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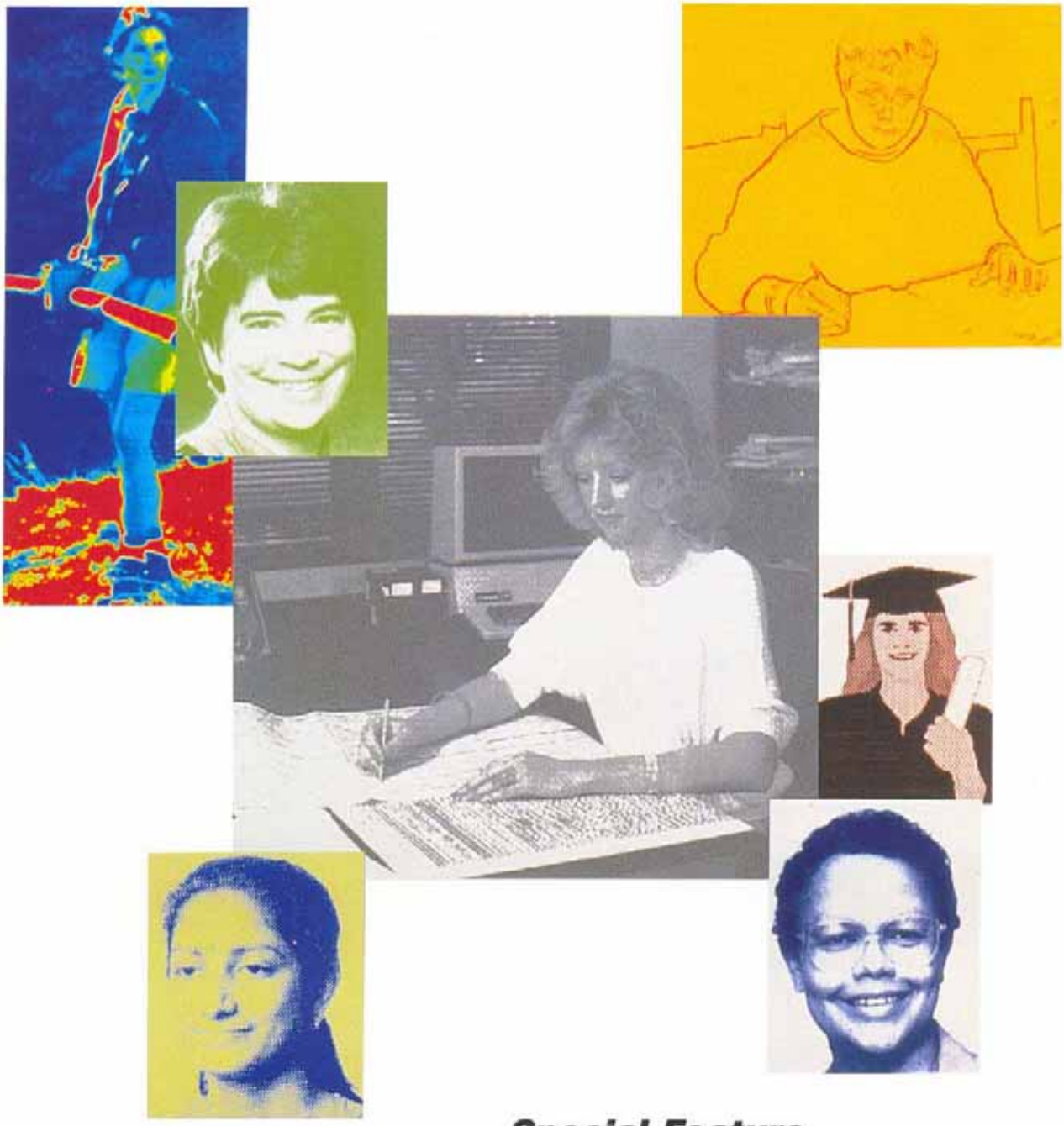

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Front Cover: Near top left (green): Kathy Hill; Top right: Cecilia Leary; Bottom left: Shanti Rajagalopan; Bottom Right: Eve Howell.

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Editors Desk

By the time you have received this Preview a new Federal Committee will have been elected. ASEG President Hugh Rutter retires from the Presidency this AGM and his parting message to the society is a case for a permanent ASEG Secretariat (p5). Under Hugh's able leadership the ASEG has continued growing as a vibrant geophysical society with energy and enthusiasm to contribute to the world community of geophysics.

Brenton Oke, Honorary Secretary who regularly and wryly reports through the Executive Brief column (p7) retires also this AGM.

Both have contributed a great deal to the ASEG and have been supportive of Preview and efforts to improve the running of the society. Their efforts are widely appreciated.

It has taken almost 3 years to centralize the operations of the Society (publications etc) and come to grips with the costs, cash flows and longer term financial viability of the society. A business plan for the ASEG is in preparation and will be presented to the membership soon.

Preparations for the Adelaide Conference are well in hand (p11). Information on Advertising for the Conference edition of Preview can be found on p10.

The issue of why there are so few women in geophysics, is our cover feature and is canvassed by Anne-Marie Anderson-Mayes. It is sure to stimulate discussion (p21). We pay tribute to a great Australian geoscientist Reg Sprigg (p12). Our conversation with Bob Sheriff concludes this issue (p30) and Tony Siggins and Des Fitzgerald detail a new South African, real-time seismic monitoring system for mines which is attracting some interest in Australia (p15). Our regular columns from Associate Editors Rob Kirk and Steve Mudge, Seismic Window (p36) and Excitations (p28), ensure a wide interest this issue. People profiles of Greg Blackburn and Natasha Hendricks are on p7 and p24 respectively.

Next issue Derecke Palmer, Associate Editor starts his Engineering Environmental and Groundwater Geophysics regular column and a new regular series - "The Innovators" profiling Australian innovations in geophysics commences , that make for a series of good stories, which we hope to bring to you through many coming issues of Preview.

Geoff Pettifer, Editor

President's Piece

A Permanent Location for the ASEG Secretariat

The Secretariat serves a number of functions which are relevant to the members and the smooth running of the Society in general. These can be described as follows:

1. Membership List

This is in a continual state of flux with new members being added and, existing members changing their address or membership category. Each year there is a mail out requesting annual membership dues. The returns have to be recorded on the data base and slow payers reminded once andsometimes twice. Keeping the data base up to date is a major function.

2. Subscribers List

There is a second data base for institutions and organisations who subscribe to the journal but are not true members of the society. This also has to be kept up to date.

3. Publishing Office

The publishing office for Exploration Geophysics and Preview is theSsecretariat. It is the contact point for technical, editorial and general information that is required to be published by the ASEG. The editor of Exploration Geophysics is regularly in touch with the Secretariat who are also in contact with the publisher Jenkin Buxton.

All Preview material is sent to the Secretariat where it is checked by the editor before being compiled "in-house" using Corel Ventura desk top publishing software. This happens every two months. Advertising in both Exploration Geophysics and Preview is also co-ordinated here.

4. Accounts

The Treasurer keeps the books for the ASEG as well as ensuring the appropriate returns to the ASC. But most of the payments to the ASEG are made through the Secretariat. These include cheques for membership, subscription, advertising and others; all of which have to be recorded, banked, and receipts issued.

5. Mail Centre

All mail to the ASEG is sent to the Secretariat from where it is distributed to the appropriate person or sub-committee. Eventually the mail may go directly to the person concerned, but it is the first point of contact. Much of the mail from the SEG comes here as does that from other societies, institutions and organisations.

6. Central Contact Point

As well as being a mail centre (including facsimiles) the Secretariat is also a telephone contact point. Many enquiries are made each day from within Australia and overseas, often regarding changes of address, missing journals, reprints etc, all of which require some follow-up.

7. Storage

The Secretariat includes an archive of previous federal committee files and previous conference files. (Eventually these will have to be sorted and culled). Also, the past issues of Exploration Geophysics, Preview, and special publications of the ASEG are stored.

Managing the business of the ASEG now requires the full-time attention of one person. It is currently handled, quite ably by Janine Cross who began a few years ago when the Secretariat moved from Perth to Melbourne. There was a learning period of at least twelve months, possibly longer, as the intricacies of the ASEG were realised and smooth running procedures established. Since that time the Secretariat has taken responsibility of publishing, and seen a growth in the number of members.

In my opinion the ASEG is now benefitting from a competently run Secretariat, but it has taken three years to reach this position. To move the Secretariat will be to commence the entire learning process again; a new person, a new place.

I recommend that the Secretariat remains in one location, Melbourne being as good a place as any, as well as being the current location. This will guarantee a continuity of skill and knowledge for all the points listed above. Mail can be forwarded regularly (urgent material) or monthly (regular items) to the current location of the federal committee. (Even in Melbourne most of the communication from the Secretariat to the federal committee is by phone, fax or mail). It will also remain the first point of contact for all matters concerning the ASEG; this is important, particularly when the federal committee is mobile, and many of its members travel frequently.

At the present time the cost of running the Secretariat is $2,950 per month ($35,400 p.a.). This includes salaries, rental, service utilities and general office materials; telephone calls are itemised separately. The costs are likely to remain for at least the next 12 months to 2 years.

I consider that the ASEG, with its growing membership and status in the world, will benefit from permanency in the Secretariat and recommend to all members that such a course of action receives their approval.

Hugh Rutter
President

Executive Brief

The Passing of Dr Reg Sprigg AM in December 1994 was a sad way to end the year. Reg was one of the pioneers of the Australian oil industry, particularly in South Australia. He was a cofounder and the first Chairman of the Australian Petroleum Exploration Association (1959), and also founded Beach Petroleum in 1960. As chief geological consultant to the newly formed SANTOS Ltd he convinced the company in 1955 to apply for over half a million km² of the northern South Australia and Queensland Great Artesian Basin, in addition to large areas in the southeast of South Australia (Otway Basin). The G.A.B. Area eventually yielded the prolific gas and oil fields of the Cooper-Eromanga Basins and the Otway Basin has had significant success in recent years.

There are several companies, and probably hundreds of geoscientists, who would have cause to be grateful for Reg Sprigg's pioneering efforts, vision, persistence and advice. It was Reg who suggested to me during a conversation in 1978 that I consider doing geology in first year University, thus solving the dilemna I had in the choice of a fourth subject (I eventually completed a degree in geology). Who knows, I may have chosen the geology unit anyway, but I think the credit should go to Reg. We pay tribute to Reg on p12-13 of this issue.

A promotions sub-committee (Koya Suto, Dave Tucker and John Mignone) has been formed to organise a students section at the Adelaide ASEG Conference in September (p10). Speakers, geophysical demonstrations and a handout package are being organised. World Geoscience has made a generous donation towards costs and the balance will hopefully be made up from additional industry support.

Dave Gamble will be preparing a 5-6 year business plan for the ASEG which will be included as a feature article in a future edition of Preview. Budgets and current financial status have been major discussion items at the last two Executive meetings. Costs are rising all the time, particularly for producing and distributing Exploration Geophysics and Preview and the Secretariat operating costs. Ways of reducing these costs without impact on quality or resorting to raising membership fees or advertising charges were discussed and arebeing investigated.

John Denham is seeking referees for the Conference volume for the mining and environmental topics.

The Mentor series in Preview is to continue, with several candidates to be approached.

We also welcome ten active, eight associate and four student members who have joined in the last two months, including one from Egypt.

Finally, in the next issue of Preview, we introduce the new Executive Committee elected at the AGM in April.

Brenton Oke, Secretary

ASEG People Profile

Greg Blackburn

ASEG Committee Member

A recent addition to the ASEG Executive Committee and also once active on the Sydney Executive, Greg brings petroleum geophysics respresentation and experience to the Committee.

Greg Blackburn received a B.Sc. (Hons) and Ph.d. In 1974 and 1981 respectively from the University of Tasmania. Greg worked for Esso Australia from 1975-1977 and since 1981 has been an independent contractor in the oil and gas exploration and production industry.

This gives him a unique perspective which we are sure will be of value to the Executive's deliberations. The Executive welcomes Greg and the talents he brings.

Preview - Next Issue

- *ASEG Research Foundation Grants 1995*
- *ASEG 1994 Finances*

NEW FEATURE

- *The Innovators - FLAIRTEM*
- *Regular Engineering, Groundwater and Environmental Geophysics Column*

ASEG Branch News

South Australia

The new year has got off to a busy start with the local branch hosting two functions already. A somewhat poor turnout was present at a post Christmas 'Drinks in the Park' in January. Why so few (a mere 25) showed up is a mystery as the weather that evening was perfect and there was a large range of refreshments available.

The second function was the Annual General Meeting held on the 22nd of February at the Brecknock Hotel. This evening was enjoyed by 52 members and partners and featured a presentation on beer and brewing by local brewer **David Pahl**. David is one of the two people who started brewing the very successful Two Dogs alcoholic lemonade. The evening also included a beer tasting, hosted by David, of beverages kindly donated by the local breweries. Our thanks to David and the breweries.

Of course the AGM included short addresses by the President, Secretary and stand in Treasurer to formalise preceedings followed by the election of 1995 office bearers. The 1995 committee is as follows:

	Company	Phone	Fax
President:			
Rod Lovibond	Sagasco	(08) 235 3762	(08) 223 1851
Secretary:			
Andy Craddock	Western Geo	(08) 234 5229	(08) 234 5876
Treasurer:			
Grant Asser	Santos	(08) 224 7626	(08) 224 7145
Committee:			
Richard Hillis	Adelaide Uni	(08) 303 5377	(08) 303 4347
Terry Crabb	MESA	(08) 274 7619	(08) 373 3269
Andy McGee	Santos	(08) 224 7317	(08) 224 7710
Craig Gumley	Santos	(08) 224 7682	(08) 224 7710
Mike Brumby	Petrosys	(08) 363 0922	(08) 362 1840
Robin Gerdes	MESA	(08) 274 7682	(08) 373 3269
Alan Appleton	MESA	(08) 274 7630	(08) 373 3269
Mark Taylor	Sagasco	(08) 235 3827	(08) 223 1851
Neil Gibbins	Santos	(08) 224 7305	(08) 224 7710
Shanti Rajagopalan	CRA Expl'n	(08) 362 8871	(08) 363 1795
Samanda Bell	Santos	(08) 224 7703	(08) 224 7710
Mike Barlow	CRA Expl'n	(08) 362 8871	(08) 363 1795

Grant Asser, Outgoing Secretary

Victoria

There has been another personnel change within the Victorian branch committee as **Andrew Barrett** from GFE Resources replaces Andrew Boyd as Treasurer.

Activity within the branch has been low over the Christmas period while members have been off at various exotic locations or still digesting the festive season. We are endeavouring to present a busier program this year, however the success of this relies heavily on the shoulders of our members as we have to once again make a call for potential speakers.

Our next meeting is scheduled for Tuesday March 28 where **Dr Tony Siggins**, Research Manager with ISSP, will talk on the principals of Ground Penetrating Radar.

Scheduled for April 11 is the Victorian Branch AGM. We expect a large turn out for this meeting, and the speaker will be **Dr Peter Hanaford** talking on "Laser Spectroscopy: Applications to Mineral Exploration."

At our last meeting in December, Frank Morrison from E.M.I. presented a talk entitled "Continuous Profiling MT and AMT for Petroleum, Mining and Ground Water Exploration". It was both interesting and informative as it demonstrated how certain processing techniques can improve the quality of MT and AMT data.

Shaun Whitaker, Acting Secretary

Queensland

The Queensland Department of Minerals and Energy two day symposium was a great success. It was held at the end of November and had about 200 delegates.

