Australian Society of Exploration Geophysicists
ACN 008 876 040

Preview

December 1998 – January 1999

Issue No. 77

Special Feature:

A New Approach to Clearing Seismic Lines in Queensland 11-16

In This Issue:

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AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS

POSITION VACANT PREVIEW EDITOR

Applications are invited for the position of Preview Editor. The position involves the coordination of the Society's bi monthly newsletter 'PREVIEW'. This position has been traditionally held in the same city as the Federal Executive but that is no longer considered necessary.

The current editor is prepared to fill a lessor role within Preview, perhaps as petroleum sub-editor, and assist the incoming editor in any way possible. The position will be come vacant in April 99.

As with all ASEG officers the position is honorary but in recognition of scope of the task the Federal Executive has authorised payment of an honorarium and reimbursement of certain expenses.

Applications and inquiries should be sent to:

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Henk van Paridon 07 3371 0244 or
with the ASEG Secretariat
07 32572725 and should arrive
by Feb 28 1999.

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Editor's Desk

A letter from Rutt Bridges, Immediate Past President of the SEG, struck a chord with me. In his letter published in this Preview he states that many SEG members do not really read Geophysics and makes a generous offer on behalf of the SEG. I must admit I am not a great reader of Geophysics but one thing I did read was the supplement to Vol. 63, No 2 March April 1998. It is a memorial to Cal Savit who had a distinguished career with Western Geophysical.

There is an article by Ken Larner entitled "In any Two-Boat Operation…." This contains a collection of Carl Savit's more memorable thoughts. My favorite is "Accuracy is the enemy of clarity" Another lesson for anyone working in a team is to remember that all too easy prejudice "In any two boat operation the guys in the other boat are always stupid." He had a sign on his desk that read "If a cluttered desk is the sign of a cluttered mind, what is an empty desk the sign of ?" Carl was first and foremost a mathematician and his most often used equation was

$$HA(t) / H(t) > 1$$

which translates to "At any given time there are more horse's asses in the world than horses". The bulk of the supplement consists of high quality papers over a variety of subjects and I commend it to you. Petroleum geophysicists who are not already members of the SEG should join sooner rather than later.

Parents of young children (couch potatoes like mine) should sit down with them on a Saturday morning and watch "Science Court". This is a great program where examples of common scientific phenomena are tested in a courtroom situation in an amusing and interesting way.

I would like to thank those members of the Queensland Branch and the Federal Executive who nominated me for the ASEG Service Certificate. I felt very proud to receive it and have given it pride of place in my office.

President's Piece

WIN A BOTTLE OF GRANGE HERMITAGE!!

It is with great pleasure that I can report on activities of the last two months, particularly the conferences in New Orleans (SEG) and Hobart (ASEG).

Firstly though, It is apparent few people read this column and the Society information articles in Preview. During the Hobart Conference I spoke to many members who were unaware of matters the Society is addressing, despite coverage in Preview. These members were quick to present their opinions: while some were good, most opinions were not based on facts and consequently unhelpful to our drive to provide a better service to all. To gain your attention, somewhere in this Preview are details of how a free bottle of Grange Hermitage could be won. Regular reading of Preview is essential for all members, so that the Society in achieving its objectives gives you value for money.

Now permit me to discuss some broader matters for the Society. In this Preview are details of a serious review of the ASEG's role and performance. The intention is to give you what you want, not what we think you want. This will involve implementing a business plan that controls financial matters, sets goals for membership mix and trends, improves continuing education and publications, has the right focus on supporting research.

The plan is to be developed over the next four months by all State branches and the Federal Executive. Here is an open invitation to you to join the dedicated planning group - please contact your State branch now. When in place, this plan will allow the Society to alter its concentration to longer-term matters.

For the record, this edition provides historical trends of ASEG membership and financial status. Digesting this information is key to better understanding where the Society should go. A membership drive is being initiated.

Also, I ask you to read in this edition about the resolutions agreed at the Hobart Council meeting, concerning:

- ASEG Federal Executive rotates on a three-year term.
- Implementation of past-president Advisory for the Federal Executive.
- Altering the sharing formula of Conference surplus.
- Implementation of two types of Corporate members.

Now to the Conferences. At the SEG Conference, held in New Orleans in September, for the first time the ASEG had a professional appearance, having a stand similar to that of other societies such as the CSEG. It is thanks to the drive of Nick Sheard that this has actually happened. The stand attracted considerable attention, particularly from international companies interested in expanding their exposure in Australia. Look forward to seeing more corporate members from overseas in the ASEG. Roger Henderson gives more details of the SEG Conference in this issue.

The Hobart Conference was a great success, exceeding the organisers' expectations. The total number of delegates was nearly 550, a very pleasing number given the difficult times currently being experienced by the minerals and parts of the petroleum industries. The ASEG owes a huge thank you to all the Conference Organising Committee, ably headed by Co-chairmen Craig Dempsey and Mike Asten. The Committee has set a high standard for the March 2000 Perth Conference.

A matter to be addressed is the perception, indeed the reality, the recent ASEG technical programmes are dominated by the minerals industry. There is too little for the petroleum industry, particularly for the interpreters. Look out in the coming months for discussion of how we should address this issue.

In summary, we have interesting times ahead as the Society (ie you) through the medium of the State branches, discusses and implements a plan to take us into the next millenium. Stay with us - the ride will be worth it!

Noll Moriarty
President

ASEG Notice of a General Meeting

A General Meeting of the Society will be held in Brisbane 13 April 1999 for the Election of Officers.

Executive Brief

Happy new year to all.

Congratulations to Mike Asten, Craig Dempsey and the rest of the Hobart Conference Organising Committee for a very successful conference. There were some doubts early on as to whether Hobart would be a suitable conference venue and the state of both the minerals and petroleum industries raised concerns over possible poor attendance. But due to the Hobart team's excellent marketing and organising strategies, the end result was a conference attended by 545 delegates in a fabulous location.

One of the highlights for me was certainly the conference dinner, or in fact the trip to the conference dinner. It began with a delightful cruise up the Derwent River. We then found a jetty onto which we could disembark, after only one unsuccessful attempt. But the real highlight was being greeted by a pipe-player from the Tasmanian police force who led us across one of the main streets of Hobart while his buddies stopped all traffic, for at least 20 minutes, so that the straggly line of geophysicists could cross the road in safety!

Congratulations to all the recipients of the ASEG awards which were presented at the conference dinner and to Sam Carey who was awarded the ASEG gold medal at a special lunch presentation. (See citation this issue) The hearty applause that followed the announcement of each recipient, indicated the high regard in which they are held in the society. (More info next issue)

Another highlight was the uptake of ASEG membership by non-member delegates. I believe there were approximately 100 non-members registered for the conference and our hard-working secretariat, Glenn Loughrey, who manned the new ASEG booth for most of the conference, managed to secure 82 new memberships including 2 new corporate members. I think that speaks volumes for the quality of the technical programme, the resulting publication and of course, the conference organisation. Well done all.

A council meeting was held during the conference, which comprised 28 representatives from the State branches, the standing committees and the Federal Executive. The council meeting provides an informal forum in which all these representatives may give input into Society matters. Please refer to Noll's article on the outcomes of the council meeting and feel free to send any comments to any of the representatives present.

On general matters, please get your 1999 subscriptions, including your membership directory listing in as soon as possible to ensure your details are listed correctly in the 1999 directory.

Financial Status - Estimated as at 19th October 1998

Cheque Account (0080 0044) balance	= $7,356.52
Premium business account	= $32,000.00
Term Deposit (CBA Commercial Bill)	= $158,000.00
Cash Management (Sands 0079 1475)	= $11,831.72
Term Deposit (Sands 5008 4219)	= $40,000.00
Net Cash:	**$197,000.00**
Trust Moneys:	$ 51,800.00
Current Liabilities:	$ 12,000.00

Robyn Scott
ASEG Hon. Secretary

Personality Profiles

GLENN LOUGHREY

ASEG SECRETARIAT

Glenn commenced his working career with the NSW Health Department where he worked as a relieving Hospital Manager at the age of 19. During his time in Wollongong he pioneered a range of independent facilities and programs for homeless and drug and alcohol addicted men and women.

He then joined the Salvation Army where he enjoyed a 16 year career, the highlight of which was to research and develop a specialised program for "troubled and street" teenagers which continues to operate. He has also written articles, which have been published, on this subject.

In 1988 he joined the Australian Kidney Foundation as the first Executive Manager in Queensland. As a result of his efforts the Foundation has grown from a one-man office to an extensive network throughout Queensland, with a high public profile and a comprehensive marketing and fundraising program.

In 1992 he joined his wife Gaye in Dellaraine Association management Services which provides specialised management services to the association and not-for-profit sector. In the ensuing period the business has grown from one client to a national oprganisation providing services to some 15 associations in any one twelve month period.

Glen has also had papers relating to kidney problems and children published and is the President of the Queensland Irish Golden Oldies Rugby Association. He enjoys good red wine, big Cuban cigars and good music.

ERRATA

Apologies to Rob Kirk and Seismic Window followers for an error in Preview 76. Two of the images fell out in the production process. That Seismic Window is reproduced in full in this issue.

Rob Kirk is moving to London with BHP and we wish him well. I still have a few more Seismic Windows but I am looking for new contributors. Do you have a seismic line or other artifact that may be of interest to Preview readers. Please send them in.

Personality Profiles

VOYA KISSITCH

ASEG WEB SITE COORDINATOR

Trained in electronics by the RAAF, Voya's association with Geophysics began in 1978 when, after 6 years of service, he left the Air Force and joined Gearhart as a wireline-logging technician in Bass Strait.

Good times in the oil exploration business in 1979, and the chance to be involved with emerging computer technology saw a move to Roma, Queensland with Australia's first digital logging system.

In 1983, Voya took up the post of Technical Instructor at Gearhart's headquarters in Fort Worth, Texas. This was followed by a variety of international postings including a stint as technical adviser to GECO in Norway and then back with Gearhart to Egypt and then Oman.

A casual association with Aerodata during 1986-87 (especially during the Charters Towers multiclient survey) introduced him to airborne magnetics & radiometrics and to mineral exploration.

