration, and resistivity modelling and inversion.

Binzhong Zhou received his BSc (1993) and MSc (1986) in Geophysics from Chengdu Institute of Technology (CDIT), PRC. He received a PhD in Geophysics at Flinders University of South Australia in 1993. From 1986 to 1989 he was a lecturer in geophysics at CDIT. Between 1991 and 1993, he was a computer software engineer for Wiltshire geological Services in Adelaide. He was a research fellow in geophysics at Lincoln College, Oxford University and a consulting research fellow at Elf Research Centre in London before he joined the Mine Scale Geophysics Group in CSIRO Exploration and Mining in 1995. His research interests include seismic data processing and interpretation for coal and petroleum industries and applying geophysical techniques to mining problems such as the delineation of deposits and the production of coal and metalliferous ore. He is a member of ASEG, SEG and EAGE.

Xianhuai Zhu is the Manager - Converted Wave Imaging, at PGS. From 1977-85 he worked at the Research Institute of Geophysical Prospecting for Petroleum, China. He was at Cornell University from 1985-86 and at the University of Texas-Dallas from 1986-90. From 1991-97 he worked at Union Pacific Resources, and from 1997-present he has been with PGS. He obtained his PhD in Geoscience at the University of Texas-Dallas in 1990. He won the The Leading Edge best paper award 1999. Xianhuai is a Member of SEG, EAGE. He is on the SEG Research Committee, and is an associate editor for Geophysics. His research interests are near-surface tomography, reservoir imaging and fracture mapping.