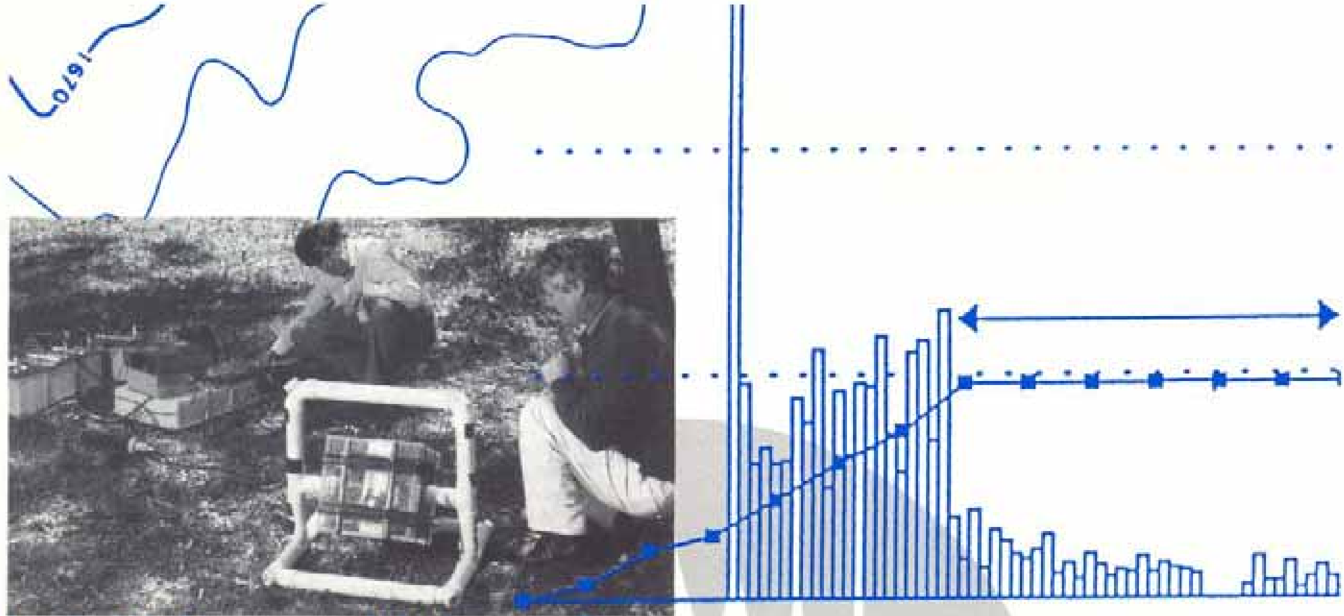
Australian
Society of
Exploration
Geophysicists
ACN 008 876 040

Preview

December 1993

Issue No.47



In this issue:

Contents

HEAD OFFICE: Suite 5, 672B Glenferrie Road Hawthorn Vic 3122
TEL:(03)818 1272 FAX:(03)818 1286

PRESIDENT: Mr Hugh Rutter, Tel:(03) 818 1272 Fax:(03) 818 1286

HON SECRETARY: Mr Brenton Oke, Tel: (03) 652 6625 Fax:(03) 652 6684

EDITOR: Mr Geoff Pettifer, Tel:(03) 412 7840 Fax:(03) 412 7803

email: grp@mines.vic.gov.au

NEWSLETTER PRODUCTION: Ms Janine Cross, Tel: (03) 818 1272 Fax: (03) 818 1286

ADVERTISING: Mr Greg Turner, Tel: (03) 881 1279 Fax: (03) 803 2052

1993 PREVIEW ADVERTISING RATES (6 ISSUES): Business Card $100; ¼ Pg $200; ½ Pg $330; Full Pg $530; Back Pg (¾ Pg) $750; Colour Advertising Approx $1,000 per page per issue depending on demand. Special rates available for advertisements accompanied by colour review articles

Registered by Australia Post, Publication No. WBG 2390, PREVIEW is a publication of the Australian Society of Exploration Geophysicists, circulated to a membership of approximately 1,100.

Artwork by Mark Littler Design Pty Ltd & Geophysical Exploration Consultants Pty Ltd

Printed by Snap Printing

Preview Deadlines

Issue	Deadline
February '94	January 21, 1994
April '94	April 1, 1994
June '94	May 27, 1994
August'94	July 29, 1994
October '94	September 30, 1994
December '94	November 25, 1994

Editor's Desk

With Christmas coming in a rush, October preview and the membership handbook late, and the usual pre christmas deadlines at work, the Preview team: Janine Cross, Geoff Pettifer and Greg Turner are looking forward to a break. We wish all Preview readers a relaxing and peaceful Christmas. Perhaps you can catch up on your reading of October and December issues or pen a contribution for 1994 (p13).

Next issue for the first time, Preview, like Exploration Geophysics, will be published as a Conference Volume as part of the conference (p17). The Conference news is on p5. Hope to see many of you there.

Thankyou to Greg Turner and co-workers for an interesting presentation of the diversity of CSIRO's Exploration & Mining geophysics research featured in our CSIRO sponsored colour article (p23-32).

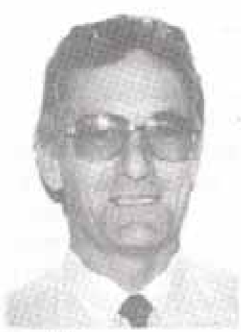
Rob Kirk's new regular Seismic Window column kicks off (p15). The challenge is out to mineral and environmental geophyhsicists to start up regular columns like this, for your specialties, to ensure balance and relevance in Preview content. Volunteers please.

Much more reading awaits inside: ASEG Finances 1992 (p35), Gippsland Basin Research opportunities (p37), orebody delineation (p43) and the Geosurveys story (p41)

Geoff Pettifer
Editor

President's Piece

Towards 2005



A Prospectus for Research and Research Training in the Australian Earth Sciences.

This document will be familiar to some geophysicists, but probably not to many outside academic circles. But we should know more about its content and particularly its conclusion as geophysics is found to be one of the disciplines regarded as inadequate in the framework of the report.

Towards 2005 is the result of a request from the Australian Research Foundation who, as a matter of policy, encourage peak bodies to commission research strategies within their discipline. The intention is involve those who perform research, those who fund research and those who use the benefit of the research, to develop a strategy for a 10 to 15 year time span. The ARC appointed the Australian Geoscience Council to conduct thte process, and they in turn invited a number of geoscientists to form a Working Party. Membership consisted of Professors BG Thom, RM Carter, DH Green, PH Walker, J. Roberts; Doctors PE Playford, PE Power, SM Richards, NL Markam, and myself.

The first task was to establish the Terms of Reference and set the limits. Earth Science can rapidly become a very broad subject and include many more disciplines than the big three of geology, geophysics and geochemistry. It was decided that soil science, and astronomy would be included, but the general guideline was that the prospectus should encompass "geology, geophysics, geochemistry and geobiology, including particularly the study of all internal, crustal and surficial earth processes". The Terms of Reference were divided in to three groups; Scientific and Economic, Organisational, and Research Training. Once the terms of reference were formulated at the end of 1990, they were circulated for comment. They were initially advertised through the Australian Geoscience Council member societies, the Geological Society of Australia, the BMR (now AGSO), the CSIRO, the State and Territory Geological Surveys and the Heads of Tertiary education earth science departments. Later, in June 1991 a number of exploration managers in the minerals and petroleum industries were invited to comment. Submissions were not restricted by invitation - anyone could comment.

A total of 72 submissions were received, including one from our own society. These were summarised and a draft prospectus issued in December 1991. Comments received on the draft document and from the public presentations in the capital cities were incorporated and a final prospectus issued in the middle of 1992.

One of the findings pertinent to our profession was that geophysics, and exploration geophysics, were seen as an area of weakness. This comment came from a number of areas. In the 1989 "Profile of Australian Science", ASTEC listed geophysics as a weakness. In dollar terms, the proportion of competitive ARC funding attracted between 1989-91 is comparatively low indicating an area of concern. Eleven of the submissions to the Working Party made the specific point of the weakness of geophysics (the discipline with the second highest number of weakness comments was Regolith Studies with seven). However, it should be noted that the Heads of Departments saw it as a position of strength based on the number (9) of nominated meritorious papers.

At this point it is worth remembering that we are considering research and research training, and not the quality of the practising exploration geophysicist.

The importance of geophysics was acknowledged in more than 50% of the submissions along with the expectation of its increasing role in the future. It was recognised that geophysical teaching and research were far below the required standard and that there was a lack of adequate resources. In most universities geophysics is not a discipline in its own right but exists as an appendage to a geology department. Many geophysics courses reflect this with their high content of geology instruction to the detriment of mathematics and physics. Many departments have one to three geophysicists on staff, which is sufficient to teach geophysics to geologists, but insufficient to mount a significant research programme. It was also noted that the costs of geophysical equipment are high, and that there is difficulty in recruiting high calibre staff. Many submisisons noted that the Australian environment, with its thick, saline weathering profile and extensive cover differs greatly from Canada and Europe where a lot of the current geophysical advances originate. In other words, overseas research results are quite often not applicable on the Australian continent.

The serious gaps in Australian geophysical research were seen as being in instrumentation research and mathematical geophysics.

The solution offered in the prospectus, which is presented as a recommendation to the ARC is to encourage greater co-operation and co-ordination between the research sections of government, industry and tertiary education. A higher level of financial support is required from the ARC. The prospectus recommends the establishment of National Earth Science and Technological Centres (NESTC) which would eventually replace Key Centres, Special Research Centres, and Co-operative Research Centres. The inter-university co-operation of Melbourne, Monash and LaTrobe, known as the Victorian Institute of Earth and Planetary Sciences (VEIPS) is quoted as being the type of organisation that should be encouraged.

Perhaps the most important outcome of **Towards 2005** is the written recognition of the poor state of research and research training in geophysics in Australia. The proposed solution is to encourage the concentration of people and resources into a fewer number of locations. It is unlikely that this will be forced to happen by decree; it will have to be made to happen by the involved groups, industry, academia and government, in other words by ourselves. Recommendations can only go so far; the next stage, if we accept the recommendation is to plan its implemenation. We need to act rather than just talk.

Towards 2005: A prospectus for Research and Research Training in the Australian Earth Sciences was published in August 1992 by the Australian Government Publishing Service and is obtainable from government bookshops. It contains far more informtion than I have included here, and I recommend that you purchase a copy if you have not already done so.

Hugh Rutter, President

Executive Brief

Your ASEG Executive at work ...

Two committee meetings have been held since the last report.

One of the key agenda items at these meetings has been discussion of delays this year in printing the Exploration Geophysics journal. These delays have reached 9 months and new members this year have not yet seen an issue of Exploration Geophysics. Some students believed they were "poor cousins" and that the journal didn't come with the free membership. This is certainly not the case. We had over 160 new members join this year and the percentage of these rejoining next year will be a measure of our effectiveness as a society. Arrangements are in progress to move the printing of the journal to a Melbourne company selected by competitive tender and under local supervision. Prof Don Emerson has graciously agreed to continue as editor and will receive editorial assistance with future issues. Prof Emerson has been principal editor of Exploration Geophysics for ten years now and has edited every issue, except the Conference issues, without assistance. We thank Terry Crabb and his team in Adelaide who have worked for 10 years in the demanding role of interface between the editorial and printing process in the production of our journal.

The Executive thanks members for their patience and hopes you will continue your support as we work toward getting publications back on track. With the increasing stature of the Society and increasing circulation of the journal overseas, we encourage authors to submit manuscripts to Don Emerson.

More foreign geophysical societies have agreed to exchange journals with the ASEG. So far we have received positive responses from Canadian, Egyptian, Indian, Chinese and Japanese geophysical societies. These journals are available to all members through the ASEG library housed at the AMF. (see p13)

It was agreed that the Conference council meeting will be held in Perth on Sunday 19th February at 3.30pm.

Preview advertising rates for 1994 were discussed and approved (p2).

We have been having a lot of trouble with the Secretariat PC that Janine Cross uses for compiling Preview, database updates/queries, mailing lists etc. A number of experts have looked at the problem and it appears it may cost more to find and repair the problem than the machine is worth. We eventually managed to convince the company which sold us the machine that it is indeed one of theirs (something they denied for some time) and that they should fix it but, predictably, they blame the software. The lengthy delays in lost time when an application randomly hangs is costing the society a lot of money, and so it has been decided to bite the bullet and upgrade the secretariat PC. If anyone would like a 386-model boat anchor to impress other boaties using old XT's and you are prepared to offer more than the trade-in offer (around $1k), drop us a line. Also, if anyone in Melbourne would like to know of at least one company NOT to buy a PC from, call Janine.

Other discussion topics included:

- financial balance sheet for 1992.
- the usual reports from the Treasurer, Preview editor etc.
- the 1994 Perth and 1995 Adelaide Conferences.

On behalf of the ASEG Federal Executive I would like to wish you all a safe and relaxed Christmas period and a successful New Year in exploration, mining, teaching, studying, looking for work, fishing or whatever you may be doing.

Brenton Oke, ASEG Secretary
Ph: (03) 652 6625; Fax (03) 652 7315

THE AUSTRALIAN SOCIETY
OF EXPLORATION GEOPHYSICISTS
ACN 000 876 040

"INCREASING THE RESOLUTION: CLEARING THE HAZE"
10th
GEOPHYSICAL
CONFERENCE
& EXHIBITION
1 9 9 4

10th GEOPHYSICAL CONFERENCE & EXHIBITION

PERTH, WESTERN AUSTRALIA
20th - 25th February, 1994
at the Burswood Convention Centre

Keynote Speaker: Don Pridmore

Investing in Geophysical Development - Clearing the Haze

Don Pridmore
World Geoscience Corporation Limited

Don Pridmore

Don Pridmore has a PhD from the University of Utah and a BSc Hons from Adelaide University. Prior to PhD and post-graduate studies into electromagnetic techniques, he spent two years as an exploration geologist with Western Mining Corporation (WMC). He then returned to WMC in 1979 as senior research geophysicist based in Kalgoorlie. In 1986 he joined World Geoscience Corporation (WGC) as chief geophysicist responsible for research, marketing and interpretation aspects of airborne geophysics. In 1990 he established a new airborne division of WGC in Houston and has since been instrumental in developing and expanding airborne magnetic applications in the hydrocarbon industry. Don is currently Director/Chief Geophysicist with WGC in Perth and maintains responsibility for research projects and marketing.

Keynote Speaker: Bob Whiteley

Environmental Geophysics: Challenges and Perspectives

Bob Whiteley
Coffey Partners International Pty Ltd

Modern civilizations are now at risk from both natural geophysical events and from industrial pollution and accumulated wastes which release toxic substances into the environment. There is little doubt that environmental hazards are increasingly man-made, increasingly voluntary and more diffuse in their impact. Environmental geophysics, in its widest sense, is concerned with the quantification and monitoring of subsurface hazards, irrespective of their origin.

A review of current activities has identified two major challenges for environmental geophysicists i.e. to understand socio-economic and environmental factors and to develop improved mathods and practices.

Recent field examples from a range of environmental geophysical studies provides perspectives on these challenges. A dryland salinity study in eastern Australia demonstrates the need to express electromagnetic responses of soils in agronomic terms. In South Australia, a new method of Radiowave electromagnetic profiling which appears to overcome some of the limitations of conventional electromagnetic methods, is used to locate diesel oil pollution plumes. In Victoria, an innovative underground-to-surface seismic technique screens old buried sewers and examines ground conditions around ageing infrastructures.

It is concluded that environmental geophysics has a bright future provided geophysicists are willing to meet these major challenges, if not, other non-specialists will increasingly enter the field as has been the case in North America.

Bob Whiteley

Bob Whiteley is principal geophysicist and Manager, Coffey Geophysics. He holds honours and masters degrees in geology and geophysics from the University of Sydney and a PhD in applied geophysics from the University of NSW. Dr Whiteley commenced his career at the Bureau of Mineral Resources, and has worked in the mineral industry as a general manager and senior geophysicist. He is a former associate professor at the Asian Institute of Technology, a senior lecturer at the University of NSW and a consulting geophysicist specialising in the geotechnical area. He has over 25 years experience in applied geophysics and more than 55 published scientific articles and one book. Dr Whiteley has worked on projects in India, Thailand, Solomon Islands, New Caledonia, The Netherlands, Papua New Guinea and Singapore.

Letters

7 November 1993

Mr Geoff Pettifer

I noticed in Preview in August 1993 that Andrew Sutherland is touting for persons interested in a history of geophysics in Australia - if you could pass this on the him (after extracting the enclosed query) I would appreciate it.

I have been for some time accumulating operational data on early airborne magnetic and radiometric surveys in Australia - just as a personal interest (but with some prompting from Pat Cunneen of Aerodata). I am in contact with a number of persons that were involved in the mid 1950s both in Australia and overseas. Could you please run a little query for me in a forthcoming Preview - requesting any **definite** knowledge from readers of airborne magnetic surveys (& radiometrics) by **any** organisation prior to 1955. Excluding BMR, Adastra/Hunting, Aero Service, World wide - for which I have definite knowledge.

Heresay has it that radiometrics were flown in the Hamersleys in the late 1940s and early 1950s and that magnetics were flown (or attempted?) out of Broken Hill in 1953. I am more interested in locating production data/surveys then experimental work (which I am sure must have occurred as "one offs"). Examples of data, aircraft and companies involved or known personnel would be appreciated for surveys pre 1955.

If enough gets accumulated here I am sure we could generate a chapter in a future history of geophysics in Australia.

Regards,

Doug Morrison

New Logo for AGSO

The Australian Geological Survey Organisation (AGSO), formerly known as the Bureau of Mineral Resources, Geology and Geophysics (BMR for short) has recently adopted a new logo in line with the restructured role of Australia's national geoscientific mapping organisation. The new logo supersedes a variety of interim title blocks adopted during the last few years. The logo was designed by Leanne McMahon from AGSO's Cartographic Services Unit following a design competition for the design of a new AGSO logo. The logo will be used on all items from stationery, to the funnel of the "Rig Seismic", to identify AGSO's new corporate image and restructured role in Australian geoscience studies.

AGSO

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

ASEG People Profile

Geoff Pettifer Preview Editor & ASEG Committee Member

Geoff is an unashamed enthusiast for geophysics. As a youth he was keen on gemstones, maths, physics and had a love of the bush and a desire to travel. What career to follow? The answer came in a 3rd year high school book prize - "The Boys Book of the Earth Beneath Us", a book about the physical mysteries of the earth, which determined him on a career in geophysics and still has pride of place on his bookshelf. His early mentors were a succession of excellent maths and physics teachers who encouraged him to question and to explore.