In early 1988 he joined CRA Exploration in Brisbane and shortly after became involved with CRA's fledgling Image Processing & Remote Sensing Group. In subsequent years, CRA's growing demand for practical computing expertise accelerated him into various IT and computing management roles.

An enthusiastic casualty of Rio Tinto's more recent reorganisation, Voya has now started out on his own as an independent computer, communications and data processing consultant. He hopes that this will give him more time to enjoy the laid back lifestyle that Brisbane affords. He is also a keen skier and traveller.

Voya has served on the ASEG Queensland branch committee for a number of years including a couple as branch secretary.

His vision for the ASEG web site is to develop it into a valuable reservoir of information for members and a focal point for Australian exploration geophysics in general.

SCINTREX CG-3H FOR SALE

We have a used Scintrex CG-3H Autograv gravity meter for sale.

The gravity meter has recently been overhauled by Scintrex in Canada and comes with all accessories and transport case.

Please call (08) 8531 0349 for more details.

Society Briefs

ASEG Financial Status

The Hobart Council, in reviewing the ASEG's financial status, agreed that the Society needs a business plan containing goals and guidelines regarding financial matters. Issues identified by the Council are:

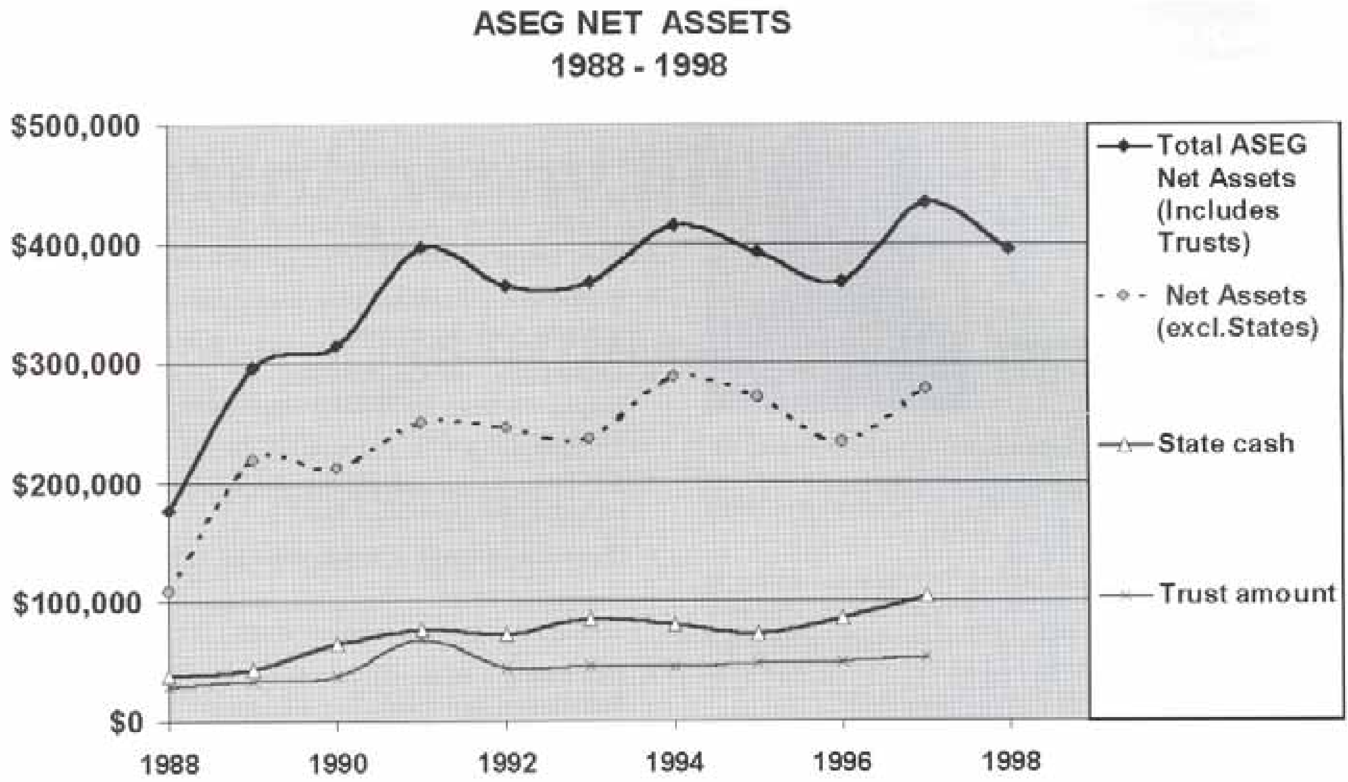
- Implement a business plan that controls expenditure and sets goals for income
- Importance of Conferences to obtain sufficient surplus to fund the non-revenue generating areas on the Society
- Set financial guidelines for the running of Society, including the State branches
- Determine the role of funds residing in State branches
- Determine whether the Society should have a limit for minimum and/or maximum assets
- Determine amount of funding for Research Foundation and continuing education

Before we look at the financial status of 1998/99, let's examine historical financial trends. Data have been compiled from the audited Annual Reports as at December for 1988-96, draft report for 1997 and predicted 1998 values. The 10-year period is sufficient to provide long term trends. The funds are separated in ASEG total net assets, net assets excluding State funds, State based funds and funds held in trust (eg Grahame Sands).

During the 1990s the total net assets have been maintained at about $375,000, plus or minus $50,000. Thus the Society is not going broke, but neither is it dramatically increasing its assets. As a non-profit Society, this is to be expected. A boost in assets occurs when surpluses are received from the very successful conferences, with the net assets run down between conferences. This highlights the importance of the conference surplus in subsidising the non-revenue generating portions of the Society (includes administration, Research Foundation, shortfall in publication costs).

Matters for future discussion are at what level should the Society's funds be maintained - maximum and/or minimum asset level - and how should the funds be invested or disbursed. For example, should there be a defined formula for membership mix, carrying the cost of publications, continuing education, research funding, prizes, scholarships, investment in assets.

Furthermore, the amount residing in States funds is healthy and is steadily increasing. As at December 1997, about 25% (ie $100,000) of the Society's disposable funds were in State accounts. It was pointed out to the Council that the funds belong to the Society, not the States. It is the only the directors of the Society who are legally responsible for ALL expenditures. These directors are the Federal President, First Vice-President, Treasurer and Secretary. Thus it was agreed a more formal definition is required for guidelines regarding State expenditure.



This business plan will decide the amount a State needs to fund its activities. The plan will address the purpose of a States' funding. The States and Federal Executive will agree on financial guidelines, including the capitation amount.

The previous Executive bravely published a budget for 1998/99 in the April 1998 Preview. This budget showed Income of $271,100 and Expenditure of $266,500. Thus on the face of it, the Society's funds are finely balanced.

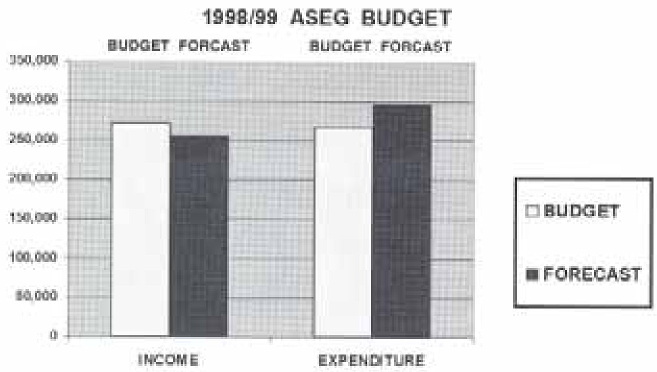
Firstly, tabled is a review of the 1998/99 Budget and forecast final amounts:

INCOME	$ BUDGET	$ FORECAST
Membership	109,200	100,000
Hobart Conference	50,000	37,000
Expl. Geophysics	64,500	44,500
Preview	39,100	44,000
Hobart Conf. Loan	0	20,000
Interest	8,300	10,100
Total Income	**$271,100**	**$255,600**

EXPENDITURE	$BUDGET	$FORECAST
Preview (ex. Conf. Ed)	70,700	65,200
Expl. Geophysics (ex. Conf. Ed)	57,400	70,800
Research Foundation	54,000	50,000
Secretariat	39,700	43,600
Accounting fees	16,600	18,000
Perth Conf loan	10,000	10,000
Capitation	9,600	11,340
Administration	5,300	11,700
Development and Awards	3,200	2,500
Insurance	0	3,400
Publicity - ASEG Stand	0	9,500
Total Expenditure	**$266,500**	**$296,040**

Notes:

- Overall funds shortfall forecast is about $40,000 ($296,040 cf $255,600)
- Preview has a shortfall of $20,000
- Exploration Geophysics has shortfall of about $25,000
- Research Foundation receives $30,000 pa for 1997-99, plus 80% of Corporate membership fees. Post 1999 amount to Foundation yet to be determined
- Most of publicity cost is a one-off expense, buying the stand.



In essence, most of income comes from membership (40%), with both publications contributing 17% each and the conference about 14%. If we aim to increase income, the most obvious place is increasing the number of members (people and Corporate). Thus a membership drive has been initiated (see article on membership in this issue). There will be examination as to what the share of income should be from conferences.

With respect to expenditure, the biggest items are the publications (Exploration Geophysics (24%) and Preview (22%)), Research Foundation (17%) and Secretariat (15%). If we aim to decrease expenditure, the most obvious way is to reduce publication shortfall (currently about $45,000 pa). Matters to be addressed include the frequency of publication of Exploration Geophysics and advertising rates in both publications. It is likely that we can reduce some Society administration costs, such as accounting fees.

A clear message from the Council meeting is that the Society needs to know where it is going and improve services to its members. The business plan will provide a roadmap, setting goals for income, limits for expenditure in the various areas. The plan will make decision making easier and give members feedback on the financial strength of the Society.

If you have ideas on how the Society can help you if it is better structured financially, please contact the Federal Executive or your State branch. (For those of you looking for information on the free bottle of Grange Hermitage, the PGS booth at the Hobart Conference had it as the prize in a raffle. Sorry to be sneaky, but we'd like people to better informed - it's for your benefit!).

Noll Moriarty, Grant Asser

ASEG Membership Status

The Hobart Council, in reviewing the ASEG's membership status, agreed that the Society needs a business plan containing goals and guidelines regarding membership matters.