We had a second student night for 1994 on 13 December. Once again it was at the University of Qld with five speakers presenting a range of geophysical topics.

Fiona Alexander talked on "non linear inversion of magnetic data". **Geoff Beckitt** presented "statistical analysis and classification as an interpretational tool for airborne radiometric data". **Andrew Lockwood** spoke on "depth estimation from spectral analysis of isolated magnetic anomalies". **Paul Phythian** delivered his results on "statistical characterisation of seismic reflection series in the Amadeus and Bower Basins". **Ben Turner** spoke on "shear wave splitting analysis of fracture induced anisotropy using a single-source dynamite VSP in the Otway Basin".

The standard of material and the presentations were consistently high and gave the judges a difficult time deciding who was to win the prizes. After much deliberation and discussion, **Ben Turner** was awarded a prize for the best technical content and **Geoff Beckitt** was awarded the best presentation prize.

The Qld branch gave a vote of thanks to **Steve Hearn** and **Peter Furness** for once again producing high quality geophysics graduates.

The Qld Branch Christmas Dinner was held on 17 December at Le Chalet, a little French restaurant in the near city suburb of Paddington. With 40 people attending, we were able to commandeer the whole restaurant. Good company, good food and good wine ensured a great evening was had by all. Sponsorship was offered to the ASEG from several companies, allowing the night to not only be good but cheap to members. Our thank are extended to these companies for facilitating the purchase of excellent wines which ensured a night to remember (although some may not remember the latter stages). In 1995, we plan to move the annual dinner to mid year so as not to clash with other Christmas functions.

On 27 February, **Dr Bob Grasty**, the head of Airborne Geophysics at the Geological Survey of Canada, gave a talk on "Environmental Monitoring by Airborne Gamma-Ray Spectrometry". It was an interesting talk and certainly gave people ideas about how geophysics can be used in environmental applications.

Easton Wren is already booked to present a two day course on "AVO: A Direct Hydrocarbon Indicator". The dates are 20 and 21 March. Expressions of interest and enquires for the course can be directed to **Henk van Paridon** at Crusader on (07) 221 6516 (or preferably by fax to 221 2068)

Easton has also agreed to talk at a branch meeting and we look forward to this. I know Easton is expecting some tricky questions, but after last time, I'm sure he is prepared. This meeting will also be our AGM.

Joe Williams has promised to present a paper on magnetics at a branch meeting before too long. He says he is still drinking and is looking forward to making up for lost time.

Wayne Stasinowsky, Qld Branch President

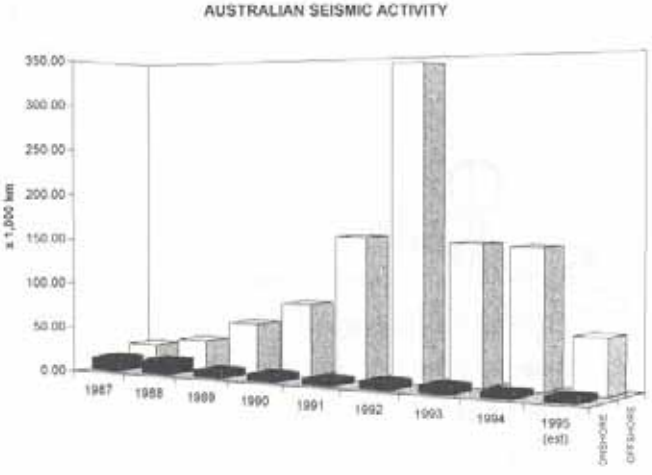
ASEG Committee Report

Geophysical Activity Committee

Seismic Activity Settles Down

The total kilometres of seismic surveying, onshore and offshore, both 2D and 3D, for all of 1994 was 158,000kms. This is almost exactly the same as last year and 1991, making 1992 an exceptional year with 352,000kms or more than double these other years.

Onshore seismic totalled 8042 line kms, 7,156 of 2D and 886 of 3D. The amount of 2D is similar to 1993 but the 3D amount has declined. Offshore the 2D was 24,500 and 3D was 125,000 line kms (83% of the total). 3D is up on 1993, which was 107,000 and 2D is 54% of 1993. Almost half of the offshore 3D was in Western Australia. WA also had the largest amount of offshore 2D. Further comparisons by States show that Victoria had the next largest amount of offshore seismic, followed by Tasmania, whereas NSW and Queensland had none. Of the onshore seismic by States, again, NSW had none, whereas South Australia had the highest with Queensland close behind.



In a breakdown by basins, the Canarvon Basin had the largest amount of offshore, both 2D and 3D, followed by the Bonaparte, then the Gippsland and the Bass Basins. The largest amount of onshore seismic was 4,773kms of 2D in the Cooper/Eronmanga, being just over half the total of all onshore seismic.

The forecast for 1995 is for much the same onshore figures as for 1994 and similar offshore 2D but much less 3D than in 1994, namely for a probable 11,000 to a possible 42,000. This would make the total a probable 34,000 and a possible 75,000 which is less than half of the actual for 1994. If this eventuates it would put the total figures back to the level of 1989/90.

R. J. Henderson, Chairman
Geophysical Activity Committee

Vale - Reg Sprigg, AM (1919-1994)

The geoscientific community and the tourist industry are mourning the passing of a great geologist, Reginald Claude Sprigg, who died following a heart attack whilst visiting Glasgow, Scotland, on 2 December. In *The Australian* of 8 December, former SA Mines Department Director- General Lee Parkin noted that ... 'his geological colleagues would undoubtedly rank Sprigg as the person to make the greatest individual impact on Australian geological knowledge since the 1930s, if not ever'.

As an employee of the Department from 1944 to 1954, followed by a long and fruitful career in private enterprise, Reg was a committed South Australian whose vital contribution to the geology and resource industries of the State is worthy of the highest recognition.

Reg, born in Stansbury in 1919, claimed that the geological bug caught him at age five, through the collection of fossil sea urchins on the beaches of Yorke Peninsula, and it never left him. By 1936, Reg had already become the youngest Fellow of the State's most prestigious scientific society, the Royal Society of South Australia, sponsored by one of South Australia's most illustrious geologists, Walter Howchin. Reg completed his Msc under Sir Douglas Mawson at the University of Adelaide in 1942 by geologically mapping the Mount Lofty Ranges south of Adelaide. For his efforts, he received the Science Faculty's highest accolade, the Tate Medal. The great Mawson was never shy in commenting that 'Sprigg was his best ever student' and Mawson became a major mentor and source of inspiration for Reg.

World War II led Reg to army service which quickly resulted in secondment to the Soils Department of the Waite Agricultural Institute and, in 1944, to the SA Department of Mines. The latter secondment was motivated by the wartime need to have a geologist investigate uranium prospects and delineate the Mount Painter uranium deposits. Permanent assignment to the Department was effected in April 1945.

During his period with the Mines Department, Reg was intimately involved with the exploration program that opened up the Radium Hill uranium deposit. Most significantly, he also pioneered systematic regional geological mapping in the State and made several remarkable contributions to international geology. As Assistant Government Geologist he became the first chief of what is now MESA's Regional Geology Division. Accepting this challenge would have been daunting to many geologists, especially as Reg continued to shoulder responsibilities for uranium, soil and other projects, but he argued successfully for peacetime air-photo coverage of SA using the most advanced technology, and provided a firm foundation for geological mapping at 1:63 360 scale in Australia.

Reg's projects with the Mines Department ranged from the remote northwest of the State to the South-East, but concentrated on the Mount Lofty and Flinders

Ranges. Here, in search of the oldest fossils, he discovered the world-renowned Ediacara fauna in 1946. Authorities of the day did not believe that such fossils could exist at the horizon, but Reg engineered a second visit to the remote discovery site with the Premier Thomas Playford and proved his point. Reg's work on the Adelaide Geosyncline culminated with a brillant sedimentological and tectonic overview that was more than 20 years ahead of its time. Much of this work lies in an unfinished Doctoral thesis.

Reg was always innovative, advanced in thinking and ready to accept a challenge, often much to the amazement of his Government and University colleagues. To prove his hypothesis that the Murray River had offshore submarine extensions, he utilised a naval presnce in 1947 to obtain deep sea soundings. In this way, the Murray submarine canyons were discovered. It was decades before this research was confirmed and then only as a result of Reg returning to the area with his own oceanographic research vessel, *MV Saori*, during the 1960s.

In 1954, Reg grew impatient of the limitations provided by Government employment. He also became tantalised by the prospects for petroleum discovery in SA following the Rough Range discovery in WA. Even so, it was a brave Reg Sprigg who left a permanent job with only limited guarantees for employment from a company that was not yet created, but was soon to become the fledging Santos. In SA, prevailing opinion considered that sedimentary cover in the State was too shallow for petroleum and that Reg was ill-advised. What subsequently occurred is the basis of legends. Reg formed Geosurveys of Australia Pty Ltd, which became the first major geological and geophysical consulting

and contracting company in Australia, employing almost 130 people over a period of 15 years. With Geosurveys staff, Reg then proceeded to trailblaze the path to discovery of the Cooper Basin petroleum province, Australia's largest onshore petroleum province, and today the most valuable single mineral resource in SA in terms of financial returns. By the early 1960s, Reg was bringing in international experts as well as poaching staff from the SA Mines Department to enhance his geological work around Australia, and all this at a time before the nickel boom brought an explosion in employment within the geological profession.

Reg and his Geosurveys staff were centrally involved with Santos during its foundation phase (1954-1960). They were the primary geological consultants who advised Santos on the initial lease area and critically redirected the exploration program to the remote northeast of the State, where gas and oil were later discovered. This was brought about by geological appreciation of long-forgotten surface anticlinal features, coupled with Reg's inimitable enterpreneurial flair. Reg was also a key consultant and seismic contractor in early Cooper Basin exploration and drilling, and was a significant factor in negotiations that secured US investment via the Delhi International Oil Co. This advent of American finance, however, also brought in American petroleum expertise, which resulted in Santos dispensing with his services and that of Geosurveys by 1960.

Following rejection by Santos, Reg was obliged to seek out new challenges. The result was a petroleum exploration program which was astounding for its uniqueness and ingenuity. Beach Petroleum NL was founded under Reg's guidance in 1962, and Geosurveys brought under its wing. The new company took up petroleum exploration licences over the Gulf of St Vincent and in the South-East. Over the gulf, Reg initiated Australia's first offshore petroleum search. With none of the financial support accorded to US explorers, the company then undertook submarine geological exploration using divers, Reg himself being one of the underwater professionals. It remains today the only submarine geological mapping carried out in SA waters. Submarine gravity surveys were also completed using an oceanographic research vessel together with systematic colour air photography. These operations were unique and the colour air photography was the first to be flown in the State.

In the late 1960s, Adelaide-based Beach Petroleum became international, first in New Zealand then in Turkey. Subsequently, Reg's talk about his pioneering geological exploits into the bandit country of eastern Turkey brought large audiences to meetings of the Geological Society in Adelaide.

Over the years, Reg became far more than just a geologist. He was also a Company Director (many times over), respected spokesman for the petroluem industry and a well-known celebrity. Thus, it is no surprise that he was the one, in 1959, to solicit interest in an 'Association of Oil Exploration Independents' through a letter to the *Australasian Oil and Gas Journal*. This subsequently initiated the Australian Petroleum Exploration Association (APEA), which today is the foremost body representing the petroleum industry in Australia. Reg was also APEA's first and longest serving President (1959-66).

The establishment of Geosurveys in 1954 also allowed Reg to pursue a plethora of other opportunities that his diverse Government experience had revealed. Those initiatives, which involved interaction with the public, are of special note. In the early 1950s, Reg foresaw a growing interest in lapidary and mineral collecting. Thus, in March 1956, he founded *The Australian Amateur Mineralogist*, a quarterly journal of 32 pages which ran for 20 issues. In parallel, Reg also set up a mineral sales company (Specimen Mineral Pty Ltd), a manufacturing jewellery subsidiary (Naturelle Jewellery Pty Ltd) and, later, Science Aids Australia Pty Ltd, which provided a wide range of goods and services to teaching organisations.

In 1968, he embarked upon a highly ambitious and innovative venture through the purchase of the Arkaroola (Mount Painter) Pastoral Lease in the remote northern Flinders Ranges. Known to Reg since his student days with Mawson, and later as a Mines Department geologist exploring uranium resources, he knew the area better than most. In addition, he recognised a conservation opportunity, a potential tourism destination, and a place for himself and his family to lay down stronger roots than 15 years as a geological consultant had provided. At a time when there were few national parks in the entire region and the term ecotourism had yet to be invented, Reg converted the derelict pastoral lease into a wildlife sanctuary and wilderness reserve. Sheep and feral goats were progressively removed. Conservation came to the northern Flinders Ranges not by Government legislation but via the efforts of Reg and his family. And the tourists came, along with Reg's many friends from around the world, to admire the stark and strikingly beautiful landscape of Arkaroola, and to ponder on its fascinating, yet immensely challenging geology.

Reg also produced an unparalleled series of autobiographical publications, including two large books and more than half a dozen other papers in books, magazines, conference proceedings and historical journals. The final testament, a 359 page volume entitled *A geologist strikes out: 1954-1994*, appeared only months before his death. These writings are not only valuable as historical perspectives on an extraordinary man who kept a daily diary for most of his life, but for their many insights and anecdotes on Reg's often highly placed colleagues.

Reg's contributions have been widely recognised. In 1968, he was awarded the Cerco Medal of the Royal Society of South Australia. Other awards followed, including Honorary Doctor of Science degrees from the Australian National University and Flinders University, the Lewis G. Weekes Inaugural Gold Medal from APEA, Member fo the Order of Australia, Fellow of the Australian Academy fo Technical Sciences and Engineering, and Honorary Member of the Geological Society of Australia.

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Real-Time, Mine-Based Seismic Monitoring

A. F. Siggins
Integrated Seismic Systems International

and

D. FitzGerald
Des FitzGerald & Associates

Introduction

Seismic activity is an inevitable consequence of mining. In Australia most deep underground mines experience some degree of micro-seismic activity, sometimes called "bumping"or "booting" in the industry. This micro-seismic activity is usually of relatively low magnitude with respect to the occasional Australian earthquakes which do cause damage and even loss of life as in the case of the 1985 Newcastle event. However, as the trend to mining to greater depths continues the magnitude of the mining related seismic activity will increase along with the attendant safety risks underground and the risk of significant structural damage.

In the Australian context, low-level mine seismicity has had a long history. Mostly the activity has been of nuisance value with little effect on mine operations. Nevertheless there has been some respectable attempts in the past to monitor activity on a mine-wide basis such as the network established at Mt. Isa in the 1970s by MIM and CSIRO. There has also been significant research conducted by CSIRO in the early 1980s into coal mine micro-seismic activity as a possible precursor to gas outbursts. CSIRO is continuing work in the coal area with a monitoring experiment recently completed at a Colliery in central Queensland.

The South Africa gold mining scene, however, presents quite a contrast in that the reef mining is at depths approaching 4 km with 5 km in the planning stages. There has been a long record of extensive underground damage, injuries and fatalities associated with the rock bursts in these mines which has driven the development of advanced seismic monitoring systems. The South African systems, particularly those of the ISSI (Integrated Seismic Systems International) company have evolved to the point where they are now fully digital, automatic and with true "real time" capability (Mendecki, 1993). There has been a significant breakthrough in technology with the development of transputer based seismometers by ISSI which provide high quality digital seismic data, by performing the digitisation right at the sensors. These processing seismometers are capable of automatic gain ranging, automatic time window and sampling frequency selection. The quality of the data is such that a range of seismic source parameters can be calculated which relate directly to the rock mechanics problems experienced by the mine.