Geoff has a B. Sc. in Physics and Geophysics from the University of Melbourne studying under Colin Kerr-Grant and Lindsay Thomas and a Graduate Diploma in Applied Geophysics from the University of NSW. Studying on a BMR cadetship under Laric Hawkins and David Johnson at UNSW, he gained an interest in engineering geophysics, secured his foothold as an exploration geophysicist and funded his first motor-bike.

Joining BMR in 1970, he worked initially in seismic and gravity, but transferred to engineering and groundwater geophysics where he was inspired by Eddie Polak, "the original geophysics enthusiast". He later, spent two busy and rewarding years at the Geological Survey of PNG. Nowadays, Geoff works at the Geological Survey of Victoria in basin geophysics and image processing, but still retains an interest in most areas of geophysics.

Working in government geophysics has been a deliberate choice - "Government plays an important role in complementing and providing a framework for private exploration and has a particular role to play in environmental, engineering and groundwater geophysics".

Geoff's main hobby seems to be Preview Editor which he finds is an additional outlet for his enthusiasm for geophysics. "I see that the ASEG is a vital group and there are a lot of interesting stories to tell about Australian geophysics and its quite achievers, that don't make it to Exploration Geophysics or our conferences, which I would like Preview to present".

There is life after geophysics. Geoff and his wife Jan have two daughters. Geoff enjoys music, watching sports his body no longer allows him to play, the occasional game of flog (a bad version of golf) and metaphysical exploration (following the footsteps of great explorers of the mind - Jung et al.).

ASEG Research Foundation

Noise Reduction in TEM Surveys.

Duncan Massie
Monash University
(ASEG Research Foundation 1992 Project - Supervisor: Jim Cull)

Introduction:

Random noise pervades all electromagnetic (EM) surveys, consequently many papers have been written on this topic. This paper will concentrate upon one TDEM system, namely SIROTEM (Buselli, 1976). However some of the processes may apply to any of the current EM systems.

The SIROTEM uses a sferic rejection algorithm followed by data binning, then linear stacking to reduce noise. A notch filter is also incorporated to attenuate the powerline 50hz waveform (Buselli, 1976). These methods prove adequate, given Gaussian noise and a great enough number of stacks. The assumption of Gaussian noise, even with sferics is not always valid as observed in the field tests documented in this paper. Furthermore airborne EM surveys are limited in their stack numbers due to the transit speed (Cull, 1991).

McCracken (1986) outlines some of the methods for noise reduction prior to collection using appropriate magnetic moments and delay times. Further reduction in noise levels is possible with care in loop positioning (eg. to avoid suspending the loop above the ground if movement is likely) and removal of known sources of noise (generator and vehicles). However a reference loop (Cull 1991; Olsen at al., 1992; Stephan et al., 1991) may provide an additional technique to increase the signal to noise ratio and field tests are now required.

A study of various algorithms using synthetic signals mixed with noise was first conducted to ascertain whether noise levels could be reduced by other statistical means. The methods investigated include standard mean and median filters along with more exotic techniques such as Nth root stacks (McFadden, 1986), radial amplitude slope rejection (Neff, 1986) and least squares curve fitting. Actual noise records were then collected to assist in identifying noise waveform characteristics along with the trialling of the reference loop technique. Construction of a down hole probe was required to investigate the nature of both the horizontal and vertical noise components with depth.

Downhole Noise:

A passive induction probe was used to record typical noise waveforms at different levels in a borehole drilled for mineral exploration. This probe consists of wound coils with no downhole amplification or filtering to reduce the cost of production. Two probes were constructed, one to record horizontal noise levels and the other for the vertical noise component. A preamplification, high frequency antialias filter was applied to the signal before multi-stage amplification. The signal then was converted to digital format and recorded on a Toshiba 1200.

The initial test site at the Flying Doctor Prospect near Broken Hill in western N.S.W highlighted problems in the construction of the downhole probe with regards to water proofing and buoyancy.

The connecting wire from the probe to the surface recorder had a high resistance leading to severe signal attenuation and poor depth capability. However an important result was obtained. A 521hz half duty waveform was observed throughout the entire day, the origin of which is unknown but it is a significant departure from the assumption of only Gaussian noise. The peak amplitude of this waveform being an order of magnitude greater than the 50hz waveform also present.

The next test site was drill hole (R488) located at Mt. Isa, central Queensland. The drill hole was used to pour backfill from the surface into one of the underground drive shafts and consequently, being open ended, was thought to be dry. The location of the drill hole was far from ideal due to its proximity to both the town and mine, both within a radius of 1km. However, since it was dry this negated the need to rigourously waterproof the probe. The surface recorder was connected to the probe by a length of bell wire which had a sufficiently low resistance to allow the hole to be logged to a depth of 580m.

Two runs were performed, one to record the vertical component of the noise spectrum, the other for the horizontal component. A reading was taken at increments of 20m with a sampling interval of 50ms and 5000 were samples recorded. The maximum detectable frequency (Nyquist frequency) is 104hz. Figure 1 show normalised power spectrums at approximately 50hz, 2000hz and 9000hz respectively for the vertical component. The normalisation factor is also present to enable comparison between the relative amplitudes.

Plots for the vertical component (Figure 1) show two spikes (290m and 380m) for 50hz becoming increasingly more distinct at 2000hz. The plot for 9000hz still contains the above spikes along with others. The increase in spikes results from the spectrum being folded back from above 10000hz due to inadequate attenuation in the Nyquist frequency filter. The horizontal probe filled with water and consequently electrolytic effects complicated any signal, hence no definitive results are presented however the peaks at 290m and 380m were present. The attenuation of the signal for the upper section of the hole (130m) is due to a combination of a change in gain and a surface collar acting as shield.

The results indicate a noise source located at approximately 290m and 380m. The sharpening of the broad peak in the vertical component may be due to attenuation of the signal strength with distance from the source. The degree of attenuation is given by the skin

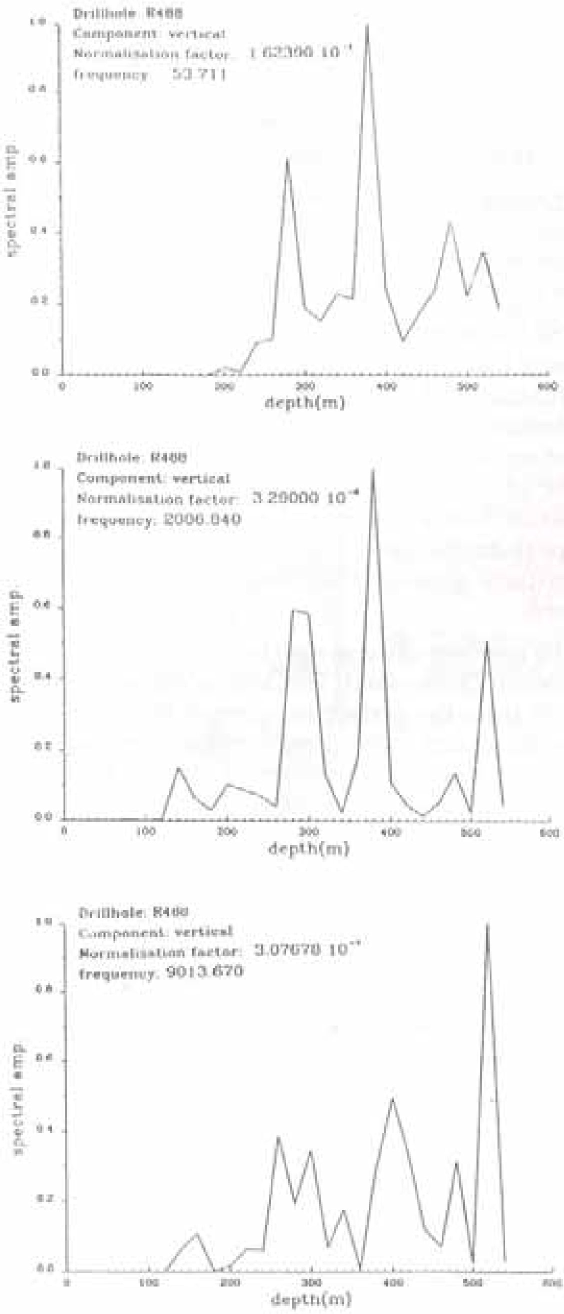


Fig. 1 Vertical component of the noise power spectrum versus depth, for increasing frequencies.

depth which is defined as the distance (z) in which the signal is reduced by 1/e (equation 2).

$z(m)=2(r/f)1/2$

(2)

where r is resistivity and f is frequency (Telford, 1991).

The SIROTEM Mk2 downhole log obtained in the same hole for exploration activities (Figure 2a) contains subtle spikes at approximately 290m and 390m. The source of these is not apparently obvious even with the geological cross-section (Figure 2b), although the close proximity of the V52 and J46 faults is a possible source.

Since both the passive and active systems detected the same anomalies implies two physical bodies with lower resistivities than the host rock acting as a conduits for EM noise. The sensitivity of the probes with respect to distance from the source is still to be investigated.

Noise reduction algorithms:

A synthetic signal, approximately equivalent in amplitude and wavelength to a standard decay curve was generated upon which various levels of Gaussian noise and sferics were superimposed. To compare each algorithm quantitatively requires a variance to be calculated between processed signal with noise and the pure signal. A programme written to simulate the processing available in the SIROTEM Mk3 (without the new sferic's rejection algorithm) was used as a base comparison for the subsequent techniques.

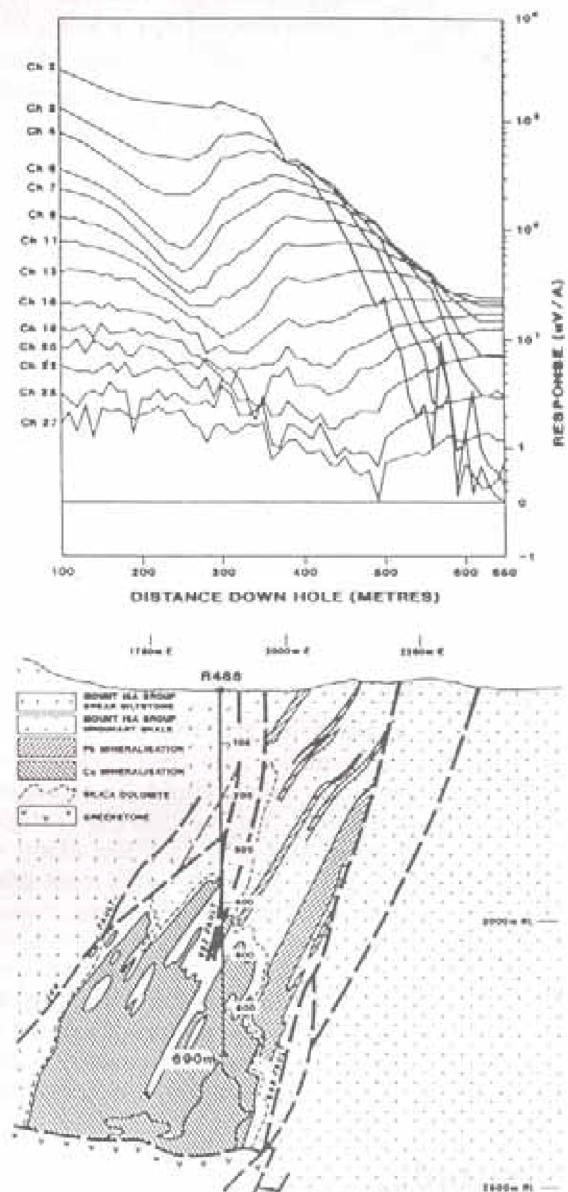


Fig. 2 DHEM results for R488, with a simplified geological cross-section (from Fallon et al., 1992)

While the mean and median filters dealt adequately with noise, the addition of sferics caused the sferic to become smeared and led consequently to decay curve distortion. This resulted in the rejection of these methods. To remove the high amplitude sferics a linear threshold was applied before SIROTEM equivalent processing. However, this method requires prior knowledge of the expected signal amplitude. A threshold level set too low truncates the early channels and places a noise bias towards the 'tail', which is generally orders of magnitude less in signal amplitude than the early channels and the threshold level. A more flexible threshold level would avoid this problem but becomes time consuming to continually modify the threshold. Single channel replacement or decay curve rejection were the options considered for a point detected above the threshold. Rejection of the entire decay curve means an increase in data acquisition time if the stack number is to be preserved. Single point replacement by the average value of the adjacent points is the more efficient method.

A novel way to reduce the noise level is to treat the decay curve in its entirety. This is accomplished using linear least squares curve fitting (equation 1)

$$y(x) = a0 + a1x + a2x^2 + \ldots anx^n \quad (1)$$

where y(x) is the best fit equation for the data points, an is the nth coefficient of the x^n component (Gerald, 1984). The equation has the advantage of not being forced to pass through the original data points, unlike the cubic spline. The degree was set to be the minimum required to fit a curve to the pure signal and was subsequently held constant.

Figure 3 shows the pure signal with the addition of 10% noise and a sferic. The best fit curve is not perturbed by the sferic, however the endpoints are distorted, indicating a need to constrain the boundary gradients.

The synthetic noise is not a realistic representation as mentioned previously and one could expect a greater signal to noise ratio in the early channels.

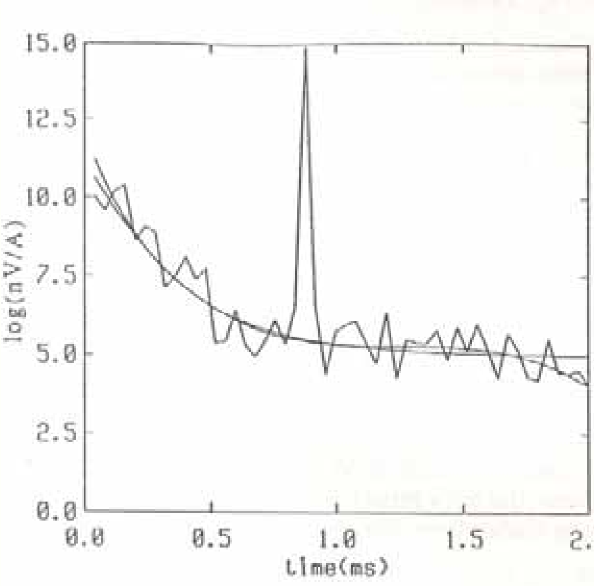


Fig. 3 Curve obtained when linear least squares curve fitting algorithm applied to a synthetic signal with 10% Gaussian noise and a sferic.

Consequently, the gradient of the initial signal could be used to constrain one end of the curve. The other gradient could be constrained by assuming the signal asymptotes to a flat gradient.

Further research upon the signal distortion caused by the above assumption is required with possible modifications to one or both boundary conditions.

Base Station:

To reduce the noise level before data collection a base station was trialled at Fosterville, northern Victoria. A 25m coincident loop was laid out along with a 25m reference loop, 100m away. By wiring the receiver input of SIROTEM Mk3 so that both loops are paralleled but in an opposite sense should result in destructive cancellation of noise leaving only the signal. The technique relies upon noise being regionally correlated, meaning each loop receives the same noise simultaneously.

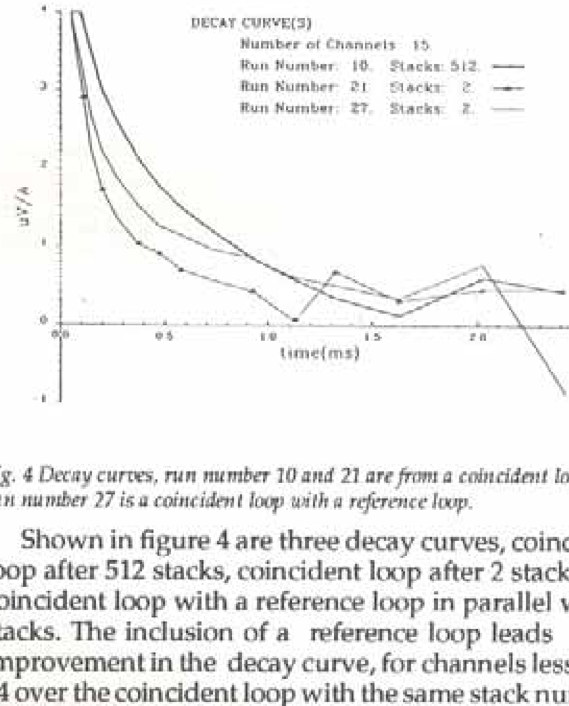


Fig. 4 Decay curves, run number 10 and 21 are from a coincident loop, run number 27 is a coincident loop with a reference loop.

Shown in figure 4 are three decay curves, coincident loop after 512 stacks, coincident loop after 2 stacks and coincident loop with a reference loop in parallel with 2 stacks. The inclusion of a reference loop leads to an improvement in the decay curve, for channels less than 14 over the coincident loop with the same stack number. However, at late times the reference loop configuration develops a slowly decaying negative transient. The explanation of this phenomenon is not apparently obvious without looking at the digital data.

To verify the assumption that noise is regionally correlated (as well as investigate the late channel signal distortion previously noted) the noise in each loop was digitally recorded. The dominant frequency is 50hz.

The data from each loop is recorded independently and written into two files then added or subtracted. Due to the recording equipment, data cannot be acquired simultaneously. Consequently there is a delay between a point recorded from loop one and that of loop two. The number of points recorded is also limited by memory size, hence a compromise between sample interval and recording time was reached, the time interval between subsequent records on each loop was 1ms.

