Australian Society of Exploration Geophysicists
ACN 008 876 040

Preview

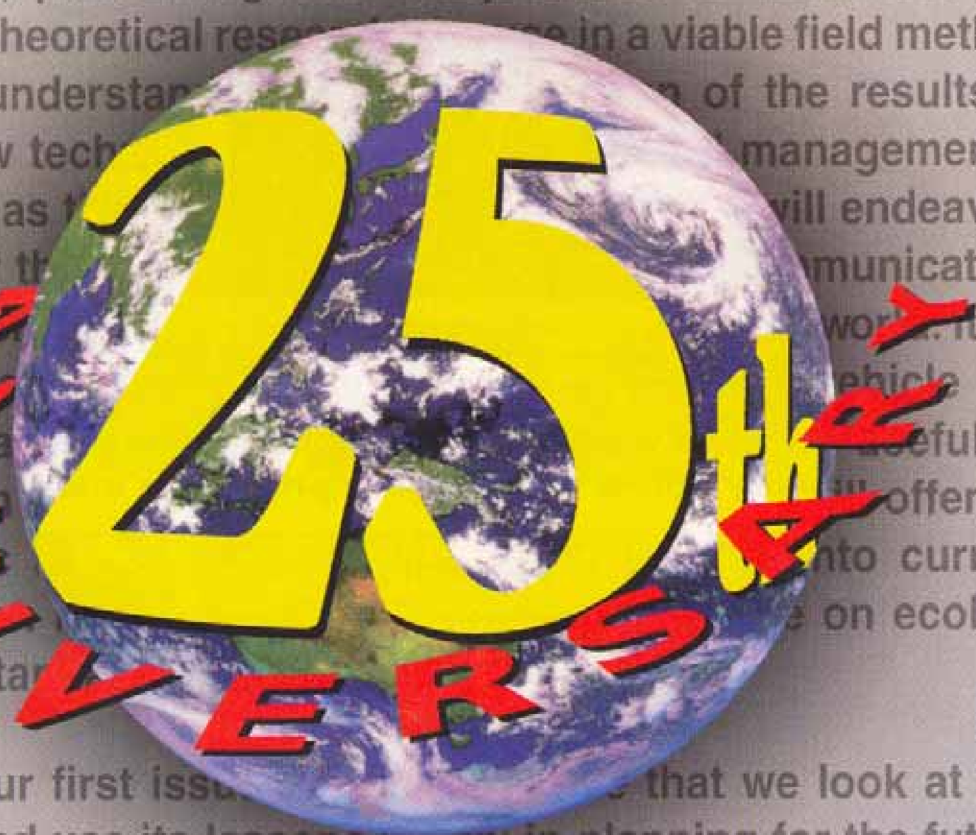
December 1996

Issue No. 65

Special Feature:

The Acquisition & Analysis of Slim Acoustic Scanner Log Data 21-32

The geophysical scene in Australia is rapidly changing, with emphasis being placed on more advanced forms of recording, processing and interpretation of data. The gap between theoretical res... in a viable field method, and the understan... of the results of these new tech... management is widening as ... will endeavour to narrow th... mmunicate to some ex... wo... it will provide ... ehicle for diss... eful to Australia... ill offer the lay ... nto current explorat... on ecology and the sta...



In this, our first iss... that we look at our history and use its lessons wisely in planning for the future. Mr E.M. McNatt ably presents four decades of progress in petroleum geophysics in our feature article, and it is hoped that a similar review of the mineral exploration field will be available for publication in our next volume.

E.R. Crain
Editor, A.S.E.G. Bulletin
(September 1970)

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Preview Deadlines - 1996/97

February	**January 20 (absolute)**
April	**March 14**
June	**May 16**

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Editor's Desk

with Guest Editor, Don Emerson

The ASEG's quarter of a century of achievement in promoting the science of exploration geophysics, and the interests of exploration geophysicists in Australia, has largely been attained by its publications. The news and technical magazine *Preview* performs well in its key role of timely and topical information flow to our members who are geographically scattered yet effectively linked by this worthy periodical which successfully conveys to all the dynamics of Australian exploration geophysics.

We publish to perceive the key elements in geophysical knowledge. In this way our knowledge is shared, our understanding is improved and a window is opened to the future. For it is on the rationale of the published past, with its empirical lessons and theoretical insights, that we aspire to future success in mining, petroleum, engineering, groundwater and environmental geophysics. To these fields of activity may be added extra-terrestrial geophysical probing and remote sensing with which our profession, sooner or later, will become involved.

In a busy professional life with its attendant commercial pressures, it can be extremely difficult to find time to write papers or articles for the ASEG unless there is a need or motivation prompted by a special event. One such event is the ASEG's Biennial Conference (don't miss the next one in February 1997 at Darling Harbour, Sydney) which attracts many excellent short papers that constitute a substantial contribution to our professional education.

The regular promotion of specialist workshops and symposia, and the subsequent publication of their proceedings, also provides that particular interest and essential motivation necessary for scientific paper writing. I believe that this should be an ASEG publication focus in future and hope that *Preview* can be used to encourage it.

I congratulate the ASEG on its first twenty-five years; may the next quarter century be just as scientifically vigorous and professionally exciting as the last.

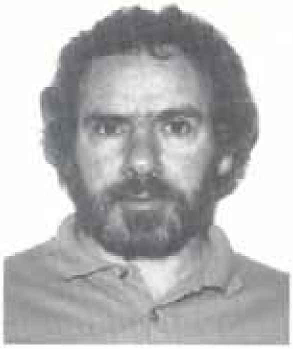
Don Emerson, Systems Exploration (NSW) Pty Ltd

Don Emerson has made a distinguished contribution to ASEG publications as long time editor (1973-1993 with minor interruptions) of the old *Bulletin of the ASEG*, later renamed *Exploration Geophysics*. I welcome his presence on the Editor's Desk for this historic issue of *Preview* and thank him for his outstanding efforts for the Society over many years.

Ed.

President's Piece

To Infinity and Beyond



The 25th anniversary of the society almost passed without notice except for the diligence of Mike Shalley and Andrew Mutton. I will leave the history to others and reflect a little on where the society may be heading but will stop short of making the full 25 year forecast.

In the last seven months or so since becoming President I and other members of the Federal Executive (FE) have been approached by a variety of people putting a variety of propositions. These have included publishing, advertising, training courses, employment referrals and even donations to charity. Whether these people are buying or selling services they have contacted the ASEG for the purpose of doing business. Although we are inclined to see ourselves as geo-magicians in a voluntary capacity, we are becoming, and are seen to be a business. It is necessary for us to present a consistent position to both our members and other people whom we deal with and I think it's fair to say that we sometimes appear as a hydra.

A lot of ASEG protocol is based on loosely recorded or unrecorded precedent. Experience has taught me to seek out this history before acting. In Brisbane we have discussed ways to reduce the learning curve for the FE and a procedures or guidelines manual, similar to the conference guidelines, perhaps in hypertext, is one way forward. It was also suggested that a President Elect position be created. We already have a past president on the FE but in the case of an interstate move it may be that the ASEG will need to pay some airfares ahead of the move. I believe our finances can stand it.

Over time some of the activities of the ASEG have moved away from volunteers In our conferences, publications and secretariat, professional organisations have performed an increasing number of our functions and this trend will continue. Our book-keeping and financial planning should also be developed with professional help. The most pressing need is to pass further responsibility for Preview publishing, including advertising, away from the editor.

At least part of publications could be produced electronically and be available on the internet. Whilst this is technically easy(?) problems with copyright and advertising revenues need to be addressed and we can learn from fellow societies that are already on this path.

The issue of registration appears to be a non-issue based on the lack of feedback received by the FE. Nevertheless, for the increasing number of our members who are consulting, registration is important. I don't believe that we should be trying to establish an alternative to the existing options but that we should work with the other bodies in whatever ways that the members feel are appropriate. I should add the SEG has recently modified it's position on registration which is now as follows: "SEG supports the concept of Professional Registration in those areas where geophysics is concerned with public health, safety and welfare."

Although the way we do things will change, the essential character of the society will remain. We will continue to provide high quality conferences, publications and courses as well as convivial local branch meetings. The nature of the beast is such that change will be evolutionary rather than revolutionary.

At the recent SEG conference a lot of people went out of their way to meet me in my capacity as ASEG President. This is because of the high esteem in which the ASEG, it's conferences and publications are held. In the future, when looking at the list of past Presidents, I will be proud to be included.

Henk van Paridon
ASEG President

Calendar Clips

December 18-20 1996
33rd Annual Convention & Meeting on Geophysical Instrumentation. Hyderabad, India

February 3-5 1997
Karlsruhe Workshop on Amplitude-preserving Seismic Reflection Imaging sponsored by SEG

February 23-27 1997
12th ASEG Conference & Exhibition (see advert. p. 11)

March 12-14 1997
The AusIMM Annual Conference
Ballarat VIC 3353

April 7-10 1997
Optimizing with Whittle
Optimization of Mine Design and Planning

(Details and more events on Page 47)

Executive Brief

As 1996 draws to a close, things are looking bright for our society. We are in a strong financial position and membership continues to grow. The publications issues are being resolved and a new system will be adopted in 1997 on a trial basis to help boost advertising and reduce the Editor's workload. 1997 is off to a great start with the conference at Darling Harbour in Sydney.

Sydney Conference

The Sydney conference next year is shaping up to be an exciting event with excellent sponsorship response, over 100 booths sold, a good variety of workshops, an interesting selection of papers and a world-class venue.

Publications

Response from members indicates that Conference Exploration Geophysics publications are highly regarded and frequently referenced. The cost of producing the conference publication has been a major financial burden to the society in past years. The Sydney conference organisers are committed to containing costs by adopting a new format style and by publishing late papers in the next issue of Exploration Geophysics. The new format uses slightly reduced font sizes and is the same as that used for SEG publications. A new set of guidelines will be produced for future conference publications in conjunction with the Conference Advisory Committee to ensure costs are contained.

Members have also commented in favour of retaining separate *Preview* and *Exploration Geophysics* publications if economically feasible. Some resolutions for the future of the society's publications will be trialled in the new year. Our current publishers, Jenkin-Buxton, will assume more advertising and editorial responsibility for *Preview*, lightening the work load of the editor, and allowing him more time to gather interesting articles and information. Depending on the success of this trial, a similar system may be put in place for *Exploration Geophysics*.

Membership

New members continue to join our society and members, both new and old, will be pleased to know that subscription rates will not rise for 1997. To encourage student members to take advantage of a year's free membership, a new subscription form has been designed, allowing students to name their course, institution and supervisor rather than cite referees.

1998 Conference

Looking further ahead, a proposal has been received by the Victorian and Tasmanian branches to co-host the 1998 conference at Wrest Point Casino in Hobart.

Financial Report

An approximate summary of the status of the society's bank accounts is as at 20th November follows:

Cheque account	$12 918
Cash Management	$214 332
Cash Management (Sands)	$8238
Term deposit (Sands)	$40 000

Best wishes to all members for the festive season and for a safe and prosperous new year.

Robyn Scott
ASEG Federal Honorary Secretary

Preview - Forthcoming Issues

Predictions of what will be in the next issue are so often so far off the mark that a name change for this column is called for. For the time being it will appear under the banner above.

Unipulse – History of Geophysics at the University of Tasmania

Excitations – Geophyscis for Geologists?

Electromagnetic Imaging – SMARTem, A New EM Receiver System

Geophysics and Black Shale – a Historical Perspective

ERRATA - OOPS twice!

1. From Ed Morrison

In my article on the History of Geophysics in Australia on the Aeromagnetic Operations in Canning Basin, 1955 (*Preview*, December 1995) an error occurred that requires both a mention and a correction (it also proves that persons other than geophysicists read Preview! and boy do they get on the phone early!).

The Mosquito aircraft N1596V and N1597V were flown to Labuan by Australian pilots Max Garroway and Bruce McKenzie and not "Joe Mullins and Wally Morley" as I stated. Max Garroway was accompanied by Joe Mullen, Operations Manager for Aero Service Philadelphia and Bruce McKenzie by aircraft engineer Tony Maurer.

Sorry folks.
Ed Morrison

Errata (cont.)

2. From Mike Shalley

In the feature article of last issue "Information Management Systems and their Uses for Modern 3D Land Seismic Acquisition" from Geco Prakla, the same caption appears on both Figures 6 and 7. The caption for Figure 6 should read *'Figure 6. Indication of how source points may be moved to avoid obstructions indicated by the exclusion zones and the topographic features of the area'.* My Apologies.

Another apology is due for placing an advertisement from another company in the body of the article. My apologies to both Geco Prakla and Geographix for that error of judgement.

ASEG Branch News

Queensland

A successful technical meeting was held in November at Oxley's on the River. A new format was trialled for this meeting with two shorter presentations instead of one. Terry Higgins of Robertson Research in Perth presented an informative overview of the theoretical and applied aspects of AVO analysis, whilst on a lighter note, Jessica Kennedy from the University of Queensland presented results from recently completed research on the management of small mineral exploration companies.

A Student Night was held on 4th December at Oxley's on the River with students from the University of Queensland, Queensland University of Technology and Griffith University presenting results from recently completed projects. The program included undergraduates:

Belinda Suthers, University of Queensland
Shear Wave Splitting of Coal VSP, Bowen Basin.

Anna Boylson, University Of Queensland
Correlation of Shallow Resistivity Sounding with Geology, Fassifern Valley, S.E.Qld.

and post graduates:

Matthew Kay, University of Queensland
Integration of Geophysics into Geostatistics in Metalliferous Mining.

Steve Garner, Griffith University
Broad Band Surface Impedance Techniques.

Duncan Lockhart, Queensland University of Technology
Geological Interpretation of Recently Acquired Seismic Data in Moreton Bay.

Prizes of $150 were awarded for Best Papers to Belinda Suthers in the undergraduate section and to Duncan Lockhart in the post graduate section.

Wine Tasting and Christmas Dinner

A reminder that the combined wine tasting and Christmas dinner has been booked for Thursday 19th December. The venue is the Telopea function room on the 10th floor of the Gazebo Hotel, Brisbane.

Andrew Davids
Branch Secretary

South Australia

November:

The SA Branch held its annual Students' Night at Adelaide University on Wednesday 27th November. A combined total of six students (from Adelaide and Flinders Universities and The National Centre for Petroleum Geology and Geophysics) presented summaries of their honours work. As ever, the students gave excellent presentations on topics ranging from downhole EM at Kambalda to inverting seismic for porosity in the Surat Basin to iron ore in the Middlebacks. The full list of speakers and topics follows at the end of this piece.

The judges deliberated long and hard and awarded a shared best paper prize of $200 to Trevor Dhu and Megan Smith, both of Adelaide University. The best presentation award of $100 went to Kylie Shirwin of Flinders University. The judges believe that both Trevor's and Megan's thesis presentations were very relevant to the ASEG because they displayed an understanding of the greater economic and exploration impact of their studies.

The student speakers and their topics follow: (Samanda supplied us with abstracts of all presentations but, unfortunately, space limitations in this issue do not permit publication. However, we wish to encourage students in this endeavour so will publish the abstracts in a later issue, probably April 1997. Ed.)

Denis Cowey, Flinders University
An East-West Magnetotelluric Traverse Across the Southern Adelaide Geosyncline.

Trevor Dhu, Adelaide University
Geophysical Signatures of Iron Ore Deposits in the Middleback Ranges, South Australia.

Michelle Dight, NCPGG
Inversion for Porosity in the Showgrounds Sandstone.

David Rowe, NCPGG
The effect of Cainozoic Deformation in the Penola Trough.

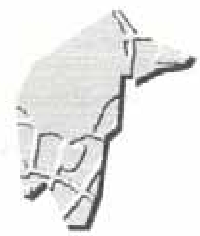
Kylie Shirwin, Flinders University
Application of Electromagnetic Techniques to Exploration Beneath Salt Lakes.

Megan Smith, Adelaide University
Integration of DHTEM, Magnetics, Petrophysics and Geology of the Miltel Ore Body and the Associated Exploration Implications.

Many thanks to Zonge Engineering for sponsoring the evening

Samanda Bell, Branch Secretary

ACT



The ACT Branch of the ASEG has been relatively inactive during 1996 due to field work commitments by many members. The branch held its AGM on 16/10/96 with the election of the following members to the Executive.

President:	Kevin Wake-Dyster Tel: (02) 6249 9401 Fax: (02) 6249 9972
1st Vice President:	Mike Sexton Tel: (02) 6249 9791 Fax: (02) 6249 9980
2nd Vice President	Peter Gunn Tel: (02) 6249 9226 Fax: (02) 6249 9986
Secretary:	Tim Mackay Tel: (02) 6249 9813 Fax: (02) 62 49 9986
Treasurer:	Peter Milligan Tel: (02) 6249 9224 Fax: (02) 6249 9986

Committee: Ted Lilley, Prame Chopra, Jane Mitchell, Alice Murray

Guest speaker for the AGM was Dr. Geoff O'Brien (AGSO) with a seminar titled "Basement controlled hybrid hard-linked/soft-linked faulting in Australian extensional basins: Implications for petroleum and mineral systems".