Membership issues arising from the Council meeting and subsequent discussions include:

- Determine goals for current member benefits, such as continuing education courses, quality of publications
- Review proportion of petroleum content in publications, conferences
- Undertake membership drive for active, associate, students
- Undertake membership drive for Corporate members
- Determine goals for membership growth (national and international)
- Determine ideal proportional mix for all categories.

Before we look at the membership status of 1998/99, let's examine historical membership trends. Data have been compiled from the audited Annual Reports as at December for 1988-96, draft report for 1997 and predicted 1998 values. The 10-year period is sufficient to provide long term trends. However, in due course the earlier years will be determined.

As at November 1998, there are 1,335 members. During the 1990s, membership has grown at an average rate of 10%. Analysis is required as to where these members are coming from (national vs international), active vs student, etc.

We are aware there is a large number of people in Australia (mainly geophysicists but also geoscientists) who are not ASEG members. Many of these people are likely to join the Society, if someone were to explain the benefits. Hence a membership drive has been initiated - please do your part to identify these potential members and be an ambassador for the ASEG.

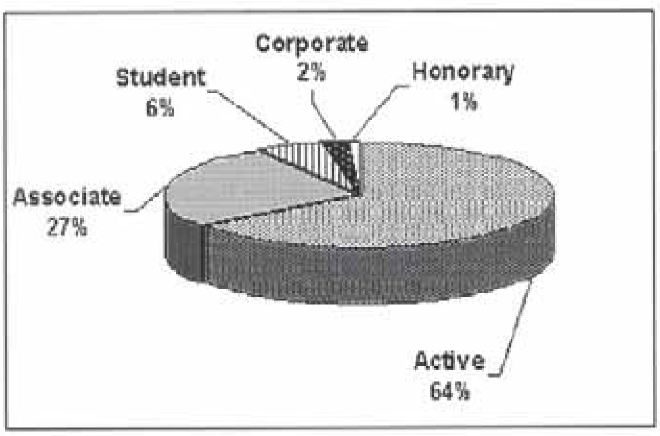
There will also be a membership drive for Corporate members - not only Australian but also international, We ask you to contact your State branch or the Federal Executive as to potential candidates.

ASEG is a non-profit company formed to promote the science of exploration geophysics and the interests of exploration geophysicists in Australia. Although ASEG has taken all reasonable care in the preparation of this publication to ensure that the information it contains (whether of fact or of opinion) is accurate in all material respects and unlikely either by omission of further information or otherwise, to mislead, the reader should not act in reliance upon the information contained in this publication without first obtaining appropriate independent professional advice from his/her own advisers. This publication remains the legal property of the copyright owner, (ASEG).

Now to the current membership split, graphed below:

The majority of members (64%) are Active, but should we expect a higher proportion of students and Corporate? It would be pertinent to compare the ASEG's proportional breakdown with other geophysical societies. Furthermore, determine the effect of a membership drive on the proportional mix.

There will be a concerted impetus to increase the petroleum content in publications and conferences. These means petroleum members are required to play a part - contribute articles to ASEG. The time will be well spent, not only for other petroleum members but also the effort will assist you in clarifying your concepts. Note the effort need not be large - it doesn't take long to submit an interesting seismic section and a range of interpretations.



Calendar Clips

1999

April 18-21 APPEA Conference, Perth

April 21-23 Murray Basin Conference, Mildura

Oct 31- Nov 5 SEG Convention, Houston

2000

March 12-16 ASEG 14th Conference, Perth

ASEG RF – Donations

ASEG RESEARCH FOUNDATION

Post to: Treasurer, ASEG Research Foundation
Peter Priest, Ste 3, 17 Hackney Rd,
Hackney SA 5069

NAME: ....

....

COMPANY: ....

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ADDRESS: (for receipt purposes)

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AMOUNT OF DONATION: $ ....

Do not detach – To be completed by ASEG Research Foundation

ASEG RESEARCH FOUNDATION

Receipt of donation

Received from ....

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The Sum of ....

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dollars being a donation to the ASEG RESEARCH FOUNDATION

$ ....

In accordance with Income Tax Assessment Act S73A, this donation to the ASEG Research Foundation is tax deductible.

Signed: ....

(This form should be retained for tax purposes)

A New Approach to Clearing Seismic Lines in Queensland

Lindsay Horn
Oil Company Of Australia Limited

Introduction

The oil and gas exploration industry is actively searching for a better, more cost-effective and environmentally friendly way of undertaking seismic surveys. Changes in social attitudes, new legislation, the rise of lobby groups and instant and all-pervasive electronic communications have all contributed to the desire to change historical ways of conducting exploration activities. However, one of the main catalysts for implementing changes has been the financial cost of the proper rehabilitation of old seismic lines prior to relinquishment of all or parts of acreage. This, in conjunction with ultimate personal legal responsibility, has fostered the changes.

The new environmental approach to seismic acquisition in Queensland undertaken by Oil Company of Australia Limited (OCA) has been facilitated by many ideas, concepts and technical advances, the most important of which are:

- Increased environmental and cultural awareness.
- The economic costs of rehabilitation of old seismic lines.
- The advent and refinement of Global Positioning System (GPS) technology.
- The experience and understanding of the key people involved in the seismic operation.

The Previous Industry Approach In Queensland

Historically, seismic programs were marked on sub-surface structure maps, transposed to a cadastral map and sent to the field crew. The crew then arranged the permitting of the landholders, with the surveyor (line pointer) establishing the take-off point, and marking it with two steel posts (star pickets).

On a few occasions in certain areas, some marking ahead of the dozers was undertaken using either a theodolite or a hand held compass. This method produced limited success as only slow, foot access was possible in areas of dense vegetation. It was in general a slow and limited method of ranging the line.

The dozer and grader, which were usually mobilised concurrently, then commenced clearing the line from that point. The dozer operator had to backsight on the two posts, which were continually moved along the line behind the dozer as it progressed in a straight line. The line pointer routinely checked the bearing of the line and where it intersected old lines. The operator, who had no idea what obstacles were ahead of him, took great pride in keeping the line as straight as possible. In those days, the mark of a good dozer operator was a line as straight as a gun barrel, extending to the distance, over hills and ridges and through creeks and yards, with not a tree left standing in the line of sight.

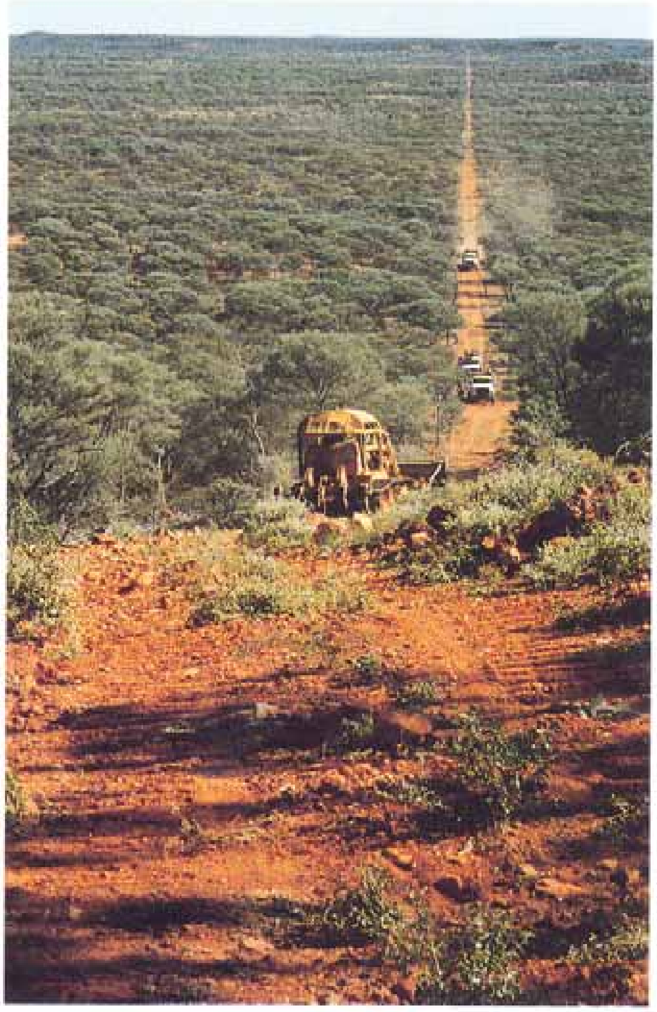

Figure 1. An old seismic line in the Eromanga Basin.

Rills (windrows) were left on both sides of the line, due to three passes of the dozer (up, back, up), as it widened the line (often to around five or six metres wide). The grader then undertook many passes, sweeping all vegetation and root stock to the side. It was believed, at the time, that all grass had to be removed to prevent the geophones from picking up any wind noise on the spread. The resultant line was very smooth, allowing the seismic vehicles to travel at considerable speed.

Line clearing production was slow in areas of numerous fences, but better in the Western Queensland properties with larger paddocks. One of the reasons was that on striking a fence, the dozer operator had no idea which way to go to find a gate, if indeed there was a gate within reasonable detour distance. Consequently, the dozer, on full hourly rate, often walked down the fence one way and then back up the other way, looking for a gate.

Figure 2. A recent seismic line in the Eromanga Basin.

Figure 3. Dozer pushing vegetation back on to a seismic line in the Surat Basin.

The long, straight, cleared seismic lines, with rills on either side that prevented the cross flow of storm water resulted in subsequent rehabilitation problems.

The New Approach

History

With changing community values, experience gained in other operational areas and the visual and economic impact of the eroded seismic lines becoming prominent, it was obvious that something had to be done. A different era requires different attributes and different techniques, plus explanation and training.

The new approach is a pro-active attempt at minimising the social, environmental and cultural impacts of seismic operations. It is based partly on previous experience in conducting seismic surveys in the South Australian section of the environmentally sensitive Otway Basin. Experience in implementing "minimum disturbance" seismic lines in the Surat Basin since 1992, plus associated rehabilitation of old seismic lines, was also utilised.