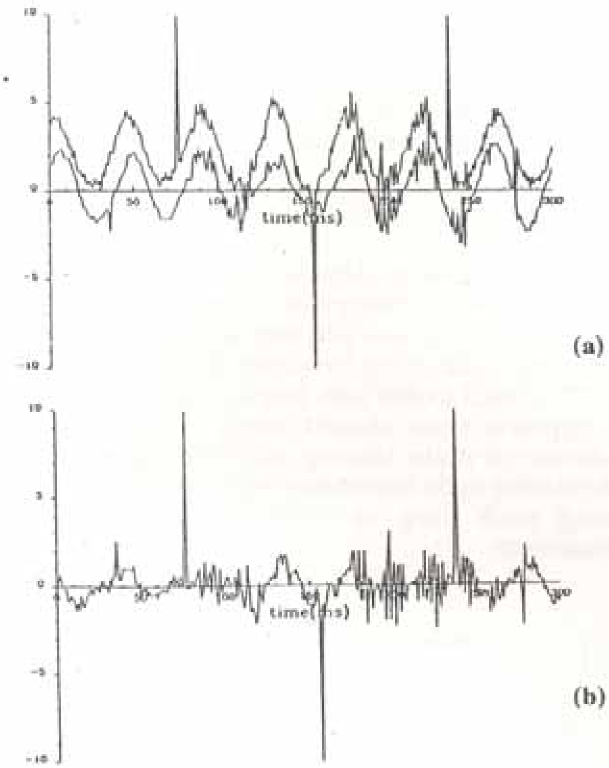


Fig. 5 (a) Comparison of EM noise plus SIROTEM transmitted waveform received by two loop separated by 100m. The offset was added to aid visual correlation of the signals. (b) Subtraction of the signals received by the two loops.

Figure 5a is the noise plus a transmitted signal detected by loop one, offset by 2 units from the noise received by loop two. Due to the sampling density being too coarse, the characteristic double spikes of the differentiated square wave transmitted waveform are not observed. A phase shift can be immediately noticed between the two signals. Direct subtraction of the two signals (Figure 5b) does not result in complete cancellation of the 50hz sinusoid nor attenuate the high frequencies. A a 1ms phase shift of loop one does not improve the data, implying a time shift of lees than 1ms.

The cause of the phase shift could be attributed to either the difference in capacitance and induction of the reference loop, or a propagation velocity of the signal through the ground. The implications of this is that direct subtraction will not completely remove correlated noise. This is observed with the SIROTEM reference loop results.

Further improvement is possible by decreasing the higher frequency filter cutoff and increased accuracy in the measurement of the phase shift by either a correlation algorithm to determine the lag or decrease the sample interval. A decrease in the sample interval is recommended to increase the resolution of the decays and allow stacking (be it linear or curve fitting) to occur which is obviously required.

Conclusions:

This study has shown that Gaussian noise provides a poor model for EM data. The worst case being actual spikes which would have associated transients complicating any EM measurements. Down hole noise logging data show significant anomalies dominating the expected decrease in the vertical noise component with depth. The identification of two noise sources corresponding with perturbations in the DHEM profile may indicate noise conduits.

While a reference loop could negate the effect of these additional signals along with the higher frequencies (including sferics), the phase shift correction must be considered. Without a phase shift any attempt to hardwire a reference loop to the SIROTEM receiver may lead to late channel distortion.

The practical use of digital recording requires increased sophistication in both the hardware and software. A floating point AD card and low pass filter, coupled with selective recording of only the transients rather than continuous records is definitely required. The phase shift correction can be easily performed with digital data by decreasing the sampling interval which leads to an increased ability to accurately measure transient decays and apply various smoothing algorithms, in particular best fit curve matching.

References:

Buselli, G., O'Neill, B., 1977, SIROTEM: A new portable instrument for multichannel transient electromagnetic measurements: Bulletin of the Australian Society of Exploration Geophysicists Vol. 8, No. 3, p. 82-87.

Cull, J.P., 1991, Signal Processing Concepts for Airborne SIROTEM Data: Exploration Geophysics Vol. 22, p. 97-100.

Fallon, G.N., Busuttil, S., 1992, An appraisal of the geophysical effects of the Mount Isa ore bodies: Exploration Geophysics Vol. 23, p. 133-140.

Gerald, C.F.; Wheatley, P.O., 1984, Applied Numerical Analysis: Third edition; Addison-Wesley Publishing Company.

McCracken, K.G., Oristaglio, M.L., Hohmanns, G.W., 1986, Minimization of noise in electromagnetic exploration systems: Geophysics Vol. 51, p. 819-832.

McFadden, P.L., Drummond, B.J., Kravis, S., 1986, The Nth-root stack: Theory, applications, and examples: Geophysics Vol. 51, p. 1879-1892.

Neff, D.B., Wyatt, S.B., 1986, Noise suppression by the radial slope rejection method: Geophysics Vol. 51, p. 844-850.

Olsen, K.B., Hohmann, G.W., 1992, Adaptive noise cancellation for time-domain EM data: Geophysics Vol. 57, p. 466-469.

Stephan, A., Strack, K.M., 1991, A simple approach to improve the S/N ratio for TEM data using multiple receivers: Geophysics Vol. 56, p. 863-869.

Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990, Applied Geophysics, second edition: Cambridge University Press.

A New Regular Feature

Seismic Window

With

Rob Kirk

BHP Petroleum

Seismic Facies Mapping - Or Why Bother with Onlaps?

Many petroleum geophysicists are sitting on a wealth of geological information - but do not realise that they are! The aim of this article is to promote the "THIRD DIMENSION".

We spend a good deal of our time acquiring, processing and interpreting seismic data with the ultimate aim of accurately reproducing the shape of three or four surfaces at different depths below our permit. We get the surfaces to map from the geologist and then "secret" ourselves away and "hey-presto" come out in two months with some "accurate" depths to these horizons. The geologist then usually takes our data and does the "selling" and gets the kudos. This structural mapping is a vital process which always must be done, prior to drilling - **BUT sometimes we can offer much more than** just 2D sheets!

(I utterly dislike the THEM and US terms that I am using in this diatribe to describe geologists and geophysicists but I will persist for another paragraph or two).

The geologist thinks that she/he (sorry, but I will use the generic "he") has a 3D picture of the geology - just look at the geological cross sections, palaeoenvironment maps etc. that are produced. The geologist automatically thinks volume (or should!) but what is "he" using as basic data? - a mere handful of ID control points! Talk about a potential for interpretation aliasing - very high frequency vertical sampling in hugely widespread samples, that is, very low frequency lateral sampling. Geophysicists on the other hand, don't always think volume - they think 2D (those "sheets"). (Most interactive seismic interpretation systems still basically think 2D as well). The seismic tool, however, offers the closest thing to volume that we have (especially when acquired in a 3D manner). Seismic facies mapping (SFM) is about trying to fill in the volume between each sheet that we mapped. Ideally, by mapping all geometries on the seismic (Figure 1) we can end up with the volumetric distribution of different seismic facies, using the terminology of Ramsayer (1979) and Vail (1987) - see Figures 2 and 3. Geologists can only do that when "their" geology is layer-cake and laterally unchanging (or when they are working within a well drilled field - ALL(!) we have to do is to calibrate the seismic facies with the well facies (or outcrop facies if we are lucky - such as in the Canning Basin of NW Australia). Our SFM is now a palaeogeographic map - whose predictability of real geology is **only** as good as our geological calibration. It is worth noting that a "by-product" of each seismic facies study is usually at least twice the number of structural horizons as previously mapped. It is more work though.

EVENT TERMINATIONS

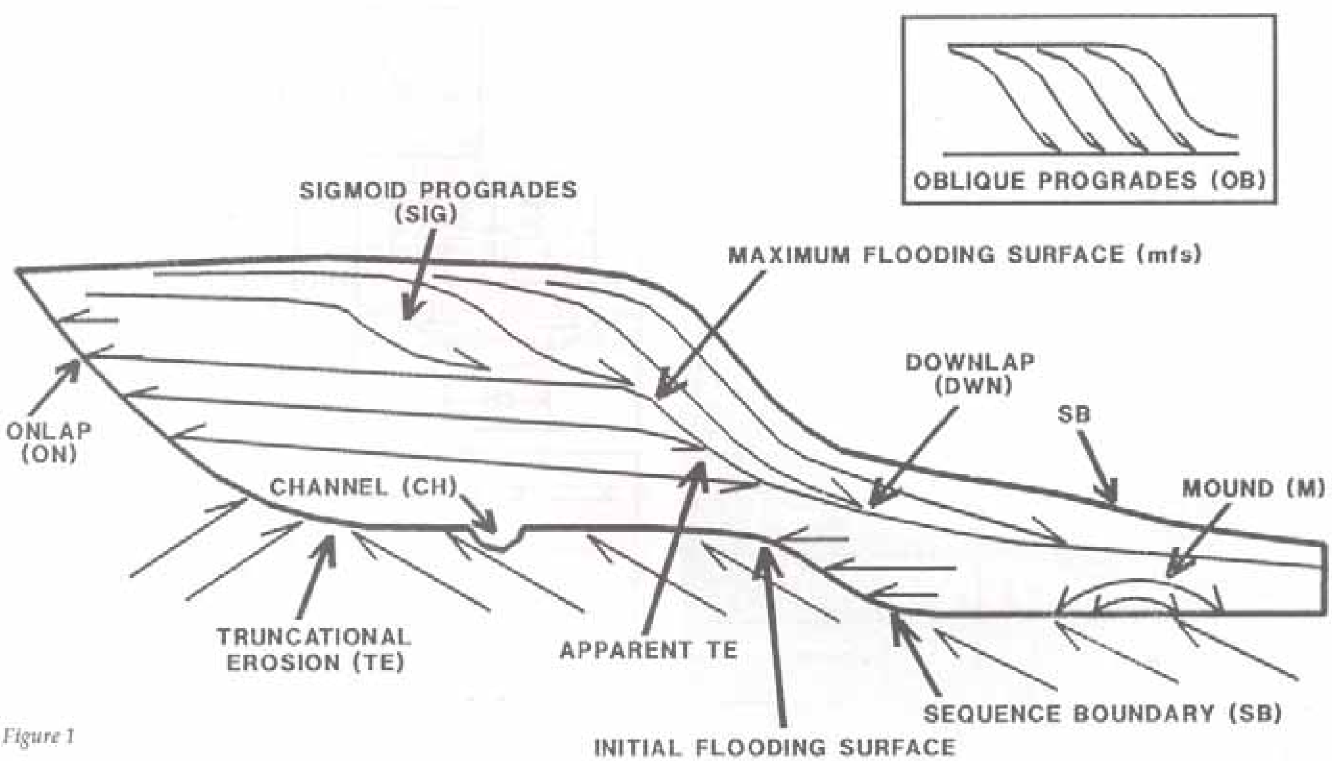


Figure 1

SEISMIC FACIES MAPPING

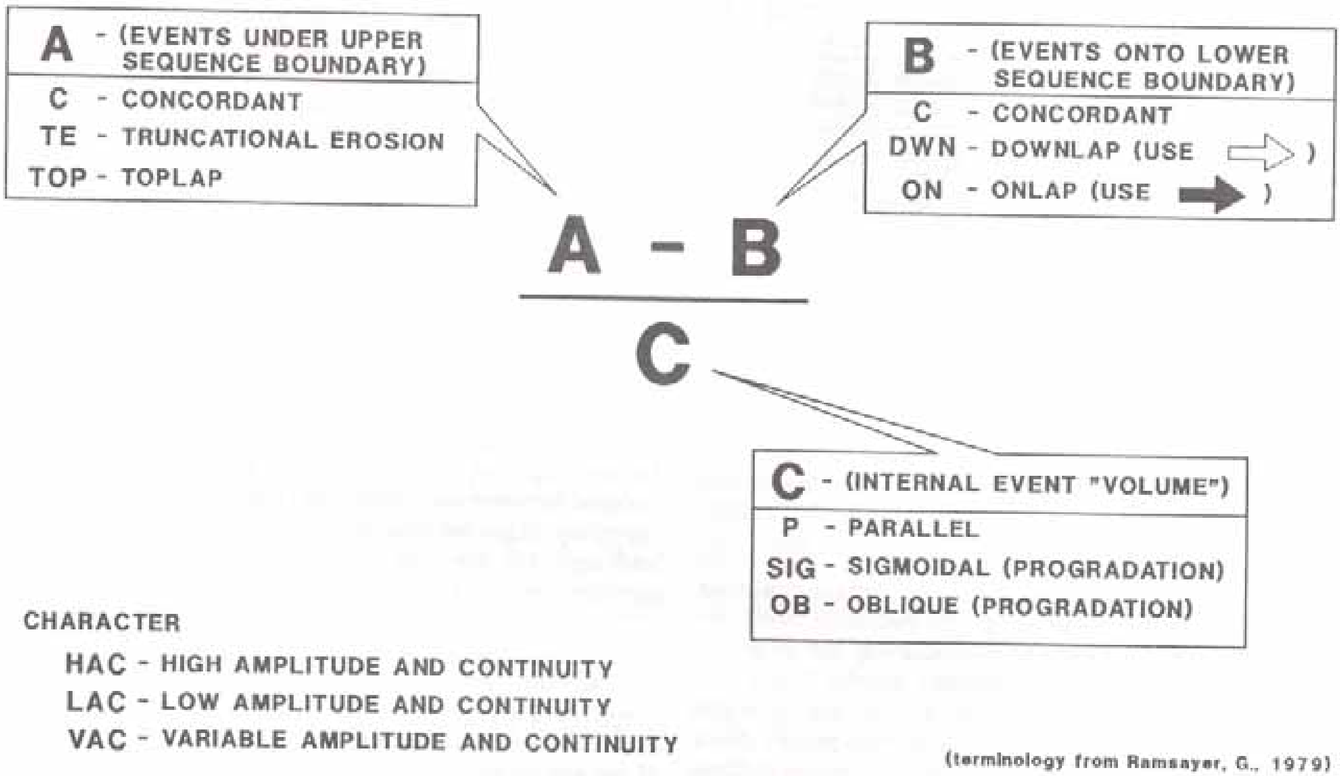


Figure 2

SEISMIC FACIES MAPPING

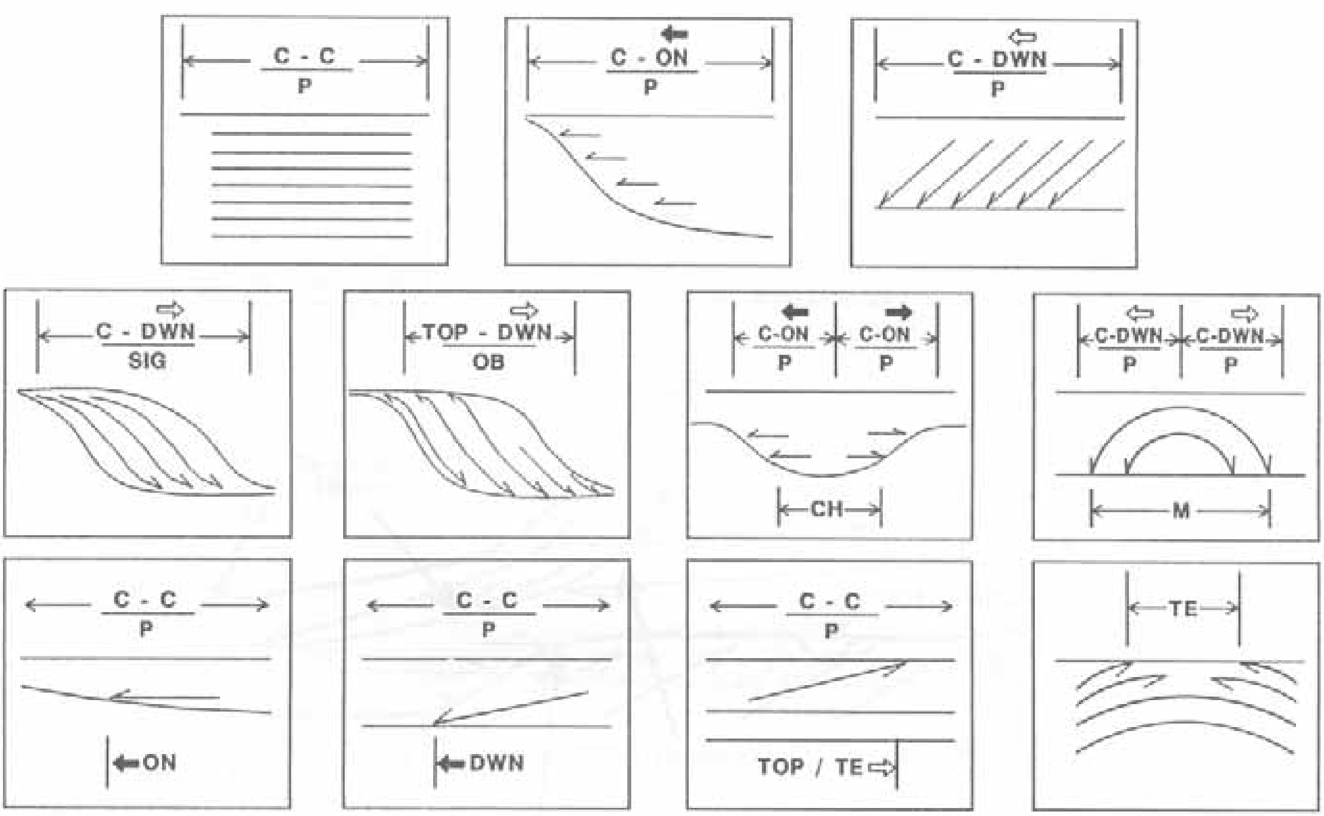


Figure 3

Seismic facies mapping is just another tool - sometimes it is of no use due to poor data quality, such as seen in parts of the Timor Sea, which may preclude facies identification. (Dipping multiples from overlying prograding carbonates for example can make beautiful seismic facies!) As with all tools there is nothing magic in it but what you find is that it can change **HOW** you think. When you start thinking volume you start thinking geology (when you think geology you have to think well data). Scale immediately comes into the picture - is my volume second or third order? This is most important and leads into the "sordid world" of geological models and "sequence stratigraphy" (see a future Preview article!).

It is very true that when interpreting imperfect (always!) seismic data sets that "I never would have seen it unless I believed it". Models are about "believing it" - see Vail (1987). (I think many people feel that SFM's are mapping processing artifacts! This is tied in with "believing it" - although some of my C-DWN/SIG's may be referring to younger multiples!).

A harsh way of putting all this is that the ungeological geophysicist will continue to map sheets whereas the geological geophysicist will map volumes which "he" has calibrated by working with a geologist and **together** they have a much better chance of predicting the distribution of seals and reservoirs - which is what this is about (and maybe even source rocks?) This is a real world case of the "whole" being much better than the sum of the individual parts.

The modern "catch phrase" is PETROLEUM SYSTEM (just ask John and Marita Bradshaw!). Those not subscribing to this tenet are destined for extinction sooner than others - the big bumps are disappearing, and we are drilling a lot of smaller dry bumps because the system is not understood. The geologist and geophysicist (and biostratigrapher and petrophysicist etc.) must work together and facies mapping is just one more way of helping.