Seismic source parameters

The most familiar parameter associated with seismic events is that of source magnitude. Local magnitude, M_L, can be defined as,

$$M_L = \log A(R) - \log A_0(R)$$

where:

A is the maximum amplitude of the seismogram (arbitrary units) at distance R from the epicentre.

A_0 is the amplitude at a distance of 100 km from the epicentre.

This calculation of magnitude derives from Richter's approach of 1935. In practice there is often a range of empirical constants added to this expression to adjust for local conditions. For example, Gibowicz and Kijko (1994) quote an expression of the form,

$$M_L = \log A_{max} + B \log R + C + D$$

where:

A is maximum amplitude observed in the seismogram (invariably associated with the shear-wave portion of the record)

B is a constant to account for geometric spreading of the S-waves from source to receiver

C is a calibration constant

D is a constant to account for site effects at the receiver

Consequently, magnitude is not a quantitative parameter derived from the physics of the tremor, but rather an index of earthquake strength. As pointed out by Mendecki (1993) magnitude on its own can be highly misleading. He quotes an example of two earthquakes with the same magnitude, but differing, in seismic moment by a factor of 400.

Seismic moment is one of the most reliable of earthquake strength parameters. In its simplest form it is expressed in terms of a force pair (double couple), shear dislocation, source model. The scalar seismic moment, M_0, (N.m) for this case is given by,

$$M_0 = muA$$

where:

m is Shear modulus of the rock

u is the average displacement across the fault

A is the fault area

To apply the above equation it is necessary to observe the actual fault. This may be very difficult in practice although it can sometimes be done in the underground mining context. Consequently, seismic moment is usually calculated from spectral parameters associated with recorded seismic waveforms. The far-field radiation patterns from a double-couple seismic source are shown in Figures 1 (a) and 1(b).

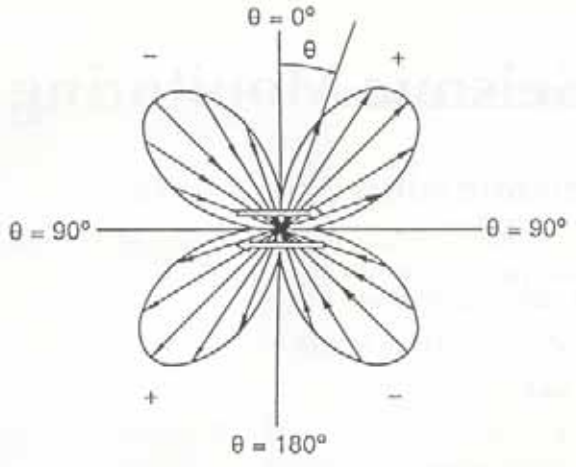

Figure 1(a) Radiation pattern of the P-wave particle displacement in a plane of constant azimuth generated by a double-couple source (after Aki and Richards, 1980).

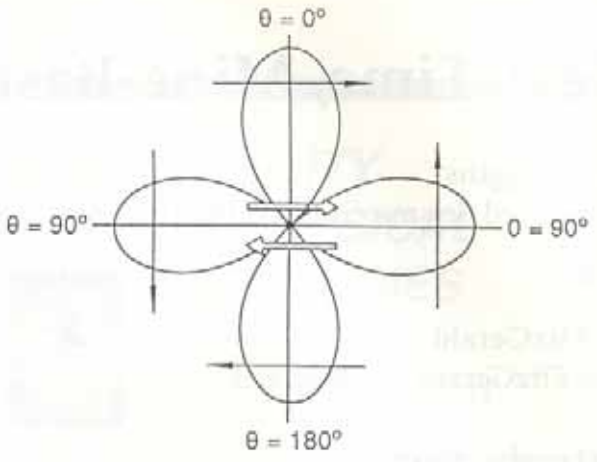

Figure 1(b) Radiation pattern of the S-wave particle displacement in a plane (f = 0, f = p) generated by a double couple source. The central arrows show the sense of the shear location. Arrows superimposed on the lobes show the direction of particle displacement (after Aki and Richards, 1980).

The double couple is just one of many possible arrangements of equivalent forces used to describe seismic point sources. There is a more general description termed the moment-tensor. The moment-tensor, ***M***, is a tensor quantity expressed in matrix form with 9 elements (3x3) with units of N.m. The scalar moment is simply the modulus of ***M***.

M can be calculated from the sign and direction of the first breaks of the P-wave and S-wave components of the seismic waveforms. The process is termed moment tensor inversion. Figure 2 presents some of the graphics from the ISSI software showing moment tensor inversions carried out on typical mine derived seismic data.

Since, as can be seen from Figure 1, radiation patterns from seismic sources can have a complex three dimensional structure with many lobes (in some respects similar to the radiation patterns arising from radio antennae) it is necessary for a successful moment tensor inversion to have the seismic source surrounded by a dense network of transducers.

Another important seismological parameter is seismic energy, ***E***, which can be obtained from the power spectrum of the seismic waveform (velocity versus frequency) corrected for the radiation pattern.

In summary, digital seismic data of the highest quality is needed to reliably extract the necessary parameters to put the seismic monitoring process onto a fully quantitative basis.

Seismology and Rock Mechanics

Quantitative seismology relates to rock mechanics directly. Seismic activity arises from a portion of the

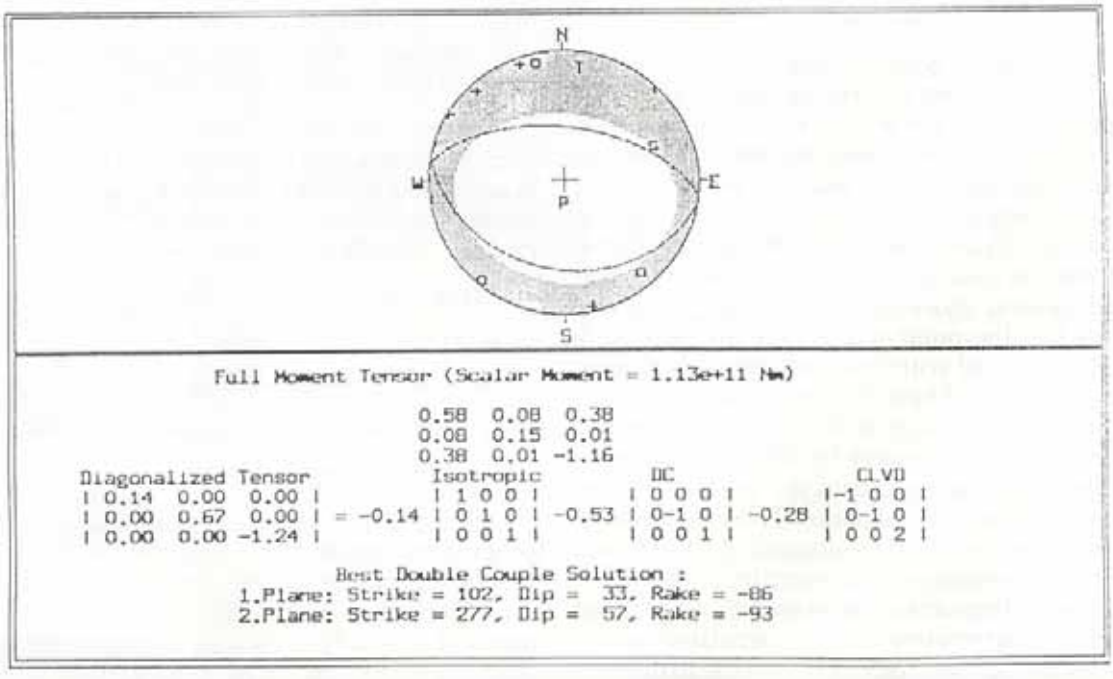

Figure 2. Moment tensor inversion on a mine seismic event as calculated by the ISS software.

rock mass which is undergoing deformation. That deformation is associated with both elastic strain (recoverable) and in-elastic strain (not recoverable). If the rate of change of strain with time is fast enough then there will be significant radiation of energy in the form of seismic waves. That process is not efficient and will depend on the radiation efficiency of the process in converting energy into compressional (P) waves and shear (S) waves. A significant proportion of the energy will be dissipated as heat. In general, a seismic event will arise from the momentary conversion of elastic strain into permanent deformation via the generation of a failure surface or slip along an established fault.

However, there will be a net elastic strain change (and stress drop) in the rock mass arising from each seismic event. The stress drop can be be further subdivided into static and dynamic components, the latter component being directly accessible from seismic data. A related parameter is that of apparent stress, s_A (Pa), which is given by,

$$s_A = mE/M_0$$

where: m is the Shear Modulus of the rock (Pa).

High values of apparent stress observed from the seismic data indicate that events are occurring in highly stressed rock.

Similarly an apparent source volume, V_A,(m^3) can be derived;

$$V_A = M_0^2 / 2mE$$

The cumulative apparent volume from a region of rock which is well covered by seismic sensors appears to correlate well with the cumulative deformation measured by conventional rock mechanics instruments. Results from a South African mine, where a highly stressed pillar was monitored with a network of seismic sensors and conventional deformation measuring instruments, are presented in Figure 3.

The time evolution of seismicity in a rock mass, such as the movement and clustering of event centres leads to concepts such as crack density diffusion and rock rheology (creep and relaxation). The ISSI company has made progress in extracting diffusion and viscoelastic

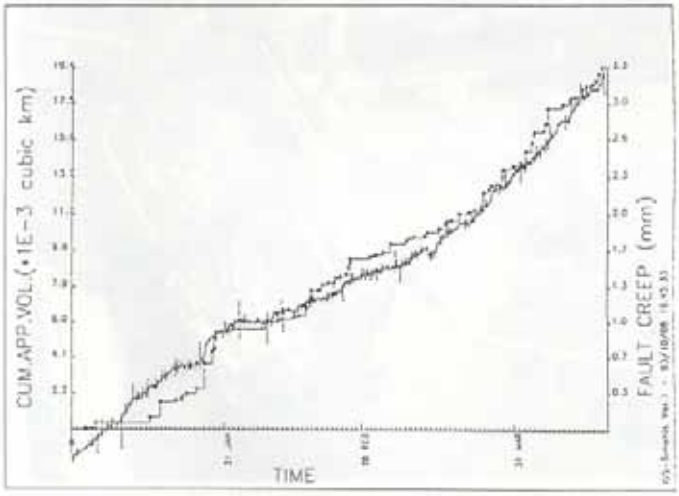

Figure 3. Cumulative apparent volume (calculated from seismic data) versus time superimposed on data from a "static" creep meter monitoring a fault - after Mendecki (1993).

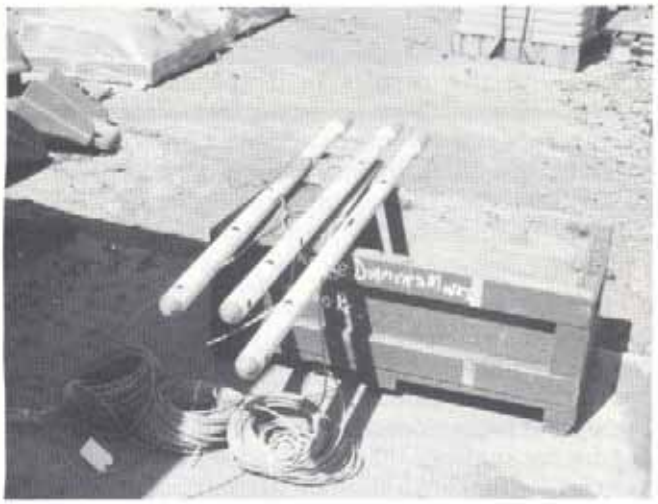

Figure 4. ISS Pacific triaxial geophone sets prepared for down-hole installation.

parameters from seismic data. For example rock viscosity can be defined in terms of a shear modulus divided by the rock relaxation time. Rock relaxation times are typically 1 to 100 days.

Instrumentation requirements

For every seismic event of M_L>=3 there are typically 10,000 events of M_L>=-1 (Mendecki, 1993) It is necessary to capture all of these events with the majority of the stations in a seismic network in order to reliably monitor the rock mass. Each station will comprise a processing seismometer and an associated down-hole, triaxial sensor, consisting of either velocity gauges or accelerometers (Figure 4). The monitoring system then comprises a network of a number of these stations. With a minimal network of 5 stations for example, there will be 150,000 waveforms to process.

The sheer volume of data involved dictates that the monitoring system must be digital and automatic. For a mine-wide digital seismic network there are a number of crucial instrumental requirements including: wide dynamic range (130 dB), automatic gain ranging, variable digitisation rates (both in amplitude and time), and time synchronisation of the network via local clocks and a master clock.

The innovative approach to these problems has resulted in a substantial advance in mine based seismic technology. A key element has been the development of transputer based intelligent seismometers and processing seismometers. Processing seismometers are capable of automatically performing a considerable amount of the processing required at each sensor station as well as waveform capture and maintaining time synchronisation. The quality of the data is assured by carrying out waveform digitisation right at the sensor.

Seismic waveforms and/or waveform parameters such as P-wave and S-wave arrival times are stored in processing seismometer memory and are transmitted to a central computer when interrogated. A central computer, usually a workstation, interacts with the processing seismometers and is responsible for network communications and time synchronisation. The central

computer can also automatically perform source location and extract the relevant source parameters displaying the results in graphical form. 3D visualisation of event source parameters such as; energy, apparent volume or apparent stress, shown on the mine geometry in their correct locations, can be readily achieved. The evolution of seismic activity with time can be displayed in the form of contour plots for example.

Information from these networks is proving to be of great value in the planning of day to day operations in many deep South African mines. For example, "hot spots" can be identified and personnel withdrawn until those areas are considered safe - refer to Figure 5. There is growing evidence that advanced seismic monitoring systems are making a substantial contribution to safety in those mines (Schutte and Essrich, 1994).

In the Australian mining scene there are a number of mine based seismic networks installed or in the process of installation. For example, Mount Isa has recently installed a 9 station, ISSI digital seismic network to monitor its 3000 orebody development. Argyle Diamond Mine is in the process of installing an ISS digital seismic network to monitor pit slope stability in its open cut operations. Mt Charlotte mine has installed a nine station PSS seismic network which has already provided valuable information relating to the design of a pillar in highly stressed rock (Mikula, Lee and Mc Nabb, 1995).There is a great deal of interest in applying this technology to longwall coal mining operations where quantitative seismic monitoring has a place in the management of coal face and roof stability.

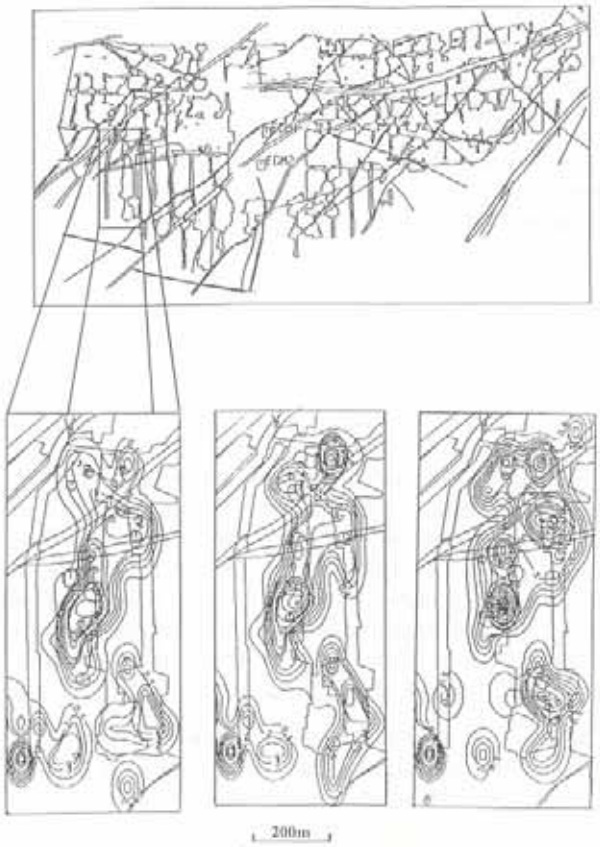

Figure 5. Seismic energy index (defined as logE/av.logE) plots for three consecutive days showing the development of a "hot spot" (centre) - after Schutte and Essrich (1994).