Concepts

The resultant new method has actually evolved from a number of ideas and techniques, brought together by the advent of GPS technology. However, to successfully implement the method, many concepts are involved. These include:

- **Realisation** of the problem
- **Social impact** of exploration activities
- **Attitudes** changing
- **Legislation** being introduced
- **Support** by management
- **Planning** enhanced and intensified
- **Educating** both office and field personnel
- **Technical advances** in satellite technology and computer software
- **Equipment** variation
- **Documentation** of field activities
- **Reputation** of OCA as an operator
- **Feedback** from landholders and others.

The Method

The environmentally sensitive method of line preparation differs from the conventional method in that the surveyor (line pointer) establishes the bearing and general location of the line ahead of the line clearers, instead of behind, or in conjunction with them, as was the procedure in the past. Prior to dozing, the surveyor marks points (coordinates) along the complete length of the route the seismic line will follow, instead of establishing the beginning of the line only, and verifying the accuracy of the "line pegging" at certain points along the cleared line. This method was initially used for the 1996 Grass Hut (Eromanga Basin) and 1996 Tarus (Surat Basin) Seismic Surveys.

Two Global Positioning System (GPS) units are used for the line location. One unit is established at a known survey location for a base station (the base), with the second unit being mounted on a 4WD Quad motor cycle (the mobile). In areas of dense vegetation inaccessible to the Quad, the mobile GPS unit is converted to portable (backpack) mode.

The (co-ordinate) ends of the programmed seismic lines (start and finish) as well as inflexion points (bends), are provided to the surveyor from the Company's data base. The surveyor then manoeuvres along the general direction of the line, marking established co-ordinate points at locations where the GPS unit locks on to the satellites. By weaving in and out of clumps of trees and bushes, and skirting gullies and channels, a number of points are flagged along the programmed route. In this manner, the lines are set out in front of the fencing and

Figure 4. GPS unit and UHF and VHF radios set up on the quad (4x4) bike (Eromanga Basin).

Figure 5. GPS in portable (back pack) mode (Surat Basin).

line clearing crews, which generally consists of a four wheel drive (4WD) work vehicle, a bulldozer and a grader, plus support vehicles.

Combined, geo-coded, Spot/Landsat TM satellite images are provided to the advance party for clarification of the proposed line locations, vegetation and cultivation both prior to, and during line marking.

The Route Investigator

The task of the route investigator is to consider the following:

- Topography
- Environmental Impact
- Cultural features
- Sites of significance
- Anticipated rate of progress.

As the GPS surveyor establishes control points along the path of the programmed line, the trained route investigator, on a heavy duty agricultural motor bike, checks the terrain. The necessarily highly manoeuvreable and rugged machine enables the route to be checked for access, areas of potential environmental damage, and areas or sites of significance.

Figure 6. Route investigator on off-road bike (Bowen Basin).

Figure 7. Poly pipe for stock watering flagged off to prevent dozer damage (Bowen Basin).

Prior to dozing, the route investigator covers a considerable distance scouting ahead of, with and behind the surveyor in order to select the best route for the line, based on programme requirements. Thus, if necessary, the line can be moved (within certain pre-determined tolerances) for any cultural, environmental or topographic reason prior to any line clearing machinery ever being on the line. In areas impassable to the off-road bike, the route investigator walks, carrying a hand held UHF radio for constant communication and safety.

Figure 8. Emu nest flagged off (Eromanga Basin).

The Line Flagger

Once the general route for the seismic line has been established by the GPS Surveyor, and checked by the Route Investigator, a second surveyor walks through/along the path, marking it in more detail. This line flagger is equipped with a high quality compass for maintaining the line between GPS control points, and a hand held 40 channel UHF radio for contact with the GPS surveyor, route investigator and fencer. The line flagger uses iridescent pink flagging to mark the complete line route for the line clearing crew, by necessity having to walk the full distance of the line, except where it traverses open country or cultivation.

Fences

In some areas, the problem of numerous boundary fences is exacerbated by the properties being divided into smaller paddocks for improved stock control.

Gates have to be scouted and checked ahead of the line clearing crew to determine suitability for the machinery.

Where either boundary or internal fences are encountered along the proposed seismic traverse, the route investigator rides both ways along the fence looking for an existing gate. If no gate is found within a reasonable distance, a suitable place for the construction of a temporary ("cocky") gate on or near the line is determined. The condition of the existing gates and fences is another factor in determining the use of gates. Some gates in poor condition require the fencer to repair them.

Figure 9. Existing gate in poor condition, subsequently repaired (Surat Basin).

In some cases it is decided to erect a temporary or "cocky" gate on the seismic route rather than construct a long detour to an existing gate. This is done to minimise environmental damage, and subsequent rehabilitation by limiting the amount of extra "line" cleared.

The Fencer

A competent fencer, with a 4WD trayback and all the necessary fencing equipment, accompanies the line flagger. This vehicle provides transport to and from the line, and pickup for the line flagger at various stages along the line.

The fencer's job is to erect temporary gates on the line at locations previously marked by the route investigator, repair broken existing gates and modify fallen fences. He also maintains contact via UHF radio with the (on foot) line flagger for safety purposes. Where overhanging branches cause a safety hazard to the drill rigs and vibrators, the fencer trims such branches with a chainsaw. This allows the line to weave around the trees.

Avoided Areas / Sites

Areas or sites of cultural or environmental significance identified by the route selector are purposely avoided when finalising the line route. By moving the line slightly, the possibility of damage by personnel and/or vehicles is avoided. Yellow flagging is used to mark any area, site or tree that is not to be disturbed.

An independent archaeologist, or similarly experienced person, travels the marked route, on a motor bike and, in inaccessible places, on foot as a backup to the route investigator to check for cultural artefacts.

System Benefits

As the line is thus flagged completely from end to end, greater flexibility results with starting points for the line preparation machinery. That is, the dozer or grader can use existing tracks, fence lines, roads, etc to gain access to points on the line. Line preparation can then commence from any such point, unlike the old system whereby the dozer could only start from one end and progress along the route to the other end. This increased flexibility considerably reduces traveling, driving and dozer walking time, thereby resulting in reduced costs for that part of the operation.

Another advantage in having the route marked ahead of the line preparation crew is that the appropriate machinery can be mobilised. Based on the findings of the

Figure 10. Cultural expert and route investigator checking large sand dune (Eromanga Basin).

route investigator (who is experienced in seismic line clearing), a slow moving dozer may only need to be mobilised for a part of the line. In open country, the (much faster) grader could be used, while the slasher may be beneficial where open grass country is encountered along the seismic route. Thus the appropriate equipment not only increases the production rate, but also minimises the environmental impact and total monetary cost.

In addition, by having the end points (start and finish) of the line pre-marked, the exact length only of the line is cleared. There is no need to cut extra length to avoid the dozer having to come back if the chaining determines the line was cut short.

The reduced clearing of the lines, in association with more machinery and an increasing environmental awareness, results in minimal disturbance of ground cover. This allows grass and root stock in general to be left intact, thereby ensuring much faster regrowth of vegetation and subsequent return to previous conditions.

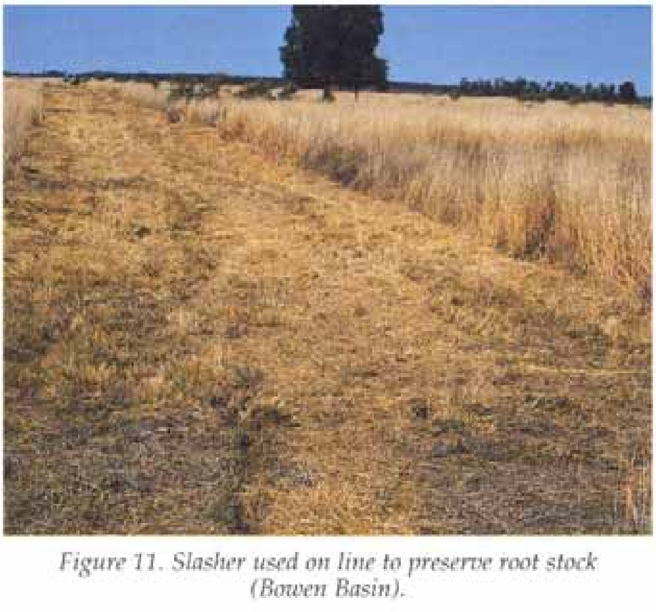

Figure 11. Slasher used on line to preserve root stock (Bowen Basin).

Crooked Lines

The new method of line preparation involves the dozer operator following the pink flagging along the established route. Unlike the conventional manner of line clearing, where the dozer operator backsights on star pickets, unaware of what is ahead of him, he now simply looks ahead from flag to flag. As the line is effectively marked for the operator, he is then able to weave around selected trees, clumps of bushes and cultural features whilst maintaining the line. This weaving down the line very effectively breaks the line of sight. Thus, every few hundred metres, the seismic line-of-site "disappears", as it does at "dog legs" at road crossings.

Social Factors

A conscious effort has been made to enhance personal contact with landholders and local authorities before, during and after the survey. An experienced local person is generally used for the permitting, depermitting and rehabilitation.

A willingness to move or bend lines, where possible in such a way as to avoid problem areas to fit in with the landholder has greatly improved rapport. The technical ability to alter lines has allowed landholder activities such as lambing ewes, ploughing, harvesting, etc to progress unhindered by seismic operations.

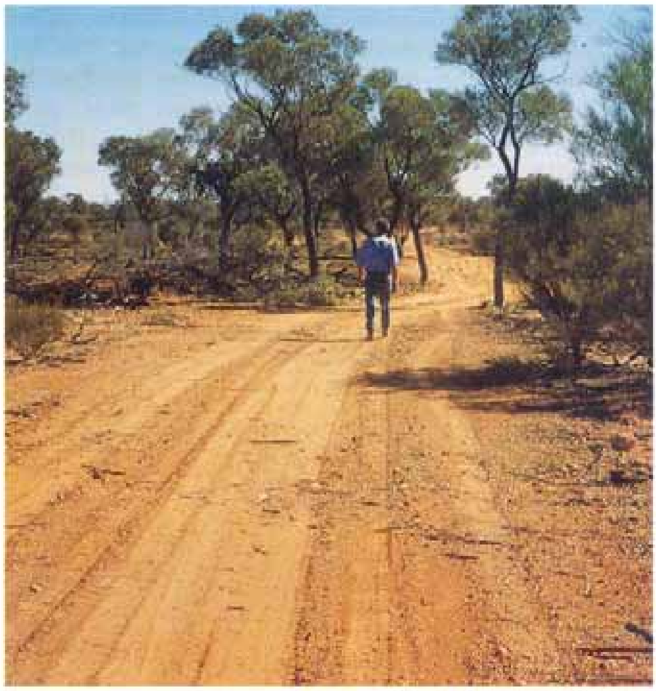

Figure 12. New line (without rills) "disappearing" (Eromanga Basin).