References

Ramsayer, G.R., 1979. Seismic stratigraphy, a fundamental exploration tool. 11th Annual OTC, Houston, Texas, April 30 - May 3, pp. 1859-1869.

Vail, P.R., 1987. Seismic stratigraphy interpretation using sequence stratigraphy. Part 1: seismic stratigraphy interpretation procedure. In: Atlas of seismic stratigraphy, Vol. 1: AAPG Studies in Geology 27, pp. 1-10. Ed Bally, A.W.

In April 1994 Preview Seismic Window looks at Sequence Stratigraphy - or Why Bother with Systems Tracts?

ASEG Promotions Committee

What is Promotion of Geophysics?

Since the establishment of the Promotion Committee, we have been thinking what is the task of this committee. What is promotion of geophysics ? Who is the target ? How to approach them ? What is the message we really want to convey to them ? Geophysics as a science ? Geophysics as an exploration tool ? Or geophysics as a career path ?

A lot of questions are there to answer before any action can take place. As Prof Vozoff rightly questions, is it responsible to promote geophysics without job prospects for graduates ? In other words 'Who in the hell is going to employ all the graduates?' (*Preview, Oct.,93, p39*).

To all these questions, our answers may be naively optimistic: by promoting geophysics we can improve the professional status of geophysics and geophysicists, attract good students to study geophysics ensuring the future of the ASEG, and make our work a little bit easier through community understanding. By saying this we are exposing ourselves to criticism. But a Hamletian attitude is not constructive. We would rather be a Quixote to procede with something constructive.

So far, we are looking into approaching secondary students through their physics teachers. Suitable material is being drafted. Also a slide set for presentations to the general public is planned. We hope to do much more and would welcome YOUR input, so if you have any suggestions or suitable material please contact Koya Suto (ph 03-895 3041).

Preview: Next Issue

- *Preview goes to the ASEG 10th Conference*
- *Conference Handbook*
- *Abstracts Volume*
- *ASEG & SEG President's Address to the Conference*
- *New feature - "Mentor" - Dr Ken McCracken*

ASEG Corporate Sponsor Profile - Aberfoyle Resources

Aberfoyle Resources Limited was formed in 1926 as Aberfoyle Tin N.L. to mine tin and tungsten at the Storeys Creek mine, and a few years later at the Aberfoyle mine, both situated near Rossarden in north-east Tasmania.

The group built its mining base in a series of exploration and mine developments which included bringing into production tin deposits at Ardlethan, New South Wales and Luina, Tasmania. A substantial tin resource was also defined at Zeehan, Tasmania.

From the commencement of Cominco's interest in Aberfoyle in 1971 the emphasis on *grass roots* exploration using state of the art geophysical techniques increased. It resulted in the discovery of the Que River zinc/silver/lead mine in 1974 and the nearby Hellyer zinc/silver/lead mine in 1983, both in north western Tasmania. The Hellyer deposit is one of the world's richest base metal mines initially containing in excess of 16 million tonnes of 20% zinc plus lead with associated silver, copper and gold.

In 1985 Aberfoyle acquired a 57% interest in the Bardoc Gold project in Western Australia, now producing at a rate of 11000 ounces of gold per year. The company also has a 65% interest in the Highway/Reward copper/gold resource in northeast Queensland.

Today, the company spends $15 million per year on exploration with offices located in Burnie, Adelaide, Perth, Broken HIll, Townsville, Charters Towers and Jakarta. The head office of the Exploration Division is in East Hawthorn, Melbourne.

Exploration is focussed on base metals in the Mount Isa/Cloncurry and Broken Hill districts and on the Eyre Peninsula of South Australia and the west coast of Tasmania; on gold in the Davyhurst region of Western Australia and on Sumatra in Indonesia; on diamonds as a partner in the Australia Diamond Exploration joint venture; and on heavy mineral sands in western New South Wales.

Geophysics plays an important role in the company's exploration program. The company employs two full time geophysicists (Jovan Silic, Chief Geophyhsicist and Greg Walker) who devote most of their time to electromagnetic and electrical geophysics.

Aberfoyle Personnel carryingout surface EM survey

The company owns two Zonge GDP-16 receivers which are employed on surface and downhole EM surveys. Airborne EM plays an important role in target definition over new areas.

In-house research projects are carried out and the company participates in several AMIRA projects. Aberfoyle's Chief Executive, Dr. S.M. (Max) Richards has held the position of President of AMIRA.

Aberfoyle

From the Universities

Flinders University Establishes Chair in Geophysics

The Flinders University of South Australia has established the Chair in Geophysics and Dr Stewart Greenhalgh has been appointed to this position (effective from 27th September 1993). The School of Earth Sciences now has six professorships, two in Geology, and one in each of Oceanography, Meteorology, Hydrology and Geophysics.

Professor Greenhalgh joined the University in 1981 and has been extremely successful in winning grants, signifying his outstanding ability to carry out academic research. He has a total of 91 publications in refereed international journals. He has also been an active teacher of geophysics courses at Flinders University, mainly in the area of seismic exploration, digital signal processing, theory of elastic wave propogation, and earthquake seismology. He has supervised 14 Ph.D./M.Sc. students and 18 Honours students.

The current major research interest of Professor Greenhalgh is elastic wavefield modelling and inversion, with particular emphasis on seismic (and radar) imaging of ore bodies and associated hard rock geological structure. The work is supported by the Australian Research Council and Western Mining Corporation.

The other tenured members of the academic staff at Flinders University, with responsibility for geophysics teaching and research, are Dr F H Chamalaun (geomagnetism, electromagnetics, plate tectonics), Dr A White (gravity, magnetics, EM, well logging) and Dr C R A Rao (elastodynamics, theoretical seismology). There are currently two post-doctoral fellows - Dr G. Heinson (electromagnetism) and Dr S Cao (seismology) - and 12 higher degree candidates in geophysics at Flinders University.

Geophysics in CSIRO Division of Exploration and Mining

Compiled by

Greg Turner

In July this year the CSIRO Divisions of Geomechanics and Exploration Geoscience were formally restructured into two new divisions - the Division of Exploration and Mining and the Division of Petroleum Resources. This new alignment takes advantage of the synergies in performing R&D for the continuum of activities from exploration to production for each of the mining and petroleum industries.

The Division of Exploration and Mining will address issues from identifying regional prospective geological settings through orebody delineation to mine design and extraction.

Geophysical techniques will play a major role in the divisions activities particularly at the interface between exploration and mining where most of the new synergy exists. A prime focus of the new division will be in the high priority area of orebody delineation. New technologies which can be used to accurately and comprehensively prove up a prospect as a mineable resource and techniques which can precisely delineate a deposit in terms of its boundaries, grades and geomechanical characteristics have the potential to provide substantial cost benefits to the Australian mining industry. The division is developing downhole TEM, radar, seismic and in-situ minerals analysis techniques as well as new visualisation products to provide these capabilities with a minimum lead time.

Concurrently the division will be considerably enhancing airborne geological mapping capabilities through developments in magnetics, multi-spectral scanning, radiometrics, gravity and electromagnetics. Projects already well underway will provide valuable tools not only for explorationists but also for land degradation studies.

The Division of Exploration and Mining is a key member of 3 cooperative research centres (CRCs). These are: the Australian Geodynamics CRC, the Australian Minerals Exploration Technologies CRC and the CRC for Mining Technology and Equipment.

The Australian Geodynamics CRC (AG CRC) is a joint venture between CSIRO, the Victorian Institute of Earth and Planetary Sciences (Department of Earth Sciences, Monash University; Department of Geology, La Trobe University), AGSO and the Digital Equipment Corporation, Australia. It aims to develop new insights into the evolution of Australia's crust and processes that have resulted in the accumulation of major minerals and energy deposits. It will do this by integrating seismic profiling and 3D tomographic data with structural geology and geochronology, using non-linear dynamics, advanced computer visualisation and data management techniques to produce new geodynamic syntheses.

The Australian Mineral Technology CRC (CRC AMET) is an joint venture between Macquarie University, Curtin University of Technology, CSIRO, the Geological Survey of WA and AGSO, World Geoscience Corporation and AMIRA and aims to develop core technologies, particularly airborne methods, for the discovery of orebodies concealed by the unique Australian regolith.

The CRC for Mining Technology and equipment (CMTE) is a joint venture between AMIRA, CSIRO and the University of Queensland. It maintains research programs in metalliferous mining, metalliferous processing, coal mining and coal processing. Projects involving geophysics concern the delineation of ore grades and rock structure in the vicinity of a metalliferous mining face and the development of sensing systems for horizontal in-seam boreholes and highwall mining machines.

This article highlights the geophysical research activities currently being investigated within the new CSIRO Division of Exploration and Mining.

Earth Strain

A new group within the Division specialises in monitoring of earth strains induced either from natural causes or from engineering or mining operations. The group incorporates the expertise developed at the University of Queensland over the past ten years for precision real time monitoring of solid earth strains for the study of earthquake sequences.

The instrumentation involved measures changes of borehole diameter imposed on a stainless steel instrument grouted permanently in place. The measurements are based on capacitance micrometry and are capable of measuring earth strains as small as 0.0001 microstrain. Within the instrument, actual displacement measurements are typically made to one one hundred millionths of a millimetre.

The strain measurement is performed using four different azimuths allowing isolation of the shear strain in the plane perpendicular to the borehole, as well as the areal strain in that plane. Most instrumented sites also include a biaxial tiltmeter (see Figure 1) operating at nanoradian sensitivities. Instruments are permanently grouted in holes, and controlled by a PC based computer system located at the surface, and usually powered by solar panels. The bandwidth of the downhole system is DC to 32 Hz, and the computer also controls standard data logging functions on site.

Though much of the development of the instrument has related to the stringent requirements of Australian and Californian earthquake studies, the potential for the instrument to monitor minescale deformations associated for example with longwall mining sequences is very significant. Experiments are in place which will allow near real time evaluation of subsidence sequences and association of the measured deformations with the mine plan and extraction sequence. The installations are remote from the mining operation, and can be continued after the mining has ceased. Instruments can be located at any horizon depth, and are capable of identification of potentially dangerous tensile strains in the subsurface materials. The measurements complement repeated ground subsidence surveys, underground extensometer measurements and pillar loading measurements. Optimisation of the extraction sequence geometry may be possible in the future.

For further information contact: Mike Gladwin
Ph: (07) 212 4562, Fax: (07) 212 4455,
E-mail: m.gladwin@dem.csiro.au

Ground penetrating radar

The radio-frequency electrical properties of both metalliferous ore and coal present a strong contrast to their surrounding host rock materials and are therefore well suited to mapping by ground penetrating radar (GPR). Consequently GPR is one of the tools being developed by the Division to provide miners with the capability for accurate orebody delineation. GPR can currently provide centimetre resolution over distances up to 1 metre and 1 metre resolution over distances up to 15 m in fresh rock.

In a joint project with BHP the CSIRO Division of Exploration and Mining and Division of Applied Physics have developed an advanced GPR system with a computer controlled receiver stage for shallow civil engineering applications. In comparative trials this system has been shown to considerably outperform other commercial systems. The priority for further developments is to adapt this system for use in boreholes and for use with frequencies as low as 10 - 20 MHz to allow reflection mode ranges of 50 metres and transmission mode ranges of 100 metres to be routinely achieved. Over these ranges GPR will be an attractive tool for mapping deposit boundaries, faults, fractures and joints as well as for the shorter range, high resolution applications such as the guidance of drill bits and mining equipment.

CSIRO has been developing GPR since 1984 and since that time has put considerable effort into developing techniques to estimate radar range from laboratory samples. This has proven to be a crucial step towards minimising the failures in the field that have plagued many GPR operators due to the wide variation in the radio-frequency electrical properties of geological materials. Small hand specimens with a single flat face can now be tested in the laboratory prior to field investigations over frequencies from 1 MHz to 3 GHz.

Successful surveys have covered an enormous range of activities including location of buried pipes and cables (see Figure 2), detection of old mine workings and limestone caves, mapping of geological layering and bedrock interfaces, mapping of pavement thickness and sub-bottom profiling in a river.

For further information contact: Tony Siggins
Ph: (03) 881 1224, Fax: (03) 803 2052,
E-mail: a.siggins@dem.csiro.au

In-situ minerals analysis

The technologies developed by the Division for in-situ analysis of solid resources including minerals and coal are based on nuclear geophysics because the gamma radiation emitted in nuclear reactions readily permits the characterisation of chemical elements. Nonetheless, the Division plans to extend this capability to make use of a range geophysical techniques in combination with the nuclear techniques and joint inversions are planned as a future project.

Currently, the Division's in-situ minerals analysis are applied, predominantly, in the form of borehole logging technologies known as SIROLOG. The SIROLOG borehole logging technology has applications to exploration, mine development and production, and is used on a routine basis in both iron-ore mining and coal mining. For iron-ore, where the most important applications are grade control and selective mining, SIROLOG is used to determine iron-ore grade, the contents of alumina and silica contaminants, bulk density and borehole diameter. For coal, where mine development is currently the most important application, SIROLOG is used to determine ash content, iron and silica contents and seam identity.

Research is also progressing on the development of surface analysers. These analysers will find application on the faces of coal mines, both open cut and underground. The surface measurement data will be applied largely to guide selective mining procedures during extraction operations. Current and future research is focussing on the development of probes having extremely high bed resolution and, at the same time, requiring radiation sources of virtually zero intensity. Two such probes, the "Zero" probe and the Low Activity probe are now at an advanced stage of development. Such design concepts will be applied in other projects, eg "measurement while drilling" for navigating drilling operations in horizontal holes. For iron ore, the research issues also include determining the feasibility of quantitative logging below the water table and of predicting, in-situ, lump/fines ratios and phosphorous contents.

For further information contact: Peter Eisler
Ph: (03) 881 1284, Fax: (03) 803 2052,
E-mail: p.eisler@dem.csiro.au

Interpretation of airborne radiometrics

Airborne gamma-ray surveying is a widely used tool for refining the mapping of surface geology and identifying regolith units. Ongoing research by the Division is developing methods for improving the interpretation of these surveys and in particular determining the significance of variations of radioelements within geological units.

The methods combine:-

- an understanding of the redistribution of the radioelements (K, U & Th) with weathering of different rock types;

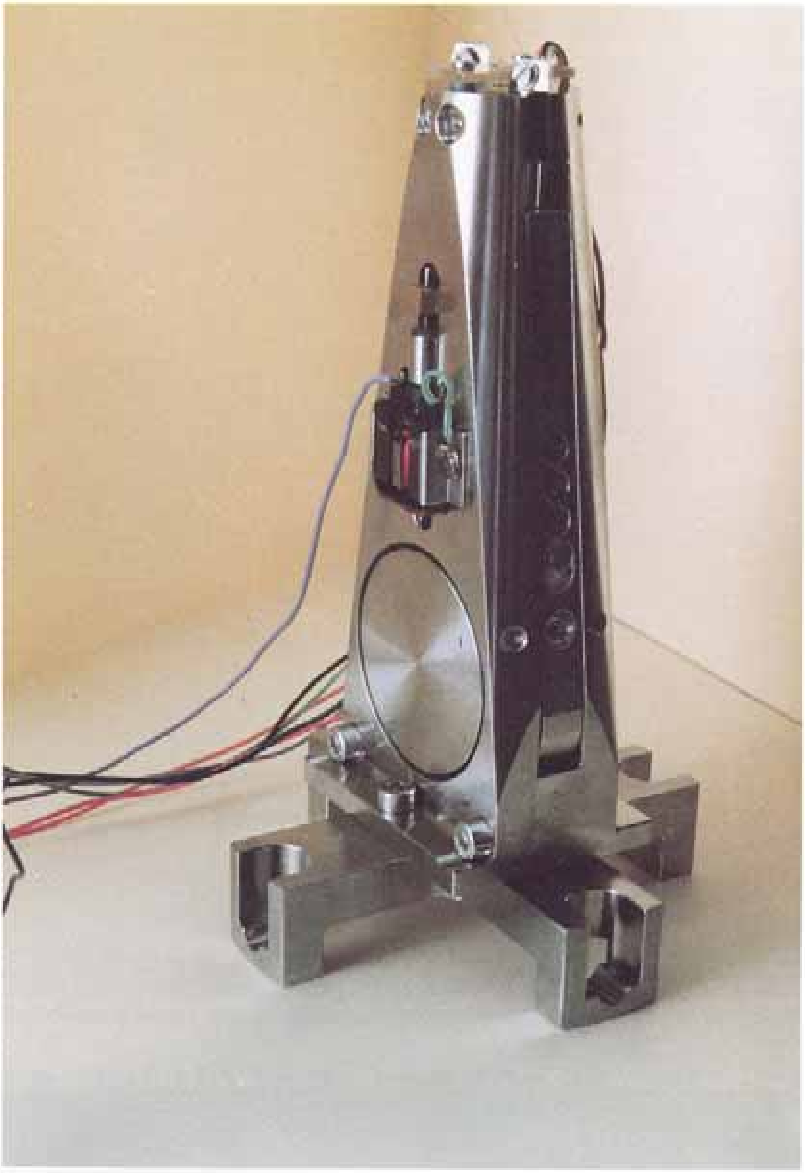


Figure 1. Close up of one of the tilt components for the earth microstrain measurements.