Conclusions

As mining extends to greater depths there will be an increase in mining induced seismic activity, largely due to the attendant higher in-situ rock stresses. Advanced mine seismic instrumentation is now available providing a means of quantitatively monitoring this activity in real time, giving location of events, energy and source volume as well as associated stress changes. The evolution of this activity with time can be also be monitored and displayed in 3D form providing Rock Mechanics engineers and Mine Management with a tool to optimise production and safety.

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AGSO at AAPG USA

AGSO geophysicist Geoff O'Brien sheepishly contemplates an unexpected rifting event atthe recent AAPG meeting in the USA when an exhibition hall roll-a-door "slumped" into the AGSO booth area.

Where Are the Women in Geophysics?

Anne-Marie Anderson-Mayes
University of WA

To those who work in geophysics, it is no secret that women are in a minority. But, have you ever stopped to ask why female participation rates are so low and what can be done to increase them?

In June 1994 there were just over 90 female members of the ASEG out of a total membership of approximately 1200 - only 7.5%. By contrast, female membership of the Geological Society of Australia (GSA) is approximately 320 out of 2900 - 11%. This is reflected in female participation rates in geology and geophysics courses at Australian universities. Generally, female participation in geology will be higher (although not markedly so) than in geophysics.

Why is Female Participation in Geophysics Low?

In fact, geophysics is just one of the fields in the group of mathematics, engineering, and physical science which continues to exhibit low female participation rates. The reasons which influence this are the subject of ongoing research throughout Australia and other western countries. Professor Eileen M Byrne from the University of Queensland has identified ten core factors which she considers to be possible influences in her book "Women and Science: The Snark Syndrome" (Pg. 25). Those which are relevant to this discussion are:

- same sex role models for women
- the mentor process
- the image of different branches of science and technology (male, female, or sex-neutral; socially responsible or systems- and machine-oriented)
- male attitudes to females in 'non-traditional' disciplines; female attitudes (self-esteem, or towards peers)
- prerequisites and school patterns of curricular choices as critical filters
- careers education and vocational counselling
- women's support networks
- affirmative action projects in science and technology

Female participation in geophysics is likely to be particularly affected by a number of these factors. Tertiary geophysics courses typically require students to have studied advanced maths and physics before they will be admitted to the course. This immediately limits the pool of potential female entrants to a greater extent than the pool of potential male entrants because female participation in advanced maths and physics subjects at secondary school continues to be lower than

male participation. With regard to image, exploration geophysics is probably poorly understood by the general community. Because of this, it will usually be identified with geology and hence the mining industry, potential environmental damage, and harsh working environments. Some may take the step of identifying it with physics which brings with it images of "boffins in basements".

None of these images is desirable or appropriate, but they will be negative influences for many women who seek a degree of social and environmental responsibility in a potential career. Lack of female role models might also be a negative influence on female participation, but recent research indicates that this is unlikely at the recruitment level. The image of the profession and careers education are probably much more important.

The very low numbers of women who have achieved a degree of longevity and advancement in the profession will be influenced by some of these factors also, but perhaps in different ways. Here, the lack of role models and mentors could be a real factor in limiting women's progression. Issues of balancing career and family will be major difficulties for many women in a profession which often demands mobility (for field work etc.) and very flexible working hours. In these 'enlightened' times, women still bear the major workload in raising children and maintaining the home environment-responsibilities which do not match well with a work environment which often requires people to be available for field work in remote areas.

Despite these continuing trends towards low participation of females in geophysics, women have been present in the profession for many years and have achieved a degree of success. Many have participated actively in ASEG life and have been represented in both government and private industry, and in both operations and research.

Women in Geophysics - Their Stories

Cecilia Leary (Cec) worked for the Bureau of Mineral Resources (now AGSO) during the 1950's to 1970's. After attending university in Perth, her career was an interesting one. In 1953 she was a member of the Airborne Reductions group (of which she later took charge for a number of years). A couple of years later the BMR was reorganised and geophysicists were allocated for aerial survey work. Cec applied for one of these jobs and was knocked back. She felt that she was being overlooked for promotion because women did not go out on survey teams. So, she took the unusual step of resigning in 1955 and returning to her parents house in Kalgoorlie. Knowing that her expertise was needed, she hoped to force the BMR's hand. In 1957 she applied for a job again with the BMR and this time was employed as a member of the geophysics team. Although women were not allowed to work in the field, Cec used to visit the camps on weekends whenever possible.

Cecilia Leary - a pioneer.

Since then, many things have changed. Today, female geophysicists take part in field work as a matter of course. Tracey Kerr is a geophysicist based in Perth with BHP Minerals Exploration. At the 1994 ASEG Conference she won the Industry Award for Best Mining and Environmental Geophysics Presentation. Tracey says, *"I have never experienced any problems regarding being female either in the office or in the field. I certainly feel that I have been given every opportunity to advance my career."* Tracey has been employed by BHP for over 8 years and has worked on projects in most states of Australia, as well as some overseas. She believes that women are under-represented in the exploration industry because the supply of female graduates is low; the work environment is perhaps not attractive to all women (or all men!); and family commitments can be an inhibitor to progress for women. *"Combining a career with children is perhaps a particular problem in our industry because in addition to the demands of being a working parent, explorationists must spend significant periods away from home. Workplaces will need to become more flexible with regard to working parents with children, if a higher level of female participation is to occur."*

Attitudes to women in field work have changed from the early days, when Cec Leary was only allowed to visit a field crew on the weekend.

Robyn Gallagher agrees with Tracey. *"Somehow it is much easier for the guys to get away for field work and extended 2-3 month trips. The industry loses a lot of women because balancing a career in geology or geophysics with children is too difficult."* Robyn, formerly of CSIRO Mineral Physics, has set up a successful one woman consultancy: GISolutions and is the recognised Australian expert in the application of GIS in geophysics. Whilst Robyn has not experienced much sexism herself (or she has chosen to ignore it), she says that you have to be tough as a women in exploration because *"a certain amount of sexism and chauvinism still exists, especially in field camps."*

More Women In Geophysics - Snapshots

A high flier in the petroleum industry is Eve Howell, currently Exploration Manager with Hadson Energy Ltd in Perth. She has been Technical Manager and later Director of ECL Australia Pty Ltd, as well as Chief

Geophysicist and later Exploration Manager with Bond Petroleum. Eve is one of the few women to have presented a key note speech at the ASEG Conference and she is a past President of the ASEG.

Eve says *"I have had very few barriers put up in my career. Very early on with BGS there was some reluctance to let me do fieldwork (from the older members of the organisation) but I insisted and eventually was doing as much fieldwork as the men (3-4 months a year). As far as family issues are concerned most petroleum geophysicists do their fieldwork early in their career and then become more office-bound as their career develops. If children are put off to late twenties/early thirties both career and family can be accommodated. An understanding partner is essential as hours will always be irregular and long and a requirement to travel continues throughout one's career. The latter requirement however, is probably no different from any other professional career that a woman might choose."*

Kathy Hill, formerly a lecturer at the Victorian Institute of Earth & Planetary Sciences and well known for her enthusiasm for her science, is now General Manager Petroleum Operations in the Victorian Government Department of Agriculture, Energy And Minerals. Kathy is an ASEG Victorian Branch committee member.

Shanti Rajagalopan, formerly lecturer in geophysics at the University of Adelaide, now with CRA Exploration, was the inaugural recipient of the ASEG Conference prize for innovation in geophysics - the Laric Hawkins Award - for her work on the use of AGC to display magnetics vertical derivative profiles.

Jennie Bauer, now with SAGASCO, was formerly Chief Geophysicist for Lasmo and before that a BMR seismic party leader.

Julie Withers of Western Mining is the resident geophysicist at the WMC's Olympic Dam operations, having formerly worked in the WMC Kambalda operation. Julie started her career with the Geological Survey of Victoria.

Marion Rose, a senior geophysicist with BHP, has particular expertise in potential field geophysics interpretation for petroleum and minerals, and has recently returned from a 3 year stint in the BHP San Francisco office.

Lorraine Mitchelmore, of BHPP has been involved in many challenging seismic processing and interpretational problems including West Murion Prospect.

Natasha Hendrick of Digital Exploration recently spent time at Oxford university as an Australian Rhodes Scholar (see profile page 24 this Preview).

This 'select sample' of some of the women currently working in the geophysical industry within Australia clearly shows that women are successful as geophysicists. Within the limited numbers of women so employed, there are other, equally successful stories. Some women will be highly experienced, others will just be embarking on their career.

Increasing Female Participation in Geophysics

In the face of such evidence it seems anachronistic to maintain any argument that inhibits female participation in the profession. To express it another way, there are very good reasons for actively encouraging women into geophysics and helping them to stay there.

It makes little sense to ignore half the pool of possible talent and skills, and even less sense to continue accepting workplaces which continue to waste talent and experience as women face the choice between family and career. Most businesses would recognise that the loss of an employee with 10 years experience is a significant economic cost.

The changes required are complex and wide-ranging, and they must begin at the earliest levels of education and follow through to the workplace. The kinds of activities which might assist in recruiting more women to the profession include school visits (especially primary school and lower secondary school) and representation of geophysics at Career Expos; open days at universities and other large institutions (AGSO, CSIRO, etc.) to demonstrate the applications of geophysics; and active seeking of media exposure of geophysics. The general community knows about geology, but geophysics is less well understood. If this can be changed, then geophysics stands to gain not just increased female participation, but an increased profile and level of understanding in the wider community.

Helen Anderson, WGC Geologist, involved in interpretation of Airborne EM (left), with Don Pridmore, WGC Chief Geophysicist.

At the same time, industry needs to become more flexible so that working parents (especially mothers) are not disadvantaged. The ASEG might be interested in working on this aspect in conjunction with other professional groups in the exploration industry. The Institution of Engineers, Australia formed a National Women In Engineering Committee which has successfully placed issues such as flexible working hours and workplace childcare firmly on the agenda. As a result, some engineering employers are now moving towards initiating these types of reforms.

Naturally, significant increases in female participation will not occur overnight. But, the contributions which individual geophysicists, ASEG branches, and university departments can make in raising the profile of geophysics, thereby encouraging more women to consider it as a career option, are an important part of the general campaign to encourage women into traditionally male dominated employment areas.

Acknowledgements

Many thanks to Ruth Lane at the National Museum of Australia for her assistance with information and photographs of Cecilia Leary.

Ann-Marie Anderson-Mayes *has a BSc(Hons) in Physics from the University of Western Australia. She was employed by World Geoscience Corporation after graduating in 1989 where she worked initially on image processing of magnetic data and later was involved with the SALTMAP project in developing data processing. In August 1993, she returned to UWA to take up the post of Programme Coordinator of the Women In Science and Engineering Project, an equity project aimed at increasing female participation in and completion of degree courses in mathematics, engineering, and the physical sciences.*

ASEG Member Profile

Natasha Hendrick - Rhodes Scholar 1994

After completing school at Moreton Bay College, Natasha enrolled at the University of Queensland in Engineering. Her plans at that stage were to pursue aeronautical engineering.

She quickly discovered that engineers are a different breed and decided to change courses. She perused the University handbook and found a course description of geophysics which "seemed interesting". After only three weeks in Engineering, she changed to the Applied Science course in Geophysics.

Her favourite subjects were numerical analysis, petrology, mineralogy and seismic exploration.

During her time at uni, Natasha maintained her extracurricular activities. She earned her Junior Leader and Leader's Warrants and canoeing qualifications in the Girl Guide Association. She also took part in the Brisbane Gang Show, a Scout and Guide song and dance stage review. This was a heavy commitment with practices every weekend for four months prior to the performance. The actual stage performances were scheduled for the two weeks of the school holidays, which just happened to also coincide with the first two weeks of University exams.

The Gang Show distraction did not seem to put Natasha off her studies since she graduated with First Class Honours and a University Medal in 1994.

Her honours thesis was titled " Evaluation of Seismic Trace Inversion Techniques". She presented her results at the ASEG Conference in Perth where her stage experience and command of the subject material enabled her to give a confident and polished presentation as those who saw it would agree.

A Rhodes Scholarship is not only based on academic qualifications, but also on extracurricular activities and community service. Natasha said her Guiding activities helped her gain the scholarship.

The scholarship entitled Natasha to study at Oxford for one to three years in an area of her choice. She chose to enrol under the Department of Engineering Science to study fault proximity surveys in the North Sea.

After one year as a probationary research student, an Oxford prerequisite for a PhD, she decided that England was not the place to complete her PhD.

She spent some time travelling Europe and attended several London stage shows before returning to the warmth and sunshine of Brisbane.

Natasha was a Research Assistant at the University of Queensland for two months before joining Digital Exploration in Brisbane. She will work at Digital on seismic data processing in their special projects group.

Natasha is very interested in seismic processing research and still has plans to complete her PhD on seismic processing in the not too distant future.

The ASEG would like to congratulate Natasha for her achievements and wish her well in her future geophysical career.

Wayne Stasinowsky, Qld Branch President.

Airborne Radiometrics - Calibration

Consulting Assignment - Dr R.L. Grasty

1. Introduction

Dr Bob Grasty, Head of Airborne Geophysics Section, Geological Survey of Canada is one of the world's leading authorities on airborne gamma-ray spectrometer surveying. The Australian Geological Survey Organisation in collaboration with State Geological Surveys and a number of leading Exploration and Airborne Geophysical Contracting companies have been fortunate in being able to engage Dr Grasty's services as a consultant for the 3 months from 23 January 1995 to 14 April 1995.

2. Rationale

The airborne gamma-ray spectrometric method has received a very non-uniform treatment in Australia. This is all too apparent when comparing survey contracts and tender documents for airborne radiometric surveys. Contracts often insist on superfluous items yet ignore issues that are quite important. Calibration and processing procedures also vary considerably, and we still do not have an airborne spectrometer test-strip that conforms to IAEA specifications. This makes it virtually impossible for meaningful comparisons between different spectrometer systems to be made, or for the results of different surveys to be compared. There is obviously a strong need to establish guidelines for system calibration and data acquisition and processing, as well as for the establishment of spectrometer test strips that conform to IAEA specifications.

3. Assignment objectives

a) Establish guidelines for the calibration of airborne gamma-ray spectrometers.

b) Establish guidelines for the acquisition and processing of airborne geophysical gamma-ray spectrometer data.

c) Prepare a set of survey contract specifications for the calibration of airborne gamma-ray spectrometers, and for the acquisition and processing of airborne gamma-ray spectrometer data.

d) Establish at least two airborne calibration strips for the determination of system sensitivities.

e) Consult widely amongst the contributors to the project in order to achieve as high a degree of consensus on issues (a)-(d) as is possible.