The branch will be holding a Christmas Luncheon seminar jointly with the ACT Branch of PESA on Friday 13th December at Brassey House, Barton with the speaker yet to be finalised. The ACT Branch of ASEG wishes all ASEG members a Merry Christmas and a prosperous New Year in 1997.

Western Australia

Technical News

Two October meetings were given over to sixteen Honours students from Curtin University. Speakers described their projects (fifteen minutes each) to large audiences of ASEG members. Thanks are due to Brian Evans and John MacDonald from the Curtin staff for their programme arrangements, and to the students for the quality of their presentations. The student speakers and their Presentation Titles are listed below:

Christopher Bishop
Petrophysics and geophysical signatures of the Wiluna orebodies.

Kelvin Blundell
An investigation into the use of multiple magnetic datasets in the estimation of depth to basement.

Kanu Bhana
Attenuation of free surface multiples.

Stephen Carter
A comparative study of geophysical techniques applied to mapping the Raeside Palaeochannel, Ida Valley Station, WA.

Wing Chen
Application of GIS in Integration of spatial datasets for gold exploration in Laverton.

Michael Enright
The optimal design of current electrodes for practical application in induced polarisation.

Simon Kawagle
Seismic expression of geologic structures using analogue sandbox models.

Brett Lantzke
Aeromagnetic survey design and assessment of data quality

Lip Win Lee
Interpretation of airborne and ground magnetic data, Tanami area, WA.

Gracian Lambert
A method for the numerical simulation of seismic wave propogation and reflection.

Christopher Manuel
Geophysical survey over the Raeside Palaeodrainage System, Ida Valley Station, WA.

Leon Mathews
Radiometrics and regolith mapping in the Mount Beasley, Peak Hill, WA.

Paul Mutton
The use of Vector component magnetic data in improving magnetic interpretation.

Christopher Walton
Recovery of elastic parameters of multi-layered transversely isotropic media.

James Small
Application of airborne electromagnetic data in the exploration of regolith and bedrock geology at Lawlers, WA.

Peter Johnson
Subsurface geological mapping with airborne and ground magnetic and electromagnetic datasets at Mount Beasley, WA.

Interstate visitors are welcome to the WA Branch's Technical Meetings. They start at 6.00 pm on the third Wednesday of the month at the Celtic Club, 48 Ord Street, West Perth.

People News

A joint AIG - ASEG seminar on 'Geophysics for Geologists' was held in Perth on 18 November. Among the prominent ASEG members to address the eighty-strong audience were W. Amann, G. Elliott, A. Foley, R. Haines, S. Mudge and W. S. Peters.

The PESA/ASEG Corporate Golf Day will be held on 29 November at the Araluen Country Club. David Howard, Neil Goodey and David Anderson organised the event.

An embryonic Perth 2000 ASEG Conference Committee has been formed. As well, a web page for WA ASEG Branch is under consideration.

Andre Lebel
Branch Secretary

Victoria

The Victorian State Branch has continued to hold meetings on a regular basis over the past few months, thanks to the efforts of our meeting coordinators.

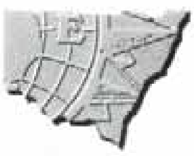
Ron Palmer organised a well attended and very successful wine tasting at the Kelvin Club.

Suzanne Haydon and Shanti Rajagopalan together organised a student night where three students were given an opportunity to present their research topics. Carol Grgic and Lynton Cull (yes, he is related) both from Monash spoke on downhole TEM techniques, and Marvena van Kann, a Grad. Dip. student from Latrobe University spoke on palaeomagnetism in New Zealand. Next month there will be a cocktail party to celebrate Christmas — time, place and venue to be announced.

David Gamble
Branch Secretary

New South Wales

December 1996



"Digging deeper beyond the dirt!"

A bumper issue of *Preview* obviously deserves the same from your retiring NSW Secretary. It has been a fulfilling and rewarding job for the last three years and I hope that I have been of service to the members. Our recent technical program since August has been:

September 1996: "Broken Hill Revisited"

Mr Richard Haren, Project Manager, GHEI, AGSO.

The Broken Hill Exploration Initiative (BHEI) is a collaborative venture between AGSO, NSWDMR, and MESA aimed at the discovery of new deposits in the Broken Hill region (150,000 square kilometres on either side of the NSW-SA border centred on the city of Broken Hill). A major impediment to the exploration for, and to the understanding of, the genesis of the world-class Broken Hill Pb-Ag-Zn deposit is the structural and metamorphic complexity of the region. Early discussions between the BHEI partners and industry revealed that a key requirement was new geophysical surveys, especially a contiguous high resolution airborne geophysical dataset covering areas of outcrop and shallow cover.

Most of the region hosting outcrop was flown with a line spacing of 100 metres, while other areas were flown at 200, 250, and 400 metres. Other datasets include gravity, regolith mapping, deep reflection seismic, geochronology and detailed structural analysis. Most datasets have been released and interpretation is either complete or underway.

October 1996: "OASIS montaj"

Mr. Mark Russell, Sales Geophysicist, Geo Instruments.

OASIS montaj for the Geologist — A Streamlined System for Integrating, Visualising and Interpreting Multidisciplinary Data

Traditionally, Earth Science software for the personal computer (PC) has been pieced together using a diverse array of independent components — ranging from basic utilities through to custom presentation software. With the recent development of **OASIS montaj**™ for Windows 95 and NT, however, the design and use of PC software is changing. For the first time, geoscientists have a single tool for exchanging and integrating information quickly and easily. In addition, this new technology gives each type of user seamless access to the specialised tools required.

November 1996: "Students' Night"

At last a Students' Evening. This was a chance for our members to make their own assessments of the real state of affairs within the academic institutions in this city! It was an opportunity to see how more is being achieved with less, and the future face of exploration geophysics.

Presentations included:

- Petroleum Potential of the Deep Marine Clastic Sequence, Browse Basin, Northwest Shelf.
  By Christan Reimann, University of Sydney.
- Non-iterative Inversion of Geophysical Data Using Simple Models.
  By Nicole Shepherd, Macquarie University
- Application of Airborne Geophysical Data and GIS near Ardlethan.
  By Peter Carristo, University of New South Wales

This last meeting of the year was also the first such Student's Night for some years and was an outstanding success. Twenty minute presentations were given and each presenter was awarded $100 for their outstanding effort and to contribute to nerve calming beverages!

General News of some of our Members:

(next page)

Prodigal Son Honoured by SEG

Congratulations from the NSW Branch of ASEG to Brian Spies on receiving Life Membership of the SEG. He gets the full treatment on p. ? so we won't go into detail here.

ET Joins ET

Dr Ted Tyne will join ENCOM TECHNOLOGY in their Sydney office from December, to take on the challenge of Market Development Manager. Ted will be working closely with David Pratt, Peter Gidley, Clive Foss and the rest of the ENCOM geoscience team to further develop and promote ENCOM's growing range of geophysical software products and consulting and training services. Ted leaves Geoterrex Pty Ltd after an enjoyable and successful three year venture as Manager, Data Processing and Interpretation.

The SMEDG-AIG Harbour Cruise

The Annual SMEDG-AIG Harbour Cruise was held on Friday, December 13. It was a an absolute roaring success once again and we all look forward to a repeat performance at the ASEG Conference Harbour Cruise in February 97. Members should note that these functions are NOT approved by the National Heart or Liver Foundations.

The Season's Greetings To All Our Members and All The Best for 1997!

Mark Russell
Branch Secretary

Vale Robin Gerdes

In Memory of Robin Gerdes, 1940-1996

By his friends on the SA Branch Committee

In Adelaide on Wednesday 16 October 1996, a large contingent of Geophysicists, Geologists and mining and energy workers gathered with the family of Robin Gerdes for a sad farewell. We had only missed him from one SA Branch committee meeting and he was taken from us a few weeks later with lung cancer complications.

Some work colleagues of Robin's put together the following tribute to help us remember him. This tribute, read at his funeral, is reproduced here for the benefit of Robin's many contacts across the society. We shall indeed miss Boyo, while his larger than life enthusiasm will remain fresh in our minds.

ROBIN GERDES

Robin was born in Horsham, Sussex on 31st December 1940. To all of us who were lucky enough to work with Robin, his passing away is the loss of a close and valued friend.

Robin graduated in geology and physics from the University of London in 1964, and then completed a one year post-graduate study of applied geophysics at the University of Leeds.

Upon completion of studies he moved to Australia where he spent his first three years acclimatising himself with the Airborne section of the Bureau of Mineral Resources in Canberra. Once acclimatised, he commenced employment with the Geophysics Section of the Geological Survey of South Australia in 1969.

For the past twenty-seven years Robin was one of the great characters of the South Australian Department of Mines.

Throughout that time he was the Department's leading authority in his specialty field of airborne geophysics. Over his long career, Robin's expertise and willingness to help at all times earned him great respect from his colleagues throughout the mining industry, many of whom have travelled here from interstate to pay their last respects today.

The last few years were particularly special to Robin as his field and interpretational expertise became the major focus of a massive government program to encourage exploration for new mineral deposits.

Robin will always be remembered, not only for his great technical skills, but for his optimism, lateral thinking, thoughtfulness, his fairness, his sincerity and his forever jovial attitude which infected all those around him. He also had great courage, being never afraid to speak his mind, irrespective of the consequences.

Throughout his time with the Department, BOYO, as Robin was affectionately named, touched the hearts and lives of all that met his path. His keen interest in collecting, not only geophysical and geological data on a world-wide basis, but also stamps, fishing reels, plates and other items was, at one time or another, shared by all.

Robin was a very unselfish workmate, loved by all. For Robin, the gaining of knowledge, and helping others to gain more knowledge, was far more important than personal ambition. Robin loved his work, he genuinely cared for his workmates, and through that care he won the respect and affection of them all.

May he rest in peace.

Conferences

The ASEG 12th Geophysical Conference and Exhibition

Co-hosted by: SEG and PESA

By now the numerous authors/speakers, who will make the ASEG's 12th Conference the success we expect, are breathing sighs of relief as their submitted efforts have been put through the hoops by an army of volunteer members of the Society including the Technical Papers Committee, editors and referees.

Planning for the conference is reaching fever pitch with less than two months to go. The hard-working Conference Organising Committee consisting of twenty persons, some new to the task and many not, started meeting over two years ago and will have held at least twenty-two meetings by the time conference takes place. The original committee list was published in *Preview # 61* (the April 1996 edition). Space does not permit us to show the whole revised committee but new members who have joined up since include Mike Smith and Vince Robinson.

As all of the committee members have full-time jobs, work for the conference has had to be done in their own time and has often meant giving up Sundays with families. Extra work has fallen on some members when their opposite numbers on sub-committees have had to travel. This was anticipated when the committee was formed, by the establishment of at least two persons in each section, but it was not envisaged that some would be away so often and for so long.

Ted Tyne and his team have survived the huge task of developing the technical programme and with the help of Richard Facer, Special Editor of the conference edition of *Exploration Geophysics*, they have reviewed the more than 120 papers submitted, organised two referees for each and transmitted the referees' comments back to the authors. Then Richard, in his own inimitable style, has edited them all for publication while at the same time devising a more economical typeset for the journal.

Under the control of the very experienced Pat Hillsdon, the exhibition will be the biggest yet organised by the ASEG. The very exciting social programme being arranged by Nigel Jones includes Professor Ian Plimer, from the University of Melbourne, as guest speaker at the Conference Dinner, speaking against creationism. And, as one of the first-timers on the committee, Katherine McKenna has spearheaded the Student Day arrangements with over 120 students committed to attend.

In the meantime, in Brisbane, your Preview editor is collecting abstracts of all conference papers together with author biographies and photographs by e-mail, floppy disk, fax and mail. The abstracts and conference details, including maps, schedules and other useful bits and pieces being put together by Ted Tyne and his crew are added to the usual Preview to become the Conference Handbook.

Roger Henderson and Mike Shalley

Brian Spies Return with SEG Life Membership

Brian Spies arrived home in July this year to assume the position of Director of the Cooperative Research Centre for Australian Mineral Exploration Technologies (CRC AMET), taking over from the founding Director, Andy Green. Andy will continue to work on scientific issues related to airborne EM hardware and interpretation.

Brian was also awarded life membership of the SEG at their recent meeting in Denver so it is convenient to use a slightly edited citation from that occasion to provide a background briefing on our eminent colleague

Brian Spies - SEG Life Membership Citation

To his colleagues, Brian's name brings to mind words like internationalism, collaboration, communication, hard work, commitment and most of all zeal. True leaders are zealots with the passion to pursue a vision with unwavering purpose; with the commitment to invest untold hours when it seems no-one else cares, and with a clarity of vision that leaves the rest of us wondering. Brian has been zealous in leading the SEG to become truly international, to chart new directions with its publications, and most recently to embrace the age of electronic communications. Yet he is a zealot with humanity and humility; he approaches every job with an outrageous sense of humour and enthusiasm, and it is more important to him to achieve the vision than to get credit.

Brian grew up in Sydney, Australia, with a fondness for mineral collecting that surfaced at a young age. In high school he manufactured thin sections of Australian rocks in his father's garage and distributed them to local schools. Brian's high school offered a strong geology component in its science program, and it was here that he was first exposed to geophysics. He double-majored in geology and physics at the University of New South Wales and went on to a graduate diploma in applied geophysics on a cadetship from the Bureau of Mineral Resources (now AGSO), where he worked with a broad range of geophysical techniques in the Australian outback. In 1976 Brian received the first SEG foundation scholarship given in the southern hemisphere. This scholarship and an Australian Public Service Board award, sent him to Macquarie University for a PhD on the application of transient EM in deeply weathered terrains. He also studied electrical prospecting methods in the Soviet Union, and was an early pioneer in the use of the transient electromagnetic method in Australia and world-wide.

Posts in mineral exploration were held in Colorado and California and Brian was a visiting assistant professor at the University of California at Berkeley. In 1984 he moved to the Arco Oil and Gas Research Centre in Texas, where he expanded his interests to include multi-component seismology and reservoir characterisation. In 1989 he was awarded ARCO's highest technical award, the "Outstanding Technical Achievement Award in Research" for development of the TEMP (transient electromagnetic probing) corrosion detection technique.

In 1990 Brian moved to Schlumberger-Doll Research in Ridgefield, Connecticut, where he led development of deep-probing electromagnetic borehole techniques for reservoir imaging and worked on reservoir monitoring with permanently-emplaced sensors. His latest appointment is with the Australian CRC AMET (see opposite).

Brian's contributions to geophysics include 8 patents and 80 publications and articles. He is on the Editorial Board of Petroleum Geoscience, is a member of ASEG, SPWLA, AGU and EAGE, and serves on the U.S. National Academy of Sciences Committee for Non-Invasive Characterisation of the Shallow Subsurface.

Since joining the SEG in 1972, Brian has served the society in numerous capacities. As chairman of the Computer Application Committee, he coordinated this year's seismic data compression workshop, and as head of the Ad Hoc Committee on Business Office Computers, he is advising the SEG on its transition into the modern world of electronic communications. Brian coordinated the launch of the SEG's World Wide Web service in 1995 and opened the door to electronic distribution of Society information to its 14,000 members via the internet. As Special Editor, Brian has developed several digital publications including the digital cumulative index and online articles from Geophysics and The Leading Edge. He chaired the Editorial Board of TLE from 1990 to 1992 and served as Associate Editor for Geophysics from 1985 to 1989 and from 1995 to present. As chairman of the SEG International Affairs Committee from 1988-1990, he was instrumental in encouraging the Society to better serve the interests of its increasingly influential international membership.

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International News

Chilean Society of Geophysicists

Large scale mineral exploitation has been active in south western South America for well over a century, notably in precious and base metal mining in Bolivia, Chile and Peru, and the now near defunct nitrate industry in Chile's Atacama Desert. Today, mineral exploitation is vigorously pursued throughout much of South America by a large number of local and foreign companies. Many are based in Santiago, the principal city of Chile, a country currently hosting both the world's largest and second largest active copper mines.

Until recently there was no local organisation catering to the needs of the significant number of geophysicists based in Chile. Early attempts to have geophysicists included in the formal geological and engineering societies in Santiago had foundered. The idea of forming a geophysical society was discussed by a group of Chilean and expatriate geophysicists culminating in a meeting of interested parties at BHP offices in Santiago in August 1995.

The initial aim was to create an informal society, open to all branches of geophysics. Meetings were to be held at approximately monthly intervals, taking advantage of specialists visiting Chile whenever possible.