Technical Advances and Changes

In the office, the use of cost effective satellite imagery to cover large areas of seismic program allows environmental and sensitive areas to be avoided prior to the commencement of field activities. The extra planning, with the incorporation of cadastral and topographic information, adds to the initial cost of the survey, but is recouped by savings in line clearing and rehabilitation costs. Heavy equipment can now traverse the seismic lines, leaving very little long term effect.

Figure 13. Four 28 ton vibrators on a line in the Surat Basin.

In the field, GPS technology and advances in computer software used in data acquisition and processing have allowed lines to be bent around obstacles and problem areas.

Other improvements include placing permanent markers on fence lines where possible, steel handles with chains and dog clips for temporary gate security, and smaller charge sizes on dynamite surveys that don't blow out, thereby avoiding leaving substantial holes.

Legislation

Seismic operations are conducted under the Petroleum Regulations, contained within the Petroleum Act. This Act is currently being reviewed. Other Acts relevant to operations are the Cultural Record Act, the Environmental Protection Act and the Workplace, Health and Safety Act. It is critical to abide by these acts, as responsibility passes from the supervisor to the manager to the general manager, and ultimately the Board.

Figure 14. Above line after the vibrators have "shaken" and moved on.

Documentation

One of the major administration changes with the new method of seismic acquisition is the photographic recording of operations, plus the full documentation of same. Whereas, one final report used to be sufficient to record the seismic survey, OCA now requires and/or compiles up to a dozen reports covering different aspects of the survey, many of which are included in the final report.

Conclusion

The introduction and adaptation of GPS technology, an increasing cultural and environmental awareness, the financial and social costs of the rehabilitation of old seismic lines and the experience and attitude of the key people involved in planning and supervising geophysical operations have all contributed to an innovative and responsible attitude to clearing modern day seismic lines.

There are many more minor changes than mentioned in this article incorporated in this new approach to seismic acquisition. They all add up to result in an improved environmental approach to exploration activities.

The greatest environmental, financial and social benefits result from the significantly reduced impact on the land and consequent lower rehabilitation costs. Increased office and field input is required for this new method. However, it is justified, based on the verbal and written positive feedback from the landholders.

Figure 15. Seismic line (hand carry section) in erosion prone country in the Eromanga Basin.

Some Features of Airborne Radiometric Data Processing

T.G. Braginskaya and E.I. Zubov

VIRG - Rudgeofizika

The main aim of obtaining aerogeophysical survey data as correct as possible is associated with employment of automated data interpretation algorithms which in particular presume analysis of the radiometric field thin structure and are very sensitive to processing errors. The airborne data processing accepted in Russia, in general, is in conformity with that described in the International Agency requirements. Therefore, it seems interesting to consider differences between our approaches arising mainly when non-standard situations occur in data processing.

We believe it absolutely necessary to analyse the stability of the spectrometer, using spectra recorded over survey lines, as our experience in processing of data shows that serious problems may take place which are easily solved by using automated algorithms during the data input stage.

In case of a complex topography a purely empirical approach for height attenuation correction proves to be efficient which in some cases allowed us to obtain results useful for further interpretation. The method we use comes to the determination of effective factors of the height attenuation directly from the measurements over the survey area.

The procedure for the determination of compton correction coefficients used in Russia allowed extension of radiometric method capabilities. First of all, radiometric surveys are meant, with a view to determine areas contaminated with falls of radioactive cesium-137 from 0.667 MeV peak after accidents at atomic electric stations and explosions. We used the same procedure for detection of areas where radioactive equilibrium had been disturbed in the uranium-radium series from the protactinium-234 peak at 1.01 MeV.

SPECTROMETER STABILITY ANALYSIS

To analyse spectrometer stability mandatory test measurements are made, using thorium and uranium button sources. As experience with these multichannel spectrometers shows, very often, there are situations when serious problems come out in processing of radiometric survey data, though ground follow-up measurements with button sources gave quite satisfactory results. For instance, when count rates differ from mean values by 3- 4 %, variations a bit higher compared with their theoretical values, due to statistics of the count rates, could be easily accounted for some variation in the positions of the sources in relation to the detector. However, more often than not, the variations are caused by instability of the spectrometer energy scale.

Due to that reason, we always analyse the spectrometer performance directly based on gamma radiation spectra recorded during the survey, applying a software package specially designed for that. To evaluate the scale stability, the full gamma-ray spectrum stacked during recording (usually of the order of 200-300 s) is used and filtered out to remove the noise component by applying a three-point triangle filter. Figure 1 shows an example of processing of a spectrum from a traverse line.

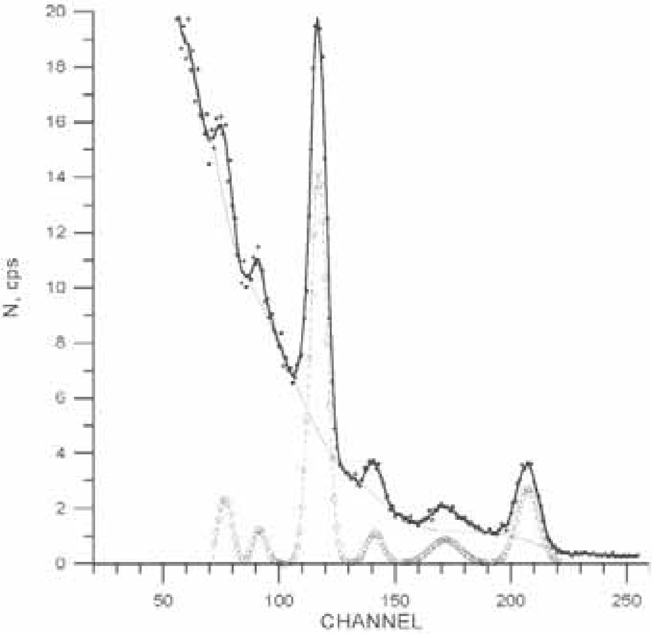

Figure 1. Processing of a gamma-ray spectrum recorded for a traverse line, the flight height is 131 m, the spectrum stacking time - 261 s. The dots denote the measurement results, the solid line - the spectrum after noise filtering, the dotted line - defined peaks, the open circles - approximation of the peaks by Gaussian function.

Compton scattering is approximated by a polynomial function which crosses the points between the photopeaks. Figure 1 shows that after removal of the contribution of scattered gamma-quanta from the spectrum, the remaining peaks are well described by Gaussian function:

$$\mathbf{I(N_i) = I(N_0) \times exp(-(N_i - N_0)^2 / \sigma^2)}, \qquad (1)$$

where $\mathbf{I(N_0)}$ is the amplitude in the maximum; $\mathbf{N_0}$ is the position of the peak maximum in the energy scale; σ is a Gaussian curve parameter associated with the ΔN half-width by the relation:

$$\sigma = \Delta N / (2 \times \sqrt{\ln 2}), \qquad (2)$$

The spectrometer energy resolution **R** is given as

$$R = 2 \times \sqrt{\ln 2} \times \sigma / (a \times E_0), \qquad (3)$$

where E_0 is the energy of the peak maximum.

The relation between the spectrometer channel number and the energy of the corresponding gamma-quanta is described by the straight line equation

$$N = A \times E + B, \qquad (4)$$

where **N** is the spectrometer channel number, **E** is the energy corresponding to it.

During measurements, the spectrometer energy scale should retain its characteristics, i.e. the energy scale "**A**" and the "**O**" position of the "**B**" energy from Equation 4. According to the IAEA requirements [1], the potassium peak position should be preserved at an accuracy to 0.5 of the channel, the thorium peak - to 1 channel. The spectrometer resolution for the thorium peak must not be greater than 7%.

The energy scale stability of an airborne spectrometer can be evaluated by drawing a straight line (Equation 4), using the least squares method, through the positions of the characteristic peaks (N0 from Equation 1) of natural radionuclides. Normally, 6 peaks are defined quite well, but in general, it is quite sufficient to use the position of isotope ^{40} K peak maxima at 1.46 MeV and ^{208} Tl at 2.62 MeV which are distinctly defined in spectra at the nominal survey altitude.

The next processing stage for multichannel spectra is in superimposing of the spectrometer scale and a reference one for this particular instrument for which maxima of the characteristic peaks fall in the given channels and which was used during calibration measurements. When analysing full spectra (ground measurements, measurements on models, height attenuation measurements etc.), to calculate the spectrum values in new "knots" - channels (after scale corrections) it is convenient to use coefficients of a cubic spline that crosses measured values of the spectra in the spectrometer initial channels. For airborne measurements, new numbers of boundary channels are calculated for windows with fixed energy boundaries.

As a result of automated analysis of full spectra recorded over traverse airborne survey lines, a full picture of a spectrometer behavior is obtained showing variations in its setting parameters during the survey and only after that analysis, a decision on the data processing graph can be made - on the application of count rates in the spectrometer standard windows or on the extraction of count rates from the full spectrum. Here, based on *a* and *b* values determined from Equation 1 for each of the line from the total spectrum of this line, new boundaries of the channels are calculated.

As our experience shows, problems arise even when modern selfstabilizing GR820 spectrometers are used, to say nothing of thermostabilized spectrometers. The time needed for the automated data analysis is not great but it allows avoiding very serious problems. Below, an example of the data analysis from full spectra is presented.

A generalized picture of the spectrometer behavior during a survey is given in Figure 2, where mean values and standard deviations of potassium and thorium peak positions in the energy scale are given for each of the flights. In the Figure, dotted horizontal lines show reference parameters of this spectrometer, i.e. its parameters during setting. The number of the spectra for each flight was 4 - 5 (for flights stopped due to weather conditions) - to 12-14. As seen, within each flight, the drift of the peaks shown by vertical segments in the plot is notably larger than that of the IAEA standards.