4. Draft Agenda

The assignment will commence on 23 January 1995 and terminate on 14 April 1995. Dr Grasty will be based with AGSO in Canberra but will travel widely to consult with contributors to the project. He will spend at least one day with each contributor during the first month of the consultancy and will attempt to resolve any issues and achieve the assignment objectives in a co-operative manner. He will be accompanied on these visits by Brian Minty of AGSO. Draft guidelines will then be drawn up and circulated to contributors. A workshop is envisaged as the final stage in the preparation of these documents. At this point it is hoped that all parties will reach agreement and final guidelines and contract specifications will be drafted. At least two test strips will be established - possibly one in the east and one in the west. Dr Grasty will also be giving talks on the back-calibration of airborne gamma-ray data and environmental monitoring in both Perth and Canberra.

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Excitations

With
Steve Mudge
RGC Exploration Pty Ltd.

This month I present some useful tools for assisting with gravity survey design. They are a procedure for computing gravity responses of compact ore targets and, more importantly, a way of graphically displaying the computed responses for a range of target sizes. Also a quick word about ER Mapper grids of geophysical data: a potential trap for both young and old players of the imaging game.

Gravity Modelling Tools

Gravity is back in vogue, particularly as GPS has taken most of the cost and pain out of getting accurate position fixes and height determinations. Survey costs haven't yet dropped to those of magnetic surveys so survey specifications must be carefully engineered if the survey is to be capable of cost effectively resolving the target. The design of any geophysical survey should always focus on the type of target being pursued; its anomaly shape, amplitude, width, the noise level expected from the surrounding geology and the noise contribution from other survey parameters. Also the target anomaly might actually be enhanced by the contribution of the surrounding geology. For example, the contributing effects of the alteration halo of massive sulphide bodies to the gravity response of the sulphides has been shown in several ASEG conference papers in recent times.

The gravity response of this class of composite target can be computed using two (or more) coincident compact bodies. I favour the use of ellipsoids as they have smooth sides and can be stretched in three directions to simulate a large range of target shapes. Often the survey will be required to detect the response from a range of target depths and sizes. The problem then is to conveniently display the anomaly parameters for the required range of target parameters.

Figure 1 shows the model for simulating a compact massive sulphide with its associated alteration halo. Choose the axes length of both ellipsoids to suit your target size (mass=density x volume), often the thickness of the alteration will not change with increasing size of the mineralisation. The density contrast of each component ellipsoid must be determined with respect to the densities of the background and the next surrounding larger ellipsoid. For example, lets say that the host rocks have a density of 2.55 tonnes/metre^3, the alteration has a density of 2.69 and the sulphide mineralisation has a density of 3.73. The density contrast for the alteration is 0.14 (2.69-2.55) and that of the sulphide mineralisation is 1.04 (3.73-2.69). The ellipsoids have the same centre location and the same attitude. Only the lengths of the three axes are changed to increase the (volume) mass of the composite target. You will be surprised at how significant the contribution of the alteration response is to the composite anomaly.

The procedure now, for a given body attitude, is to compute the anomaly along the required survey profile, which maybe the direction of the horizontal axes for a flat lying body. The anomaly peak amplitude and full-width-at-half-maximum (FWHM) can then be determined. I use FWHM as a measure of anomaly width which is essential for determining survey observation intervals. Alternatively the equations describing the body response can be rearranged to accurately calculate these parameters. This is repeated for a range of target masses, say from 25 million tonnes (mt) to 1000mt in steps of 25mt, for a range of target depths from, say 50 metres (m) to 1000m in steps of 50m. The whole computational procedure can be repeated for a range of dips.

The problem now is to graphically display the results. This can be done easily by constructing a set of contour plots, or nomograms (?), for each target attitude

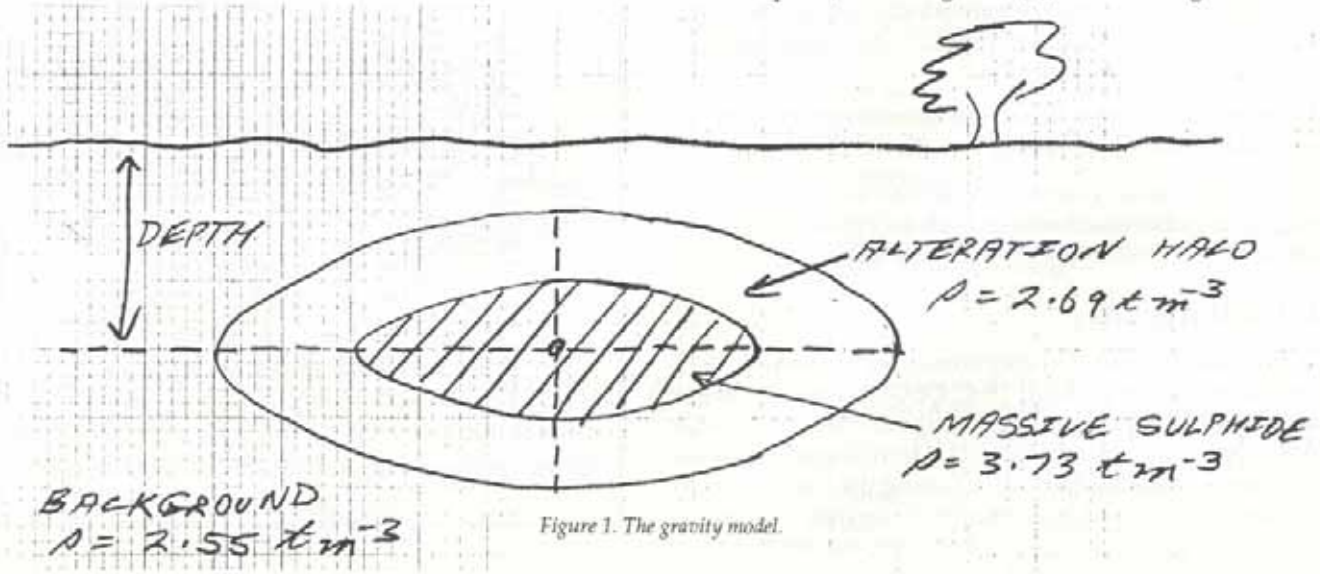

Figure 1. The gravity model.

showing contours of anomaly amplitude and anomaly FWHM versus target size (mt) and target depth to centre (metres). Examples are shown in Figures 2 and 3 for a flat lying body whose vertical axis length was kept constant over the size range.

You can now see the amplitude and width of the response for the full range of targets (mass versus depth) and it is now a relatively easy matter to specify observation intervals for a given target dimension. Try to avoid one point anomalies when specifying data intervals (make the intervals closer if your budget can tolerate it) and do consider the expected responses from the various sources of noise.

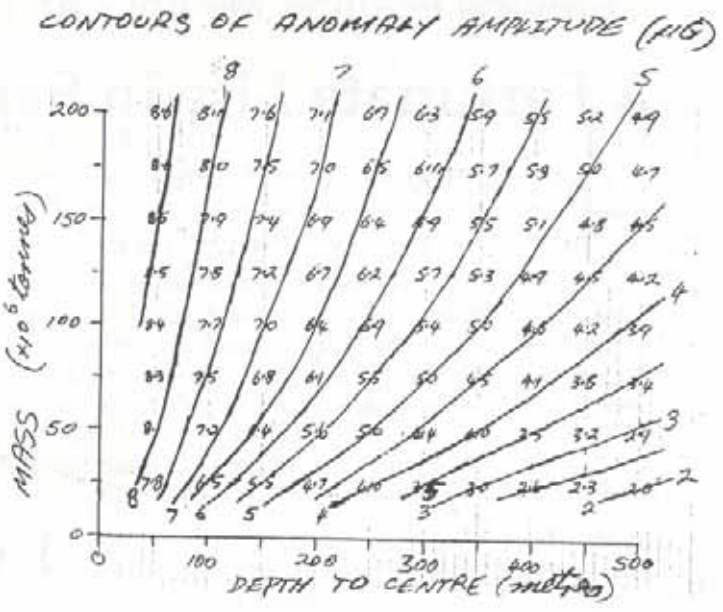

Figure 2. Contours of anomaly amplitude

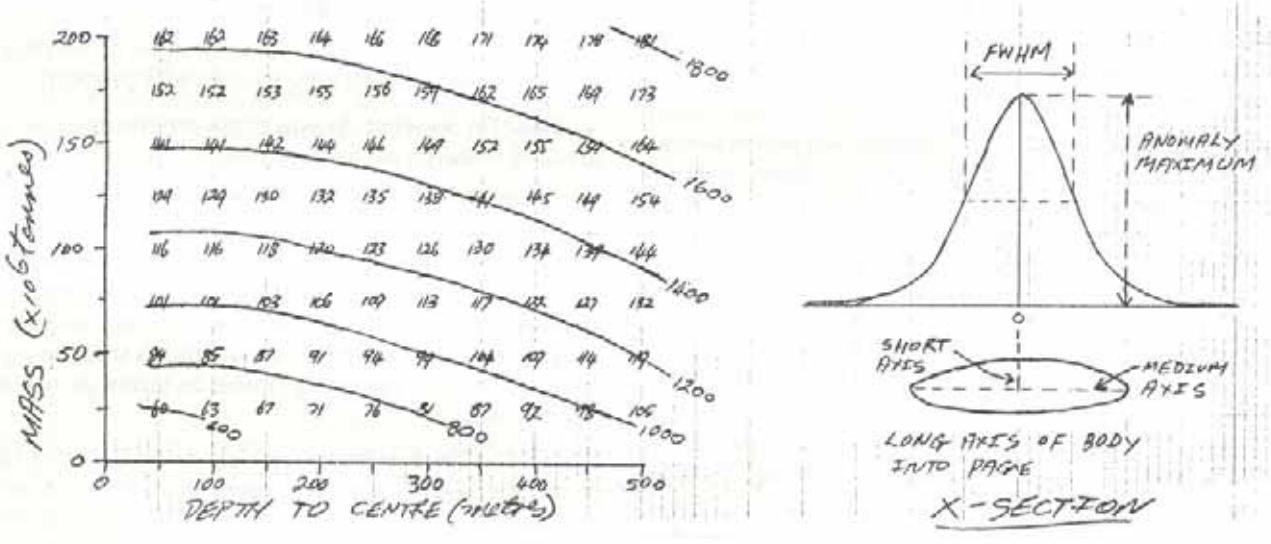

Figure 3. Contours of anomaly full-width-at-half-maximum (FWHM) for a profile across the long axis of the body.

ER Mapper Grids

Gridded geophysical data is usually located at the centre of an image pixel, ie you have an interpolated grid value at a particular location which is transformed into an image pixel at that location. However one must proceed with a little caution when displaying these grids with the ER Mapper imaging system.

Things are a bit, or should I say half a pixel, different in ER Mapper. It registers a grid to the top left hand corner of the display. In fact, it seems it uses the top left hand corner of the top left hand pixel as the grid origin and not the centre of the top left hand pixel. I've seen geophysical grids displayed that turned out to be half a pixel out in both the X and Y directions because of the difference in definition of grid origin.

This means that if you have a grid that has cell dimensions of 10 metres in both the X and Y directions, and the top left hand grid value has a co-m

I guess the ER Mapper handbook is correct: it talks about the top left hand corner and not the top left hand pixel of the image.

Contributions:

Please send contributions to Excitations column to:

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A Fortunate Life in Seismic

In this concluding article Bob Sheriff talks with John Denham and Geoff Pettifer about perceptions of Australian geophysics and the ASEG as well as his views on US research in geophysics and SEG activities.

GEOFF: Do you feel you know enough about Australian geophysics to tackle the question of - how geophysics in Australia is different from the US.?

BOB: My experience is very limited to be sure. But I have the feeling that interest in sound geophysics here in Australia is probably greater than it is in most other areas and greater than the average interest in the United States. In terms of the techniques I don't think they're very much different. I think the methods that are applied in the US are the same methods that are applied here so there is no major difference in that regard.

We have sufficiently good communications today that if one of us discovers some new improved technique it will be readily known to the other and will become wide spread ... world wide. The world is a whole today, we are all really one big family. We have essentially no nationalistic boundaries. I've never felt any sense of nationalism with respect to geophysics.

When I first came to Australia I didn't come as an American. I came because of geophysics and when we hire somebody to do geophysics we are interested only in their geophysical qualifications and their thought processes, we're not interested in their nationality. That's true of Australians and Americans and that's true of people almost anywhere in the world. I see no national constraints at all.

GEOFF: So looking ahead five to ten years what do you see?

BOB: I have been over the years notoriously poor at sensing the changes. We have very few big changes. Most of our changes have been small.

As for foreseeing where we are going in the future, all I can see is how we are going to improve the techniques that we presently have. I think we will improve them on a steady basis. Actually the improvements on a more or less continuing basis are rather overwhelming. I mean we haven't had any big changes in our geophysical technique now for 2 decades at least. And yet the improvement in data quality has been impeccable over that period. There has been no single advance. Its been the aggregate of many many advances.

JOHN: I think that's 100% right. A good example of this is, as you may have heard, BHP recently made a gas discovery in the Otway Basin at a well called Minerva. I wrote the epitaph on BHP's efforts there in 1976 and for good reasons because data quality we couldn't see what was going on. BHP is back there dealing with quite good quality data now. They can see what's going on, its structurallly quite complex which is why none of the wells that have been drilled there before were of much use. As you say, what are the major changes since then?

BOB: Why is the data today better than it was then?

JOHN: In 1976 we had air guns we had digital processing ....

BOB: ... then we had all the basic factors that we have today except today we use them better - our aggregate has upped enormously but there is no single process to which you could attribute the improvement.

JOHN: That's right. Its a combination of not only the new processes, its learning to use them properly.

GEOFF: So what do you think are the most exciting areas of research at the moment?

BOB: My own interest at the present time is mainly in terms of broadening the expanse of geophysics by moving more into reservoir properties. This is my hot topic today. I'm here in Australia not as just a visitor,I'm here as a missionary because i've come to "convert you heathens" to the fact that there is much that we can do that we are not presently doing in terms of reservoir geophysics.

JOHN: The first thing we have got to be able to do is to see a reflection from our reservoir, or from anywhere near our reservoir.

BOB: I agree if you don't have any data, its difficult to work with. Of course there are many areas in which you do have data and we are still not using the data and technology that we already have. I'm not concerned so much with where we are going to go in the future, but I think the least we can do is to make maximum use of what we have.

BOB: In terms of reservoir geophysics we have an enormous handicap because we're involved with different disciplines and in most companies we are involved with different managements. Most companies have their group that handles reservoir simulation and

Mentor - the rationale

mĕ'ntŏr *n.* Experienced and trusted adviser. [F, f. L f. Gk *Mentōr* adviser of the young Telemachus in Homer's *Odyssey* and Fénelon's *Télémaque* (root **men-* think)]

So says the Oxford Dictionary. In the Mentor series of articles we talk to prominent mentors and change agents in the field of geophysics to see what makes them tick and discuss their views on geophysics.

so on and is completely isolated from anything that involves geophysics.

GEOFF: It sounds like a problem analogous to the early history of engineering geophysics, with the professional separation between geophysicists, geologists and engineers

BOB: In the US the engineers often have no appreciation that geophysics can help them solve their problem, and that's the problem we have in reservoir work.

JOHN: Either that or they think it can answer all their questions and are very rapidly disillusioned.

BOB: I agree and that's an equal danger, that you go overboard and you expect miracles and miracles don't very often occur. There's only a limited frequency for miracles.

GEOFF: Your teaching and research programs in the US -are they mainly concerned with reservoir studies?

BOB: In recent years my interest has been mainly in seismic stratigraphy and in reservoir geophysics. Today you don't have to sell people on seismic stratigraphy. They are already pretty well sold on seismic stratigraphy. My missionary efforts today are devoted towards reservoir geophysics and they are mainly trying to communicate to engineers that we have something that maybe can help them and that they ought to at least look at it.