The inaugural meeting, held on 25th September 1995, was addressed by Nick Sheard, Chief Geophysicist of MIM Exploration, who conveniently happened to be visiting Santiago at the time and was promptly commandeered for the honour. Over the following twelve months the Society has held a further eight meetings, making liberal use of visiting specialists.

The Societies current distribution list numbers over twenty organisations including universities, government agencies, mining companies and geophysical contractors; there are an estimated fifty practitioners of geophysics, of one form or another, in Santiago. Visitors are very welcome at Society meetings, details of which may be obtained from Randall Nickson, BHP Minerals, Santiago, telephone (56-2) 206 5200, fax (56-2) 206 5352. Prospective speakers are doubly welcome.

An excellent introduction to the wider Santiago mining community is the "Mining Club" gathering at the Boomerang Bar in Providencia, held every Friday evening from 6.00 pm where free beer is on offer until the keg(s) run dry. Entry is by way of your business card, and you might even meet a few geophysicists there.

Details of Society meetings held over the past twelve months will be published in the next issue of Preview.

Terry Harvey
South American Correspondent

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Publications Report

Why We Didn't Merge

As you are by now aware, the proposed merger of Preview and Exploration Geophysics is not proceeding. Here are some of the considerations behind that decision.

The possibility of a merger arose some time ago, in response to the perception that the society's publications were a major financial burden. It was thought that a merged magazine might be easier to administer, and more cost effective. The opinion of members was canvassed at that time, and the survey results were printed in *Preview #61* (Page 9, Figure 3). Of the options presented, a combined publication appeared to be well received. However, the option of retaining separate publications was not canvassed.

More recently, a Publications Review Committee was convened, and has carried out an independent analysis of costs and revenues for our different publications. In September, results were circulated to all state branches and standing committees in the form of a discussion paper, and the major points are summarised below.

The Cost of our Publications

Firstly, it is worth considering what is 'acceptable' in terms of publication costs. One way to put this into perspective is to consider that your membership dues inject some $75,000 per annum into the society. Most members would accept that a proportion of their dues should go towards producing our publications. We suggest then that it might be acceptable for our publications to impose a net cost to the society of, say, $10 - 20,000 per annum. On the other hand, we probably couldn't afford $50,000 per annum. So what do they actually cost us?

Regular Issues of Preview and Exploration Geophysics

Examination of recent regular (i.e. non-conference) issues indicates that the per issue production costs are of order $7000 and $11000 for *Preview* and *Exploration Geophysics* respectively. Revenue from advertising and 'library' subscriptions is such that the net cost to the society is some $500 per issue ($3000 per year) of *Preview*, whilst Exploration Geophysics is close to cost neutral.

Our analysis indicates that typically twelve advertisers are common to the two publications. Loss of revenue if publications were merged could be of the order of $2000 per common issue. In addition, it is clear that our advertising rates, particularly for *Preview*, are much lower than those for other publications of comparable circulation and quality.

Our conclusions regarding the merger are:

- Regular issues of *Preview* and *Exploration Geophysics* are not currently imposing a major cost burden on the society.
- Given the tendency of *Preview* to rightly include articles of a 'less-rigorous' nature, differentiation of refereed articles would present a problem in a combined journal. The standing of *Exploration Geophysics* would suffer. Consequently library subscriptions could well be reduced.
- In view of advertising overlap, and possible loss of library subscriptions, it is not clear that a merger would, in any event, reduce costs.

Conference Volumes

We believe that a far more pressing costing problem relates to conference volumes. The production cost of a conference volume is variable, but of order $100,000. Advertising revenue is of order $15,000 per issue, whilst library subscription revenue of some $25,000 can justifiably be allocated. Thus each conference issue imposes a net cost of some $60,000. This cost has traditionally been shared between the conference organising committee and the society as a whole.

This raises the subject of how conference volumes should be budgeted for, as touched on in **President's Piece** of *Preview #64*. I would strongly support the view that we need a fundamental change in thinking regarding conference profits. Our conference attendees and exhibitors probably have an unhealthy perception that our conferences tend to make huge profits. Unfortunately, in amassing this perceived profit, the society as a whole is slugged with a significant bill for the conference volume. I suggest that a committee which could make a conference break even, whilst fully funding the conference volume, should be seen as making a great contribution to our society. (I write this as a reformed profiteer. I remember feeling quite cocky when the Gold Coast Conference made a perceived six figure profit.)

Editorial Logistics

Finally, it needs to be urgently recognised that the only reason our publication costs have been contained at current levels is that we have traditionally relied on volunteer labour. Our society owes a huge debt to our past and present editorial members. However, as our society becomes more mature and professional it is clear that we cannot assume that such editorial masochism will always be available. With this in mind we are taking steps to streamline, and further commercialise, editorial and advertising procedures. It is clear that a more realistic advertising schedule is required to cover this more professional approach. However we value the long-term support given by our regular advertisers, and are committed to providing good value for their advertising dollars. Further details of these initiatives will appear in the next issue of Preview.

Steve Hearn
First Vice President

Front Cover *Preview #65*

Our front cover for this issue was designed by Graham Meadowcroft of Jenkin Buxton. I am indebted to Bob Smith of CRAE for the loan of the first ASEG Bulletin editorial, part of which forms the background of the cover.

Ed.

The Acquisition and Analysis of Slim Acoustic Scanner Log Data

Peter Elkington,
BPB Wireline Services, East Leake, LE12 6JX, England

Introduction

The Slim Acoustic Scanner generates continuous high resolution formation images in boreholes as small as 3 inches (76mm) in diameter. Such images provide quantitative information about the lithological and structural characteristics of rock masses previously available only from rock core. In particular, it is possible to derive unambiguous orientations for any planar feature that intersects a borehole, and infer in-situ stress field orientation from the borehole breakouts which are readily identified on the images.

The tool contains a rapidly rotating transducer which emits repeated short bursts of sound energy. Each burst produces a borehole wall reflection whose amplitude and travel time characteristics are measured by the tool and recorded at surface. As the tool traverses the hole, a continuous helical scan is made. This is transformed into a series of circumferential scan lines which are then rotated into a common frame of reference to remove the effects of tool orientation and borehole trajectory. Continuous false colour images are constructed by adding successive scan lines one above another on a display screen or plotter.

Background

Formation imaging tools are not new. They are a common log in oil and gas wells, where they are used primarily to help evaluate fractured reservoirs. In this market the scanning tools and their associated processing software have become very sophisticated and are capable of providing images of excellent quality.

In the mining sector, imaging logs are far less common, and the pace of development has been correspondingly slow. This has made it difficult for the existing service providers to demonstrate imaging as a cost effective option.

The Slim Acoustic Scanner (SAS) is a new development based on experience in the hydrocarbons sector. The acoustic transducer at the heart of the tool is the result of extensive computer and physical modelling to evaluate the pressure field which arises from the interaction of tool and borehole. It achieves excellent spatial resolution and signal to noise ratio whilst maintaining good immunity to hole ovality and tool eccentralisation effects.

Downhole Equipment

Figure 1 shows a schematic of the tool. It comprises two parts: the Slim Scanner Head ISSH) sub and Slim Acoustic Processor (SAP) sub. The maximum diameter of the tool is 21/4 inches (57mm).

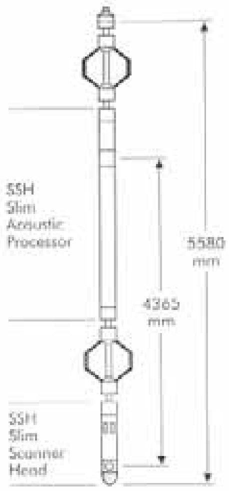

Figure 1. SAS tool schematic. The in-line centralisers are optional. Without centralisers, the length reduces to 3.59m (11.8 ft).

It is important that the tool is properly centralised in the borehole. If it is not, the distance between transducer and borehole wall will not be constant along a circumferential scan line. Since the borehole fluid attenuates the acoustic signal, the amplitude of the reflected signals will also vary around the hole. This gives rise to an artefact on the amplitude image which, whilst amenable to reduction by the processing software, is best avoided in the first instance.

For this reason, the tool is equipped with a pair of optional in-line centralisers. Each centraliser comprises four articulating arms which contain rollers to reduce friction at the borehole wall. The arms are linked at their base to a common spring loaded pivoting assembly. This causes the arms to expand and contract as the borehole changes shape, thereby maintaining proper centralisation, even in deviated boreholes.

The acoustic transducer is mounted in a rotating head assembly where it is exposed directly to the borehole fluid. Unusually, there is no pressure resistant window, which means that signal attenuation is at a minimum. It also means that the transducer is closer to the outer diameter of the tool, which contributes to a further reduction in transmission loss through the borehole fluid.

The head is driven by a stepper motor which causes it to rotate at 8 revolutions per second. During each rotation, the transducer is pulsed 200 times at its resonant frequency. Following each pulse, the transducer is switched to receive mode, at which point it is sensitive to the pressure field reflected from the borehole wall. A magnetometer adjacent to the transducer provides the azimuthal information needed to orient the image in a vertical well. Additional navigation information is provided by two level cells in the processor sub which allow the tool to be oriented in the general case of an inclined borehole.

The processor sub also contains a natural gamma ray measurement which facilitates depth correlation to core data and other open hole logs. Provision has also been made for a z-axis accelerometer measurement (although it is not available in all tools). By measuring the small variations in tool acceleration as it traverses a borehole, it is possible to compute its instantaneous speed and hence the precise distance between adjacent depth samples. Without this measurement, it must be assumed that the depth measured by the position of the logging cable at surface corresponds to the actual tool depth.

Acoustic Transducers

The active element in the transducer is a piezo-electric plate. This is made to resonate, with a rapid initial transient response, by driving the element with a large, short duration voltage spike applied across the face of the plate. The duration of the pulse is in strict relation to the resonant frequency of the plate in order to maximise the output from the electro-mechanical conversion process (it is typically of the order of 1 microsecond).

A quarter wave matching plate is bonded to the front face of the piezo material. This provides impedance matching to the borehole fluid and greatly increases the efficiency of the transducer. Material behind the plate absorbs energy radiated into the tool and absorbs internal reflections. Finally, a concave acoustic lens is used to focus the pressure field and improve the ultimate spatial resolution.

The shape of the pressure field developed by the transducer depends on its diameter, its resonant frequency (governed principally by the thickness of the piezo-electric plate), and on the focal length of the acoustic lens. Other factors control the amplitude of the field; these include the mechanisms used to damp the transducer resonance and to minimise reflections from behind the transducer.

Good approximations of the pressure field can be achieved through mathematical modelling, and these techniques were used to investigate possible transducer designs for the range of borehole sizes of interest. This work resulted in a number of prototype designs being constructed which were then evaluated in a range of laboratory jigs.

Figure 2 shows the results of a pressure-field test on a 500 kHz, 38mm diameter transducer with a 76mm focal length lens. It was constructed from data acquired in a large water-filled tank, and shows the pressure field amplitude in the plane perpendicular to the lens and passing through its centre. The nodes are 1mm apart. It has the following characteristics:

- lack of sensitivity in the near-field region (in this case about 40mm in front of the transducer).
- a relatively flat on-axis response in the far-field which allows operation over a range of hole sizes.
- good focussing, as demonstrated by the V-shaped ridges in the near-field and narrow far-field response.

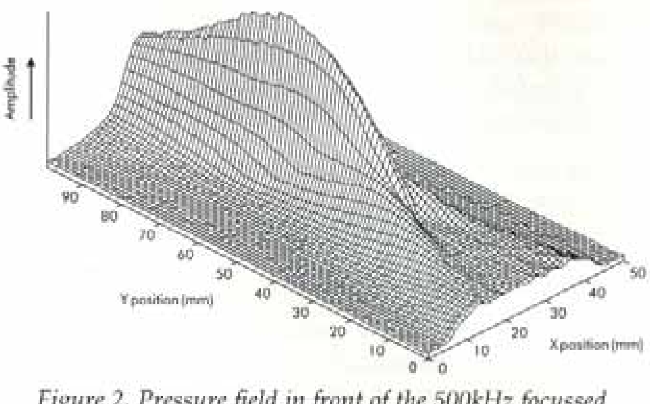

Figure 2. Pressure field in front of the 500kHz focussed transducer. Data obtained in a large water- filled tank; node spacing 1mm. The X-position is across the transducer and the Y-position perpendicular to the transducer.

Figure 3 (next page) shows the pressure field for a 1 MHz, 1/2 inch (13mm) diameter transducer. In this case the onset of the far-field response is much closer to the transducer face.

It will be apparent from figures 2 and 3 that in order to maintain optimum performance in hole sizes ranging from 3 to 8 inches (76 to 203mm), two transducers are desirable. We have therefore selected a 1 MHz transducer for the approximate range 3 to 5 inches (76 to 127mm), and a 500 kHz transducer for holes larger than 5 inches (127mm) in diameter.

Pulse Conditioning

So far we have considered the spatial distribution of the signal. However, it also varies in time, as shown in figure 4.

The top trace is plotted on a linear amplitude scale, and shows the transducer output during transmission (first envelope) and whilst receiving the first reflection from the borehole wall (second envelope). The sound pulse develops a sharp transient followed by a reverberation which is strongly damped by the transducer housing during the ring-down period. The reflected pulse has a similar characteristic, but may be more complex if the borehole wall is rugose.

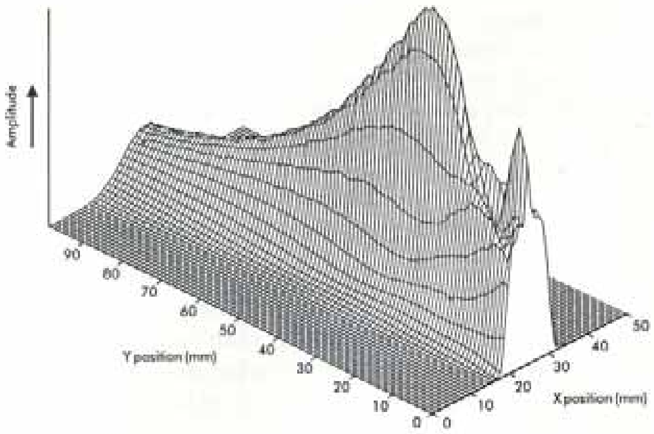

Figure 3. Pressure field in front of the 1MHz transducer. Orientation and spacings as per figure 2

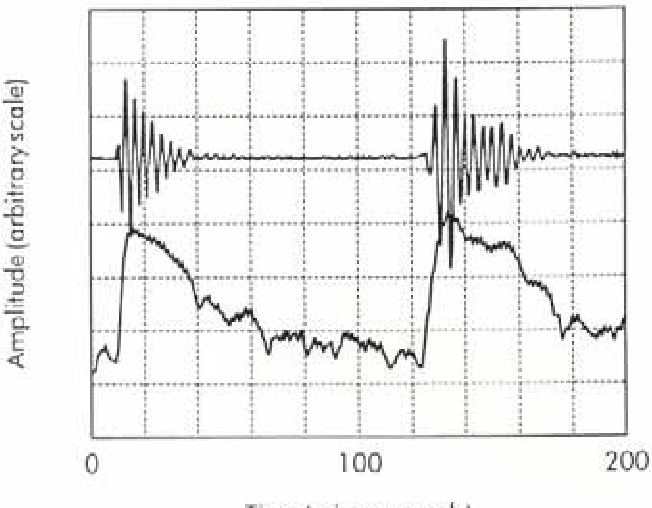

Figure 4. Typical transducer signal as a function of time. The upper trace shows the raw transducer output for one firing cycle; the lower trace is the conditioned signal. The first envelope is the transmitter firing, the second is the first borehole wall reflection. Signal conditioning makes it easier to characterise reflections from diverse borehole environments.

We wish to measure the arrival time and characterise the peak amplitude of the reflected signal over a wide range of borehole environments. In order to simplify the task, we have chosen to condition the measured signal prior to further processing. Specifically, it is rectified, filtered and transformed onto an attenuation scale. The lower trace in figure 4 shows the results of the processing, plotted on a linear attenuation scale. It is now a simple matter to measure the peak energy, and to characterise the ring-down. The full waveform is sent to the surface, where it is examined during logging, and is used by the engineer to quality control the log.

Travel Time and Amplitude Detection

The travel time is used with the borehole fluid velocity to compute a 360 degree caliper image. It is measured from the initiation of the transmitted pulse to a point where the conditioned signal from the first reflection exceeds a pre-defined discriminator level.

In order to make the measurement immune to disturbance from noise, a multi-stage discriminator is used. For a period immediately following pulse initiation, the detection system is inactive. This is the blanking time, and is of the order of 30 mseconds, but may be altered by the engineer depending on hole size (figure 5).