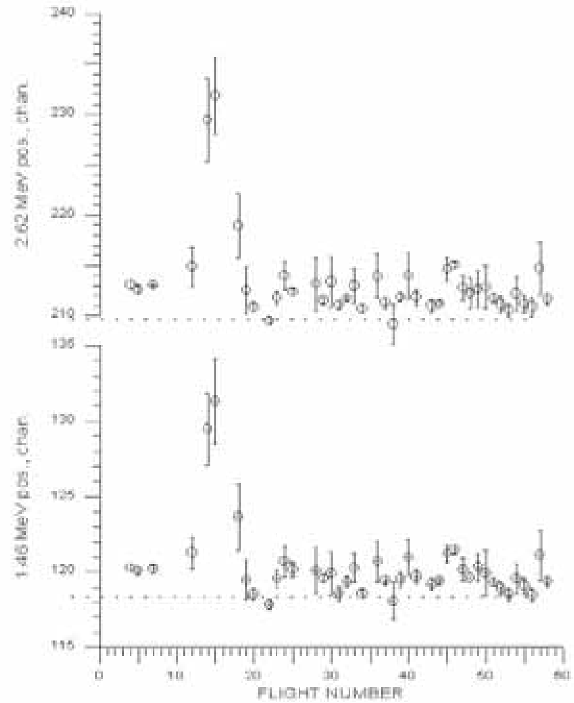

Figure 2. Mean values and standard deviations for the 1.46 MeV potassium and 2.62 MeV thorium peak positions during the 1996 surveys.

Figure 3 shows how the potassium peak position was changing during routine flight 33. Diurnal time was plotted on the abscissa axis, the first two and the last two points correspond to the measurements over a test flight and at a large height.

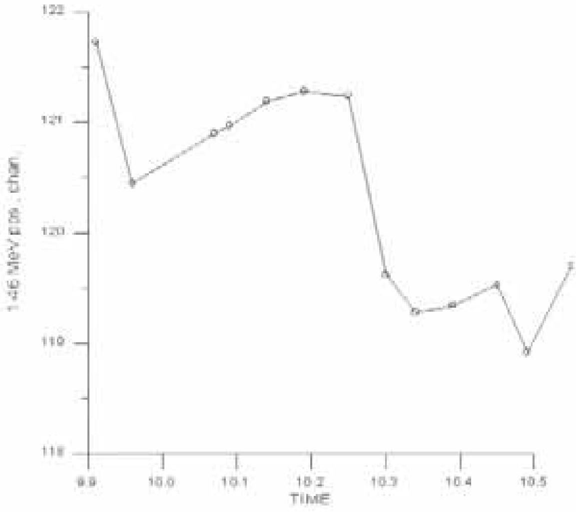

Figure 3. The position of the 1.46 MeV potassium peak during flight 33.

For about 1 hour, the potassium peak had drifted for more than 2 channels. Besides, at least for 3 flights (Figure 2), an abnormal drift of the peaks was observed.

Effects of the energy window positions on recorded count rates are shown in Figure 4 - distinct bands for the spectrometer standard windows practically disappear after extraction of data from full spectra for corrected spectrometer windows.

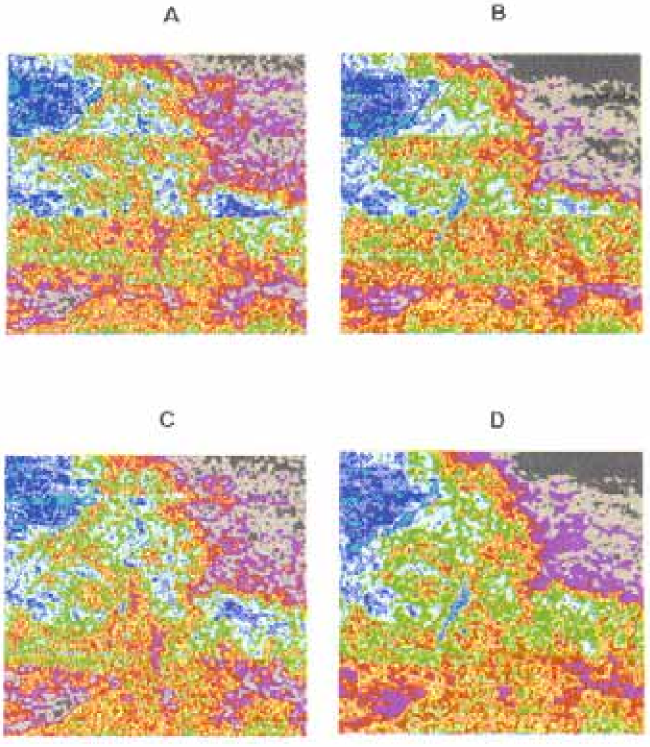

Figure 4. Maps of Thorium and Potassium windows raw data prior to correction and after correction.
A - Th.W. raw data, standard window
B - K.W. raw data, standard window
C - Th.W. raw data, corrected window
D - K.W. raw data, corrected window

HEIGHT ATTENUATION CORRECTION

Radiation from an infinite half-space with uniformly depth distributed gamma-ray sources consists of an unscattered component - direct radiation - with the energy of gamma-quanta from monoenergy sources $\mathbf{E_0}$ and of a scattered component containing gamma-quanta $E < \mathbf{E_0}$ with a certain energy composition dependent on the energy of an initial gamma-quantum and medium properties. The intensity of the unscattered radiation **J (h)** in the atmosphere at the altitude h from the earth surface is described by King function of the second order **E (x)** [2]:

$$J_0(h) \sim E_2(m_0 * h * r / r_0), \qquad (5)$$

$$E_2(x) = x * \int_x^{\infty} (\exp(-z)/z^2)dz, \qquad (6)$$

m is a linear attenuation coefficient of gamma-quanta of the E energy inversely equal to the length of a free travel in a medium with electron density r.

For the interval

$$0.3 < x < 2.0, \qquad (7)$$

the approximation shown below works fairly well:

$$E_2(x) = 0.7 * \exp(-1.45 * x). \qquad (8)$$

For the height range traditionally used in airborne radiometrics, the indicated interval $\mathbf{x = \mu * h}$ usually satisfies the inequality given above (7) and the exponential approximation (8) gives quite good results. Note that the height used must be corrected for temperature and pressure, as these two values influence the density and hence, scattering properties of the air.

In this way, the height attenuation correction is possible, assuming that the radiation exponentially attenuates, depending on the height the detector is flown

$$N(H) = N(h) * \exp(\mu * (H - h)), \qquad (9)$$

According to the technology [1], Compton stripping for each of the spectrometer windows is carried out after compton correction of count rates. Here, the dependence of compton stripping coefficients on the thickness of the absorbing air layer should be known. The other version for the solution to this problem uses reduction to the level of the ground surface of the total gamma-radiation (i.e. direct and scattered) in each spectrometer window and then compton stripping of the spectrum.

This way of solving the problem uses effective coefficients of gamma-ray attenuation for a mean concentration level of natural radionuclides, in a survey area, determined for the sum of the direct and scattered radiation for each of the spectrometer windows. These coefficients can be calculated both for individual series of height attenuation measurements and directly from the survey results, in case recorded radar altimeter readings greatly differ. In this case, the computation procedure is very simple and gives results with a low noise level. Experimental investigations of gamma-ray attenuation over long natural sites with significantly different concentration ratios of natural radionuclides showed [3] that effective attenuation coefficients vary insignificantly for sites with a uniform distribution of the radionuclides. This analysis has led us to employment of the second version too, which we believe allows for a more flexible approach to each particular situation, and for real measurement results, - a better correction for influence of the carrier height on the recorded count rates. The count rates measured at the nominal survey altitude in the spectrometer windows are reduced to the ground level, using effective coefficients obtained, and only after that, with the compton coefficients, the compton stripping is carried out with the constants determined from spectra of long models on the ground surface level.

Each of the two ways considered above for gamma-ray attenuation by the atmosphere near-surface layer presumes that the radiation source is a half-space of an infinite length with a uniform distribution of three natural radionuclides. It is clear that for real conditions, even at a flat relief, the situation is significantly more complex. For instance, radiation from local anomalies attenuates faster with distance compared to a half-space; besides, for a non-uniform depth distribution of sources (of a thin layer type at the surface), gamma-radiation also attenuates faster than from long sources. It is clear that for small targets that sharply differ in concentration from enclosing area, the two ways will give incorrect results; advantages of the first computation method, which seems to be better theoretically justified, become doubtful.

In principle, if necessary, complex topography situations can be defined and attempts can be made to introduce a theoretically justified correction. However, here, some new circumstances arise.

Normally, in surveys over sites with a relatively simple relief for flights, the height differs little from the nominal one. Usually, for the 80 m nominal survey height, the entire range of the radar altimeter readings falls within 60-120 m and any of these two algorithms for the height attenuation correction gives good results. In practice, however, often, there are cases when the application of a simple exponential algorithm leads to unsatisfactory results. If recorded radar altimeter readings differ from the given height by more than 30-40 m, most likely, they evidence that the relief is not flat. Here, for a number of reasons, there are doubts as to whether it is right to use a simple exponential law. First of all, theoretical considerations lead to corrections in the law of gamma-ray attenuation itself and a correct application of formulas requires at least correct initial data. However, in case of a complex topography, it should be born in mind that radar altimeter readings are not in conformity with the real distance to the centre of the detector field of view. In draped surveys, recorded radar altimeter readings may differ greatly for lines flown "up hills" and those of "down hills", and this difference will depend on too many factors, such as the carrier type, wind speed, slope steepness etc. In flights along mountain slopes, side radiation may play a large role. Under these conditions, it is unreasonable to seek for a general theoretical approach to the solution of the problem and here a purely empirical approach turns to be effective.

Consider a typical case of an airborne radiometric survey over an area with a complex topography - the western part of the area is a plato, 600 m high with a scarp dipping into a valley. When flying in the western direction "up hill", the pilot increased the altitude, while flying "down hill" - it was a draped survey. Figure 5, plots are presented for the main adjacent lines covered in the opposite directions.