I think many of our engineering efforts don't even use the best of our geophysics. They inherit a geophysical map which is the same map on which the discovery was made. Nobody ever realises that map involved all kinds of arbitrary decisions which at the time were reasonable, but in the light of what we know today, the whole interpretation ought to be reworked, and we don't rework it.

GEOFF: Are you talking reprocessing as well?

BOB: Yes, but more than that, in terms of the geologic concepts. I mean when you do an interpretation you have a geological model in mind and that geological model may be completely wrong. What you did recognise in that geologic model was that something was unusual in that area and that unusual feature turns out to be the discovery.

Most of the discoveries we make are actually serendipitous. We discover them for the wrong reason. We discover them because something unusual happened in the data and we recognise something unusual but we gave it the wrong explanation. The anomalies were there and the anomalies were correct. It was our explanation of the anomalies that was wrong.

GEOFF: But that's human nature isn't it?

BOB: All this is human nature. That's what we are dealing with.

GEOFF: The nature of geophysical research in the US has always intrigued me. I notice your name appearing on the academic and industry seminars that were written up in GEOPHYSICS for quite a while. You get the impression that, a lot of the research has been carried out in-house. Is this still the case? How does it relate to university research? How is research funded? What is the next stage? Can you say something about all this?

Edgerly cartoon - Bob Sheriff making a Presentation

BOB: We have had recently some major changes. We don't really understand the nature or implications. A number of companies have in effect shut down their research organisations, and are hoping that they can pick up the research from some other source. They've laid off an awful lot of their research personnel. A lot of these research personnel are still being supported as contract operations rather than company employees.

GEOFF: Are these personnel absorbed into universities?

BOB: Mostly not. The attitude of companies towards the universities has always been a mix of the following attitudes - one is: they want to be part of it, they consider it partly a charitable contribution, on the other hand they want to get some results from it. They're in effect afraid not to be part of it. They're afraid that the competition will get a leg up on them, because the competition is supporting the research and they're not supporting them. So the thought that you're going to lose out against you competition has been one of the most powerful tools for getting industry support. Competition is a very important aspect of the oil business. But that's not really the basic problem we're talking about.

GEOFF: In terms of the amount of dollars and the amount of effort in geophysics research ? Has it really dropped off or is it just restricted in where its being carried out?

BOB: It has dropped off. But it has also been shifted. Its been shifted towards small research efforts, groups of consultants who are really in a sense doing research.

GEOFF: Are they basically making their living doing research?

BOB: Yes, and often they have some underwriting from the companies too, often from the companies who have let them go, as a matter of fact. I do have very considerable concern about this whole business because I really don't think that this is a long term sustainable

way of proceeding. Research shouldn't have to have a short term payout and regrettably the payout term is the important factor in many of these research areas. In a company you can't afford to go too long before you get some return on your investment. So therefore our seismic research seems to be more and more short term.

JOHN: Bob, if I can ask a question about Vibroseis research. Probably the most outstanding example of geophysical research funded by an oil company is the invention of Vibroseis. That undoubtably was one of the major advances in geophysics. Fortunately Conoco had been prepared to pour money into that for close to 20 years considering that it went public if I remember rightly, about 1960 which was already about 5 years into their research. It was probably 1970 before it achieved the promise or even started looking like achieving the promise that it was introduced with. By 1970 it was well and truly in the public arena. Could any manager in Conoco, in retrospect, if they'd known what was in the future, could they have justified to the shareholders putting the companies money into the Vibroseis hat?

BOB: I don't think so. I don't foresee any research of that sort getting sufficient support today to carry it through. The nature of the whole industry has changed. It used to be every company was out competing with every other company. Today its more and more you try to distribute the risk. If you make a discovery, you try to bring other people involved with it, because there's the exchange: your new discovery with their discovery. So distributing the risk has become much more of the sense today that it was at that time.

It used to be every company was out competing with every other company. Today its more and more you try to distribute the risk.

At the time of the Vibroseis story every company wanted to go out and discover something exclusively for itself. We certainly had this aim in Chevron. In Chevron we were interested in going into a country and getting exclusive rights in that country. That's why we liked Western Australia. In Western Australia when Chevron was involved with WAPET, we had all of Western Australia in effect. Not completely all but virtually all, and we were interested in that type of approach. Today that's a different sense entirely. Today you want to sell off part of your company in return for getting shared risk opportunities elsewhere.

GEOFF: So in terms of this modern approach to research, in terms of developing say for instance, marine vibroseis today, do you think the way it would happen today would be for a consortium to get together?

BOB: Yes I think that's the only way it could be done. Even there I would have my doubts it could be done on a basis that is long enough term to carry it to fruition. You look at the Stanford projects today for example. There we have a number of different companies that are trickling in funds in the hope that they will get some benefit out of it and there are similar things at our allied geophysical laboratories at Houston. There's the School of Mines and a number of other venues around the US and I don't know how many other venues around the world. There are some like at Delft, that are operating under a similar basis. Edinburgh has a similar concept in terms of trying to get broad spread, broad scale industry funding to carry out, what hopefully is long term research.

The basis for financing, especially with respect to long term research, has changed very markedly. It changed partly back in those days of very high interest rates in which an investment very far into the future had essentially no present worth because you had to discount the future returns at the current discount rate, which was so high that unless you get returns in your investment within the next relatively few years its of no value. What you get 10-15 years down the line - it has such small present worth.

GEOFF: So for economic reasons they are going into the short term thinking mode .... .

BOB: .... and we are very much in that short term thinking mode today, despite the fact that the interest rates have gone down, we should have changed our philosophy. Our attitudes change much more slowly than the interest rates change

JOHN: I think that's a very perceptive comment.

GEOFF: You have been involved in SEC for a long time. In what capacities?

BOB: At the present time I'm on the SEG production and development geophysics committee, I'm on the academic liaison committee, I have sometimes been on the publications committee but not at the present moment. I have also been involved with the continuing education committee. I guess those 4 committees are the main areas of my interest.

GEOFF: In terms of the evolution of the SEG, in terms of various roles it has carried out, do you have any comments?

BOB: The SEG has always tried to be an international organisation. It has had some very severe handicaps in that respect. One time we had a meeting in Mexico City which turned out to be a disaster for a number of reasons such as power failures in the exhibit hall and various other things. The SEG has always wanted to be international. We have tried to work with the Chinese, with the Russians, with any number of other areas. Basically, again because we don't think of ourselves in national terms. I don't think of the SEG as an American organisation, I think of it as an organisation of geophysicists, not as an organisation of nationality.

The limitations of course come when, if you want to hold a convention and its a long way off, how are you going to get people there and who's going to fund them to get there and so on? The practical problems have continued to bear in on us in these efforts. But there has

been no shortage of international thinking in terms of SEG management for any number of years nor is there today, but there are practical problems in how you are going to implement it.

In terms of the ASEG I've been over the years somewhat frustrated because the fact is that the literature of the ASEG doesn't go anywhere on a world-wide basis. Nobody on a world-wide basis knows what goes on, what is published in the Australian journals. We have the same problem closer to home with Canada. We don't know what goes on in the Canadian journals because most Americans don't look at the Canadian journals.

When I was an officer of the SEG, one of the things I set out to try to do was to try to bring in the group that's called KEGS, which is the Canadian (mainly) mineral geophysical group. We bought them in as a section of the SEG and they've come into the SEG in fair strength? Actually I guess probably more of the mineral activity in the SEG comes from KEGS than comes from the American mineral efforts.

The Canadian "problem" is that Canadians have a national identity that they want to impress on their society. This is something the Americans don't have complete empathy with and I think probably the same "problem" applies with respect to the Australians. The Canadians want to maintain their own national integrity and regrettably maintaining their own national integrity often means that they are unheard.

JOHN: The point is that the ASEG is in fact an SEG section.

BOB: I know that. But the fact is you still have your own publication and nobody outside of Australia knows about it. That's a bit of an exaggeration I think, but that is still the basic fact. From what I understand the SEG effort is to have essentially all of exploration geophysics literature available on the CD ROM. My understanding is that the effort is to expand these initiatives, and the first effort to do that was the cumulative index. I was part of the committee involved with the cumulative index. We wanted to make available to people at least a knowledge of what was available in the exploration literature. Its still limited to the English publications and there are a few (not all that many) but there are Russian and Chinese publications in addition that ought to be included that are not. At least it is a big step ahead.

R.E. Sheriff with SEG Kauffman Gold Medal, Calgary 1969

GEOFF: What is the purpose of your visit to Curtin as Haydn Williams Fellow? What did you and Curtin University hope to achieve by it?

BOB: The University of Houston and Curtin have an exchange/co-operative agreement. We have at Houston a facility called the Allied Geophysical Laboratories which historically has been supported by industry contributions (not the university). The university provides the venue, industry the funding. We have had quite extensive processing and modelling facilities research. We developed most of the modelling techniques that are most often used today, but we had essentially no activity in terms of data acquisition and Curtin was interested in data acquisition. It seemed that Houston and Curtin would make a good match, because we sort of complemented each other. The exchange agreement developed. We have had Curtin people come to the University of Houston. I am the second person to come from Houston. Dan Lowenthal was here recently, I have stayed longer (3 months). Another is coming soon and another in 1995. It was through this agreement I became involved with Curtin. What I have been doing here at Curtin is mainly talking to people, the students; giving short courses and helping out with the CRC projects. These involve CSIRO, Adelaide and NSW universities in some cases. The work at Curtin is similar to what I do with my own graduate students in Houston and that work has continued of course, by fax.

Our undergraduates at Houston, are only a handful. Our graduates have held up reasonably well during the industry downturn up to the present semester.

The cut backs we had in the mid eighties didn't lose people from the profession because they thought this is merely another "crying time" to pass through and we'll just hold on and come back. This time the attitude is different. This time people are saying this is no longer a temporary change. This time its a permanent change and therefore I'd better go sell insurance or do something else. So we have lost an enormous number of geophysicists from the profession as a result of the cutbacks that have occurred within the last 2 or 3 years and they will never come back. So the number of geophysicists has shrunk very considerably. That doesn't show up in the SEG 's statistics like it ought to, I think. I have a difference of opinion between the SEG's statistics and my own view of the situation.

JOHN: Can I suggest a reason for the difference may well be that the SEG never has every geophysicist as a member. I don't know what the proportion is, but my guess is its probably no more than about one third. Its the dedicated ones who are going to hang on longest who aren't going to change their profession if they can possibly avoid it.

GEOFF: One of the things that is happening in Australia, is that there's been a bit of a discussion about

registration of professionals. We have a group call the Australian Institute of Geoscientists (AIG) which is the umbrella organisation for all earth scientists and it tends to carry out the politicking, and other societies such as the GSA (Geological Society of Australia) and the ASEG carry out the technical functions. In other words the technical societies will remain technical and stay out of politics and the umbrella organisation will carry out lobbying (eg. access to sensitive areas for exploration). I'd be interested in your comments on what's the situation in the States? Is the SEG becoming political; is registration an issue? One of the things about registration, which I believe is the driving force and this again has come out of the knowledge gained from the experience of engineering geophysics say and reservoir geophysics: and that is that where there are multi-disciplinary teams involved in investigations with potential for highly expensive litigation there's a need for registration. So in reservoir geophysics or geophysics in general, is there a push for registration in the States?

I've never been sympathetic with registration. I feel registration is a job protection vehicle ...

BOB: There is a big push for registration. I've never been sympathetic with registration. I feel registration is a job protection vehicle, in other words the reason you want to register people is so that people won't compete with you. You limit the amount of competition that you have to engage. I don't believe that you can determine on any practicable governmental basis the competence of geophysicists by government examination. I was one time asked to be on the committee of the California registration committee and I looked at the qualifications and said, look, I can't qualify myself. Why do you want me on your committee? Its ridiculous. I mean the qualifications for being a geophysicist in California included so many hours of this course and so many hours of that course and so on. This doesn't really qualify a person as a professional.

If I wanted to hire someone on whose judgement I would base economic decisions, I would go to people who know them and base my decision entirely on that. I wouldn't base it on whether or not they are registered as a professional geophysicist. The ideas of registration of professional geophysicists I think is anathema. I do not like the idea?

But it is coming, whether I like it or not - it is coming. Therefore we must make the best of it. The SEG policy over many years was, we were going to oppose registration, except eventually we came around to the fact of recognising that whether we oppose it or not, it is coming and therefore we might as well adapt to it and try to make the best of the situation. And so that's the way I see it today, is that we must make the best of the situation, buts its nothing I like. I do not like unionism frankly.

GEOFF: In terms of just the political nature of the SEG, is the SEG a technical society or political or both?

BOB: The SEG has always tried to be a technical society. We have strenuously tried to avoid politics. The idea of registration is one of the places where we finally came to the conclusion that we couldn't really avoid politics. We came to the same conclusion earlier on, in fact a decade or so ago, when the industry was severely attacked by the press during the inflation of oil prices and so on, we decided we had to have better public relations. We had to have better governmental relations. So we have reluctantly embraced these various ideas, because they were essentially being forced on us. I don't think any of these are areas in which we elected to do something. We're always being pushed into them. The SEG is being pushed into political situations, but they are doing everything they can to try to avoid it.

GEOFF: Is there no organisation in the US like the AIG that carries the political fights for technical societies?

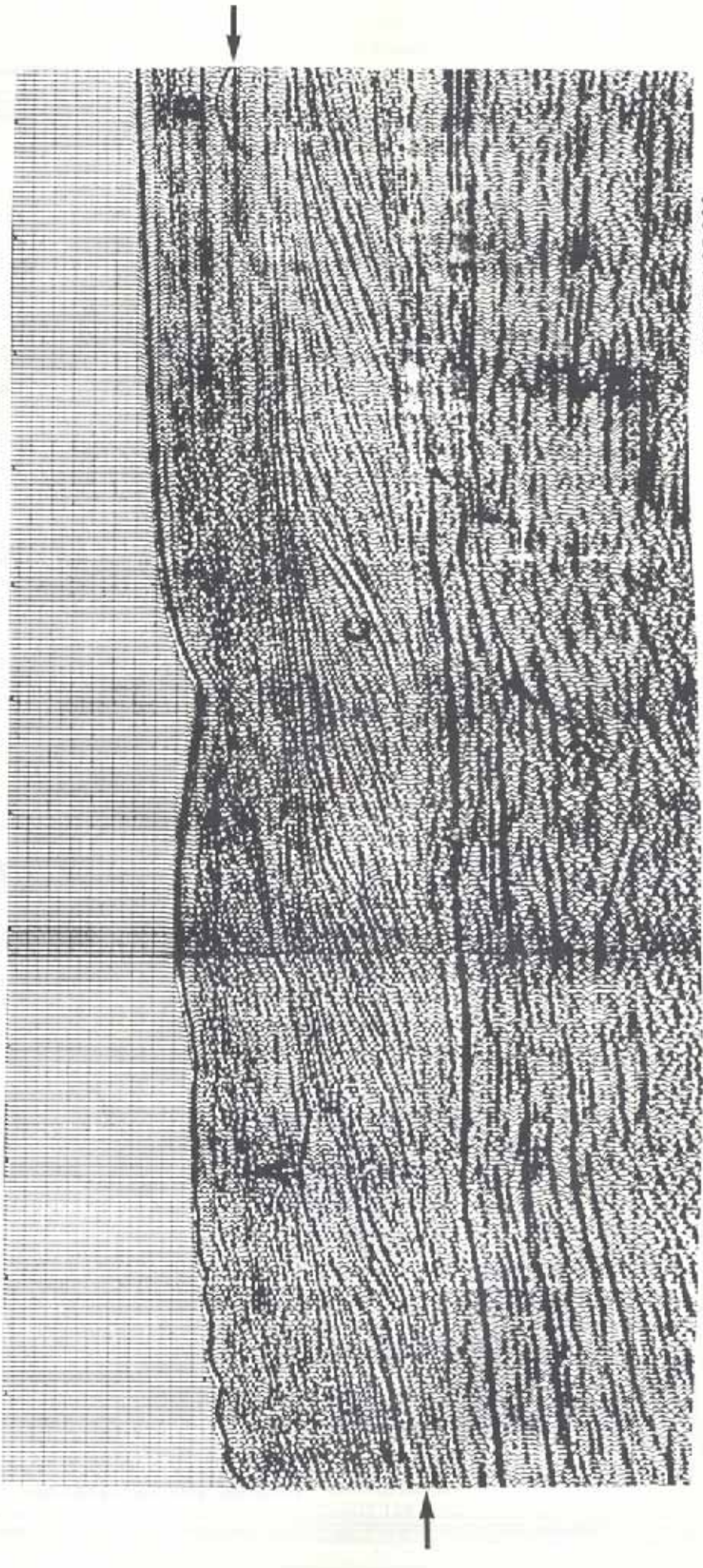
BOB: There is an organisation of geophysical contractors for example which is trying to alleviate the legal problems in terms of acquiring seismic data. There is the American Petroleum Institute which is very strongly a political arm, trying again to protect the interest of the petroleum industry. So there are other organisations that are trying to do this, but the SEG is not one of them.