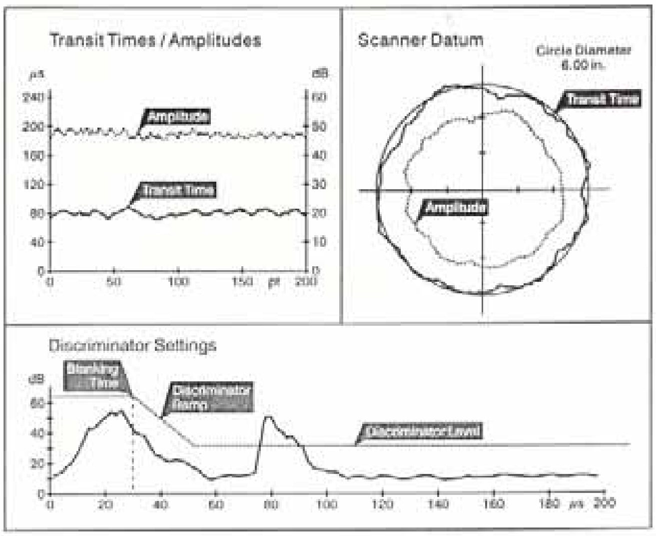

Figure 5. Typical output from the SAS set-up screen. The lower display is used to optimise the blanking time, discriminator ramp and final discriminator level for the current borehole environment. The upper display provides additional quality control. The mud velocity can be determined by running in casing.

After the blanking time, a ramped discriminator follows the ring down to the final discriminator level setting. This arrangement means that reflections can be detected in very small boreholes where they are superimposed on the transmitter ring-down. It also allows for optimum operation in muds which have diverse attenuation properties (heavy muds tend to be more attenuative than water or light muds). In large holes or heavy muds where signals are of reduced amplitude, this arrangement largely removes the risk of premature triggering by random noise spikes.

After the discriminator has been triggered and the arrival time recorded, a window is opened and the conditioned wavetrain searched for its peak amplitude. Pairs of amplitude and travel time values are digitised and stored for each pulse cycle; these are accumulated in downhole buffers prior to transmission to the surface after each revolution. The digitisation provides resolutions of 0.25 dB amplitude and 0.5 microsecond.

At the end of each revolution, a complete conditioned waveform is also transmitted. This allows the engineer to monitor the quality of the signal in real time.

The information needed to optimise the detection system for current hole conditions is presented in the SAS set-up screen - see figure 5. There are three separate plots. The lowermost plot shows the conditioned signal from a single reflection, with blanking time, ramp and discriminator superimposed. The amplitude and travel time data from one complete revolution are plotted in the top left display. Both scan lines should be free of noise spikes. Finally, in the top right, the amplitude data are displayed around the hole, and travel time superimposed on a circle corresponding to bit size.

The data in figure 5 are from open hole. When data are acquired in cased holes, the actual mud velocity can be adjusted in the software so as to give an exact match to internal casing diameter. The relationship between mud velocity and hole size is shown in figure 6 for three different mud velocities; it includes the correction needed to take account of the delay between initiating a pulse, and the development of the pressure field.

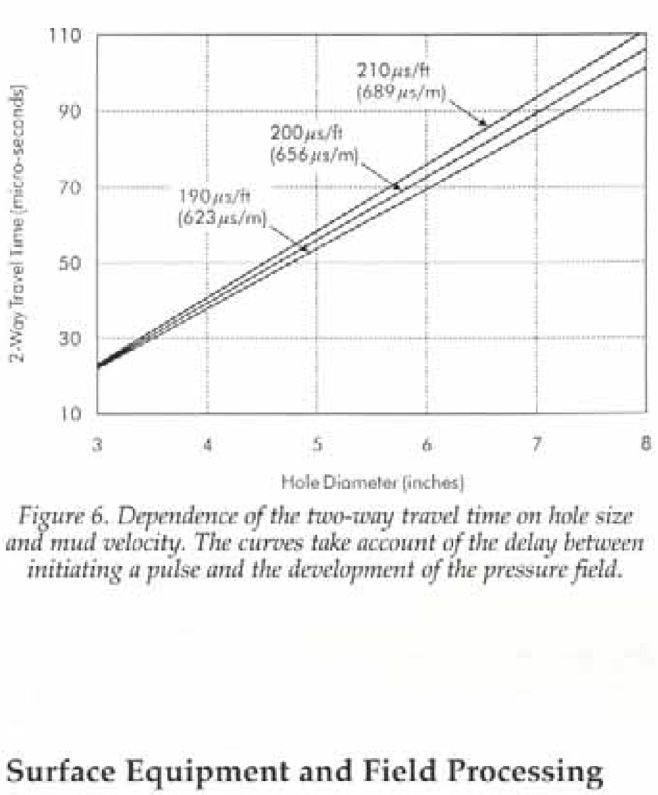

Figure 6. Dependence of the two-way travel time on hole size and mud velocity. The curves take account of the delay between initiating a pulse and the development of the pressure field.

Surface Equipment and Field Processing

The SAS may be run from any Slimline Service Unit using single core cable. The surface computer associates depths with the downhole data, orients the images with respect to true north, and controls the presentation and plotting of the images and related data. The information is processed and plotted during acquisition to maximise the opportunities for quality control.

A typical field plot is shown in figure 7 (see p.29). The salient features are:

- track 1 (left of depth track) - Gamma Ray, X and Y acoustic calipers (sampled from the 360 degree caliper), Cable Tension, and overlays of discriminator settings on conditioned waveforms. Timing marks are presented as ticks on the left side of the grid from which the logging speed can be deduced.
- track 2 (right of the depth track) - the Compensated Amplitude image is typically plotted on a 0 to 360 degree azimuthal scale, i.e. from north back to north.

The image has been compensated for mud attenuation effects using information from the travel time image, and is displayed using a dynamic grey scale. This allows the grey scale to change based on the distribution of data values within the image. It has the advantage of generating contrast in the image, at the expense of removing the link to absolute amplitudes (these are, however, available for subsequent reprocessing).

- track 3 (far right) - the Travel Time image, typically also plotted on a 0-360 degree scale. This too is displayed using a dynamic grey scale to emphasise detail. By default, long travel times plot darker than short times and the image is oriented with respect to true north.
- depth track- contains the depths (in metres or feet), and borehole tilt and azimuth plotted as tadpoles.

The rotation to true north requires the magnetic declination to be known. This is printed on the log tail, and is positive for magnetic north east of true north, and negative for the inverse.

Output Curves

The following curves are recorded, identified by their four character mnemonic:

DPTH - Measured Depth (metres). An exact value is obtained every 10 revolutions of the scanner head (1.2 seconds); depths for intermediate scans are calculated by interpolation.

CDEP - Corrected Depth (metres). Depths corrected for known offsets, and where available, for instantaneous speed computed from the z-accelerometer.

HVOL - Hole Volume (cubic metres). The wellbore volume computed from the 360 degree calipers, integrated over a depth increment.

AVOL - Annular Volume (cubic metres). The difference between the actual wellbore volume computed from the 360 degree calipers, and the volume excluded by casing, integrated from TD.

BITS - Bit Size (inches or mm)

CASX - X Acoustic Caliper (inches or mm). Actual direction is controlled by the X Caliper Orientation parameter in the Logging Constants part of the log tail.

CASY - Y Acoustic Caliper (inches or mm). Y caliper is orthogonal to X caliper.

GRSR - Raw Gamma Ray (cps)

GRAS - SAS Gamma Ray (API). The calibrated and filtered Gamma Ray.

SAST- Raw Data Block. The (unplottable) raw data block.

DISC - Signal Discriminator dB. A curve showing the current discriminator levels. Usually plotted with RSSC as a quality control.

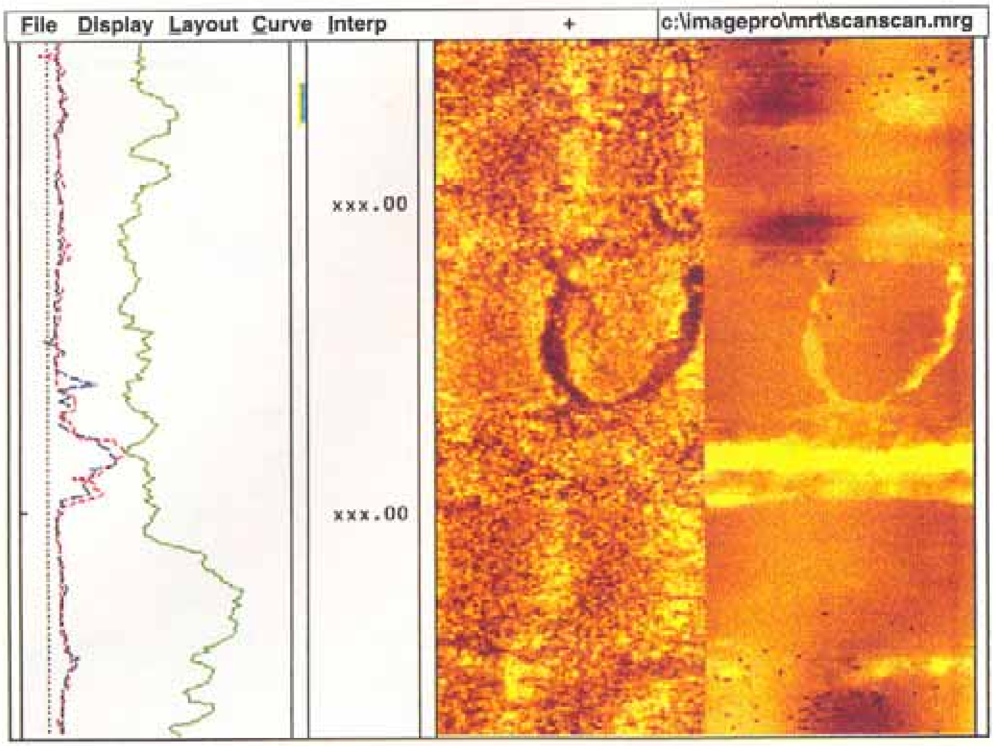

Figure 11. SAS amplitude and travel time image, 1:15 depth scale, from an Australian borehole drilled through coal bearing strata. The planar yellow feature on the travel time image is a cave, above which is a non-planar feature interpreted as an open fracture. Elsewhere, the travel time image is relatively featureless, indicating a smooth borehole.

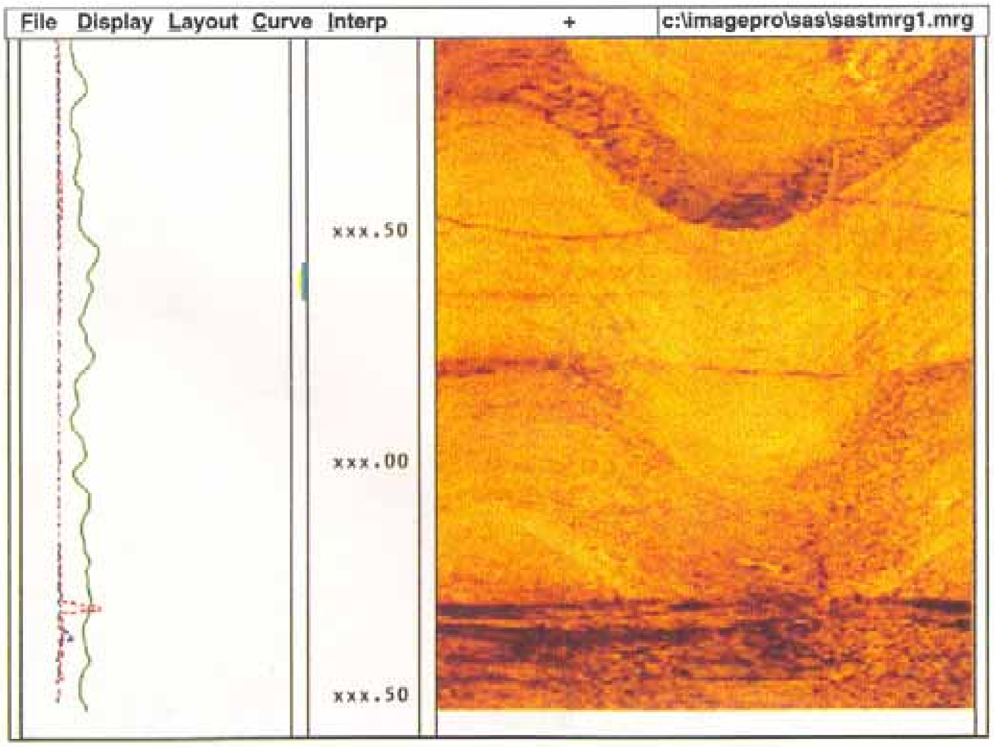

Figure 12. SAS amplitude image, statically normalised, in a 3 inch diameter water-filled hole, rendered by PC ImagePro.
Depth scale is 1:10.

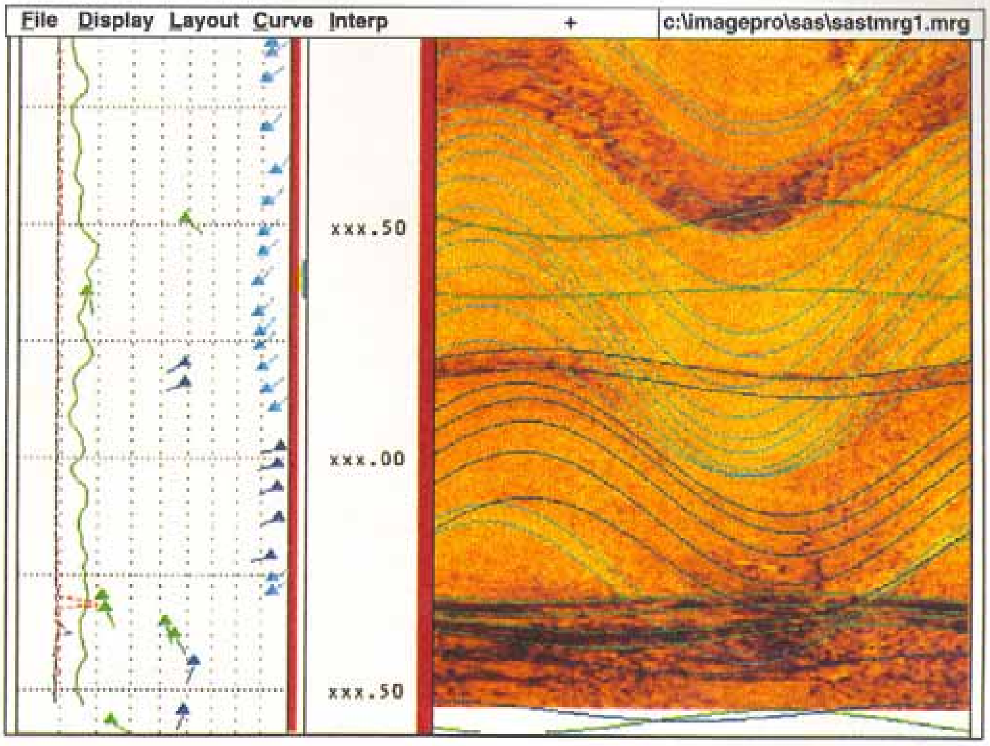

Figure 13. As Figure 12, with interpreted dips and sine waves.

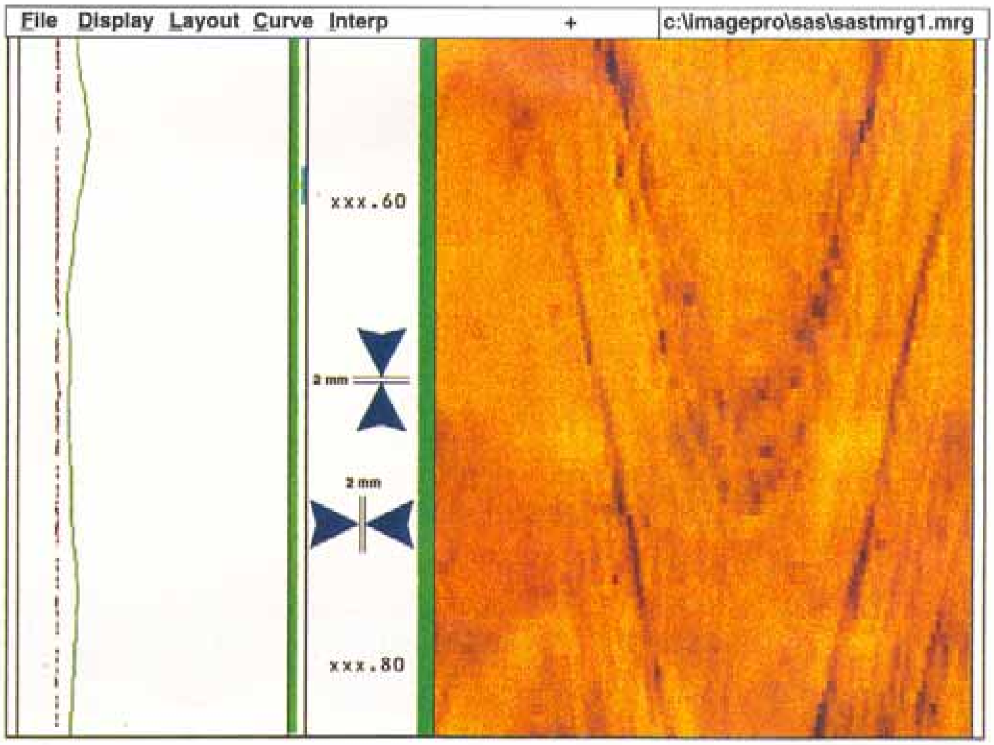

Figure 14. SAS amplitude image at 1:2 depth scale showing two narrow fractures. Note the 2 mm scaling marks.