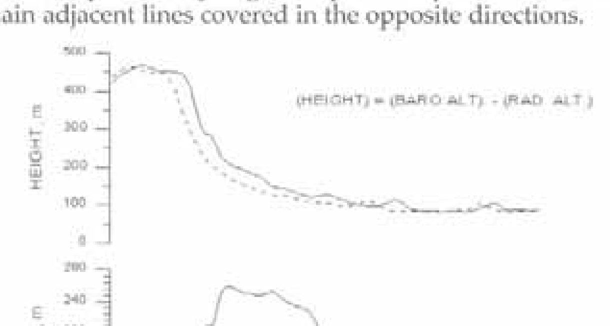

Figure 5. The relief height, radar altimeter readings and corrected values for Th.w. for the lines 1 and 2: line 1 - solid lines, E - W direction, thin solid line - correction according to the formula (9), thick solid line - correction according to empirical law ,VIRG line 2 - dashed lines, W - E direction.

The corrected count rates for thorium in these two lines are close enough for all parts of the line, except for the part flown "up hill" for line 1, where a positive correlation between the count rates and the radar altimeter readings is clearly observed.

To analyse such situations, we use the histogram method. The entire combination of the data from the survey area is considered. Samples of the count rates in the spectrometer windows that were preliminary corrected for the background are taken, for the given successive intervals of the radar altimeter readings. Then a mean count rate for all the points is determined (not less than 200) that fell within the given interval. Naturally, it is expected that in the general case, the concentration of radionuclides is not associated with the radar altimeter readings. Then, the obtained association between the mean count rate and the height interval gives an empirical dependence of the count rate in the window on the radar altimeter readings.

Figure 6 shows a result of such data analysis. For the area under consideration, the histogram method was applied separately to analyse the lines covered in the opposite directions, as in the north-east part of the site there was also a hill there, where the altitude was increased in the eastern direction.

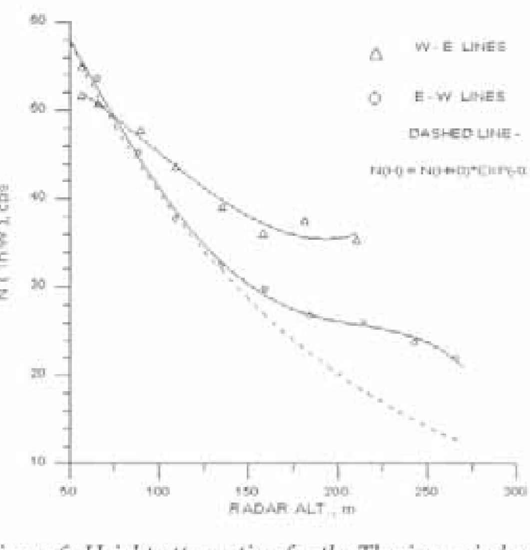

Figure 6. Height attenuation for the Thorium window count rate, determined by means of histogram method (solid lines) and exponential function calculated according to the calibration results (dashed line).

The following typical features can be noted here:

- the dependencies turned to be different for the flights in the eastern and western directions, and this can be accounted for different measurement geometry;

- for the lines covered "up hill" in the western direction, the application of the exponential dependencies for heights greater than 120-150 m will lead to an increase in the corrected count rates which was just noted in Figure 5.

The case considered clearly shows that the height attenuation correction traditionally used may lead to incorrect results. In a complex topography, we make use of an empirical function, similar to that presented in Figure 6, obtained for each site. Figures 7a,b show the result of such a data processing for thorium for the analysed part of the area. Distinctly seen are two groups of the lines flown up hill in the western direction (Figure 7c). When the traditional exponential reduction is applied

(Figure 7a), two spots with elevated concentrations, obviously associated with the geometry factor, can be seen in the corrected thorium map. Figure 7b presents the result, calculated using the empirical function given in Figure 6. Here, there is no obvious effect of the topography on the result.

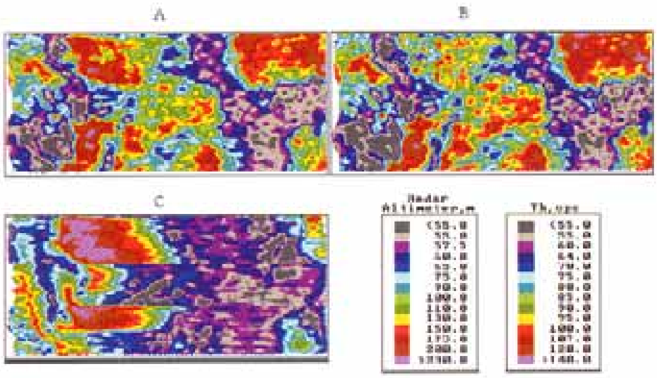

Figure 7. The corrected values for Th.w. and radar altimeter readings for the area. A - Thorium corrected with exponential reduction, B - Thorium corrected with empirical function, C - radar altimeter readings.

As our experience shows, this sufficiently simple approach allows obtaining of significantly better results, to a large extent, eliminating a false field structure associated with the geometry factor.

NEW POSSIBILITIES IN APPLICATION OF SPECTRA FROM LONG SOURCES FOR COMPTON STRIPPING

As it was indicated earlier, in processing of airborne radiometric data, the conformity of the recorded radiation and the spectrum of an infinite half-space with uniformly depth distributed sources is presumed. The shape of the spectrum depends on the size of the model, as the intensity ratio of direct and scattered radiation depends on the size of the radiating target. Figure 8 presents

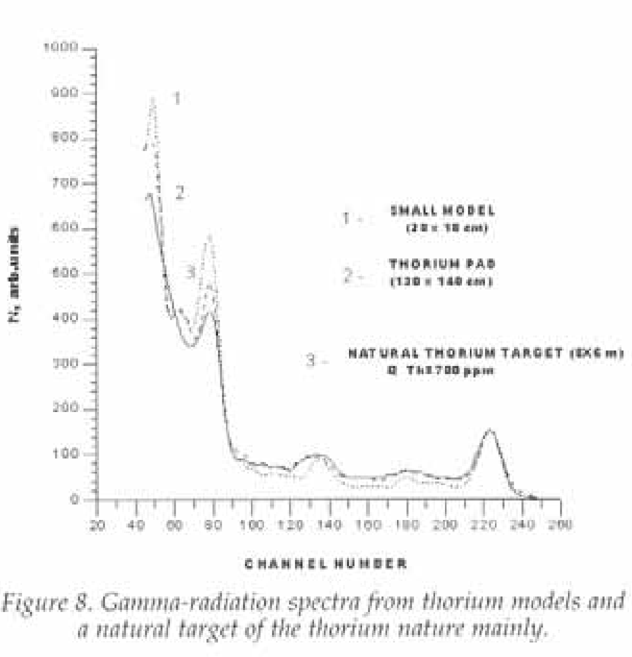

Figure 8. Gamma-radiation spectra from thorium models and a natural target of the thorium nature mainly.

spectra measured by the same spectrometer for a standard small thorium model, a model of an intermediate size, and from a natural target with the thorium concentration of about 700 ppm.

The application of the so-called "single spectra of a half-space" for determination of compton correction coefficients seems to be the most correct. The determination procedure for those spectra had been developed at VIRG [3]. For that purpose, special ground measurements of spectra from three natural rather lengthy targets were made. Each of those targets had a significantly increased (by about 100 times) concentration of one of those three natural nuclides. After correction of those spectra for background radiation, compton correction coefficients for determination of concentrations of natural radionuclides can be easily determined by summing up count rates for each of the model spectrum within optimal energy windows.

The application of such single spectra, as a base for analysis of spectra from natural targets, allows definition of peaks fairly well in the energy area lower than 1 MeV, which is hardly possible, if spectra from transportable models are used. Below, possibilities will be considered, when single spectra are used.

In analysing of multichannel spectra, they are approximated by least squares method. Here, functional $\mathbf{F(N_U N_{Th}, N_K)}$ minimum condition should be observed:

$$F(N_U N_{Th}, N_K) = \sum (W_i * (N_i - (a_{iU} * N_U + a_{iTh} * N_{Th} + a_{iK} * N_K))^2), \quad (1)$$

where

$\mathbf{N_U, N_{Th}, N_K}$ are factors that characterise concentrations of thorium, uranium and potassium at a measurement point;

$\mathbf{i=1,..., k, k}$ - number of the spectrometer channels,

$\mathbf{N_i}$ - pulse count rates in the i-th energy channel of the spectrometer;

$\mathbf{W_i}$ are weight factors that take into account contributions into the functional from each channel.

The $\mathbf{a_{iU}, a_{iTh}}$ and $\mathbf{a_{iK}}$ coefficients are determined, using single gamma-ray spectra.

Weight factors, for energies greater than 1MeV, are accepted equal to 1; for lower energies, where the measured spectrum from three model spectra may differ, sufficiently low weight factors are taken - about 0.01. It is as if an analytical continuation of the calculated spectrum into the area of low energies takes place. The difference between the measured and calculated spectra gives much information, since it is the quantity that shows the deviation of the recorded spectrum from the accepted model - the sum of three spectra from uniformly distributed natural radionuclides.

In case a natural target has no features in composition, spatial distribution of natural radionuclides etc., its spectrum is simply a sum of spectra from three natural radionuclides with an accuracy to an experimental error (Figure 9).

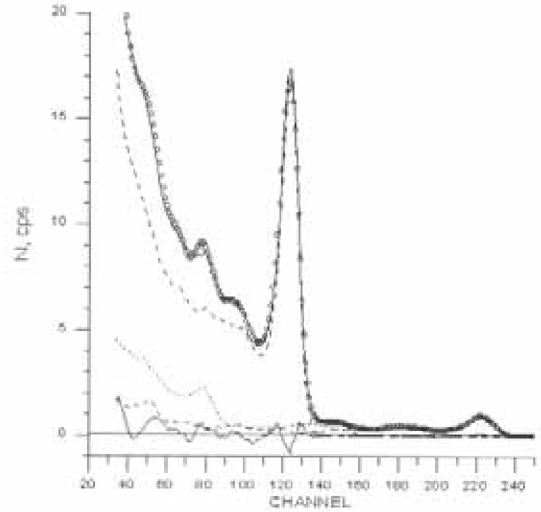

Figure 9. Approximation of gamma-ray spectra from natural targets, using least squares method. Ground measurements on the test range Horinsk. Open circles - measured spectrum, solid line - fitting of the spectrum by the sum of Th, U and K single spectra, dashed lines - single components, thin solid line - difference between measured spectrum and fitting.