Seismic Window

With

Rob Kirk
BHP Petroleum

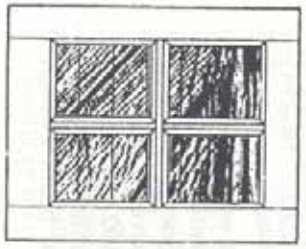
Two Seismic stratigraphy examples to work on this issue - one from offshore Canning Basin and another from offshore Alaska.

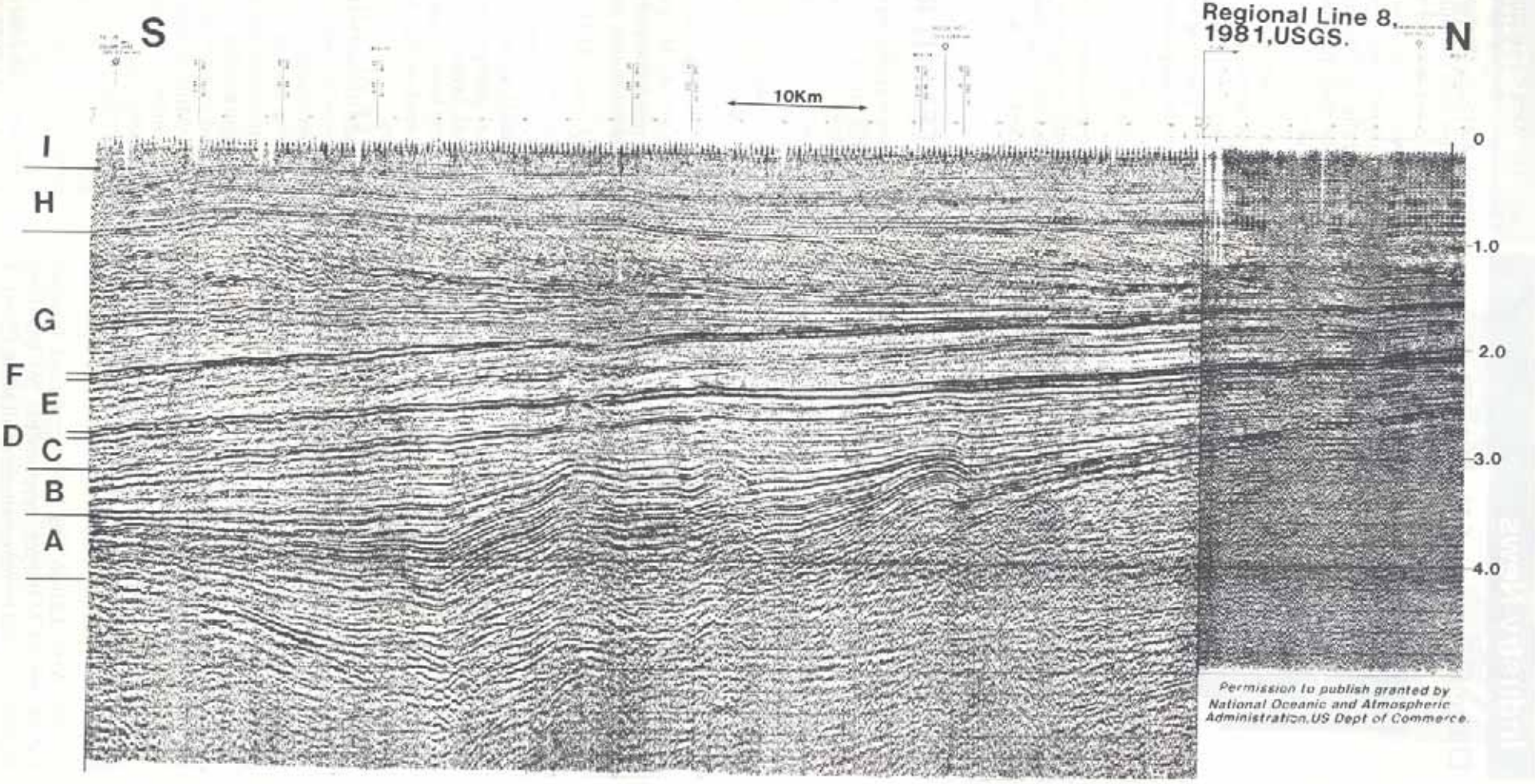


This line is from the offshore Canning Basin and shows prograding Tertiary carbonates. Note the deep water prograding geometrics at C - we could calculate a crude palaeo water depth from the height of the top-down lap. What do we have at A? It appears to have velocity pullup and a low-to-high acoustic impedance. What about a sequence boundary under this mound form which links the arrows at either end of the section? The parallel, top set events above C represent shallow water, platform carbonates. Note how the earliest mound (A) events are significantly downdip from the last shallow water platform unit of the preceding (C) sequence. A may represent a lowstand carbonate reef of the next sequence, growing downdip from the older exposed (and incised) carbonate platform. Base level eventually rose, the old platform was flooded and new "pinnacles" grew (B).

SEISMIC WINDOWS

This squeezed seismic line is from the North Slope of Alaska and is not far from the giant Prudhoe Bay field. (An excellent data set can be obtained from NOAA inexpensively - contact me if interested on (03) 652 6750). A doodle with your red pencil will allow a very interesting tectono-stratigraphic story to be told. Packages A, B, C contain Triassic to early Carboniferous sequences. (The high amplitude facies in A are carbonates). Package D is the Triassic Shublik Shale - it's high amplitude character is due to it being a rich source rock.The organic content giving the unit a low density, low sonic character which produces the continuous reflection. Package E is the prograding Jurassic Kingak Shale. Package F is the Neocomian Pebble Shale - this is another (worldwide) rich source unit. This thin unit covers a time span of 5-10 million years. Package G is the Cretaceous Torok Formation - a series of third order sequences whose distal prograding toes are composed of turbidites (higher amplitude, more continuous facies) and whose prograding slopes are shale. Package H is the Cretaceous Nanushuk Group - comprised of the deltaic (and fluvial) facies (parallel and continuous) of the third order sequence mentioned above in G.





Industry News

Dave Gibson of Kevron Retires

After a long and distinguished career in aviation, Dave Gibson the General Manager of Kevron Geophysics is about to retire at the age of 67.

Dave cut his teeth as an "Ag" pilot and has subsequently operated in many interesting and exotic areas of the world. His adventures would make excellent reading if he ever decides to become an author.

After operating his own aviation companies for some time, Dave along with venture partners Kevin Radford, Gary Paterson and Gordon MacDonald created Kevron Geophysics in 1986. They commenced operations with Dave acting as Chief Pilot fortheir one aircraft fleet. In 1990 Dave became General Manager while still performing chief pilot duties. He was largely responsible for the current position of the company as one of the most successful and prominent aerial geophysical survey companies in Australasia.

Under Dave's guidance, Kevron Geophysics (occasionally confused with other companies bearing the Kevron tag), has expanded to include 3 Aero Commander aircraft that flew an amazing 7,000 hours last year. Around 30 staff members are employed in the data acquisistion and processing of client data.

Dave relinquished the Chief Pilot role in 1992 to concentrate wholly on the management of Kevron Geophysics. He attributes the success of the company to its committment to the latest technology and the dedication and skills of its employees. Dave says that this has allowed the company to achieve a reputation for delivering top quality data on time.

There is no doubt that Dave's friendly personality and shrewd business skills have also been a major contribution to this situation.

Dave's idea of retirement is to run an aircraft welding shop at Jandakot and to restore a vintage "Harvard" ex military training aircraft.

Dave's successor as General Manager of "Kev Geo" is Denis Macneall who has over 30 years of experience in the aviation industry as an aircraft engineer, a highly qualified pilot and an experienced manager.

PGS Nopec Reorganises

PGS Nopec, Perth has announced organisational changes in order to provide better support for its move towards Multi-Client 3D Surveys.

Odd Arne Larsen has been appointed Business Development Manager, responsible for planning, negotiations and commencement of all Multi-Client 3D projects for PGS Nopec in Australia/SE Asia.

Odd Arne Graduated in 1984 from University of Oslo with a degree in Petroleum Geology and later gained a MS in Marine Geology from University of Tromso. He held various appointments in seismic data processing for another major seismic contractor and was coordinator for seismic speculative processing and acquisition in Norway until he in 1992 was transferred to Australia as Speculative Seismic Manager. His experience also includes geological basin evaluation and marketing.

Martin Bawden has been appointed Geophysical Operations Manager, responsible for coordinating all technical aspects of multi-client surveys, including the geophysical planning of the surveys and the quality control of the acquisition, processing and navigation. Martin will also provide technical support to all PGS Nopec's clients.

Martin graduated from University College of Wales, Cardiff with a degree in Geology/Physics in 1977, and has worked for a number of geophysical contractors in various parts of the world until joining PGS Nopec in 1993.

GEOTEM III Released

Geoterrex is pleased to announce the availability of GEOTEM® III, a multi-coil time-domain airborne electromagnetic (AEM) system. The new system is the result of several years of multi-coil bird and receiver design, development and testing. This enhancement to the widely used single-component GEOTEM® system provides a powerful new tool to the exploration and resource evaluation community. The GEOTEM® III system is the first commercially available multi-coil time-domain AEM system intended primarily for mineral exploration and will provide greater diagnostic informatoin than was previously possible.

Time-domain AEM systems historically measured the in-line horizontal (x) component. The new towed bird and next-generation digital receiver of the GEOTEM®III system are designed to collect two additional components, the vertical (z) andthe horizontal lateral (y). The z-component shows significantly lower noise and is most useful in detecting both extensive flat-lying conductors and deep conductors.

The additional multi-coil information permits calculation of the energy envelope, which is a valuable quantity to image. The energy envelope has a single peak over a vertical conductor and two peaks over a dipping conductor one at either end. The asymmetry in the response profiles for the individual components can be reduced by normalising each profile by the energy envelope. Multi-component data greatly improve the interpretability allowing characterisation of conductors by providing quantitative determination of depth, dip, strike and offset.

For more information contact:
Geoterrex Pty Ltd
7-9 George Place
Artarmon NSW 2064
Tel: (61-2) 418 8077; Fax: (61-2) 418 8581

Geophysical Data Releases

Australian National Gravity Database - 1994 Release

AGSO has released the 1994 version of the Australian National Gravity Database. This release contains approximately 800 000 gravity values, which represents an increase of roughly 130 000 new values to the 1993 edition of the data base. Approximately half of the new data were obtained on the Tarcoola and Port Augusta 1:1 million Sheet areas over the Stuart Shelf region of South Australia. The next largest additions were over the Broken Hill and Adelaide Sheet areas, where over 27 000 new observations have been added.

Offshore, approximately 13 000 new values over four 1:1 million Sheet areas have been included in the new release.

The complete data base on 9-track ASCII or SUN tar exabyte and costs $7500; 1:1 million Sheet areas are available for $350 each and annual amendments will be provided for $750 for those who have purchased the 1993 or previous additions of the data base.

Dubbo, Narromine, Forbes and Bathurst - (NSW) gravity data.

AGSO and the New South Wales Department of Mineral Resources (DMR) have released the results of gravity surveys carried out over the Bathurst, Dubbo, Forbes and Narromine 1:250 000 Sheet areas, as part of the Lachlan-Kanmantoo National Geoscience Mapping Accord (NGMA).

The surveys were carried out in 1993 and 1994 and added 2012 new gravity observations, spread as evenly as possible over the four Sheet areas. In addition, Newcrest and North Mining have contributed a total of 17 173 new stations over the Narromine and Forbes Sheet areas. These data sets, which have not yet been included in the national gravity data base are available for $200 per map sheet, $300 for 2 map sheets or $500 for the four complete sheet areas. The data sets are available from either AGSO or DMR.

Duketon and Wiluna (WA) gravity data.

AGSO and the Geological Survey of Western Australia (GSWA) have released the results of a gravity survey over the Duketon and the northeast part of the Wiluna 1:250 000 Sheet areas. This survey was carried out in 1994 and supplements data acquired over the Edjudina Laverton, Leonora and Sir Samuel 1:250 000 Sheet areas during 1991-1993. The 1994 data, acquired over Wiluna ,complete the coverage started in 1993. The new stations are spaced approximately four kilometres apart along roads and tracks. Some parts of the map Sheet areas have very limited access and the station spacing is no better than the 11 kilometre regional coverage. The survey added 694 stations to Duketon and 334 (in addition to the 606 added in 1993) to Wiluna.

NSW DEPARTMENT OF MINERAL RESOURCES

The digital gravity data are available for $200 per Sheet area from either AGSO or GSWA.

Hann River/Mount Mulgrave (Qld), gamma-ray spectrometry images.

A composite Potassium, Thorium, Uranium (Red, Green, Blue) colour pixel image map for the 1:250 000 Hann River Sheet area, and the 1:100 000 Mount Mulgrave Sheet area (part of the Walsh 1:250 000 Sheet area), Queensland has been released. This data set was acquired in 1991 as part of the North Queensland NGMA project and complement the magnetic anomaly data already available. The image is compiled from a 90 m grid over the survey area and costs $300.

Pixel-image maps for the CYPLUS project.

AGSO has added to its suite of maps and images generated for the Cape York Peninsula Land Use Strategy CYPLUS)

These include :

Cape York Digital elevation model, pixel image map.

A digital-elevation model of the Cape York region of north Queensland covering the Jardine River, Orford Bay, Weipa and Cape Weymouth areas has been imaged at 1:250 000 scale. The basic data were acquired in 1986 on east-west lines flown at 150m above the ground and spaced at 1500 m apart. The point-located data were gridded to a 400 m cell size. The images are available from AGSO at $300 each.

Cape York Peninsula magnetic anomaly map.

Colour and grey-scale pixel image maps at 1:1 million scale for the Cape York Peninsula region of north Queensland have been released.The maps show the Total Magnetic Intensity (reduced to the pole) and its Vertical Derivative. The images were compiled as part of the Cape York Peninsula Land Use Strategy (CYPLUS), which is a joint Commonwealth/ Queensland project. The area mapped is bounded by 10-16°S by 141-145.5°E, The data have been gridded to a 400 m cell size and the images cost $300 for the colour version and $250 for the grey-scale.