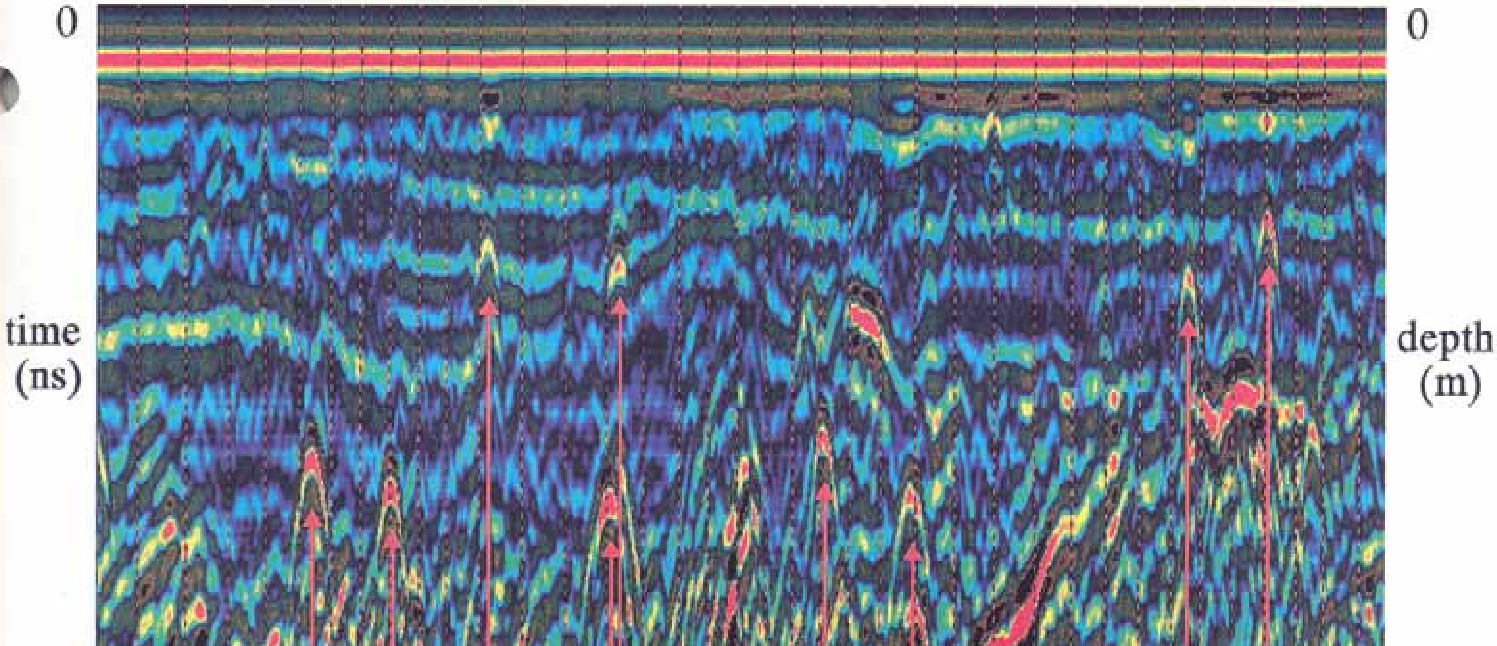


Figure 2. Ground penetrating radar image of buried pipes above dipping sandstone bedrock in North Sydney, New South Wales. (Dashed lines are superimposed on the data at 1m intervals).

Figure 3. CSIRO's logging vehicle for in-situ minerals analysis shown during a survey in the Bowen Basin, Queensland.

Figure 4. Field portable γ-ray spectrometer in use for ground truthing airborne radiometric data in the Binurra area in north-east Queensland.

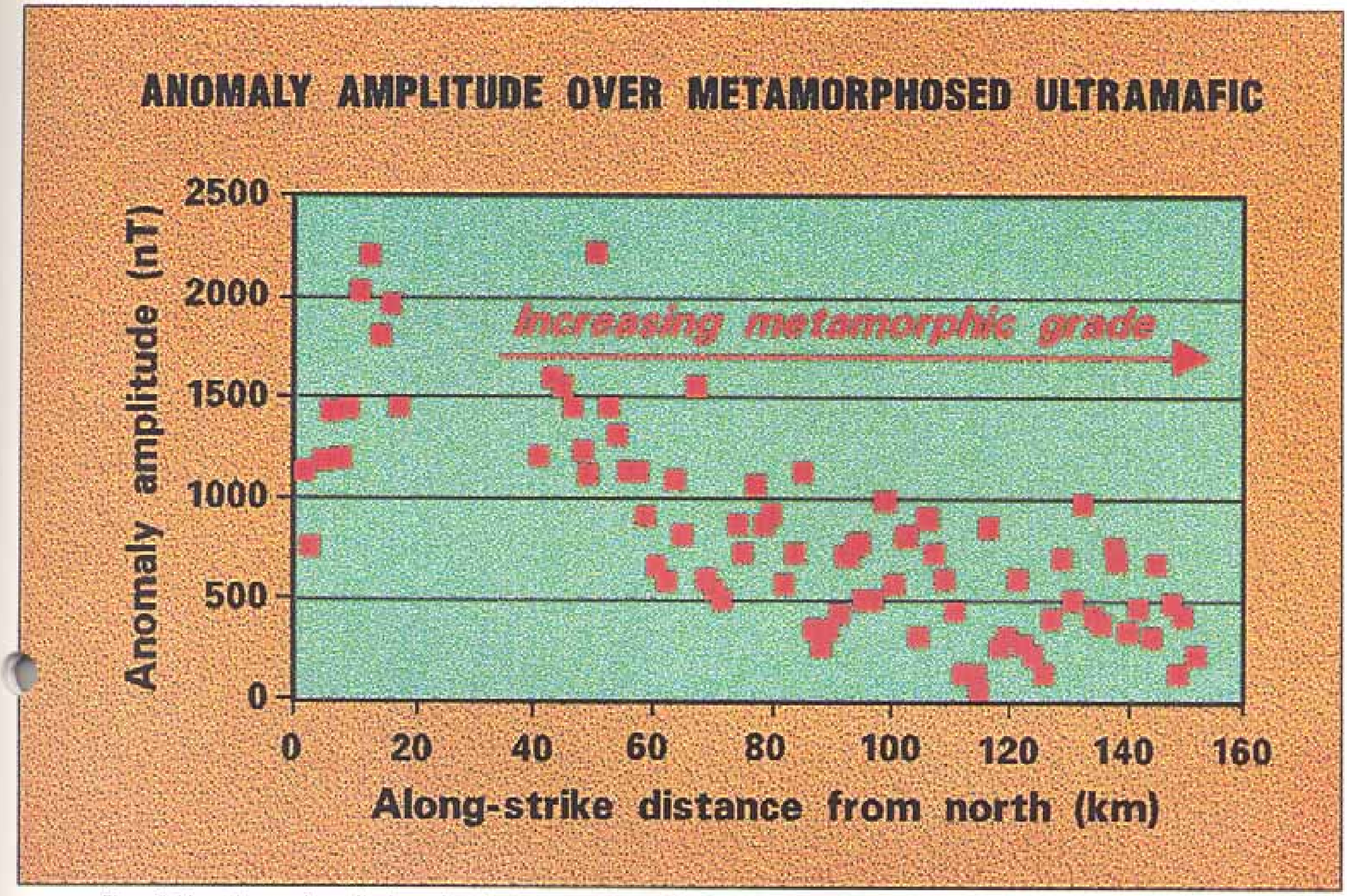


Figure 5. Magnetic anomaly amplitude as a function of metamorphic grade for the major ultramafic unit of the Agnew-Wiluna Belt in the Yilgarn Block, Western Australia.

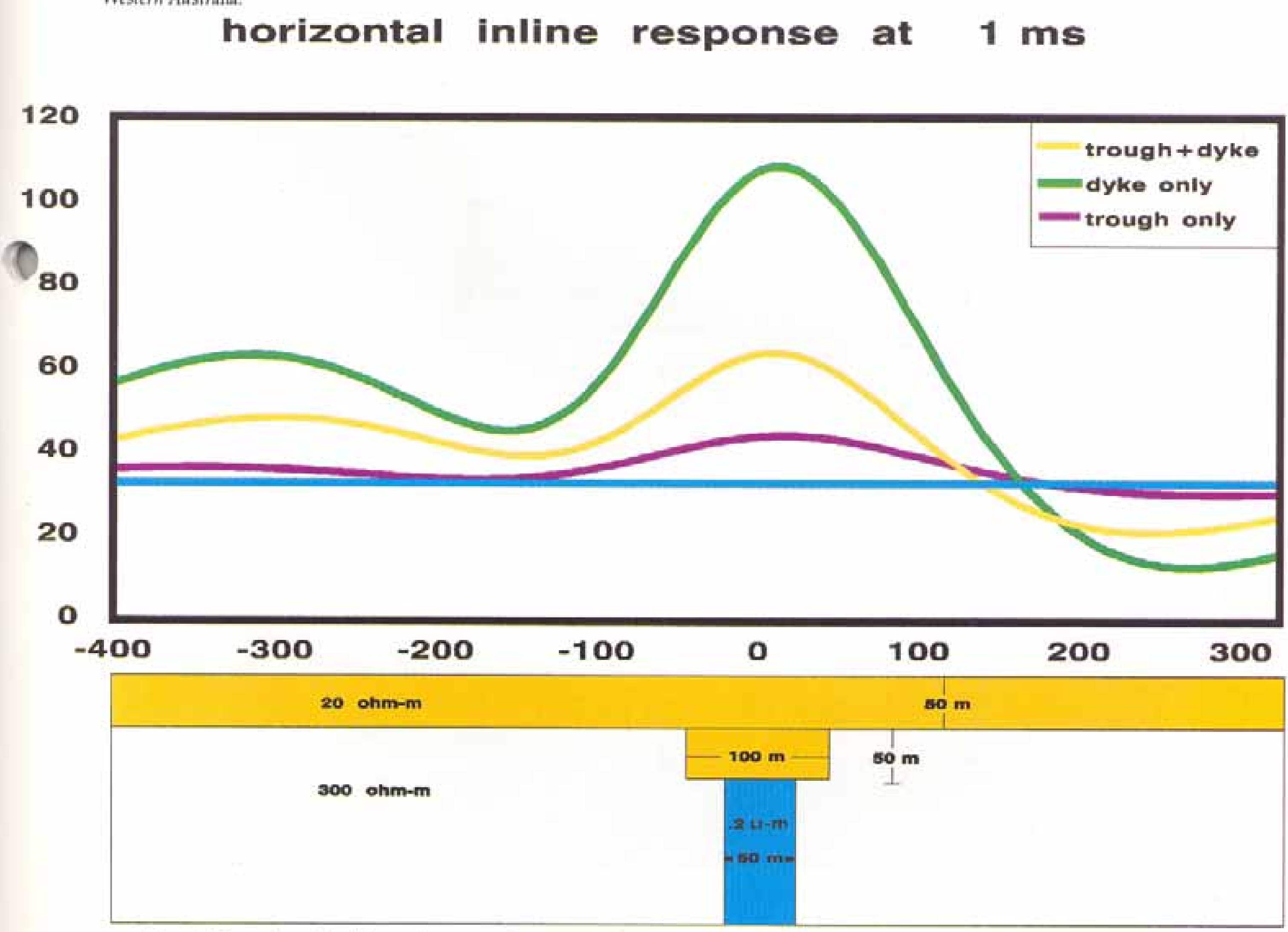
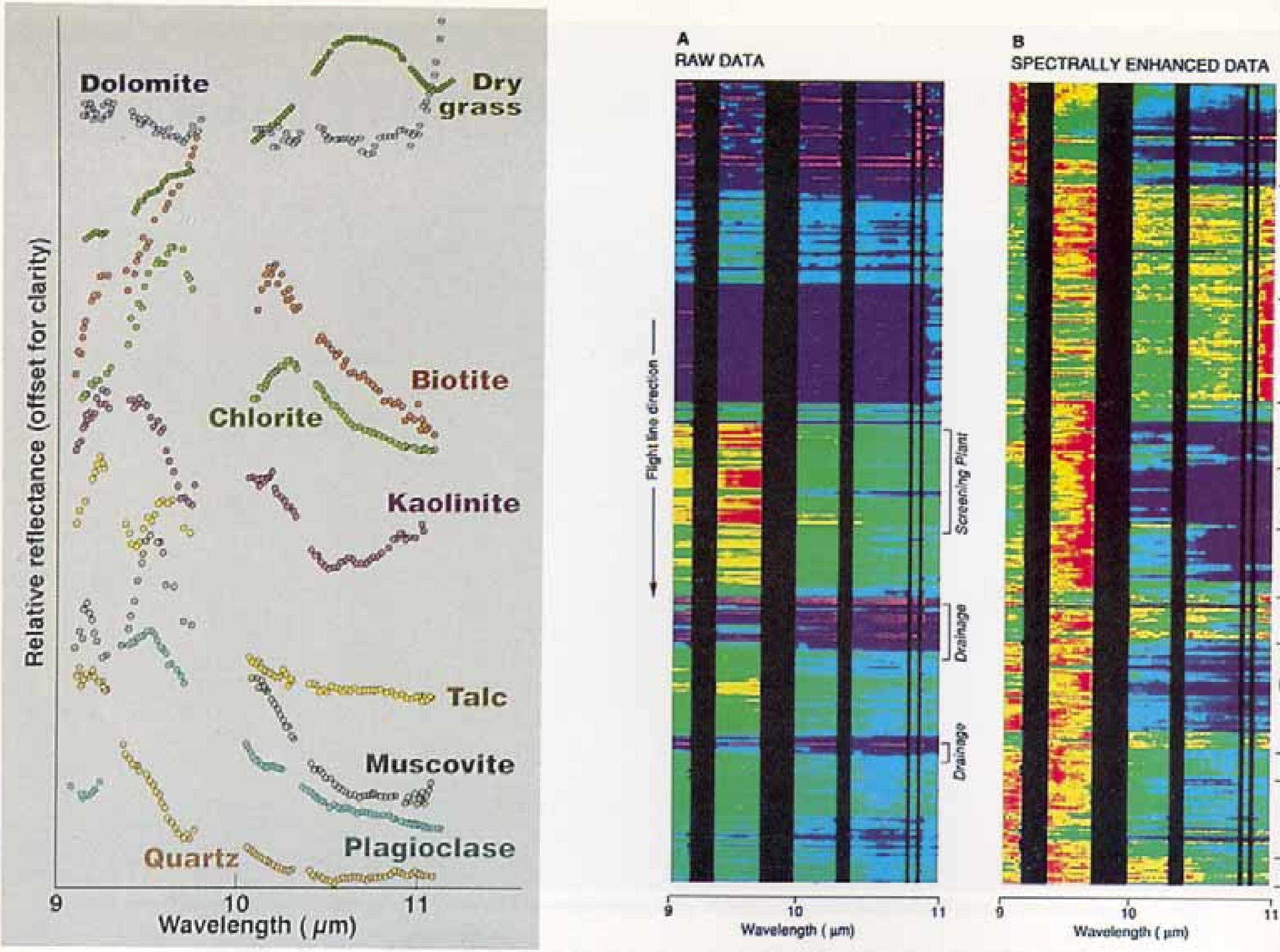


Figure 6. Comparison of the airborne electromagnetic response of a long dyke and a weathering trough with the responses of the trough alone and the dyke alone. The figure shows the details of the model and the horizontal inline responses at 1ms as calculated by Samair.



(a) (b)

Figure 7. (a) Laboratory CO_2 laser reflectance spectra of selected pure geological materials. (b) Airborne CO_2 laser profile from Mt Fitton, South Australia. Profile B covers the same area as Profile A but has been processed to enhance the compositional information.

Figure 8. AIRSAR images from Coppin Gap, Pilbara Region, Western Australia. (Flight direction left to right; near range at top of images; approximate scene centre lat. 20° 51.2′ S, long 120° 17.5′ E). From top to bottom images are single band grey tone displays for the P, L and C bands and a colour composite of all bands.

- the application of DEM data to model the landscape into components and map areas of sediment deposition or erosion;
- the integration of radiometric data with other remotely sensed data sets such as Landsat TM.

Weathering of rocks to form soils generally results in a loss of K, but U and Th concentrations may either decrease (felsic rocks) or increase (basic rocks) - the amounts being dependant on the extent of weathering, the mineralogy and chemistry of the rocks. Iron-oxide and clay distributions play a major role in the concentration of radioelements in weathered materials. These can be obtained from TM data and used to determine variations of radioelements within surface materials over different geological units.

A difficulty with applying topographical analysis to interpretation of radiometric data is that landform elements (e.g hill tops, mid and toe slopes, valley bottoms, etc) are usually of a similar size to the radiometric footprint (approximately 200m wide by 300m long). The aerial data is collected at about 70m intervals so that the ground is multiply sampled and each radiometric measurement combines signals from several landform elements. Progress has been made by the Division on the use of circularly symmetric Fourier-domain filters for restoration of the lost detail in gamma-ray surveys which will overcome this problem. Understanding the effect of regolith processes on the distribution of radioelements within surface materials over individual geological units allows much of the variation within surveys to be explained. Unexplained variations may be indicators of other unmapped geological processes such as mineralisation. Studies at the Division have shown that radioelement variations associated with mineralisation can be subtle and must be separated from the identifiable sources of variations in order to be recognized.

For further information contact: Bruce Dickson
Ph: (02) 887 8767, Fax: (02) 887 8909,
E-mail: b.dickson@dem.csiro.au

Magnetics

Magnetic phenomena play an important part in exploration and not only in the very familiar role of "bump" detection. The technology that has given us high resolution surveys and the rapid growth in its application to mapping has outstripped understanding of the relationships between magnetics and geology. This has led to an urgent need to understand more thoroughly the geological processes that create, modify and destroy magnetic minerals. These processes may relate to metamorphism, weathering or a variety of alteration styles. A simple example of the effects of metamorphism on magnetic properties and observed magnetic signatures is afforded by the anomaly associated with the major ultramafic unit of the Agnew-Wiluna Belt in the Yilgarn Block. Figure 5 illustrates the steady decrease in anomaly amplitude as the metamorphic grade increases from prehnite-pumpellyite facies in the north to mid-amphibolite facies in the south.

With the ultimate goal of integrating magnetics with geology, The Division, in collaboration with AMIRA have conceived a multi-module research project to extend our knowledge in these areas. Thus it will become possible to combine magnetic images in a more meaningful way with the geology and produce more informative maps. Defining targets with maps that contain information on metamorphism, alteration, etc, will be easier and more reliable.

In another project, the Division is developing efficient algorithms for magnetic modelling. These algorithms are designed to handle extreme situations where anisotropy of susceptibility and self-demagnetisation can not be ignored. Like magnetic remanence, which over the years the exploration industry has become very familiar with, the magnetism of rocks in extreme situations can lead to magnetic field behaviour that initially defies logic. Smarter magnetic modelling packages will allow explorationists to develop a deeper intuition of the magnetic method and will lead to better drill hole siting.

Finally, the refinement of a pair of sensitive vector magnetometers has recently allowed the Division to fulfil a long term ambition, to investigate the relationship between magnetic anomalies and geomagnetic field variations in order to determine rock magnetic properties, such as the Koenigsberger ratio, *in situ*. This will provide the industry with a more direct means of testing magnetic targets and thus reduce drilling costs.

Research in magnetics thus focuses on industry problems and attempts to overcome some of the shortcomings that have become apparent with the advent of high resolution magnetic surveying.