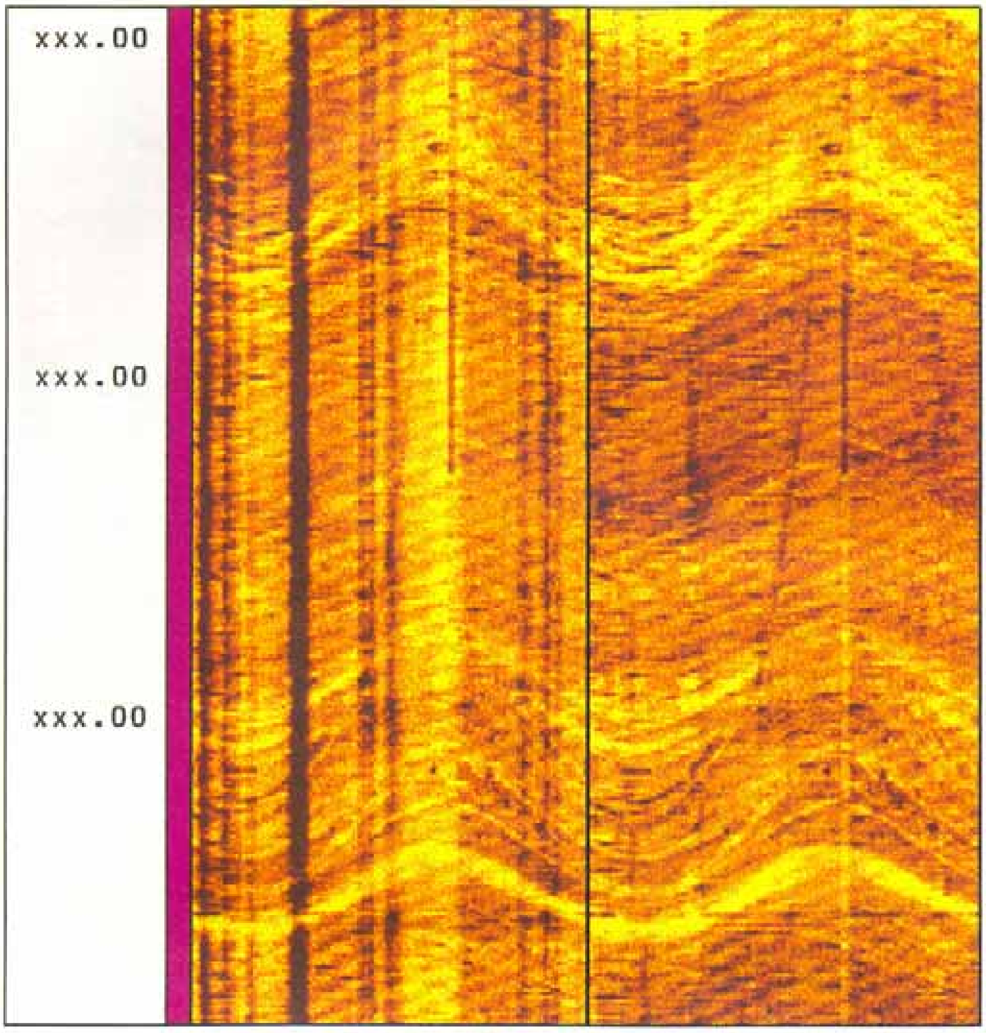

Figure 15. Amplitude image before (left) and after (right) vertical enhancement.

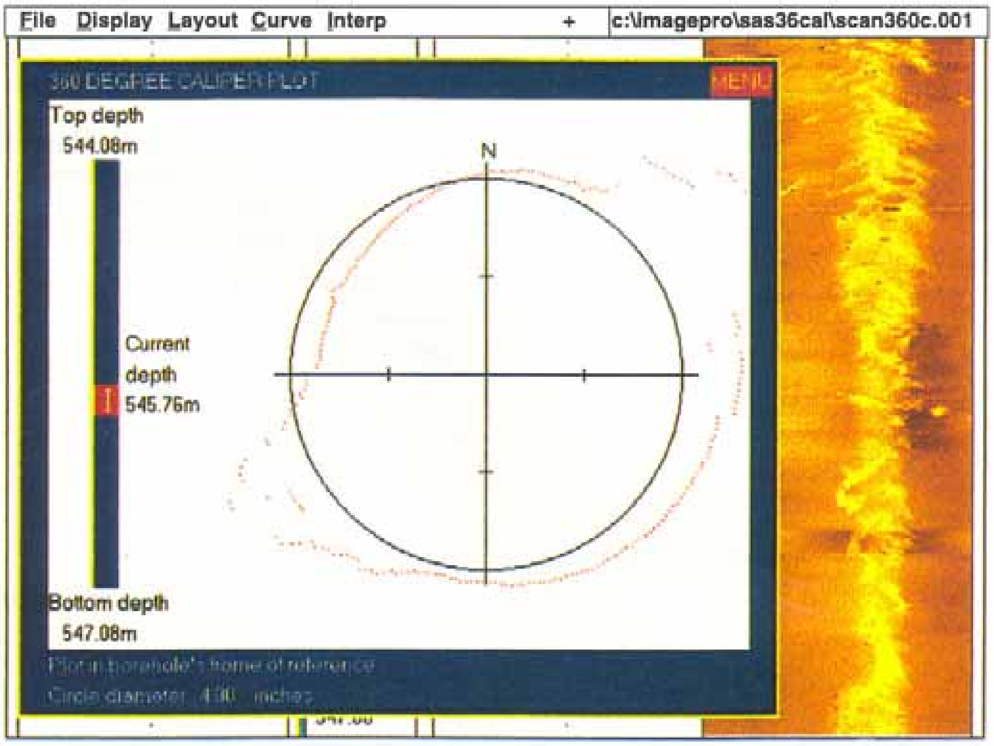

Figure 16. 360 degree caliper plot showing breakout.

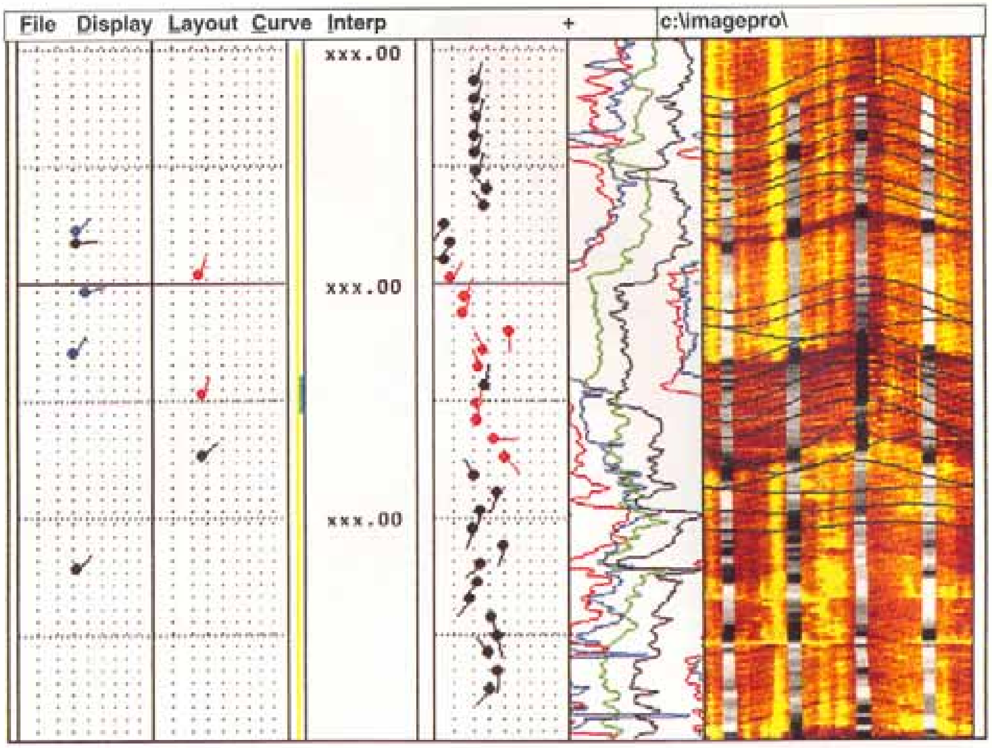

Figure 17. PC ImagePro composite of dipmeter traces, dipmeter pseudo-image and amplitude image. The sine waves are from the dipmeter step and interval correlation and may be quality controlled by comparing them with the amplitude image. The three dip sets relate to results from different filtering procedures.

RSSC - Received Signal (dB). The received waveform after conditioning.

LCXU - Level Cell X Raw (volts).

LCYU - Level Cell Y Raw (volts).

MSIN - In Phase Magnetometer (volts).

MQUD - Out of Phase Magnetometer (volts).

AAZD - Apparent Azimuth (degrees). Azimuth of the magnetometer measured with respect to magnetic north in the tool's frame of reference.

AZAS - Azimuth of SAS (degrees). Azimuth of the scanner datum point with respect to true north, measured in a clockwise direction (looking uphole) in the horizontal plane.

AZID - Borehole Azimuth (degrees). Azimuth of the borehole with respect to true north, measured in a clockwise direction (looking uphole) in the horizontal plane.

RBAD - Relative Bearing (degrees). Orientation of the magnetometer with respect to the vertical plane through the long axis of the tool, measured on the low side of the sonde.

TILD - Borehole Tilt (degrees). The borehole tilt away from the vertical.

ACCZ - Z Accelerometer. The z accelerometer channel (where fitted).

WAV3 - Unoriented Amplitudes (units of 1/4 dB).

WAV4 - Unoriented Transit Times (units of 1/2 microsecond).

WAV8 - Oriented Amplitudes, Compensated (units of 1/4 dB). Amplitude data compensated for mud attenuation and time of flight, aligned to true north. Automatic Contrast may be enabled.

WAV9 - Oriented Travel Times (units of 1/2 microsecond). Two way travel times, aligned to true north. They are not corrected for blanking time or initiation delay. Automatic contrast may be enabled.

AMPB - Compensated Amplitude Bias. Allows automatic contrast to be removed from compensated amplitudes.

TRB - Transit Time Bias. Allows automatic contrast to be removed from compensated transit times.

VAMP - Vertical AMplitude (units of 1/4 dB), amplitude log recorded in the same azimuths as CASX.

Spatial Resolution and Detection Threshold

There are many criteria for judging the quality of an image. Amongst the most important are spatial resolution and detection threshold (some literature does not differentiate between the two measures; they are, however, quite different and should not be confused).

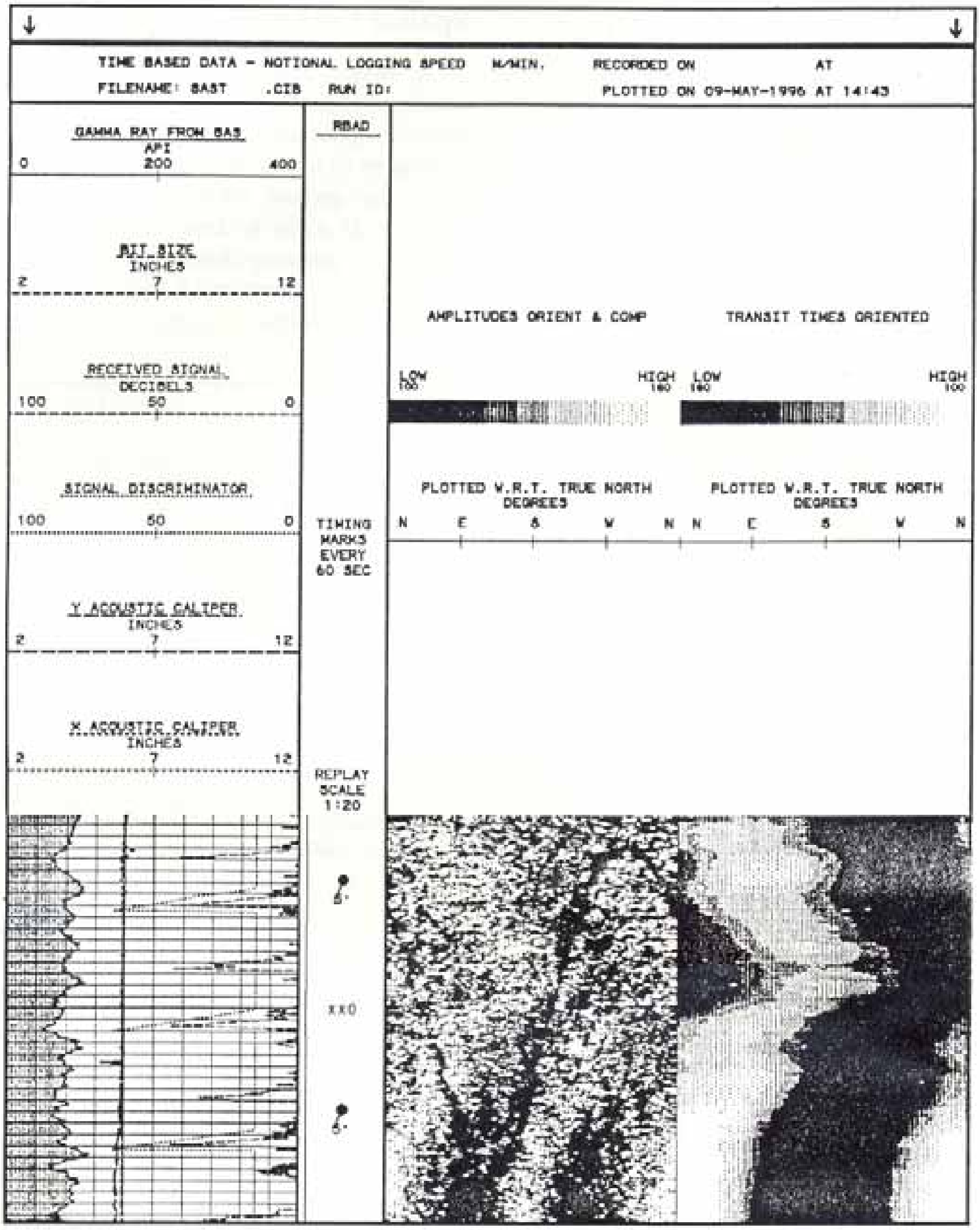

Figure 7.
Part of the log header from an SAS field log showing the image data as it is presented in real time.

Spatial resolution is the minimum distance between events such that they can be distinguished as separate entities. There is a stricter definition which requires the events not only to be separated, but quantified such that the intrinsic magnitudes of the features can be ascertained. However, in the context of image analysis, the former is the more relevant definition, since absolute values will, in any case, be disguised by processes such as dynamic normalisation.

Detection threshold simply refers to the smallest event that can be detected by the system. In general, this is much smaller than the system resolution - it is much easier to see an isolated feature than it is to distinguish between two similar features close together.

We must now distinguish between intrinsic and usable resolution. Intrinsic resolution is solely a function of transducer design. However, logging speeds, sample rates and the manner in which the images are constructed are additional design factors which control the usable resolution. The borehole environment may well impose further restrictions.

In evaluating the SAS, we have studied angular resolution around the hole (and by implication, the vertical resolution) and the detection threshold.

Angular Resolution

This was determined in fluid-filled steel pipes in which a sequence of grooves were cut in positions progressively closer together. Data were collected from both the 500 kHz and 1 MHz transducers in pipes ranging between 6 and 8.75 inches in diameter. These are large compared to the normal operating range of the SAS,

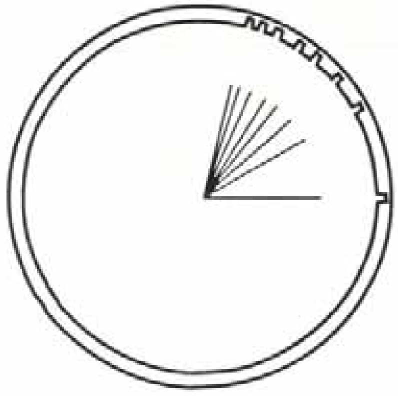

Figure 8. Schematic of the 8.75 inch (222mm) diameter grooved pipe used in the determination of angular resolution.