Bonaparte Gulf airborne geophysical data.

AGSO has released products for the Medusa Banks (WA) and the western two-thirds of Port Keats (NT) 1:250 000 Sheet areas, where data were recorded along east-west lines 500 metres apart and 100 metres above the ground by AGSO in 1994.

The complete digital data set is available for $24500, grids are available for $2250 per map sheet area and contour maps at $120 for each 1:250 000 map Sheet area.

This survey has filled in a major gap in the data coverage of Australia and provides significant new information on the structure of the northern part of the continent where the onshore Kimberley craton abuts the offshore Bonaparte Basin.

Colour and grey-scale pixel image maps of the same areas are also available at $300 and $250 respectively for each 1:250 000 map Sheet area.

Lissadell airborne geophysical data.

AGSO has released the digital data and contour maps from the Lissadell (WA) airborne geophysical survey data flown during 1994. The survey was flown as part of the Kimberley-Arunta NGMA project, with flight lines 400 m apart and a nominal ground clearance of 100 m. The complete magnetic and radiometric digital data set comprising approximately 47 000 km of new survey data costs $10 750 and the contour maps cost $250 or $120 each for transparencies and dyelines respectively.

Northwest Kimberleys airborne geophysical data.

AGSO has also released a new airborne geophysical data set for the Camden Sound, Montague Sound and Prince Regent 1:250 000 Sheet areas in the northwest Kimberleys of Western Australia. The survey was flown by World Geoscience Corporation for AGSO during 1994 to fill a major gap in the data coverage of the Australian continent. Magnetic and gamma-ray spectrometric data sets were recorded on flight lines flown at 800 m spacing with a 100 m ground clearance.

A complete 1:250 000 Sheet area costs $3000; grids contour maps and profiles are also available at the usual AGSO prices.

Bendigo Airborne Geophysical Survey.

New aeromagnetic and gamma-ray spectrometric data sets have been released for the Bendigo and Heathcote 1:100 000 Sheet areas of the Bendigo 1:250 000 Sheet area. This survey was flown as a joint AGSO/GSV project under the Lachlan NGMA. Data were recorded along 400m spaced east-west lines flown at 100 m above the ground. Parts of the Heathcote Sheet area were flown at 200 m spacings.

All the digital aeromagnetic and gamma-ray spectrometric data sets from the Bendigo survey are now publicly available. They were gathered to provide an improved information base to encourage future exploration in Victoria as a co-operative Victoria/Commonwealth project. The data obtained will also be of assistance for resource assessment and development and for land management issues.

Standard NGMA prices have been applied to the data sets. These range from $10750 for the full 400 m spaced data set, to $40 for a dyeline contour map at 1:100 000 scale.

ASEG RESEARCH FOUNDATION

Post to: Treasurer, ASEG Research Foundation
Peter Priest, 39 Ningana Ave, KINGS PARK, SA 5034

NAME: .....

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COMPANY: .....

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ADDRESS: (for receipt purposes)

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Membership

New Members

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

Tasmania

Craig KUNS
RSD 713
Gawler TAS 7315

South Australia

Suzanne ROBERTS
12 Turnbull Road
Enfield SA 5085

Noel GUPPY
C/- Sagasco Resources
GPO Box 2576
Adelaide SA 5001

Queensland

Damian KELLY
16 Swan Street
Brassall QLD 4305

Adrya KOVARCH
6 Nyora Street
Everton Hills QLD 4053

Victoria

Jarrod DUNNE
Earth Sciences Department
Melbourne University
Parkville VIC 3052

New South Wales

Benjamin PAYNE
Geophysical Research Institute
University of New England
Armidale NSW 2351

Guy HOLMES
104 Garden Street
Alexandria NSW 2015

Overseas

Charles BLUMENTRITT
18210 Forest Town Drive
Houston Texas 77067
USA

Manuela MEXINER
C/- Gold Fields Geological Centre, Geophysics
PO Box 6171
Oberholzer 2502
South Africa

Hesham EL-KALIOUBY
National Research Centre
El-Tahrir St.,
Dakki Cairo
Egypt

Dan LOEWENTHAL
Geophysics Department
Tel Aviv University
Ramat Aviv 69978
Israel

Change of Address

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

New South Wales

Dave ROBSON
From: Western Mining Corporation Ltd
PO Box 157
Preston VIC 3072
To: Geological Survey of NSW
PO Box 536
St Leonards NSW 2065

Hamish JENKINS
From: Trout Hall
PO Box 8
Captains Flat NSW 2621
To: RMB 1485 Ravensdale Road
Yarramalong NSW 2259

Paul HARRISON
From: C/- Amoco Aust Petroleum Co
PO Box 7488
Perth WA 6850
To: C/- Amoco Aust Petroleum Co
PO Box 318
Liverpool NSW 2170

Susanna SCARANO
From: 22 Tunks Street
Ryde NSW 2112
To: Parker & Parsley Australasia Ltd
Level 9, 255 Elizabeth Street
Sydney NSW 2000

Stephen LYNCH
From: World Geoscience
65 Brockway Road
Floreat WA 6014
To: 44 Bristol Street
Merrylands NSW 2160

Keeva VOZOFF
From: IGM, University of Cologne
Siebengebirgsallee 163
Cologne 50939
Germany
To: Harbour Dom Consulting
PO Box 596
North Sydney NSW 2059

David ALLEN
From: 55 Harbourne Road
Kongsford NSW 2032
To: 5 Mulgray Avenue
Maroubra NSW 2035

Troy MACKLIN
From: 52 Kelly Road
Modbury SA 5092
To: 95 Rosedale Road
St Ives NSW 2075

Western Australia

Ed COLLINS
From: Hadson Energy Ltd
35 Ventnor Avenue
West Perth WA 6005
To: Apache Energy Ltd
Level 3, 256 St Georges Terrace
Perth WA 6000

WESTERN ATLAS INTERNATIONAL
From: PO Box 785
Cloverdale WA 6105
To: PO Box 6383
East Perth WA 6892

Louisa McCALL
From: 12 Read Avenue
Mosman Park WA 6012
To: Central Norseman Gold Corp
PO Box 56
Norseman WA 6443

Harry CORNELIUS
From: 2 Raidell Place
North Epping NSW 2121
To: PO Box 149
Laverton WA 6440

Darryl HARRIS
From: Faulkner House Hale School
Hale Road
Wembley Downs WA 6019
To: Woodside Offshore Petroleum
1 Adelaide Terrace
Perth WA 6000

Stephen JEFFREY
From: U8/328 Albany Highway
Victoria Park WA 6100
To: U51/328 Albany Highway
Victoria Park WA 6100

Antony PRICE
From: 15 Grant Street
Cottesloe WA 6011
To: U8/13 Stirling Highway
Nedlands WA 6009

Andrew DUNCAN
From: Aerodata Holdings
65 Brockway Road
Floreat WA 014
To: 62 Vincent Street
Nedlands WA 6009

David McINNES
From: CRA Exploration
21 Wynard Street
Belmont WA 6104
To: C/- Western Mining Corp
P.O. Kambalda WA 6442

Mark BRAILEY
From: 120 Burrendah Blvd
Willetton WA 6155
To: 4/162 McDonald Street
Joondanna WA 6060

Brett ASCOTT
From: 25 Urch Road
Roleystone WA 6111
To: 2 Wehl Street
Newman WA 6753

Samuel ROBERTS
From: 103 Miller Street
O'Connor ACT 2601
To: 5 York Avenue
Bentley WA 6102

David RICHARDS
From: CRA Exploration Pty Ltd
PO Box 3709
Manuka ACT 2603
To: C/- CRA Exploration Pty Ltd
PO Box 175
Belmont WA 6104

Christopher LEES
From: 75 Agincourt Drive
Willetton WA 6155
To: Tesla-10 Pty Ltd
41 Kishorn Road
Applecross WA 6153

Gregory STREET
From: PO Box 102
Cottesloe WA 6011
To: World Geoscience Corporation
Locked Bag 6
Wembley WA 6014

Exploraiton Data Services
To: 45A Great Eastern Highway
Rivervale WA 6103

Western Atlas
From: PO Box 785
Cloverdale WA 6105
To: PO Box 6383
East Perth WA 6892

Andrew BISSET
From: 9/77 Nightcliff Road
Nightcliff NT 0810
To: CRA Exploration Pty Ltd
PO Box 175
Belmont WA 6104

Queensland

Karen CHRISTOPHERSON
From: 969 Gold Coast Highway
Princess IC Palm Beach QLD 4221
To: PO Box 855
Hamilton Central QLD 4009

Zhiqun SHI
From: University of Adelaide
Dept of Geology & Geophysics
Adelaide SA 5005
To: MIM Exploration Pty Ltd
GPO Box 1042
Brisbane QLD 4001

Jennifer LEVETT
From: 6 Arundel Street
Glebe NSW 2037
To: 4/57 Maryvale Road
Toowong QLD 4066

Richard LANE
From: CRA Exploration
Private Box 509
Box Hill VIC 3128
To: CRA Exploration
PO Box 1641
Milton QLD 4064

Zhiqun SHI
From: 15 Bartlett Street
Paradise SA 5075
To: 24 Cordeaux Street
Hill End QLD 4101

Graeme HAINES
From: Haines Surveys
PO Box 65
Modbury North SA 5092
To: Haines Surveys
PO Box 196
Aldgate SA 5154

John JACKSON
From: MIM Exploration
12 Paterson Crescent
Mt Isa QLD 4825
To: 76 St Johns Avenue
Ashgrove QLD 4060

John HART
From: 28 Potts Street
Melville WA 6156
To: C/- BHP Minerals Exploration
Level 4, 152 Warf Street
Spring Hill QLD 4000

Victoria

Greg BERESFORD
From: School of Earth Sciences
University of Melbourne
Parkville VIC 3052
To: On-Line Geophysics
50 Bridge Street
Northcote VIC 3070

Alan HOGAN
From: 18 Meredith Circuit
Kambah ACT 2902
To: C/- CRA Exploration Pty Ltd
Private Bag 3
Bundoora VIC 3083

Robert HARMS
From: 3 Barcoo Place
Kaleen ACT 2617
To: 19 Otter Street
Collingwood VIC 3066

Acacia Resources Ltd
From: 1 Spring Street
Melbourne Vic 3000
To: Southgate
Level 11, 60 City Road
South Melbourne Vic 3205

Pradeep JEGANATHAN
From: BHP Petroleum
13th Fl, 120 Collins St
Melbourne VIC 3000
To: 6 Percy Street
Balwyn VIC 3103

Aberfoyle Resources Limited
From: 1st Floor, 123 Camberwell Road
Hawthorn East VIC 3123
To: Level 31, 525 Collins Street
Melbourne VIC 3000

Rado REBEK
From: CRA Exploration
71 Ridge Street
Gordon NSW 2072
To: CRA Exploration
PO Box 8093
Northland Centre VIC 3072

Greg BLACKBURN
From: 9 Balmerino Avenue
Toorak VIC 3142
To: Blackburn & Associates
22 Stirling Street
Kew VIC 3101

South Australia

Iestyn BROOMFIELD
From: 58 Vine Street
Magill SA 5072
To: 57 Edward Street
Mogill SA 5072

Matthew RUTTY
From: University of Adelaide
Dept Geology & Geophysics
Adelaide SA 5005
To: CSSIP
SPRI Building
Warrendi Road
The Levels SA 5095

Tasmania

Jonathon ROOT
From: H.I. Resources Taskforce
PO Box 21
Dampier WA 6713
To: 2 Wynyard Street
South Hobart TAS 7000

Overseas

Denis REY
From: Gencor African Exploration
PO Box 61820
Marshalltown
Republic of South Africa
To: Gatro Gabon - Gencor Group
BP 9773 Libreville
Gabon
South Africa

Philip WANNAMAKER
From: Utah University Research Inst
391 Chipeta Way, Ste C
Salt Lake City Utah 84108
USA
To: ESRI - Research Park
391 Chipeta Way, Ste C
Salt Lake City,
Utah 84108-1295 USA

Jim WOMACK
From: Western Mining Corp
PO Box 114
Daw Park SA 5041
To: C/- 107 E Kittyhawk
Midwest City Ok 73110
USA

Scott MACINNES
From: Zonge Engineering & Research
3322 East Fort Lowell Road
Tuscon Arizona 85716
USA
To: PO Box 857
Soldotna, Ak 99669
USA

James SMETHURST
From: Shell Nigeria
To: (Shell Albania, GM)
c/o SIPC (ODLC/3)
Shell Centre
London SE1 7NA
UK

Rhiannon MORRIS
From: Rio Tinto Finance & Exploration
Rua Do Bocage, 20
Gandola 7570
Portugal
To: C/- Angela Southway
Riofinex North Ltd
PO Box 695, Castlemead
Lower Castle Street
Bristol BS99 1FS UK

Where are they?

Does anyone know the new address for the following members?

Samantha SCHELLAARO
Last known address:
23 Danby Street
Torrensville SA 5031

Graham BUBNER
Last known address:
CRA Exploration Pty Ltd
PO Box 175
Belmont WA 6104

Tina Ann MANDER
Last known address:
PO Box 672
Nedlands WA 6009

Michael HALLETT
Last known address:
University of Sydney
Dept of Geology & Geophysics
Sydney NSW 2006

John HOLMES
Last known address:
BHP Petroleum Limited
GPO Box 1911R
Melbourne VIC 3001

Michael HOUSE
Last known address:
Unit 17, 159 Fairway
Crawley WA 6009

Resignations

The following members have resigned from the society and their details need to be deleted from the relevant state branch databases.

Lorraine SMITH
LG Smith & Co
PO Box 186
Subiaco WA 6008

Harold STEAD
9 Narelle Avenue
Pymble NSW 2073

Calender of Events

April 24-27 1995

8th SAGEEP Conference
Orlando, Florida, USA
For further details:
Tel: 303-771 6101

May 29-June 2 1995

EAEG 57th Annual Meeting & Exhibition/7th EAPG Conference
Glasgow, Scotland
For further details:
Tel: 31-3-404-62 640

August 20-24 1995

The First Latin American Geophysical Conference & Exposition
Rio de Janeiro
For further details:
A.H. Ross Jr.,
Technical Program Co-Chairman
RIO '95
SEG Business Office
PO Box 702740
Tulsa, OK USA 74170-2740
Ph: 918-493 3516
Fax: 918-493 2074

September 3-6 1995

ASEG 11th Geophysical Conference & Exhibition
Adelaide
For Conference Details see page11

October 1-3 1995

Bowen Basin Symposium
Mackay Entertainment Centre, Mackay
For details:
Mr Ken Preston
Secretary - Organising Committee
C/-Pacific Coal Pty Ltd
GPO Box 391
Brisbane QLD 4001
Fax: (07) 220 0217

19-23 February 1996

13th Australian Geological Convention, & AGSO Jubilee Symposium
Canberra
For further details:
See advertisement this issue
Or from 13th AGC
GPO Box 2200
Canberra ACT 2601
Fax: (06) 257 3256

March 25-29 1996

8th Australiasian Remote Sensing Conference
National Convention Centre, Canberra
For further details:
ACTS
GPO Box 2200
Canberra ACT 2601
Ph: (06) 257 3299
Fax: (06) 257 3256

23-27 July 1996

Western Pacific Geophysics Meeting of the American Geophysical Union
Brisbane
For further details:
Mike McElhinny
Gondwana Consultants
Po Box 5
Hat Head NSW 2440
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Fax: (065) 65 7604