For further information contact: Phil Schmidt
Ph: (02) 887 8873, Fax: (02) 887 8909,
E-mail: p.schmidt@dem.csiro.au

Mathematical modelling

In collaboration with its AMIRA sponsors, the Division has produced a computationally efficient 3-D EM modelling program for ground systems, Samaya, which allows users to explore the time-domain responses of heterogeneous regions in layered half-spaces. Given that a single model has been computed, users can experiment with different transmitter waveforms and receiver window combinations in negligible extra computation time. Moreover, additional models with the same geometric structure, but with different conductivity structures can be modelled in about a third of the time required by the initial model.

Samair, the airborne incarnation of Samaya, is currently being used to perform resolution studies which will be the basis for defining the next generation of airborne EM equipment. In a study recently presented at the Tucson airborne EM workshop, the response of a long dyke under a weathering trough was compared with the responses of the trough alone and the dyke alone. It found that at normal airborne measuring times, that the response was dominated by the trough. As shown in Figure 6, at intermediate times, the dyke could be detected but the trough attenuated the direct response. At late times, (signal level below current noise levels) the trough boosted the dyke response.

The Division has also developed a program, Arjuna, which computes the time-domain EM response of an arbitrarily complex geological model of infinite strike length for any 3-D source. This allows the user to investigate the response of various realistic geological cross sections in a fraction of the time required by the equivalent 3-D model. Recent studies have shown that this paradigm gives answers which are close to 3-D models with long strike lengths at early and intermediate delay times but that at late times, the response is equivalent to a fully 2-D model excited by 2-D sources.

Leroi, a program which will allow the user to model the response of fully interacting multiple thin sheet targets in a conducting host has almost been completed. This program can be used to model deformed strips, synclinal structures constructed by intersecting sheets, and the interaction of orebodies with fault zones.

In its next three years the Division will be building a full-domain, full waveform 3-D finite-element modelling program which is planned to be more accurate and yet will require an order of magnitude less computer time than is the case with current 3-D finite-element or finite-difference programs. A generic inversion program which can be used for full 3-D as well as thin sheet inversion will also be delivered to sponsors.

The Division, in collaboration with the CSIRO Division of Radiophysics, will also be using funding from a successful CSIRO priority bid to develop the next generation of downhole EM interpretation technology. This will span the range from exploration, to resource assessment to mine planning based upon frequencies currently used by TEM systems on up to the sub-radar range. Initially, this will be focused on existing and planned commercial equipment but will also be used to define the parameters of a future CSIRO designed system. This work will be done in close collaboration with mining companies and the CMTE in Brisbane.

For further information contact: Art Raiche
Ph: (02) 887 8636, Fax: (02) 887 8909,
E-mail: a.raiche@dem.csiro.au

Mineral mapping

The Division, in partnership with the CSIRO Divisions of Material Science and Technology, Mathematics and Statistics and Soils, is embarking on a new multi-divisional program - Mineral Mapping through Imaging Spectrometry - to develop new technologies for remotely identifying rock and soils minerals from their hyperspectral signatures, using the concepts of field, air and spaceborne imaging spectrometry. The program plans to bring together the required mix of skills from around CSIRO necessary to develop the sensors, algorithms, software, underlying science and applications required to deliver an indigenous mineral mapping capability for geological mapping, exploration and land degradation studies.

After nearly a decade of successful applications research (supported by many exploration companies and AMIRA) the project aims to increase the hardware and software research so that Australia will have systems appropriate to its needs. This previous applications research has demonstrated the worth and capability of airborne identification of a wide range of iron oxide, hydroxyl, sulphate and carbonate bearing minerals. These are significant components of alteration systems around ore deposits and also of the weathered regolith. Australia's dependence on its minerals industry, the magnitude of its land degradation problems generates an increasing demand for mature local solutions. The Division believes that appropriate new sensors could revolutionise the efficiency with which some exploration and most geological mapping is performed.

Apart from developing the supporting science the project aims, with external commercial partners, to work towards a range of field, airborne and spaceborne designs and prototype and operational systems. This will involve continuing work with the Geoscan, AVIRIS and GER imaging spectrometers whilst local systems are developed. Commercial partners and investors are being actively sought to assist with components of this long term strategy.

One recent milestone in the Mineral Mapping strategy is the geological commissioning of the Division's mid-infrared, airborne CO2 laser spectrometer. This is a proof of concept instrument for development of specific new solutions for silicate and carbonate mapping in the 9.0 to 11.5 micrometre, mid or thermal infrared region. This unique, active spectrometer has recently completed a major campaign of geological mapping, along with NASA's TIMS (Thermal Infrared Multispectral Scanner), in the Broken Hill, Olary and Flinders Ranges regions. Data analysis will proceed during the next few years as part of a new Mineral Mapping AMIRA project which will develop new field and airborne methods for identifying minerals that may be vectors to ore-bearing environments. Figure 7 illustrates some of the laser data and the variation in mid-infrared spectral signatures sensed over a range of mineralogies, rock types and vegetation in the Flinders Ranges.

For further information contact: Jon Huntington
Ph: (02) 887 8839, Fax: (02) 887 8909,
E-mail: j.huntington@dem.csiro.au

Radar remote sensing

The Division has begun a new initiative in geological and regolith-landform mapping via radar remote sensing. Much of the present studies are based on the analysis of optical datasets including those from Landsat Thematic Mapper and high resolution, airborne multispectral scanners. The recent deployment to Australia of the JPL AIRSAR system on NASA's DC-8 research aircraft provided the opportunity for exploration companies to sponsor through AMIRA, a research project to examine the potential role of radar data to exploration.

The NASA/JPL airborne imaging radar polarimeter (AIRSAR) is a four-look, quad-polarization, three frequency instrument. AIRSAR collects measurements at C-, L-, and P-bands (5.7 cm, 24 cm, and 68 cm wavelengths respectively). The radar transmits and receives horizontal and vertical waves, therefore, four combinations are recorded, producing quad-polarization. This allows the calculation of any polarization combination, including linear, circular or elliptical. Also, data on relative phase difference between co- and cross-polarized returns can be calculated.

The shorter wavelength C- and L-bands are more sensitive to small-scale variations in surface roughness that can be related to the extent of soil erosion, size of surface lag gravels and the extent of weathering. P-band has a greater potential for geological studies of subsurface features.

An example of the uniqueness of AIRSAR data is shown in a comparison of the radar backscatter for horizontally transmitted and received enhancements of P-, L-, and C-band data recorded over the Coppin Gap region in the Marble Bar District of Western Australia. The lower figure is a colour-composite of each channel in R:G:B. These data were recorded at an altitude of 8 200 metres on 19th September, 1993 using a NASA DC-8 research aircraft. The data have a ground resolution of 6.7 metres in slant-range and 8.2 metres in azimuth, and the full scene covers an area 12km in slant range and 60km in azimuth.

Coppin Gap lies in an Archaean greenstone belt within the Pilbara craton. Excellent exposures of a sequence of mafic and ultramafic rocks are prominent on all images as alternate dark and bright patterns within this belt. The strength of the backscatter is strongly dependant upon the erosional and structural forms of the outcropping geology, and its dielectric behaviour. It is possible to recognize different lithologies within the sequence based on surface roughness, vegetation cover and possibly compositional information provided in the images. Topographically expressed structures including regional foliation trends and fault patterns are also very apparent at both the regional and local scale.

The penetrative capability of the longer-wavelength signals is apparent in both the P-band and colour composite images and, to a lesser extent, in the L-band image. Patterns within the sandplain region in the lower-left sector suggest an extension of the adjacent greenstone lithologies beneath the sand veneer. An indication of the relative depth of sand and levels of penetration for each band is indicated by the varying intensities of radar backscatter from the subsurface materials.

For further information contact: Ian Tapley
Ph: (09) 387 0263, Fax: (09) 387 8642,
E-mail: i.tapley@dem.csiro.au

Seismic monitoring

In-mine seismic monitoring is undertaken on a routine basis in many of the deep mines of South Africa and Canada where catastrophic rock bursts represent a daily hazard. Seismic monitoring allows the locations and magnitudes of rock bursts to be determined and unstable areas of a mine to be identified. Except for a few instances, the problem is not severe in Australia. Seismic monitoring, however, can still provide extremely useful geotechnical data. Figure 9, illustrates an example. In this case, a seismic monitoring station was established on the ground surface, directly above the operating face in a longwall coal mine. Over the 8 days measurements were taken, thousands of events were recorded. Their frequency correlated well with the rate of mining but significantly, they continued even when there was no mining. A cyclic pattern in the number of events is attributed to the cycle failure in the roof and loading on the longwall supports. A period of anomalously high seismic activity is believed to be associated with the release of methane gas trapped in the overburden. Current research is being directed at locating the seismic events to determine the extent of fracturing in the overburden. The possibility that the fractures might extend to and drain overlying aquifers is a major concern to some underground mining operations.

For further information contact:
Peter Hatherly
Ph: (07) 212 4621, Fax: (07) 212 4455,
E-mail: p.hatherly@dem.csiro.au

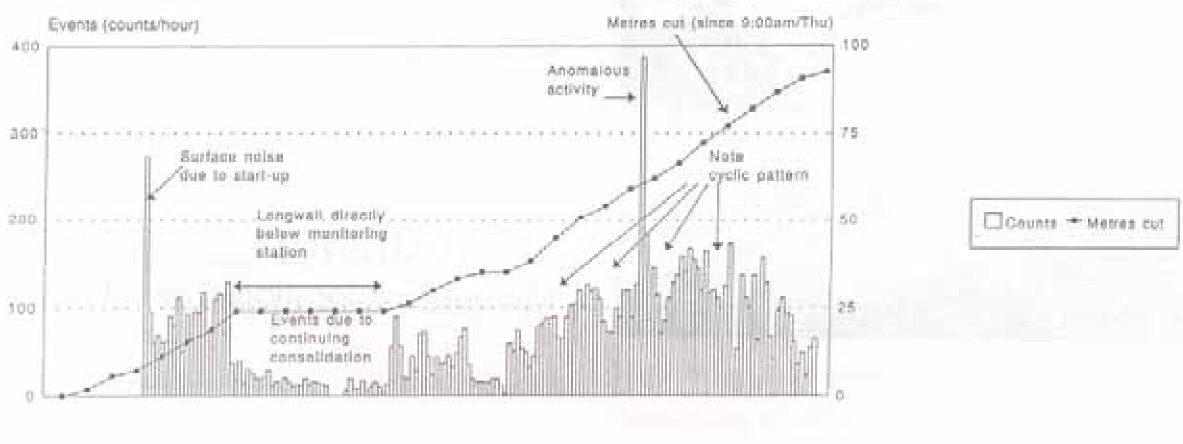


Figure 9. Comparison of seismic activity with mining rate at Tahmoor coal mine, New South Wales.

Electromagnetics

In the past three years, a major part of the Division's electromagnetic (EM) geophysics research has comprised the development of a broadband airborne EM system called SALTMAP in collaboration with World Geoscience Corporation Ltd (WGC) in Perth. A total grant of $1.5 M was provided by the federal government's GIRD and the Western Australian government's WARD schemes for this research and development. The purpose of SALTMAP is to map the resistivity of the regolith in three dimensions, and in particular, to locate the existence of potential soil salinity hazards, by associating lateral and vertical variations in resistivity with hydrogeological factors (such as recharge) which affect the movement of salinity.

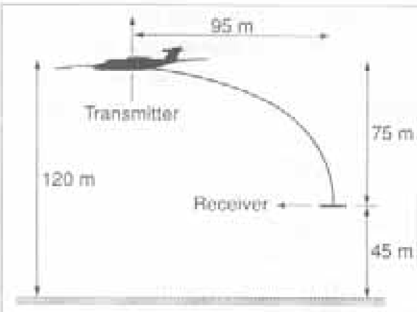


Figure 10. Geometry of the SALTMAP system transmitter and receiver. SALTMAP is installed on World Geoscience Corporation's Britten-Norman Trislander

To operate SALTMAP, a transmitter loop has been mounted on WGC's Britten-Norman Trislander aircraft (Figure 10) and three-component measurements of the broadband EM response are made with three orthogonal receiver coils enclosed in a bird which is flown at some distance below and behind the aircraft. This bird was designed and constructed at the North Ryde laboratories.

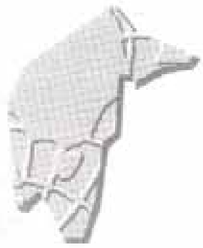
The design specifications for SALTMAP were derived using advanced inversion software developed within the division (see Mathematical Modelling section). Further investigations have recently been carried out using an airborne EM one-dimensional inversion program developed by WGC and Macquarie University to model the response of SALTMAP over various saline environments. In collaboration with the CSIRO Division of Water Resources, ground-based transient EM (TEM) surveys have been made to establish calibration lines for SALTMAP.

An AMIRA project to develop new sferics rejection algorithms and TEM sensors other than induction coil sensors is about to be completed. In collaboration with the CSIRO Division of Mathematics and Statistics, a new method of rejecting sferics has been incorporated into SIROTEM. Details of this algorithm will be released at the end of this year. The use of commercially-available magnetic-field sensors has been investigated, and further developments are to be carried out as part of a new research project supported by CRCAMET and AMIRA.

For further information contact: Jock Buselli
Ph: (02) 887 8837, Fax: (02) 887 8909,
E-mail: j.buselli@dem.csiro.au

ASEG Branch News

ACT



The ACT Branch of ASEG held a seminar and meeting on 21st October, presented by various personnel from CRA Exploration Pty Ltd, with the seminar titled "Informal demonstration of software used by CRAE for managing geophysical datasets". The seminar was held at the CRAE offices in Canberra, and provided ASEG members with an insight into computer hardware and software facilities that CRAE currently use to manage geoscience datasets including landsat, magnetic, gravity, cultural info, mineral depoist locations and geochemistry information. The demonstration was excellent in showing the current computer power for Macintosh and IBM compatible PCs, and the range of relatively low-cost off-the-shelf software available to manage and integrate datasets.

The AGSO/ASEG Spring Golf Classic was held on the 5th November at the Belconnen Golf Course, with Alan Hogan again taking out the Golf Champion's cap.

The branch is yet to finalise a Christmas function and venue, however Christmas and New Year Greetings are sent to all ASEG members, and we hope that 1994 brings new ideas and enthusiasm in an otherwise depressed geophysical exploration industry.

Kevin Wake-Dyster, Secretary

South Australia

An informative talk by Malcolm Lansley of HGS was well received and well attended on October 20. Malcolm has extensive experience in 3D seismic acquisition and processing techniques, and he gave a presentation on 4D seismic. He presented the results of using repeated 3D seismic in the North Sea to trace fluid flow from EOR schemes. Special thanks to Halliburton Australia Pty Ltd for their sponsorship of this meeting.

The annual students presentation evening was heldd on Novemeber 18, and was generously sponsored by SAGASCO Resources. What promised initially to a be a very full and varied agenda turned out to be somewhat disappointing when four students withdrew. After a hasty reorganisation the following agenda was presented to the 70 or so members who attended:

1. James Donley: Seismic and electrical study of part of the McArthur Basin.

2. Michael Carbone: Variations in permeability and porosity.

3. Steve Markham: Induction effects on Gawler Craton tied to South Australian Exploration Initiative aeromagnetic surveys.

4. Nick Gyngell: Magnetotelluric study of the Willunga Basin.

5. Daniela Davi: A structural interpretation of a detailed ground magnetic survey, Burrawing area, Tumby Bay, Eyre Peninsula.

6. Mark Wegner: Gravity and aeromagnetic study of the Bendigo Granite.

Judging was very difficult as all papers were of a similar calibre and consequently the prize for best paper was divided between two students. Congratulations to James Donley and Nick Gyngell for best paper. Mark Wegner is to be congratulated for the best presentation. Once again thanks to SAGASCO for their sponsorship of this meeting.

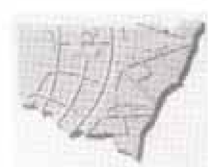
Grant Asser, Secretary

Editor's Note:

Oops - We're sorry

In October 1993 Preview (p54) we incorrectly assigned Ashley Duckett's face (opposite) to Grant Asser (incoming Secretary). Ashley has been SA Branch Secretary for most of 1993.

New South Wales



The NSW ASEG General Meeting was held at the Bowlers Club, Sydney, on October 27 continuing the environmental geophysics and environmental management theme adopted by the NSW Branch this year. Noel Merrick from the National Centre for Groundwater modelling, with specific reference to Sydney's very topical third runway project. The talk was well received in what was a comprehensive account of the science and its implications.

A current update for the AIG/ASEG symposium, "Geoscience - Managing the Environment" set for February 9-11, 1994, at the University of NSW has seen strong support from fields such as mining, environmental engineering and geophysics, waste management, and technological applications for the geoscientist Workshops focussing on geophysics and environmental geochemistry are to run consecutively, with the three day symposium culminating in a social dinner and excursion on the final day. Any enquires should be directed to one of the following people:

Michael Leggo (02) 259 1201	Tim Pippett (02) 529 2355
Bill Ryall (02) 809 0666	Brian Gulson (02) 887 8666
Philip Hellman (02) 484 8163	David Cohen (02) 697 4273
Dereke Palmer (02) 697 4275	Aro Arakel (02) 334 0887

Shane Wright, Secretary

Western Australia

Christmas Greetings from the Western Australia Branch ... may you have a happy, safe and prosperous new year!

On October 29th, a small group of enthusiasts gathered for the celebration of Octoberfest, with bus transport between venues. Many thanks to ASB, Tesla 10 and Aerodata for the use of their premises, and congratulations to Lou Vincent for correctly identifying the most beers, and commiserations and the Berocca for Sid Greenham who failed to get any correct, but obviously enjoyed trying.

Student nights were held on November 10th and 17th. A total of eight excellent presentations were given over the two evenings. Congratulations to all those who presented papers, it is gratifying to see that our profession is being augmented by such talented newcomers. Special note should be made of two papers and their presenters:-

Antony Price for his paper "Correlation of Gravity and Magnetic Data from Corsair, WA" which was awarded "Best Technical Paper" and

Chris Dauth who earned "Best Presentation" for his paper "Influence of Groundwater on Mapping geoelectric Boundaries within Regolith, Mt Gibson, WA".

The lead up to the Christmas silly season will start with the annual PESA/ASEG golf day on December 3rd.