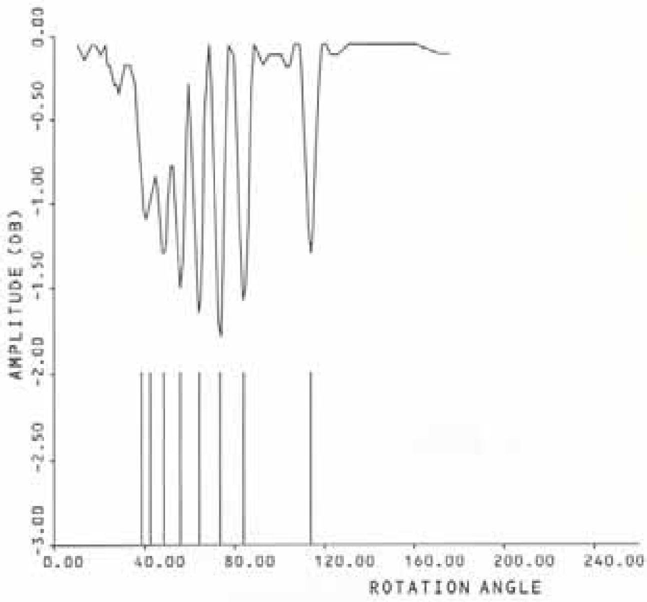

Figure 9. Part of an Amplitude scan line acquired in the grooved pipe of figure 8. All but the closest grooves are resolved.

and the resolution in small hole sizes, particularly with the 1 MHz transducer, can be expected to be significantly better than reported here.

Figure 8 shows a schematic of one of the grooved pipes. The results for the 500 kHz transducer in the 8.75 inch pipe are presented in figure 9.

It will be seen that all the grooves are differentiated except for the pair at 38 and 42 degrees which appear as a single feature. From the plot, we deduce that the angular resolution is 7.5 degrees at 8.75 inches. The corresponding linear resolution on the borehole wall may be calculated as 2r tan(angular resolution /2), where r is the borehole radius. This corresponds to 0.57 inch (14.6mm) in an 8.75 inch hole, or 0.26 inch (7mm) in a 4 inch hole.

As previously indicated, the actual resolution in a 4 inch hole will be better than this. This is supported by additional laboratory data using the 1 MHz transducer in a grooved 6 inch pipe, which gives an angular resolution figure of 6 degrees.

Spatial Detection Threshold

A second series of experiments was performed in which steel pipes were scribed with grooves having a common separation but progressively smaller width.

Figure 10 shows the results from a scan in an 8 inch pipe. The groove width reduced progressively from 12mm (0,47 inch) to 2mm (0.08 inch). The tool clearly detects all grooves down to and including the 2mm groove. Experiments in a 6 inch pipe were able to detect sub 1 mm grooves.

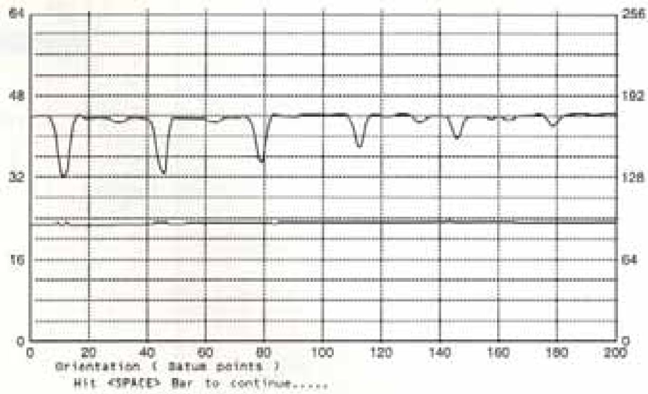

Figure 10. Amplitude (upper trace) and travel time (lower trace) scan lines across a sequence of equally spaced grooves with widths of 12, 10, 8, 6, 4 and 2 mm. Data is from the 500kHz transducer in an 8 inch pipe.

Resolution and Sample Rates

The image displayed on the log is constructed from discrete samples taken as the scanning head traverses a helical path along the borehole wall. In order to take advantage of the resolution available from the transducer, it is essential that the samples are taken sufficiently frequently.

In the SAS, 200 sample pairs are taken per revolution, of which 100 are used in image construction. This corresponds to an angular sample rate of 1 per 3.6 degrees. This is sufficient to meet the Nyquist criterion for reproducing the intrinsic resolution of 7.5 degrees at 8.75 inches.

The vertical distance between samples depends on logging speed. The symmetry of the transducer means we can use the linear resolution computed from the angular resolution as our basis for comparison. To resolve two features separated by 14.6mm (to use the worst case figure given above) means sampling with an increment of no more than 7.3mm to satisfy the Nyquist criterion. For convenience, we use optional increments of 5 or 10mm. A simple calculation will show that unique samples will be obtained at these increments at logging speeds of 2.4m/min and 4.8m/min respectively (about 500 ft/hr and 1000 ft/hr respectively).

Computer Centre Interpretation

The steps taken to generate real time images in the field have already been described. The quality of these images is such that qualitative interpretations may be made and, in vertical wells, good estimates of dip can be derived. However, far more can be obtained using the interactive image processing software available at a BPB Computer Centre. Specifically, it is possible to bring to bear a wide range of image enhancement and interpretation techniques to reveal information not apparent on the monochrome prints. Such processing also allows dips to be accurately computed regardless of borehole trajectory.

It should be noted that the automatic contrast control generally used to display field images needs to be removed prior to computer centre processing. This is because the enhancement methods will assume that the data are completely raw, and have not been subject to prior processing.

We have written two image processing packages, both operating on standard office or notebook PCs with colour screens. **Q-Scan** is streamlined to handle BPB format directly, and is the preferred choice for the basic analysis of SAS data. **PC ImagePro** is more generic, and handles logs from other service companies, in addition to those from BPB. SAS data must undergo format conversion before being read by PC ImagePro, but the software is capable of the most sophisticated analysis.

Image Enhancement

The dynamic range of the data behind an SAS image will normally exceed the ability of a colour display to render all the detail in a single presentation of the image. It is therefore important that the analysis software is capable of isolating parts of an image to enhance features which may be otherwise invisible, or masked by other events. There follows a brief description of some of the methods used in PC ImagePro to enhance images; most are also available in Q-Scan.

static normalisation - the colour range is mapped to a fixed range within the available data. This means that a particular data value always maps to the same colour, so that (for example) lithological comparisons can be made along the full length of the wellbore. The range can be made broad to accommodate a wide range of amplitude or travel time variations; this is done when presenting a continuous plot of the full borehole. Alternatively, a small depth interval can be selected and the colours mapped to a narrow data range.

dynamic normalisation - the colours are mapped to a data range that is varied dynamically on the basis of the statistics of the data distribution. In PC ImagePro this can be done over a small interval, over a whole screen, or over the whole borehole. It has the effect of a continuously variable contrast control. It reveals most of the features present in the data, at the expense of losing the link between colour and absolute values.

colour bias - the centre of the colour palette is usually mapped to the centre of the distribution of data values within the image. Colour bias shifts the colour palette up or down the data distribution and has the effect of highlighting events at the extremes of the distribution.

palette selection - the colours used to display images are constructed from a colour palette. Each palette is a sub-set of all the colours in the visible spectrum. The standard palette is made up of "earth tones" ranging from yellow through brown to black. Each colour in such a palette differs only slightly from its neighbour, and this gives a pleasing continuity to the image. An alternative approach is to use the whole spectrum, so that adjacent colours in the palette are more different. This tends to emphasise boundaries between features.

vertical enhancement - hole ovality and tool eccentricity cause vertical stripes to appear on the image due to the unequal travel time and attenuation around the hole. These usually have the same orientation (in the earth's frame) over long intervals, even if the whole tool is rotating. Vertical enhancement is a 2 dimensional filter which removes such coherent noise and leaves the background variations.

Dip Computation

The intersection of an inclined plane with a vertical circular wellbore defines a line which, on an unwrapped image, is an exact sine wave. The amplitude of the sine wave defines the dip angle, and its phase with respect to true north defines the dip azimuth.

In the more general case of a plane intersecting an inclined, non-circular borehole, the calculation is more complex and less amenable to mental computation. By way of illustration, a sine wave with no amplitude (in other words, a horizontal line on the image) could be a boundary with no dip in a vertical well, or a high angle dip whose amplitude differs from that of the borehole by 180 degrees.

Q-Scan uses the tool navigation and travel time data to compute the exact dip of a plane through 3 points highlighted by an interpreter on the screen (PC ImagePro will calculate the best fit sine wave if more than 3 points are highlighted, or it can fit a "rubber band" sine wave to a feature). The resulting dip is displayed conventionally as a tadpole, whose head position on a scale denotes the dip angle, and whose tail points to the compass bearing of the dip azimuth.

PC ImagePro also performs the inverse process- it will transform tadpoles into sine waves. This is an extremely useful means of quality controlling dips that have been automatically generated by the machine. It is most frequently used to compare dipmeter dips with sine waves on pseudo-images generated from the dipmeter resistivity traces. In some circumstances, both dipmeter and SAS are run to exploit the complementary nature of the measurements, in which case the acoustic image can be examined for evidence of a sine wave generated from a dipmeter tadpole - figure 17.

Dip Statistics and Interpretation

An adequate interpretation may be gleaned from a qualitative assessment of an image coupled to the determination of some representative dips. Indeed, in the case of most shallow holes drilled in support of mining activities, this will generally be sufficient.

Sometimes a more detailed quantitative analysis is justified. The following are some of the tools in PC ImagePro (many of which are also in Q-Scan) used in pursuit of a detailed understanding:

- ***zonation***. Zones in this context are intervals or units of interpretation. They may be defined on the basis of the log responses, the local stratigraphy, structural units, or some other attribute which reflects some commonality within the interval. Within each zone, dips of the same type can be averaged. Such decimation of dip data often simplifies its interpretation and helps identify the geological processes at work.

- ***classification***. Unlike dips computed automatically from dipmeters (in a process which averages events over an interval), each tadpole derived from the inspection of an image is generally associated with a specific event. For example, it may be associated with an open fracture, a filled fracture, a lamination in a cross bedded unit, an erosion surface, an unconformity, or with beds distorted by faulting. An experienced interpreter will be able to identify the signature of such features and classify them accordingly. Classified dips are represented through the use of colour and shape in the tadpole heads.

- ***stereoplotting***. Stereoplots are a convenient way of representing dip vectors on a 2-D plot. Computer centre software can present equal area and equal angle stereoplots, and plot dip vectors or poles to planes. They are particularly useful for identifying dip clusters from which spherical mean dips can be computed to pass through to the zonation routines. They can also be used to examine dip trends. Great circle fitting and eigen vector analysis are the principal tools used here.

- ***stick plotting***. Sticks are lines on a borehole track drawn in an oriented vertical plane; the dip of each stick is the apparent dip of the corresponding tadpole in that plane. They are used to help visualise dips. Some users place them over seismic sections as a way of matching features.

- ***azimuth-vector plotting***. These are constructed by joining the tails of successive tadpoles on a crossplot of dip azimuth versus depth. The patterns are used to help correlate units from neighbouring boreholes.

Examples (see pages 25-28)

Figure 11 shows amplitude and travel time images from an Australian coal hole. The most frequent use of the travel time image is as a quality control on the amplitude image interpretation in caved or rugose intervals. This travel time image is featureless (indicating smooth hole), except for the planar cave and non-planar fracture. The latter is interpreted as being open, as a filled fracture would be visible on the amplitude image only.

Figure 12 is an SAS amplitude image from a 3 inch (76mm) diameter water-filled borehole. The depth scale is 1:10, and the depths are annotated in metres (the interval shown is 1.5m). There are a large number of dips with widely varying angles, reflecting a variety of different features. The normalisation used is static, and is a compromise for the interval as a whole. Figure 13 is the same interval with sine waves superimposed. Some of these were picked by interactively enhancing small parts of the image. The different sine wave colours correspond to different dip classes, also reflected in the colour and shape of the dip tadpoles.

Figure 14 is a 1:2 plot of part of a fracture set showing the excellent resolution available from the tool Also plotted for reference are pairs of vertical and horizontal lines separated by 2mm.

Figure 15 shows an example of vertical enhancement. The image on the immediate right of the depth track is the raw image; in this case the vertical stripes are caused by mudcake. On the far right, the striations have been largely removed.

Figure 16 is an excellent example of breakout. Here the 360 degree caliper shows that the wellbore has caved in a particular orientation. This corresponds to the direction of minimum horizontal principal stress.

Figure 17 is a composite acoustic image and dipmeter plot. The dip traces are displayed as traces and image stripes plotted over the amplitude image. Interpretations of such composite data can take advantage of the complementary nature of the measurements; the acoustic image also acts as a quality control on computer generated dips from the dipmeter.

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ASEG 25 Years On

From Dave Johnson, Canberra, ACT

ICOGEO and the conception of ASEG

As a newly appointed lecturer at the University of NSW, I was asked in early 1969 to help organise a conference which came to be known as the first International Conference on Geophysics of the Earth and Oceans (ICOGEO). It was held in January 1970 at the University of New South Wales.

The driving forces behind it were Cliff Elliott (then Professor of Physics at the University of Newcastle) and Laric Hawkins (then Associate Professor at the University of New South Wales). The organising committee worked very hard to achieve a successful conference which has had far reaching consequences.

The conference was supported with seed funding by the Australian Institute of Physics, the Australasian Institute of Mining and Metallurgy, and the Geological Society of Australia. The early 1970's were an exciting time in the resources industry in Australia and the conference attracted a large number of national and international speakers. It was attended by over 500 delegates.

Sessions began with a keynote followed by a number of technical papers. Social events included an unforgettable Conference Dinner at the Round House (I recall that I had programmed myself to give a paper at the beginning of the next day - a learning experience).

But the most important activity of the conference, from our point of view, was the first official meeting which culminated in the creation of the ASEG. A group of people who became the founding members met one evening under the leadership of Ken Richards (then with Esso Australia) and, from that, the first committee developed. Unfortunately I cannot remember all of the founding members, but they included some wonderful people from the Australian geophysical community, some of whom, sadly, are no longer with us.

The Sydney based ASEG Committee quickly established a program of activities including the holding of monthly meetings at the Mining Club and the publication of the Bulletin of the ASEG under the guidance of Editor, Ross Crane, who now runs a cattle station in the Rockies west of Calgary.

The ASEG was formed as a section of the Society of Exploration Geophysicists (SEG) and received considerable support from the parent body. Building on the success of the first conference a second ICOGEO, with similar format, was held in 1973 at Sydney University. The Organising Committee was reformed with some new faces, including Keeva Vozoff (the newly arrived Professor of Geophysics at Macquarie) and Ken McCracken (then Director of the newly formed CSIRO Mineral Physics Laboratory). We were fortunate that seed funding was available for the second conference from the relatively minor profit made from the first. The newly formed ASEG was the major sponsor and assisted with promotion.

Having acted as Secretary for the first two ICOGEO's I vowed never to be involved again but (the best laid plans etc.), while on an overseas trip I was volunteered in my absence and we were right back into it.

The third ICOGEO was quite different from the previous ones in that it was run as a segment of the twenty-fifth International Geological Congress which was being held in Australia. The major effect of this was that no income from registration fees was made available to the ICOGEO committee although, of course, all the venue costs were covered by the IGC registrations. The ASEG allowed us to use some of the profits of the previous conference to cover the costs of promotion.

After this our committee decided that they would start a series of ASEG conferences which soon became among the most important events in the exploration calendar, both in Australia and internationally. I like to think that the groundwork was laid with the organisation of the ICOGEO conferences.

Dave

From Rod Hollingsworth, SA Branch

'I hope they still have as much fun as we did.'

The South Australian branch of the ASEG was, we believe, the first of the state branches to be formed. It had its origins back in the dim days of the mid seventies when the Whitlam Government was in power, Rex Connor held sway and petroleum exploration was not the flavour of the month. However, a few noble souls like Bernie Milton of the SA Mines Department (as it was then) felt there was still room for a friendly society to lighten the lives of those few geophysicists in S. A. who hadn't fled overseas.

The first meeting was organised in late 1974 and a mixed group of eager starters turned up at the Australian Mineral Foundation to launch their new society. Unfortunately someone had forgotten to book the rooms and the AMF was closed, so after banging on the doors for about twenty minutes, the starters wandered off to various pubs to lick their wounds and plan their next meeting.

The next meeting was held in mid 1975 at the University under the guidance of Bernie Milton and Professor Boyd. With an injection of some new blood from interstate, and a venue that was open, the meeting proved a success and the SA branch was launched with Bernie Milton as the first President. Formal inauguration of the branch is dated at 13th April 1976. Since then the group hasn't looked back with conventions, symposia, wine sales, social functions and goodness knows how many meetings under its belt.

However, it is the early meetings I remember best. After our experience with the AMF, the meetings were held at the Public Schools Club for several years. Like most clubs the Public Schools were experiencing tough times and were prepared to let a bunch of geophysical yahoos enter their dignified rooms. We always started with beers, and sometimes with sandwiches, if the secretary remembered to order them, and a technical talk would follow. We actually had some very good talks but the accent was on informality and it was quite in order to take your large bottle of beer (real geophysicists didn't drink stubbies in those days) and place it between your feet for additional refreshment during the talk.

Following the talk we usually adjourned to the bar, or one of the local hotels. In those halcyon days of informality, and no random breath tester, the monthly celebrations would usually run late, often finishing up at the Crazy Horse (the less said about which the better perhaps). Attendance at meetings was usually twenty to thirty which included most of the geophysicists in town. Events such as the annual students night and the tradition of holding the Christmas Party at the President's house were born of this period.

As the years rolled on the Branch has become much larger, better organised and more professional. I hope they still have as much fun as we did.

Rod

From Ken McCracken, Jellore, NSW

'A Sign of the Times'

The birth of the ASEG was a sign of the times. First - a sign of dissatisfaction with the "black magic" status of geophysics in those days - when visiting gurus would make a three night whistle stop in Oz, tell us that the Linky Dinky Electrical-Stuff-of-Meter was ideal for exploration (and also incontinence and freckles), and then leave. It came hard on the heels of the nickel boom; and we will all recall that IP announcements were a key factor in the "run-up" of a few of the stockmarket high flyers of the day.

AMIRA had just been formed. Even CSIRO had been shaken out of its lethargy (by the bad aspects of IP - "inside knowledge"). Key academic appointments were made at this time; David Boyd and Keeva Vozoff to mention two luminaries. Companies recognised the need for geophysics tuned to the Oz environment.

So out of all these forces came the ASEG. In my view it performed its most important function in running the ASEG conferences. **They have made Australian geophysics a force to be reckoned with.** They are now the pre-eminent force in **mineral exploration** geophysics in the World.

It is interesting to ponder how many of our geophysicists have contributed to the success of the conferences. Since they move around from state to state a large number of people have been on the committees etc. - it has been a remarkably egalitarian factor in making the ASEG what it is.

Then came the "Bulletin of the ASEG" now known as Exploration Geophysics, and Preview. Each in its own way was a major factor in giving ASEG an identity. Don Emerson must be given great credit for this.

All in all - a highly productive 25 years. For all those who helped start it off in life - they have created the institution that made Oz geophysics come of age.

Ken

From Joe Williams, Ipswich, Queensland

and previously Perth, WA, among other places

'... the main geophysical activity was brewing in Sydney.'

My story is intrinsically related to my employment with the BMR (now AGSO), especially in the Metalliferous Geophysical Section which I joined in 1962. Bob Smith was my first party leader. The late John Haigh completed an Honours Degree at Hobart Uni. that year whilst a BMR cadet. They and many others were ASEG stalwarts. Jim Dooley, in the Observatory Section, is another name that springs to mind. He was active in the Institute of Physics and, with others, organised a geophysical section. However, only physics graduates could become Fellows and some of us resented this, but at least there was a forum and quite a few seminars were organised under the auspices of the section. Another with whom I became acquainted at about this time was one Mike Shalley, then with MIM. He suffered one of my field trips on the West Coast of Tassie. One meets editors (or future editors) in the most amazing places ... ?

However, the main geophysical activity was brewing in Sydney - and well brewed it became. The first International Conference on Geophysics of the Earth and Oceans (ICOGEO) was held in January 1970 at the University of New South Wales (See Dave Johnson, above). As I recall it, the steering committee organised the first meeting of the ASEG and we haven't looked back. I'd say that probably every member has since published in the journal and held some executive office. I missed the early hard work because I was based in Darwin - a lonely geophysical outpost as Lindsay Duus, who located the Narbalek uranium deposit at about that time, can tell you. But now, having our own Society was the start of geophysical contact across the continent.

We later moved to Sydney before settling in Perth where I arrived with my family in 1973, for a two year stay which lasted for eleven years. It was here that I began my closest association with the ASEG in helping to launch the WA Branch. It didn't take me long to catch up with Des Rowston (Mines Dept.) who introduced me to the Ozone Hotel and Stew Gunson from WAIT (now Curtin Uni.).

There were, at the time, two points of contact with other geos. The monthly AIMM Sundowner at Perry Lakes Stadium was a must. There was also a group of geophysicists who met, when possible, on Friday nights at the Victoria Hotel and talked of forming a local branch. Some of the names that come to mind are Dick Irvine, Alan Brash, John Haigh, Frank Lindeman and Les Starkey, with Norm Uren floating in the wings. Remoteness from head office probably played some part in the beginnings of the Perth Branch.

We began with a steering committee which held a series of lunchtime meetings at the Grosvenor Hotel to see if a branch might be formed. This was followed by a meeting at WAIT with Peter Dallimore as guest speaker to decide if a WA Branch could be sustained. The consensus was positive and we started the hard slog. SA had just gone through the exercise and I spent much time on the phone gleaning Bernie Milton's know-how to streamline our passage.

We got underway in early 1976 with a little over twenty members, growing to over ninety a year later. There was such a feeling of pride that we had proved the gloom and doomsayers wrong. The WA Branch now has the largest membership in the country.

Des Rowston was the inaugural President, Stew Gunson the Vice President, Dick Irvine the Treasurer (I think) and yours truly wrote the minutes. Our early meetings were held in the lounge of the Ozone Hotel which was just across from the Mines Department. As well as with our local speakers, I have fond memories of illustrious international visitors such as Stan Ward, Milton Dobrin, Dave Strangway and their ilk.

This was a major step in the development of the state network, culminating in the rotation of the federal executive. We were now a truly Australian Society.

Our publications contain a veritable Who's Who of the geophysical fraternity down through the years but what is more pertinent to this anniversary, is the diversity and excellence of topics we can now present and the consistently high editorial standards. Techniques have improved, presentation has gone ahead in leaps and bounds, but the original concepts of the Society have never wavered, and of that, we can all be proud.

Joe

From Sydney Hall St. Lucia, Queensland

A Centenary of Gravimeters?

The passing of twenty-five years of the ASEG prompts a dip into history which serves to put our own history into a world perspective, as well as demonstrating the hazards and uncertainties of research and development. It might also raise the question "Is Australia poised to lead the world into a new age of gravimeters?"

Perhaps it is only apocryphal, but I believe I once read that the origin of the spring gravimeter started with the offer of a reward at the turn of the century by the British Association for the Advancement of Science (BAAS). But search as I may through all of the reports of the association (1836 - present day), I have found no evidence of such an offer. However there is no doubt the BAAS was aware of the need for a sensitive instrument, easy to use, rapid in its observation and impervious to extraneous influences, as they set up a committee of distinguished persons for this purpose.

The committee was "... appointed for the purpose of inviting designs for a good differential gravity meter in supersession of the pendulum, whereby satisfactory results may be **obtained at each station of observation in a few hours**, instead of the many days over which it is necessary to extend the pendulum observations."

In the report of the British Association, 1884, the names are listed as follows:

The Committee

General J. T. Walker	Prof. G. Chrystal
Sir W. Thompson	Prof. G. Niven
Sir J. H. Lefroy	Prof. A. Schuster
General R. Strachey	Prof. A. H. Poynting
Prof. A. S. Herschel	(Secretary)

General J. T. Walker became a general in the Royal Engineers, saw active service in India and the NW frontier, was superintendent of "the great trigonometrical survey of India" and undertook the publication in twenty volumes of that endeavour. He became Surveyor-General of India in 1878, FRS in 1865 and President of the BAAS in 1885.

Sir William Thomson was Lord Kelvin (no less) or Baron Kelvin as was the preferred title of his day.

Sir John Henry Lefroy: In 1839 a naval expedition was mounted to "simultaneously observe magnetical (sic) observations in both north and south hemispheres..." Lefroy was selected to make magnetic observations at St. Helena and the Cape of Good Hope. In 1842 he joined the observatory (magnetic?) at Toronto and mounted a two man expedition by canoe and snow shoe to Hudson's Bay to make his observations. He became Director-General of Ordnance in 1868, Governor of Bermuda in 1871 and Governor of Tasmania in 1880. During his Tasmanian governorship he found time to observe the magnetic variations at Hobart, the results of which can be found in the publications of the Royal Society.

Sir Richard Strachey was a lieutenant-general of the Royal Engineers and saw service in India (he had a horse shot under him in action on the Sikh frontier). He was one of the British commissioners at "The Prime Meridian Conference" held in Washington in 1884. He later gained a reputation as a meteorologist and geographer, served on the council of the Royal Society and was twice a vice-president of the Society.

Professor George Chrystal was professor of mathematics at Edinburgh University and some of us older geophysicists may still have a copy of his "Treatise on Algebra" in our bookshelves.

Professor Alexander Stewart Herschel FRS, was the second son of the famous astronomer and was "Hon. Professor of Physics and Experimental Philosophy" at the Durham College of Science, Newcastle-on-Tyne.

Professor Arthur Schuster was Professor of Applied Mathematics (1881-8), then Professor of Physics (1888-1907) at Manchester, vice-president of the Royal Society (1919-24) and president of the British Association (1915). He worked in both spectroscopy and terrestrial magnetism - there was once a magnetometer which bore his name.

Professor J. H. Poynting is a name of repute amongst electromagnetists as in 1884 he published his theorem on the Poynting vector.

The 1884 Report: The Committee's first report gives Sir John Herschel the honour of first suggesting the principle of a spiral spring supporting a mass for "a statical differential gravity meter" in his 'Outlines of Astronomy' last published in 1839. The committee, after describing barometric and torsional gravimeters stipulated:

"The following conditions should be satisfied by the instrument:-

It should be portable.

It should be capable of use in ordinary buildings and under varying conditions of temperature and pressure.

Effects of change of temperature should be ascertainable, so that they may be allowed for.

The zero point should remain fixed if temperature and gravity are the same.

It should not be affected by terrestrial magnetism.

It should give variations of 1/100 000 in the value of gravity."

A seemingly actual instrument, designed by Sir W. Thomson is described as consisting of a pre-stressed flat spring - a strip pre-stressed so that it curved upwards, mounted horizontally with a mass at its free end to straighten it. It was then tilted upwards to a position of near-unstable equilibrium. Was this the first spring gravimeter?

The committee requested reappointment with the addition of Professor G. H. Darwin (son of Charles Darwin) a geodetist and tidal theoretician, and Mr. Herbert Tomlinson.

The 1887 Report: The second report was brief.

"Since the last report the committee has received an account of a proposed instrument from Mr. C. V. Boys." This was a horizontal quartz fibre supporting a mass-arm at its centre, the fibre being twisted till the mass-arm was horizontal. The report concluded "Sir William Thomson reported fatigue problems with his metal spring."

The Committee requested reappointment with the addition of C. V. Boys," ... And (that) they apply for a grant of £10 to aid in the construction of the instrument.

The 1888 Report: The third report was even more brief.

"Mr. Boys has not been able to construct the instrument referred to in the last report. Meanwhile no new design has been received."

"The committee asks for reappointment and a renewal of the grant of £10 made last year."

The Sequel: There is no account in the Reports of the British Association of any subsequent meeting of the Committee, so the sequel is a matter of conjecture. Perhaps interest shifted to the infant subject of seismology, as in 1894 a committee of the BAAS met on the subject of earth tremors and reported on the use of the Milne seismograph in 1896. We had to wait till the 30's and 40's of this century for the flurry of ingenious designs culminating in the zero length spring meters of the Frost, North-American, Worden and Lacoste instruments. Perhaps a jubilee is more in order than a centenary.

Author's Note: I have obtained the biographic details from the ***Dictionary of National Biography****, OUP, 1973 and* ***Who was Who****, 1897-1915, A. & G. Black, Lond. 1929.*

Sydney

From David Boyd, Adelaide SA

Reflections on Half a Century in Geophysics 1946 to 1996 - A Personal Account

These reflections are prompted by the 25th Anniversary of the ASEG and musings on the life of a geophysicist.

My career, from the time I built my own magnetometer, has taken me through many parts of the world and has been both exciting and exceedingly satisfying. I cannot think of a better job than being a geophysicist. That was the case fifty years ago, and it still is, as geophysicists are some of the most practical, ingenious and innovative people you will meet. Geophysicists have not changed much during the last fifty years, but almost everything else about the profession has, including instruments, interpretation procedures, computing facilities, map production, transport and communications.

To get things into perspective, when I was a student I was closer in time to the discovery of the Moho by Mohorovicic (35 years), and the reliable estimate of the depth of the core by Gutenberg (29 years), than to the present.

As a physics student I discovered geophysics through Harold Jeffries' book "The Earth", and exploration geophysics through a book with the wonderful name of "The Principles and Practice of Geophysical Prospecting" by Edge and Laby (see Preview August 1994) which was a report on experimental surveys carried out in Australia between 1928 and 1930. Failures were reported with as much care and detail as successes so that you obtained a balanced picture of what was involved in applied geophysics. Through this book I became familiar with Walleroo, with Renison and with the deep leads of the Victorian Goldfields.

It is probably difficult to appreciate just how antiquated some of the equipment was at the time. In Edge and Laby the geophones still relied on mechanical amplification and each had to be protected from external wind noise by a tent. In my first seismic survey with BP in 1947, searching for oil in massive limestones in

England, we used the refraction (yes refraction) method with a spread of six huge geophones (about 10kg each), a shot to spread distance of twenty km and explosive charges of 400kg. We could shoot three spreads on a good day.

In 1947, one of the exciting events, and an early example of international cooperation by geophysicists, was related to the destruction of the U-boat pens at Heligoland using 2000 tons of surplus explosives. Geophysical teams across Europe stood by to record the shock wave and to apply the results to a closer study of the Moho. To determine the instant of explosion an army surplus radio transmitter was placed on top of the charge. We could hear that old instrument sending its signal for another two seconds after the detonation (pretty robust!).

I do not suppose much thought is given these days to the use of refraction seismic fan surveys as was done in Texas in the 1920s for the location of salt domes. A similar application emerged in the mid sixties in South Africa where I was involved in discussions with DSIR on the location of major solution cavities in the Rand. The cavities were related to the de-watering of the gold mines and, on occasions, buildings had disappeared into huge holes overnight. I suggested that the cavities might be located in the same way as the salt domes, by carrying out continuous seismic profile surveys between drill holes with spark sources in one series of drill holes and receivers or hydrophones in another to allow location of anomalous velocity regions. The idea caught on.

My special field of interest, airborne magnetic surveys, began with ground work. The commercially produced magnetometers of the early days were essentially magnetic balances and would seem primitive today. The magnetometer with which I started my first survey as a student in 1944 was even simpler. I built it myself by adding a counter weight to a dip needle and made it unstable enough to get a large deflection from a small change in field strength. Uncalibrated, it had a repeatability of about 50 gammas (nT) and took about fifteen minutes to make a reading. But it was quite good enough to follow a dolerite dyke from outcrop across alluvium two metres thick and also to locate the boundary of one of the local Permian volcanoes - a most satisfying experience.

In airborne magnetics, what strikes me now is how quick we were to make use of the latest technology and, incidentally, to keep the price of data collection and map production almost unchanged over the fifty year period. When we tried to get into digital recording and computer processing, about 1962, the firm's accountant sank our proposal at the board meeting by pointing out that four companies had already tried to do this and had gone bankrupt. We stuck to more conventional techniques for a year or two after that but were always eager to try the new technology. Magnetometers developed from fluxgate through proton to the alkali vapour instruments used today, with a sensitivity well below the magnetic noise level of the aircraft and the natural field.

Accurate positioning is, in its way, just as important as accurate measurement of the field and for many years this was a major shortcoming of the surveys. The base maps of the early surveys were mosaics of aerial photographs and distortions in the base map corrupted the pattern of the contours. Decca Navigator, Doppler and inertial navigation systems made accurate flying and positioning more routine and satellite navigation has greatly improved the quality of modern magnetic maps.

Digital recording and modern computing facilities have produced better processing and presentation of the magnetic data. Forty years ago the only computers were nothing more than mechanical adding machines driven by an electrical motor. It is only during the last twenty-five years that paper chart records, processed by hand, have disappeared to be replaced by effective digital recording. We knew forty years ago how to calculate the various derivative maps which could be so useful, but the labour involved meant that they could only be used for special problems. Now it is a matter of routine and provides so much more for the interpreter. High resolution imaging was also made possible by modern computing and makes the results so much more accessible to geologists. Twenty-five years ago we produced crude images using conventional wide page computer output to get the lighter and darker tones of an image by using the different letters of the alphabet.