Andy Padman, Secretary

Queensland

No branch meetings were held in November

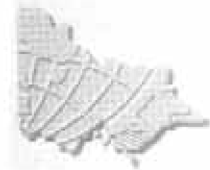
Our main social activity for the year was our Annual Dinner held on 27 November at the Bangkok Thai Restaurant. The event was a combined dinner with AIG members for a total of about 40 people. The AIG and ASEG branches supplied the drinks making the evening exceptional value. Everyone appeared to enjoy themselves, particularly the red wine drinkers. The fact that the only drinks left were light beer may indicate something about the branch members of both societies but I will leave any analysis until after my headache clears. The evening was considered a huge success.

Committee members have decided to wait until after the Conference to hold any short courses. Feedback on the type of material you wish to cover would be appreciated. Any ideas on guest lecturers would also be appreciated.

Since most of the current students will complete their theses in the middle of next year, we have decided to postpone the student night until then.

Wayne Stasinowsky, President

Victoria



December 8th is the annual Student night to be held at the Kelvin Club. Four students from various Victorian Universities will be presenting a 15 to 20 minute talk on the following:

Geoff Parker - Monash University

Alternative IP data presentation for interpretation.

Tim Mackey - Monash University

Sources of error in gridding and processing airborne magnetic and gravity data..

Jane Mitchel - Monash University

Ararat: Geology and Geophysics.

Rachel Perry - Melbourne University

Seismic reflection and opal exploration.

The 1993 Victorian ASEG Committee wishes everybody a Merry Christmas and Happy New Year. We would appreciate the members continued support for 1994.

Zis Katelis

ASEG Financial Statement - 1992

Summary Report

This report outlines the state of the ASEG finances as reported to the end of 1992. These have only recently been completed, and are still being audited as this is written. I do not anticipate any difficulties there.

Thanks to the support of Branch Treasurers, almost all of the financial information was available at Easter this year, but the delays have occurred in tying up some of the fine detail in some areas. One example was the difficulty in locating the Hawkins Fund; there was no record even of the bank where it was lodged, much less of the account operators!

The overall income to the Society was just over $268 000, slightly down from 1991, and resulted in a surplus over expenditure of $49 000.

The distribution of income and expenditure by major divisions is illustrated here, with some comments.

Summary Table ($,000)

1992 Income		1992 Expenditure	
Member Dues	39	Society Running Costs	54
Interest etc.	18		
Publication Revenue	37	Publication Expenses	118
Donations	0	Grants and Awards	10
Conference surplus	120	Surplus	49
States' Revenue	55	States' Expenditure	37
Totals	**268**		**268**

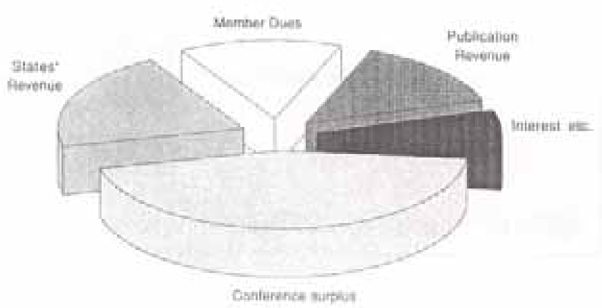
Income Features

Donations in previous years were mainly to the Research Foundation, but we have now been advised that, since the Research Foundation is a separate organisation, their transactions should not appear as part of ASEG books. (Donations for the Foundation are simply forwarded directly to the Foundation Treasurer if received by ASEG.)

Publication income and expenditure includes both Preview and Exploration Geophysics. These have not been separately isolated in the Financial Statement to allow simple comparisons with the 1991 situation, but I expect to show them separately in 1994.

The Conference surplus is that from the Brisbane, 1992, Conference, but does not include the final distribution from that conference.

Sources of Income

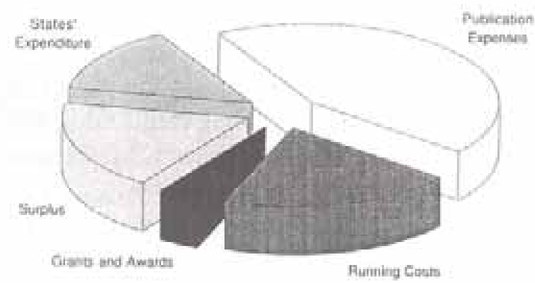


Expenditure Features

Over 50% of the "Running Costs" item represents secretariat expenses (including postage), and accounting fees make up a quarter, while capitation payments to the States are the third-largest item.

Although costs for Preview are lumped together with those for Exploration Geophysics in the Publication Expenses item, the journal accounts for 90% of the costs.

Expenditure Distribution



A significant item in the Publication Expenses area was the writing off of more that $5 000 in bad advertising debts accumulated during the previous few years, bringing the total written off to over $15 000 in the last two years.

Most of the running costs are met from membership fees, plus interest on the Society's capital, and the massive shortfall in publication is covered by the surplus on the conference.

Changes from 1991

The conference surplus is a really significant improvement over 1991, and buoys the rest of the Society activities.

Membership income is down somewhat from 1991, as the result of a different date at which invoices were sent out and a lack of information about the income received in 1991 from 1992 membership fees. We plan to control this more tightly in future; total income from membership should be around $50 000 in a normal year. This offsets roughly the losses incurred in publishing Exploration Geophysics and Preview.

Most costs have increased noticably, although the increase in Society running costs is almost completely ($17 000) due to the move away from the 'shelter' of government support for the secretariat function. The net surplus is, accordingly, down.

Present Situation

The Society is still, obviously, in a very healthy state, with more than $300 000 in reserve. We have committed to a payment of $15 000 per year to the Research Foundation for three years on the basis of this. However, the very high cost of publishing Exploration Geophysics, if continued, would swiftly diminish the reserves.The Executive Policy has been to maintain reserves against a catastrophic loss on a Conference or Publication.

More Details

Copies of the full Financial Statement will be sent to the States as soon as the Auditor has cleared the books and they have been tabled at the Federal Executive. I expect that they will then be available to interested members for review.

Lindsay Thomas, Federal Treasurer

Obituary - David Lyus

All those involved with airborne geophysical surveys, worldwide, were saddened to hear of the sudden death of David Lyus, Manager - Electronics for Geoterrex Pty Ltd Australia, of a heart attack while installing a helicopter magnetometer and spectrometer system for a survey at Bau village, Vanua Levu, Fiji, 18th October 1993.

Following extensive aircrew service as a Certified Telecommunications Engineer in the Royal Air Force, David joined Canadian Aero Service in 1959 as an electronics technician and airborne operator on surveys in Spain; within a year he was installing and operating magnetometers systems for Aero Service in Australia. David was project manager on many early commercial surveys during this time.

From 1966-72 David was the Manager - Electronics for Geophysical Resources Development Company (GRD Co) and from 1972-87 was the Manager of Technical Operations for Geometrics International Corporation. SInce 1987 and until his demise, David was the Manager - Electronics for Geoterrex Pty Ltd in Australia.

Davids experience, expertise and ability to adapt, install and calibrate survey and navigation systems for both fixed wing and rotary wing aircraft brought him a reputation, on all continents and over four decades, that will not be equalled. His early adaption of military ASQ10 fluxgate magnetometers to survey configuration, his uncanny ability to degauss an aeroplane and his brilliant and innovative adaptations of doppler navigation systems to exceed manufacturers stated capabilities are legendary.

Over the years, Davids exceptional diligence in obtaining the highest quality raw magnetometer and radiometric data set the standards and baseline for the industry worldwide.

He will be sorely missed by his many friends and colleagues.

Doug Morrison

Gippsland Basin: Opportunities for Further Research

Peter Moore
Esso Australia Ltd.

Key Risks For Petroleum Exploration

- Source
- Maturation
- Migration
- Trap Geometry
- Reservoir
- Seal
- Preservation

Gippsland Basin Risk Categories Ranked By Relative Importance

Seal

- 70% of the basin's remaining potential lies in fault dependent traps.

Trap Geometry

- Many key remaining leads lie in areas where depth conversion issues are critical.

Reservoir

- Locally important: (1) Deep play potential; (2) Top Latrobe play in the east.

Migration

- Key to assessing oil/gas split and potential on shelf-slope break.

Source

- Important to deep basin potential and flank areas.

Maturation

- Also key to assessing oil/gas split and potential on shelf-slope break.

Preservation

- Key to assessing flank areas affected by fresh water wedge.

Risk Rank 1: Seal

Status of Knowledge

- Good sequence stratigraphic framework and modern grid of regional seismic.
- Good theoretical and empirical models for cap seal and fault seal efficiency.
- Limited understanding of anomalous fault-sealed discoveries (e.g. West Tuna).

Opportunities For Research

- Studies of fault gouge composition and behaviour in coal-bearing sequences.
- Development of predictive models for fluid flow on cementation in fault zones.
- Studies of the effects of inversion of faults on fault seal capacity and fault gouge composition.
- Finer palynological subdivision of the stratigraphic section.

Relevance to Ongoing Exploration

- Widespread, general application for future Intra-Latrobe exploration.
- The majority of identified leads are fault-dependent.

Risk Rank 2: Trap Geometry

Status of Knowledge

- Modern exploration utilises 3D seismic.
- Remaining Top Latrobe leads are sensitive to depth conversion errors.
- Depth predictors to within 1 percent are often required for commercial success.
- Intra-Latrobe trap geometries in the west of the basin are often poorly defined due to poor seismic imaging.

Pacific Titan Shooting seismic in Bass Strait.

Opportunities For Research

- Improved methodologies for acquiring and processing seismic data in areas of rugose water bottom.
- Improved methodologies for acquiring and processing seismic data in areas where sub-coal imaging is a problem.
- Improved understanding of the Seaspray group (especially the relationship between facies, diagenesis and velocity response).

Relevance to Ongoing Exploration

- Sub-coal imaging is critical to deep Intra-Latrobe exploration in the west of the basin.
- Better depth conversion methodologies for the Seaspray Group would lower risks on leads in the east.

Risk Rank 3: Reservoir

Status of Knowledge

- The presence of reservoir is generally not a problem in the Gippsland Basin.
- There is an abundance of well data from the upper Latrobe Group.
- There are two key problem areas: (1) Top Latrobe Group in the east; (2) Deep play potential.

Opportunities For Research

- A model for the evolution of the proto-Marlin channel could contribute towards understanding of reservoir distribution at the top Latrobe in the east of the basin.
- A regional sediment distribution and basin fill model could contribute towards understanding of rervoir quality in the deeply buried Cretaceous units.
- A regional heatflow and temperature model would help constrain any diagnetic model.
- Further work on the evolution and distribution of dolomites may be warranted.

Relevance to Ongoing Exploration

- Deep basin tests require an accurate and predictive reservoir model.
- Top Latrobe tests in the east require an accurate sequence stratigraphic model.

Risk Rank 4: Migration

Status of Knowledge

- Sandy Latrobe section is quite leaky:- 90% of discovered hydrocarbons occur at Top Latrobe Group.
- Main Intra-Latrobe seals are thick marine shales (eg. Flounder) or thick, clay-rich non-marine units, however thick non-marine units can form major seals (eg. Kingfish, Fortescue).
- Specific migration pathways are poorly understood, due to complex non-marine geology and the intricate nature of the problem.

Opportunities for Research

- Integrated study of all data relevant to migration pathways: - Intimately linked to the problems of defining fault seal and cap seal potential. - Also linked to an understanding of faults as potential migration conduits.

Relevance to Ongoing Exploration

- Widespread, general application for future Intra-Latrobe exploration.

Risk Rank 5: Source

Status of Knowledge

- Presence of widespread, non-marine, oil prone source is well established:
- Oil vs gas potential in mature areas relates to abundance of long-chain aliphatic groups:
- Coals are believed to have significant oil-generative potential.

Opportunities For Research

Major

- Quantification of oil generative capacity of coals
- Improved link between non-marine subfacies, coal types, and oil potential.

Minor

- Documentation of source potential for marine units.

*Sikorsky 57b on Diving Support Vessel **Shearwater Sapphire** at Mackerel Platform in Bass Strait.*

- Documentation of source potential for Golden Beach and Strzelecki groups.

Relevance to Ongoing Exploration

- Generally low, but locally very significant - Deep plays, flank areas, SE basin edge.

Risk Rank 6: Maturation

Status of Knowlege

- Good regional grid of VR and temperature data from well control.
- Fair set of information on oil and gas maturation levels: - Significant oil generation at 0.9 - 1.3% VR.

Opportunities for Research

Major

- Development of temperature and heatflow model for deep, undrilled section.

Minor

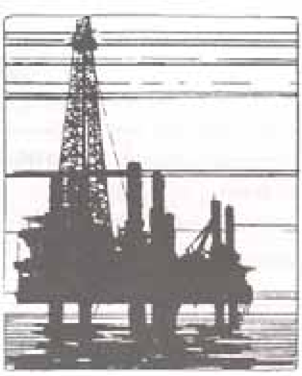
- Study of kerogen kinetics for various source types.
- Further refinement of heatflow history for the basin.

Relevance to Ongoing Exploration

- Generally low, but locally very significant: - Hydrocarbon potential adjacent to the shelf/slope break

Summary and Conclusions

- There are ample opportunities for quality research to be carried out in Gippsland.
- Gippsland is semi-mature: problems requiring solutions are complex ones needing a sophisticated approach which integrates all available data.
- Esso is currently focussing its own research on (1) seal quantification and mapping, (2) improved depth conversion methodologies, (3) improved seismic data and (4) better reservoir quality predictions.
- We encourage universities and other groups to talk to us as part of their research process.



History Of Geophysics

Geosurveys

Geosurveys of Australia Limited was established in 1954 as the brainchild of Dr Reg Sprigg. Its aim was primarily to serve exploration interests in mining, prospecting and oil exploration, particularly on behalf of smaller companies, groups and individuals.

Reg Sprigg had a background with the CSIRO Division of Soils and the South Australian Geological Survey.

After the Second World War, responsible mining people recognised that the Australian exploration industry had suffered a severe lack of new discoveries during the early twentieth century. In fact, since 1923 when Mt Isa was discovered, and with the exception of Aberfoyle tin and King Island scheelite, few worthwhile new finds had been recorded. This situation could not be allowed to continue. New enterprise was needed and the discoveries of oil and uranium in 1953 and 1954 lead to the formation of the company.

When Rough Range made news headlines in 1953, Dr Sprigg decided to launch out as a consultant geologist. Greater public interest in mineral potential, particularly in uranium and oil made this move possible. A uranium company, Uranium Development and Prospecting NL, operating in the Darwin-Katherine region provided the first opportunities. Regional scouting involved in this operation provided an unusual opportunity to view many of the metalliferous prospects in the Darwin-Katherine area and also of the Mt Isa region. Significant uranium discoveries were made on the Alligator River field, and the Adelaide River Mine produced uranium for sale to Rum Jungle until its forced premature closure, a closure prompted largely by external influence.

Soon afterwards, the formation of SANTOS Limited, in which Geosurveys was directly involved, provided the other needed opportunity, namely, an entrance into the promising field of oil exploration.

By mid 1954, it was possible to employ additional geological assistance, enabling Geosurveys to follow a number of new and promising exploration leads in the Northern Territory and also in Western Australia, South Australia and Queensland.

In view of the past history of mining exploration, the need to diversify was fully realised and the opportunity to enter into exploration for base metals arose. Low grade nickeliferous laterite deposits had been briefly viewed by Dr Sprigg and Mr RB Wilson for the Mines Department in 1953 when engaged in regional mapping in Mt Davies area in the far north-west of South Australia. A small syndicate was formed to investigate this deposit and was followed by the incorporation of Nickel Mines of Australia NL. Subsequently, the International Nickel Company of Canada joined in the search on a major scale and Geosurveys became the principal field contractor for the project.

During the early phases, a number of first class geologists joined the staff. Of these, Mr Bruce Webb merits special mention.

In 1955, Mr RF Middleton, who had been associated with Dr Sprigg on the Radium Hill project for the South Australian Government, became Geosurveys' Accountant and Secretary and joined the Board of the Company.

The Sprigg family home at Todville Street, Woodville West, with its several acres of land, was made available on generous terms by Mr CA Sprigg, senior, and converted to drafting offices, laboratories and a depot.

An associate company, Specimen Minerals (Australia) Limited, modelled very modestly on the lines of Wards of New York, the largest mineral and specimen dealing company in the world, was formed. Mr DR Walter was appointed its manager. A wide variety of Naturelle baroque jewellery was produced by this company, and this venture proved highly popular and profitable. New warehouses were erected at Woodville. Mineral, rock and fossil specimen stocks, and equipment stores for prospectors and students were accumulatedd. These operations were subsequently divested from Geosurveys.

The first year or so of Geosurveys' existence had seen its principal interests in consulting. The need for expanded geological and geophysical services, and for the supply of special equipment necessitated increased staff, and the addition of new services and facilities.

The petroleum section became better defined and senior overseas personnel were imported. Many young Australian geologists were added to the staff as well as more senior scientists and technologists.

With the establishment of the petroleum section came the need for more diversified laboratory techniques. A photogrammetric section was added to speed the basic geological mapping so essential to oil exploration. This became a major company activity.

Map making from vertical aerial photographs was made a specialist operation, and to this was added the professional services of photo-interpretation for the rapid preparation of preliminary field geological maps to support expanding field teams. Geosurveys inaugurated the first non-governmental geophoto organisation operating in Australia.

Darby Van Sanden in the 5½ tons diving chamber he designed for operations to 130 metres below sea level from Geosurveys MV SAORI - circa mid 1960's.

Other new sections were soon added. New services included airborne geophysical surveys, surface gravity surveys, mine surveying, topographical mapping, traverse levelling and astrofixing. Well equiped soils engineering laboratories were established and the field of electronics was entered temporarily to cope with the demand for advanced soils testing equipment.

Geosurveys grew to own four truck mounted drills. The largest was a Failing 1500. The others were two Mayhew 1000s and one Conrod Stork.

The Mayhews were fully engaged in seismic shot hole drilling and, whereas the Failing was used extensively in this sphere, it was used also in water, structure and stratigraphic drilling in oil exploration. Company workshops were expanded on a large scale to handle the specialised maintenance of these plants.

In 1958 the company's head office was transferred to DaCosta Building, in Grenfell Street, Adelaide.

A new company, Geoseismic (Australia) Limited was formed in June 1959 to handle seismic exploration in conjunction with Geosurveys. Additional North American experts were bought to Australia to manage and reorganise these operations.