While I have always enjoyed getting into the field my greatest love in geophysics has been interpreting magnetic maps and images and linking them to the geology. I was lucky to become involved in interpretation of aeromagnetic data after a period during which I had taught structural geology and spent some time mapping regions of metamorphic rocks in the Scottish highlands. This experience let me combine geological and geophysical information in a way that enhanced the understanding of the geology and focused on the problems which needed to be solved. The process is a great crossword/jigsaw puzzle with (for explorationists) a real crock of gold at the end if you can just get the answers right . I can think of few greater pleasures in life. Part of the challenge of interpretation is to communicate the results to the geologists and others who must use them. I have always tried to be both specific yet un-dogmatic in what I say and to get people to incorporate my ideas into their own frame of thinking.

I wish all young geophysicists as much enjoyment and excitement in the next half century as I have had in the one that has just passed.

David

From Bill Langron, Kiama NSW.

'A geophysicist is a gentleman geologist'.

I guess I was close to being one of the original members of the ASEG and was President of the society in 1972-73, third in line, having followed Robin McQeen and Lindsay Ingall. Even at that time we had over four hundred members Australia-wide, mainly due to the sheer hard work and enthusiasm of people like Ken Richards, Don Emerson, John Wardell and of course, Lindsay.

That task was continued later by Roger Henderson, Lee Furlong and many others.

Monthly meetings were held in the old Mining Club in Pitt Street, usually with about thirty in attendance. We had good speakers, and meetings were often varied at short notice to accommodate distinguished visitors arriving in Australia. Stan Ward was one such welcome visitor.

In those early days the "average" person was not at all sure what a geophysicist was or did. My definition (borrowed from my first boss, the late Lou Richardson) was "a geophysicist is a gentleman geologist".

During my presidency we had very little cash but many ideas of what we would like to do. Don Emerson performed a Herculean task then, and for years afterwards, in producing four issues of a high class Bulletin each year. We were backed by a few faithful advertisers and (I think) five company sponsors, including my own employer, CSR.

A high priority of our executive was to raise awareness of geophysics and geophysical education in the schools and universities - the late Laric Hawkins was an early flag bearer in that effort. Executive meetings were usually held with lunch (I well remember Lindsay Ingall's favourite restaurant, the Coq d'Or, now demolished). There, many of the dreams were turned into reality after a couple of reds and a good dose of contagious enthusiasm.

At this time too, we had our first international meeting, in conjunction with the University of Newcastle and Macquarie University (the 2nd ICOGEO). As many of us were engaged in the exploration for uranium at the time we also hosted our Uranium Conference. SEG were lobbied to hold one of their annual meetings in Sydney, but we had not reached a sufficiently high stature to be taken that seriously by the parent group.

Another significant event during this period was the advent of our first female committee member, Anna Orsatti, who brought charm and a fresh breeze to the running of the Society. Since then it's been great to see so many female geos taking executive responsibility - hopefully the patriarchal society has gone forever.

On a more sombre note, a disturbing trend of the time was the number of highly qualified geophysicists out of work, driving cabs or working in restaurants. In response to this we started our unemployment register, with some success, until the market improved.

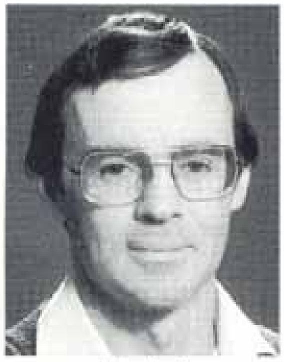
Now, I am amazed at how the Society has grown. The really big step was the transfer of the executive to other Australian cities, and the establishment of state branches to make us a truly national society. Membership has mushroomed, students are catered for, and the Geophysical Conferences and Exhibitions are now huge events (surely the likes of John Webb of Austral must feel very proud of what they helped to start). And the growing list of sponsors, overseas members and the quality of ASEG publications indicates a vibrant society of considerable standing in the world community.

My congratulations to all my fellow geophysicists who have carried the flag over the years, and made the Society what it is today. One final word: another of the great breakthroughs has been the publication of Preview - I guess I shall always think of Hugh Rutter, especially for his efforts here; and Stephen Mudge for "Excitations". And it's great to know that Preview is now in the hands of an old friend, Mike Shalley - well, not so old really.

Bill

From Pat Hillsdon, Bowral and Jim Cull, Melbourne

'... many notable individuals'



Jim Cull

The mists of time have not been totally lifted from the origins of the Victorian branch of the ASEG but the early informal meetings were held at the Mitre Tavern, not far from BHP's exploration offices. There had been a long time belief that the AusIMM shouldn't monopolise technical meetings in Melbourne and out of this grew the conviction that it would be a good thing to establish an ASEG branch there.

The triumvirate of Thomas, Lilly and Hillsdon went through a two to three year period of decision making, that is deciding that another informal meeting was essential. But no sooner had Hillsdon and Lilly left town to further their careers elsewhere than - Lo and Behold - an ASEG branch appeared within months. And there were quite reasonable attendances at the early meetings (1979-80).

Society meetings have long since moved to the hallowed halls of the Kelvin Club which provides a central location close to public transport with post-meeting facilities including excellent cuisine.

There have been many notable individuals based in Melbourne over the years and most members have been active on Branch Committees at different times. However several long serving members deserve special mention. In particular Geoff Pettifer has made an outstanding contribution resulting in an enhanced profile for Preview. In addition Lindsay Thomas has provided long term stability as Treasurer while Mike Asten, Hugh Rutter and Kathy Hill have provided the primary contacts to the National body over many years.

Looking to the future, ASEG promotes active links with the University sector through ASEGRF funding. There are now significant opportunities to promote geophysics as a key part of VIEPS (The Victorian Institute of Earth and Planetary Sciences), a collaboration between Melbourne, Monash and Latrobe Universities. Staff from each University participate in the program and offer coursework options in their own speciality. Consequently students obtain access to facilities and expertise not otherwise available in a single institution. This collaboration is further enhanced through joint submissions for research grants involving access to shared facilities.

The VIEPS Field Camp has now been extended to allow participation of other universities and private company personnel. The camp, held at Dookie near Shepparton, allows participants to access modern equipment and software considered to be the emerging industry standard. Des FitzGerald and Associates play a more direct role with software demonstrations while other industry groups, including Encom and Seismic Image (Vista), have allowed access to their products. We look forward to many productive years of educating young geophysicists.

Pat and Jim

Exploration Geophysics for the 21st Century: The Australian Perspective

C. McA. Powell and N. Uren

The organisational and social aspects of the event reported below were summarised by Leonie Jones (Unipulse) in the last issue of Preview. The edited interim report which follows covers the background, recommendations and conclusions from the meeting.

Ed.

Introduction

From October 10 to 13, 1996, a group of 26 academic, industry and government scientists from all States met in Western Australia to develop a discussion paper on how to ensure research and education in exploration geophysics is viable in the 21st Century.

The impetus for the meeting came from a proposal submitted to a new program of the Australian Research Council (ARC), the Research Initiatives Program, by the University of Western Australia on behalf of Curtin University, The University of Queensland and UWA. This new ARC program, for which guidelines were first announced in March 1996, is designed to support specific activities that encourage greater collaboration amongst researchers funded by DEETYA, and enhance development of a research capacity in fields which are not well represented in the Australian research effort.

The proposal was based on the perception that Exploration Geophysics, which was listed in the 1992 ARC Discipline Research Strategies report, Towards 2005: A prospectus for research and research training in the Australian earth sciences, is in need of a boost in support. Indeed, Exploration Geophysics, which has been an ARC priority area for the past three years, attracted only three successful ARC Large Grants in 1995, by far the smallest number for any of the seven priority areas. The ARC recognised the need for exploration geophysics researchers, who are widely dispersed across Australia, to come together in a workshop to develop a strategy to strengthen the discipline to ensure it is viable in the 21st Century.

The task of writing the Special Initiatives proposal was taken on by Chris Powell, a member of the ARC's Research Training and Careers Committee, who was familiar with the issues. When the proposal was funded, an organising committee of Mike Dentith, John McDonald, Chris Powell and Norm Uren, was constituted to convene the workshop. Funds were available from the ARC for about 20 APEX economy airfares from the eastern states to Perth, with a modest amount for accommodation. The venue chosen was at Mandurah, about one hour's drive south of Perth, and twenty-six scientists (seven from NSW, five from Victoria, four from Queensland, four from Western Australia, three from South Australia, two from ACT and one from Tasmania) met over three days to address a variety of issues. Note that a list of attendees was published in the Unipulse column in *Preview #64*. The people invited were mainly exploration geophysicists, but there was one Deputy Vice Chancellor (Research), one Pro Vice Chancellor and two geologists. Fifteen people were directly involved in teaching and research in universities, four were from companies, three from CRCs, two from CSIRO, and one each from AGSO and private consultancy. Five additional invited industry representatives were unable to attend owing to pressing business commitments.

Key Conclusions and Recommendations

The key conclusions and recommendations of the meeting were as follows:

Vision: Establish world leadership for Exploration Geophysics in Australia.

Geophysics was identified by the 1992 Towards 2005 report as a "... discipline of the earth sciences ... inadequate in research output and research training but in which research strength is critical to national need". The implication in this report was that the main weakness is in applied or exploration geophysics.

Exploration geophysics is an essential and sometimes only method of exploration for resources in offshore Australia, and also onshore where surficial cover obscures ore deposits. Resource exploration is very important to the Australian economy, with mineral and hydrocarbon exports in 1994-95 valued at $30.3 billion or 6.8% of the GDP (Commonwealth Department of Primary Industries and Energy, 1996). Because of its significance, the decline in research elsewhere in the world and the leadership potential in Australia, the science of exploration geophysics must be fostered.

Recommendations

1. Strategic decisions are imperative now to increase the quality and amount of exploration geophysics in Australia, especially in view of the decline in exploration geophysics research internationally.
   - Geophysical representation on the ARC Council and/or Panels is desirable, preferably by an Exploration Geophysicist
   - Co-location of CSIRO facilities with selected universities should be encouraged
   - Development of "centres of excellence" should be encouraged; there should be at least one Key Centre and possibly a Special Research Centre in Exploration Geophysics.
2. As a consequence of developments in geology and exploration methodology, geophysics should be an essential component of all geology courses.

3. There is no single preferred model for the delivery of exploration geophysics.

   - We see value in a diversity of teaching and research models
   - Broader cooperation between institutions is one way to enhance geophysics teaching and research (e.g., Victorian Institute of Earth and Planetary Sciences and Sydney University's Consortium of Geology and Geophysics).
   - CRCs are an excellent means of creating critical research mass and collaboration between universities, other research organisations and industry. They provide good opportunities for research and postgraduate training in exploration geophysics

4. Closer liaison between industry and academic institutions should be encouraged.

   - University systems must recognise the value of industry experience in its selection processes and practices
   - Academic programs could be adapted to facilitate vacation employment in industry by students and staff
   - Staff interchange between academic institutions and industry should be encouraged and facilitated
   - Academic institutions should be encouraged to share each other's equipment and facilities for the mutual benefit of staff and students
   - Co-sponsorship of ARC research infrastructure bids for expensive geophysical equipment should be encouraged
   - CRCs provide significant funding for identified areas of critical importance to Australia where proven research excellence can be found.

5. There is value in building and maintaining "centres of excellence" in geophysics with different foci.

   - High profile leadership of such centres is essential for success (see 4 above)
   - Recognition of industry experience as a selection criterion would assist in universities recruiting from a wider field
   - Co-funding of chairs in exploration geophysics can assist in attracting the right people

6. ARC Key Centres and Special Research Centres are a possible means to strengthen the research base in Australia. Any new centres should:

   - Promote closer liaison with industry
   - Develop critical mass in areas of current neglect
   - Adopt new distance teaching technologies for greater cost effectiveness
   - Facilitate networking with other universities and industry

7. University-led research consortia with industry should be encouraged:

   - High profile leaders are essential
   - Research must be focused on industry relevant topics
   - Credibility must be earned to attract support
   - Competent project management is essential
   - Collaborative research grants should be utilised more in exploration geophysics

8. There is a need to attract high-quality students to the industry by:

   - Offering summer schools
   - Providing scholarships
   - Promoting the image of exploration geophysics as a profession
   - Developing courses with a strong maths/physics background
   - Encouraging double degrees (e.g. BSc/BE)

Further Action

A fuller report on the meeting is being developed, and will be available for circulation to interested parties by mid-December, 1996. The draft of the fuller report will be discussed at a Forum from 4.30 pm to 6.30 pm on Wednesday, 27 February 1997, at the Australian Society of Exploration Geophysicists' meeting in Sydney, after which a final report will be prepared for submission to ARC. The intention is that the final report will serve as a prospectus for exploration geophysics in Australia in the next decade. Anyone who has a particular point to make, or who wishes to have further recommendations considered, should contact one of the organisers prior to the February meeting, in order that the item can be included for discussion.

Contact Addresses of Organising Committee

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Membership

New Members

We welcome the following new members to the Society. Their details need to be added to the relevant State Branch databases.

Western Australia

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Change of Address

The following changes need to be made to the relevant State Branch databases:

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To: 4/895 Marion Road
Mitchell Park SA 5043

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To: 35 Franklin Road
Cherrybrook
NSW 2126

Bob RICHARDSON
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Terrey Hills
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To: PO Box 55
Newport Beach
NSW 2106
Tel: (02) 9906 5220
Fax: (02) 9906 5233

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Craig RAYNES
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Karratha WA 6714
To: c/o CRA Exploratian
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128/1 Ulsoor Road
Bangalore 560042
Karnataka
INDIA

Where are they?

Does anyone know the new address of the following members? Last known addresses are given below:

Mr. H. MIYADA
PNC Exploration Aust Pty Ltd
26 Lyall Street
South Perth WA 6151

Harry CORNELIUS
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Ruth PEACH
Suite 510, 715-5 Ave SW
Calgary AB T2P 2X6
CANADA

Mark BROWNE
C/- Woodside Offshore
Petroleum
1 Adelaide Terrace
Perth WA 6000

Previously Published 'Unknown addresses'. Does Anyone know where they are?

Boris Adamek
Tim Allen
Stephen Arnott
Geb Aruai
Brett Ascot
Anastasia Boylson
Andrea Broaddus
Ian Cameron
John Caon
David Catsoulis
Rebecca Denne
Iain Dison
Kim Hutchings
Brett Edwards
Eduardo Escanero
Angus Goody
Shaun Gregory
Brett Harris
Lachlan Heasman
Geoffrey Hines
John Holmes
Kevin Jarrie
Justin Keating
Boyd Kolozs
Robert Kusi
Martinus Ligtendag
Alison McCutcheon
Lisa Miller
Daniel Morris
Michael Nelson
Stuart Neilson
Ben Oostermeyer
David Ormerod
Sudhir Paul
Risto Pietila
Antony Price
David Radclyffe
Patricia Reeve
Tully Richards
Matthew Rutty
Charles Sheen
Mrs. Hege Smith
Desell Suanburi
Sally Sutherland
Victoria Tan
Serguei Tchrakrashnev
Matthew Venn
Khamphira Viravong
Richard White
Dave Widdoes
Andrew Wolski
Gang Yu

Calendar of Events

February 3-5 1997
Karlsruhe Workshop on Amplitude preserving Seismic Reflection Imaging co-sponsored by SEG at the Lufthansa Training Centre Seeheim Germany
For Further Details:
P. Hubral, Geophysical Institute
Karlsruhe, Germany
Fax: 49-721-71173
email: workshop@gpiwap1.physik.uni-karlsruhe.de

February 23-27 1997
12th ASEG Conference & Exhibition, Sydney Convention & Exhibition Centre, Australia. Sponsored by ASEG, SEG & PESA
For further details:
ASEG Conference Secretariat
Conference Action Pty Ltd
PO Box 1231
North Sydney NSW 2059
Australia
Tel: +61-2-9956 8333
Fax: +61-2-9956 5154
E-mail: geoins1@ibm.net

March 12-14 1997
The AusIMM Annual Conference
Ballarat VIC 3353
For further details:
Conference Secretary
R.M. Croggon , Univ. of Ballarat
PO Box 663
Ballarat VIC 3353
Tel: +61-53-279 113
Fax: +61-53-279 137

April 6-9 1997
Sinkholes and Environmental Impacts of Karst
Springfield, MO. USA
For further Information:
Dr. Barry F. Beck
P. E. LaMoreaux and Associates Inc.
PO Box 4578,
Oak Ridge, TN.
37831-4578 USA
Tel: +1 423 483-7483
E-mail:pelaor@use.usit.net

April 7-10 1997
Optimizing with Whittle
Optimization of Mine Design and Planning
Hyatt Regency, Perth WA
Post-conference tour of Kalgoorlie Super Pit
For firther details:
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July 7-10 1997
Instanbul '97International Conference and Exposition
Instanbul, Turkey
Sponsored by SEG, Chmb. of Geoph. Engineers of Turkey and EAGE

September 14-18 1997
Exploration '97 4th Decennial
Toronto Canada
For further details:
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Fax: 0011-1-905-513 1834
Email: 103214.545@compu-serve.com

If you wish to place your event in our Calendar contact Janine Cross at the ASEG Secretariat
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