Seismic techniques were the most costly of all geophysical operations. The basic equipment included rotary drills, highly complex, truck mounted electronic equipment and much auxiliary plant in the form of vehicles, tankers and shooting trucks. The costs were high, but the technique was a foremost tool in oil exploration.

At the end of 1963, Geosurveys of Australia Limited changed its name to Geosurveys of Australia Pty Limited which company later became a subsidiary of Beach Petroleum NL. Beach Petroleum had been formed to exploit, amongst other things, the lease areas which Geosurveys had gained control of largely through default in payment of fees by small, underfinanced leaseholders for which it had performed work.

Geosurveys owed much to its senior staff, both professional and technical. Some were from North Americal, others from Europe, and many were from Australian universities, a fact of which the company could be justifiably proud. However, the enthusiasm of its key personnel guaranteed its success. Most of its staff was young and ambitious and the rapid growth of the company bought its own excitements and rewards.

Geosurveys - Beach Petroleum N.L. first seismic survey conducted on S.A. metropolitan beaches in mid 1960's

Dr Wilfred Stackler, originally of SEISMOS, Germany, emigrated to Canada, post WWII, then to Australia to join Geosurveys of Aust. P/L in 1960's is seen here with the gravity meter operator.

By 1967, the revolution in seismic exploration bought about by new digital technology had sounded the death knell of the small geophysical contractor. Two or three big players had already begun to control the marketplace.

By 1975, the squeeze between the big players and the needs of Beach Petroleum NL resulted in the company's operations being transferred to Melbourne, ending an exciting and productive chapter in the annals of South Australian and Australian geological, geophysical and minerals exploration history.

The company was responsible for many firsts in Australia. The following is just an extract.

- The first permanent contract gravity team in Australia.
- The first wholly Australian airborne scintillometer survey.
- The first contract geophoto laboratory.
- The first marine gravity survey.
- The first deep sea diving chamber in Australia.
- The first contract SCUBA-operational services.
- The first offshore exploration/probe drilling in Australia.
- The first use in Australia of average gravity gradient in geophysical exploration.

Geosurveys was pioneer in the use of aircraft in its sphere of operations, using both fixed wing aircraft and helicopters from the very early days.

Toward the end, Geosurveys of Australia Pty Limited included the following subsidiaries.

- Geoseismic (Australia) Limited
- Geoservice Pty Ltd
- South Australian Oceanographic Research Institute Ltd

Reg Sprigg

Geosurveys - 40th Anniversary Celebration

In the 1950's and 60s, a South Australian, Dr Reg Sprigg, and his company, Geosurveys of Australia Ltd, played an enormous part in the exploration for and development of, the natural resources of this country.

In May 1992 there was a reunion of former staff of Geosurveys of Australia Ltd. Of the 400 approximately people who had worked for the organisation throughout the 20 years of its operation, around 200 people were located, and approximately 90 former employees attended the reunion.

The success of that occasion prompted the idea of a 40th anniversary celebration of the founding of Geosurveys on 12th March 1954. It was also suggested, by Reg Sprigg, that it be held at his home at Arkaroola in the Flinders Ranges of South Australia.

This reunion is now planned for the 12/13th March 1994, at Arkaroola.

The secretary of the organising committee is :

Fleur De Laine
37 Diosma Drive
Coromandel Valley SA 5051
Ph: (08) 278 4080 (H)
or Department of Mines and Energy of S.A.
Ph: (08) 274 7579

Because of the enourmous influence of the man and the company, and the time that has elapsed since the enterprise closed, we feel that in addition to the former Geosurveys staff already located and contacted, or knows of anyone who has not been, please write or ring the above.

We would very much like you to be part of this momentous occasion.

Orebody Delineation:

A summary and discussion of the outcomes from the AMIRA Annual Technical Meeting, Kalgoorlie, September 9, 1993.

The AMIRA Annual Technical Meeting was held in Kalgoorlie on the 9th of September. It had the dual themes of orebody delineation and continuous excavation. The meeting was well attended with over 110 delegates turning up. Three key papers on ore delineation were presented. One was delivered by Dr Ken McCracken who reported on the results of the AMIRA study "The application of geophysics to mine planning and operations". Dr Andrew White from the University of Queensland delivered a paper entitled "Taking geophysics from the black box to the mine face". In the paper entitled "What is the prize", Peter Williams of WMC outlined some of the problems and clearly highlighted the cost to industry of poor delineation of the orebody.

After presentation of the main papers the delegates were broken up into a series of discussion groups. Each group had the task of examining issues relating to one of the two main themes of the meeting. Three groups discussed the impact of technologies of orebody delineation and in particular what are the impediments to the implementation of this technology.

Each group reported back to the meeting after their deliberations. From the group discussions and the subsequent open discussions the following key points emerged.

- Technologies already exist that provide the basis to help miners improve the definition of the orebody.
- To be routinely used, however, the technology has to be adapted or developed further specifically for the harsh conditions underground.
- There is no one technology that will be suitable for all problems, it is important that the right technology is chosen for the specific problem.
- There are significant impediments to the use of this technology, both cultural and technological.
- There is a need to build credibility in existing technology before embarking on a major R&D effort.
- Routine application of such technology will require better communication between mining geologists, geophysicists and mining engineers.

Some of the delegates pointed out that orebody delineation is not just a matter of defining the limits of the orebody it must include an economic definition as well as internal spatial variability of a number of different parameters.

Some of the discussion groups considered the following questions; Why should miners adopt this technology? What are the potential benefits associated with better delineation of the orebody? The benefits that were identified include:

- less dilution/higher grade
- increase reserves
- less diamond drilling and better location of holes
- optimised mine design
- lower mine and mill costs
- improved safety

In AMIRA's view orebody delineation is a continuous process which commences at the early mine planning stage and continues on to the operating end where detailed information is obtained using all available holes to continuously update the 3D geological model of the orebody.

Ken McCracken pointed out that ore delineation has not only a scale dimension but also a time one as well. Thus at the early mine planning stage where holes may be 100 metres or so apart a different approach may be required to that necessary at the operating end, ie. at the scale of the stope, where holes may be 20 metres apart or less. Also the timeliness of results at the early planning stage is not as critical as it is at the operating end. This difference imposes more rigorous constraints on the specifications of the technology that can be applied at the operating end and in particular in the underground environment.

What are the impediments to converting existing technologies into useable technologies and to the utilisation of such technology?.

One major impediment is a cultural one. In the past miners have accepted dilution as a necessary evil perhaps because there was little they could do about it. Management was under no real pressure to improve the situation because the bottom line was generally quite healthy. Little was done to use existing technologies to alleviate the problem. Thus there is no history of routine use of remote sensing technologies in the mining sector as there clearly is in the exploration sector. Times have changed however, mines now have to be more efficient and be able to compete internationally more effectively. To achieve the improvements companies have mainly concentrated on reducing costs by employing more efficient extraction processes and through staff restructuring. This emphasis on reducing costs meant that management has tended to overlook the potential to improve the revenue side of the equation.

It has been estimated that the loss to dilution could be as high as 25% of all mine costs as a result of increased cost of production and lower head grades being mined. It may in fact be much higher. Dilution not only reduces grade but has a cascading affect on mine and mill costs. Peter Williams indicated for example that if dilution can be reduced by 5% at WMC's Kambalda nickel mines it is possible to save about $4.5 million/year in mine, mill and transport costs. Alternatively if one can realise an increase in production grade of 0.1% through better ore delineation then a increase in revenue of about $8 million is expected simply from increased metal production. These figures are not representative for all mines. However, they do indicate the sort of benefits expected through improvements in head grade and product throughput. Clearly better ore delineation will result in reduced costs as well as increased revenues.

Ken McCracken's AMIRA study indicated that the application of geophysical and other technologies could significantly reduce some of the losses due to dilution and furthermore it may be possible to identify pockets of ore which otherwise would be lost to mining. Until management acknowledges the potential revenue increases that could accrue as a result of the application of these technologies it will always be difficult to convince them that they should spend money to better define the orebody. Currently, miners only spend about 1.5% of the underground operating budget on ore delineation.

Another key impediment that AMIRA has identified but was not raised at the ATM is the lack of champions in the mining companies who are prepared to take risks and push the technologies. AMIRA's experience has shown that it has been with the support of a few progressive and perhaps visionary companies who have been prepared to take the risks and back a technology, that new technologies have been developed and are now routinely applied by the industry at large. This has only been possible through the backing of champions and of course management support. Without these key ingredients it is unlikely the technology will be used at all.

Another cultural or perhaps organisational impediment that did not receive much attention at the ATM is the apparent lack of a team approach to solving the problems. Much has been said about the lack of communication between the mine engineer and the mine geologist. The lack of reliable and timely information on the orebody has major implications not only on mining operations but also for the mill. It is also clear that in the past geophysicists have not been recognised as having a role in the mine. The explorationists have learned the value of geophysics and more importantly have recognised the need of a team approach where the exploration geologist and geophysicists work closely together with the same goal in mind. This culture is embedded in the larger multi-commodity companies the same companies who own and operate mines. What is needed in the mining environment is a similar team approach in which the geologist, geophysicist and mining engineer work toward the same goal of maximising recovery and minimising dilution through the better definition of the orebody.

These cultural impediments are going to take time to overcome. However, if management believes that the application of technology is going to result in major rewards, there will be pressure at the operational level to use the technology. McCracken and Williams have demonstrated the magnitude of these rewards.

The discussion groups at the ATM recognised that a major impediment to the routine application of geophysical and other technologies arises from the technology itself. Some of the groups were able to identify what these impediments are and in doing so came up with the following attributes a technology must have before it can be fully utilised generally and in an underground environment in particular:

- its use must be cost/time effective,
- it must be portable, robust, and easy to use,
- it must be able to define the shape of the orebody and provide information on grade and rock mass characteristics,
- it must provide results that are meaningful to the mine geologist and mining engineer, ie better visualisation techniques,

- it must measure the necessary parameters with the right precision and resolution, and
- it must be able to be fully integrated with mine planning systems.

On the question of R&D, it was recognised that before industry commits to the technology and to spending large amounts of money on R&D it will be necessary to remove another major impediment, credibility. There is a real need to demonstrate that existing technology can help to solve some of the problems. In other words there needs to be some "wins" on the board.

This issue was tackled in the day following the Annual Technical Meeting during a sponsors' meeting of Ken McCracken's project. The aim of the meeting was to examine what R&D projects AMIRA should be developing and to formulate an R&D strategy. The following points came out of this meeting:

- The credibility issue should be addressed by undertaking carefully controlled trials of existing technology.
- There must be an industry wide approach to the problem. A lot of effort could be wasted without this collaborative approach.
- The trials should be carried out through one or more AMIRA projects focusing on specific problems.
- The extent of the company trials that have already been undertaken should be ascertained through a questionnaire to be prepared and circulated by AMIRA.
- The outcomes of the individual company tests should be pooled and assessed and the results used to plan the collaborative trials.
- The collaborative trials should encompass the testing of borehole technology as well as seismic and RIM techniques in the tomographic mode.
- A proposal for these collaborative trials is to be prepared by Dr A. White of the CMTE and Dr. P. Hatherly of the CSIRO.

AMIRA was very encouraged with the level of support and the quality of discussions in Kalgoorlie. Clearly not all the issues were addressed. For example one of the issues that has concerned AMIRA is that if we do in fact develop a technology that will provide the necessary information at the right precision and resolution necessary to maximise recovery and reduce dilution, are the present mining methods flexible enough to take advantage of the new technology? As a result of the Kalgoorlie meetings we now have a way forward to tackle the main issues which will lead, perhaps in small steps, to industry fully utilising the necessary technologies that will reduce mine and other costs as well as increasing revenues.

Joe Cucuzza
Research Coordinator
AMIRA
9t Floor, 128 Exhibition Street, Melbourne, 3000
Tel.: (09) 654 8844 Fax: (03) 654 8661
Email: joe@amira.com.au

Membership

New Members

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

Western Australia

Anthony ROBERTS
23 Langley Way
Booraboon WA 6154

Robert FLETCHER
5 Plume Court
Lesmurdie WA 6076

Alan SHERRARD
41 Newport Gardens
Hillarys WA 6025

Dr Colin RODNEY
4/4 Perina Way
City Beach WA 6015

Michael HAYNES
Dominion Mining Ltd
P.O. Box 465
West Perth WA 6005

South Australia

Mark WEGNER
18 Down Crescent
Salisbury Downs SA 5108

Michael CARBONE
66 Diagonal Road
Somerton Park SA 5044

Desell SUANBURI
Flinders University
School of Earth Sciences
GPO Box 2100
Adelaide SA 5001

Thomas DAVIES
Santos Ltd
11fl, 101 Grenfell Street
Adelaide SA 5000

Robert KUSI
Flinders University
School of Earth Sciences
GPO Box 2100
Adelaide SA 5001

Victoria

St John Benn LEES
4 Mount Street
Wycheproof Vic 3527

Nicholas GYNGELL
33 Bolton Avenue
Hampton Vic 3188

Matthew GRIGG
40 Lansdown Street
Balwyn North Vic 3104

Angus GOODY
BHP Petroleum
120 Collins Street
Melbourne Vic 3000

New South Wales

Nadar FATHIANPOUR
Unversity of New England
Department of Geology & Geophysics
Armidale NSW 2351

Timothy DONNEKY
25 Geelans Road
Arcadia NSW 2159

Change of Address

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

New South Wales

Dr Raymond SHAW
From: Petroconsultants Far East Pty Ltd

7th Fl, Afro Asia Bldg
63 Robinson Road 0106
Singapore
To: 9 Dugald Road
Mosman NSW 2088

Mr Tibor SCHWARTZ
From: Water Resources Group
GPO Box 1096
Darwin NT 0801
To: Geophysical Research Institute
University of New England
Armidale NSW 2351

Western Australia

Silvano PAGNOZZI
From: Petrofina Exploration
Level 2, 476 St Kilda Rd Melbourne
To: 94 Valerie Street
Dianella WA 6062

Michael WEBB
From: WMC
P.O. Box 5665 Townsville
To: WMC
P.O. Box 4243
Kalgoorlie WA 6430

Peter WHITING
From: Halliburton Geophysical Services
44 Church Road, Yagoona NSW 2199
To: 68 Dollis Way
Kingsley WA 6026

Victoria

Ken WITHERLEY
From: BHP Minerals Inc
Expl. Dept. 550 California St
Sanfrancisco California USA
To: BHP Mineals Inc
801 Glenferrie Road
Hawthorn Vic 3122

Queensland

Mr Geoff HINES
From: 25 Louise Street
Waterford West Qld 4113
To: Digital Exploration Ltd
54-56 Brookes Street
Bowen Hills Qld 4006

Overseas

Stephanie BOWEN
From: Shell Internation Petroleum Co
HRDH/53 Postbus 162
Den Haag 2501AN The Netherlands
To: NAM, 6DP/12
Postbus 25
9600 AA Hoogezand
The Netherlands

Kazuya OKADA
From: 4-32-2 Soshigaya
Setagaya-Ku Tokyo 157 Japan
To: Sumitomo Metal Mining Co
Mineral Resources Div.
5-11-3 Shimbashi Minato-Ku Tokyo 105
Japan

Deaths

Dr John WEBB
34 Quentin Street
Chapel Hill Qld 4069

Mr Dave C. LYUS
12/9 Ellalong Road
Cremorne NSW 2090

Mr Cameron Wason
137 Camberwell Circuit
Robina Quays Qld 4226

Where Are They?

Does anyone know the new address for the following members?

Dr. K. Gallagher
Last known address:
C/- Fisscon Track Research Group
Dept of Geological Science
Uni of London, Gower Street
London WC1E 6BT UK

Mr Peter Carver
Last known address:
HGS
P.O. Box 106
North Ryde NSW 2113

Mr James Low
Last known address:
80A Second Avenue
Mt Lawley WA 6050

Ms Amanda Tully
Last known address:
31/1740 Pacific Highway
Wahroonga NSW 2076

Mr Paul Farrell
Last known address:
PM Farrell & Assoc International Pty Ltd
P.O. Box 197
Surfers Paradise Qld 4217

Mr Andrew Barrett
Last known address:
BHP Petroleum
GPO Box 1911R
Melbourne Vic 30012

Mr S Clauson
Last known address:
6/88 Raglan Street
Mosman NSW 2088

Mr Tom Evans
Last known address:
BHP Petroleum Pty Ltd
GPO Box 1911R
Melbourne Vic 3001

Mr Bob Coppin
Last known address:
Santos Ltd
GPO Box 2319
Adelaide SA 5001

Mr Jaroslaw Kicinski
Last known address:
7 Cygnet Court
Yangebup WA 6164

Mr Gary Reed
Last known address:
SA Department of Mines & Energy
42 Torrens Street
Happy Valley SA 5159

Calendar of Events

February 20-25 1994

ASEG 10th National Conference and Exhibition
Increasing the Resolution; Clearing the haze.
Burswood Convention Centre
Perth, WA
For further details:
Don Pearce
Promaco Conventions
Unit 9a Canning Bridge Commercial Centre
890-892 Canning Highway
Applecross WA 6153
Tel: (09) 364 8311
Fax: (09) 316 1453

March 1-4 1994

7th Australasian Remote Sensing Conference.
Theme: Mapping Resources, monitoring the environment and managing the future.
For further details:
7th ARSC Conference Secretariat
P.O. Box 29
Parkville Vic 3052
Ph: (03) 387 9955
Fax: (03) 387 3120
Email: 7arsc@dar.csiro.au

March 20-23 1994

APEA 1994 Conference & Exhibition
For further details:
Danelle Baxter
Conference Manager
APEA Limited
P.O. Box H172
Australia Square NSW 2000
Ph: (02) 221 4899
Fax: (02) 221 4592

March 27-31 1994

7th Annual SAGEEP Symposium
The Application of Geophysics to Engineering and Environmental problems
Boston
For Further details
Mark Cramer
Ph: 303-771 6101

April 25-30 1994

Continental Processes
A decade of Drilling Discoveries
Sante Fe, New Mexico,
USA
For further details:
Dr Barry Drummond
AGSO
GPO Box 378
Canberra ACT 2601
Tel: (06) 249 9381

August 14-17 1994

West Australian Basins Symposium
PESA (WA) Branch
For further details:
Jim Durrant
Tel: (09) 299 7175

September 26-30 1994

Geoscience Australia - 1994 and Beyond.
12th Australian Geological Convention
Geological Society of Australia
For further details:
The Secretary
12AGC
P.O. Box 119
Cannington WA 6107