In the case presented in Figure 10, the soil surface was contaminated with cesium-137 isotope, which has an intensive peak at 0.667 MeV and is well seen in the differential spectrum. The spectrum shown in the Figure was recorded over a "cesium" test site near St.Petersburg. This was the differential method that was used during an airborne radioecological survey over the USSR territory. The cesium channel of the spectrometers was selected in the range of 0.59-0.75 MeV.

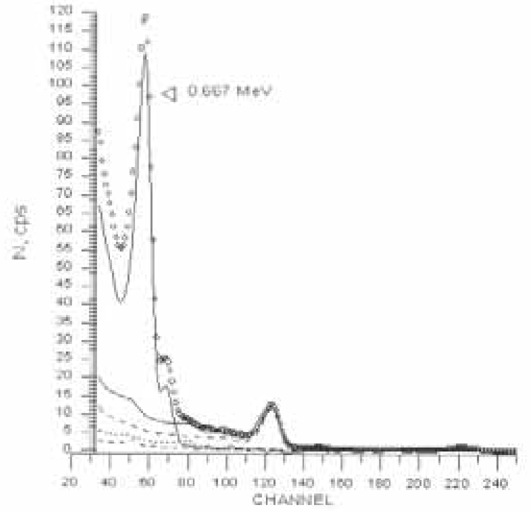

Figure 10. Approximation of gamma-ray spectra from natural targets, using least squares method. Ground measurements on the test range Lomaha. Open circles - measured spectrum, solid line - fitting of the spectrum by the sum of Th, U and K single spectra, dashed lines - single components, thin solid line - difference between measured spectrum and fitting.

Figure 11 presents maps with concentrations of natural radionuclides and areas contaminated with cesium recorded over the USSR territory, the survey altitude is 50 m. The correlation coefficient of the airborne data with the results of ground follow-up for Cs-137 turned to be 0.96.

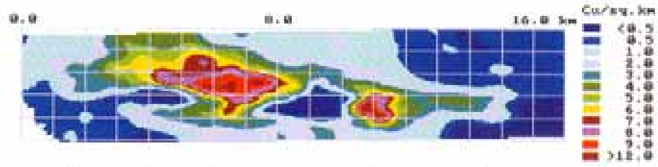

Figure 11. Airborne radiometric map of Cesium -137 contamination of the territory near Chernobyl.

We used the same procedure for the detection of sites, where radioactive equilibrium had been disturbed in the uranium-radium series [4], based on the protactinium 234 peak at 1.01 MeV (Figure 12). According to chemical analysis data, in the sites like those, the concentration of uranium in rocks is much greater than that determined by gamma-spectral method, as in this method, uranium concentration is determined from the bismuth-214 peak at the assumption that radioactive equilibrium exists in the uranium-radium series.

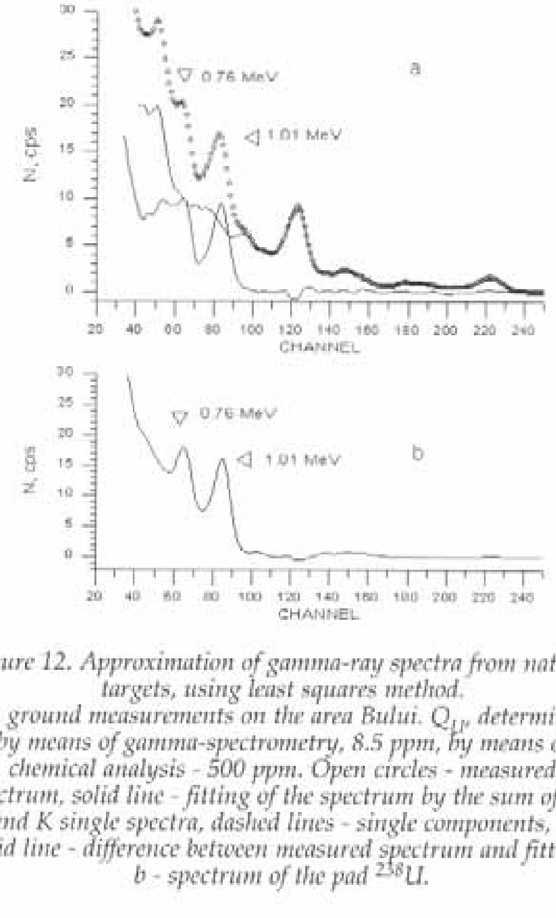

Figure 12. Approximation of gamma-ray spectra from natural targets, using least squares method.
a - ground measurements on the area Bului. Q_U, determined by means of gamma-spectrometry, 8.5 ppm, by means of chemical analysis - 500 ppm. Open circles - measured spectrum, solid line - fitting of the spectrum by the sum of Th, U and K single spectra, dashed lines - single components, thin solid line - difference between measured spectrum and fitting.
b - spectrum of the pad ^{238}U.

During airborne measurements over the area with a site like that, in the energy window at 0.91-1.2 MeV, a zone with an increase in the count rate compared to the model one was clearly seen (Figure 13), i.e. again in the sum of the count rates from uranium, thorium and potassium.

The capability of identifying these zones allows obtaining of new data for geological interpretation of processes that take place in rocks.

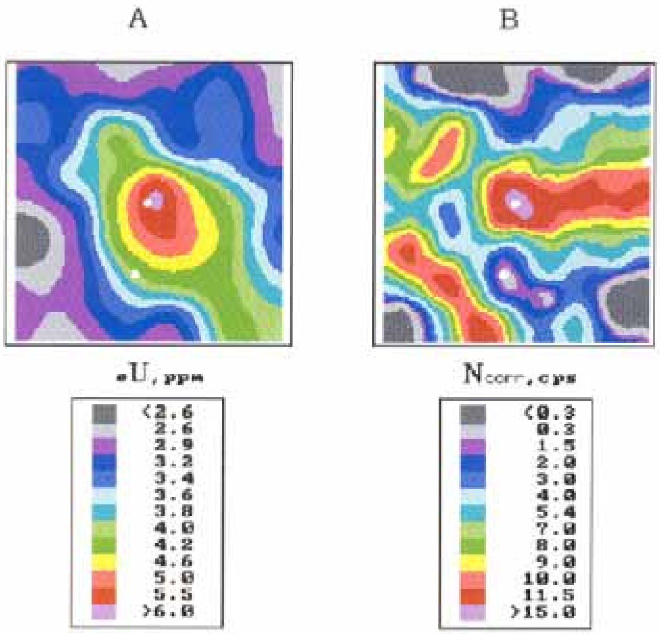

Figure 13. Airborne radiometric maps of eU (a) and the difference between measured count rate and the fitting for the energy window near 1.01 MeV (b), the area Bului ("young accumulation" of Uranium).

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Physical Properties of Fractured Rock - Bulk Resistivity

D W Emerson & Y P Yang

Introduction

Rocks may manifest a secondary porosity in the form of macroscale joints, shears or fractures. Joints are usually discontinuous in their own planes, shears tend to be large and continuous but often with mineral infill, and fractures are broken rock zones which may range in width from under a metre to tens of metres. These have been discussed by Gale (1982). "Fracture Porosity" here is the occurrence of extensive planar voids and embraces joints, shears, fractures and secondary pockets of voids. This secondary porosity can be significant with regard to electrical resistivity, (Keller & Frischknecht, 1966; Parkhomenko, 1967) elastic wave propagation (Sjøgren et al, 1979; Winterstein, 1992) petroleum production (Aguilera, 1980; Nelson, 1985) and hydraulic conductivity (Gale, 1982). Such a secondary porosity could range from <0.1% to about 5% but is usually ≤1%. It is superimposed on the matrix porosity which itself could range from very tight, →0%, to highly porous, say 30%. Pirson (1970) has discussed porosity partitioning between block or matrix and fracture-vug porosities. Laboratory sample tests and limited radius of investigation borehole logs respond to the rock block and its matrix porosity which includes integranular voids, and mesoscale fracturing and microcracks. Fractures, joints and shears are very common geological features, but only some zones have apertures of sufficient width to affect macroscale physical properties; the others are infilled with minerals often with properties similar to those of the wall rocks. An outline of fracturing and primary and secondary porosity may be found in Aguilera (1980), Gale (1982) and Nelson (1985). Barton et al (1978) and Beavis (1985) describe quantitative methods for the appraisal of discontinuities in rock masses. It is the resistivity effect of a conductive water filled fracture zone that will be discussed here.

Fracture Zone Model

Consider the simplified case of a fractured block of rock with vertical or horizontal or inclined joints in the direction of current flow and with the joints 100% saturated with water of resistivity ρ_w which interfaces with the rock matrix blocks that each have a water saturated resistivity ρ_o. In the approach adopted here, F the matrix formation factor (inversely related to matrix porosity) and the matrix water resistivity are subsumed in ρ_o. The joint or fracture porosity is m and usually is a very small fraction e.g. 0.01 (i.e. 1%). For a zone of length (l) and crossection area (A), comprising the rock block and joint, a simple consideration of resistances ($R=\rho l/A$) in parallel leads to the equation for bulk macroscale resistivity ρ_b:

$$1/\rho_b = m/\rho_w + (1-m)/\rho_o \qquad (1)$$

The same equation holds if the joint porosity is split between two orthogonal joints in the direction of current flow. However, anisotropy applies in these cases and the resistivity depends on the azimuth of measurement. For high ρ_o (1) reduces to an Archie type equation with a (fracture) porosity exponent of -1.0, a well known result.

Perhaps the most useful practical approach in a first pass estimate is to consider three orthogonal joint directions or chaotic fracturing, which can be regarded as isotropic. For these cases resistance elements in series may also need to be considered if the fracture and matrix porosities communicate. In the Russian literature Nechai (1964), using theory and fracture testing, provided the equation:

$$1/\rho_b = 2m/3\rho_w + [3-2m]/[\rho_o(3-m)] \qquad (2)$$

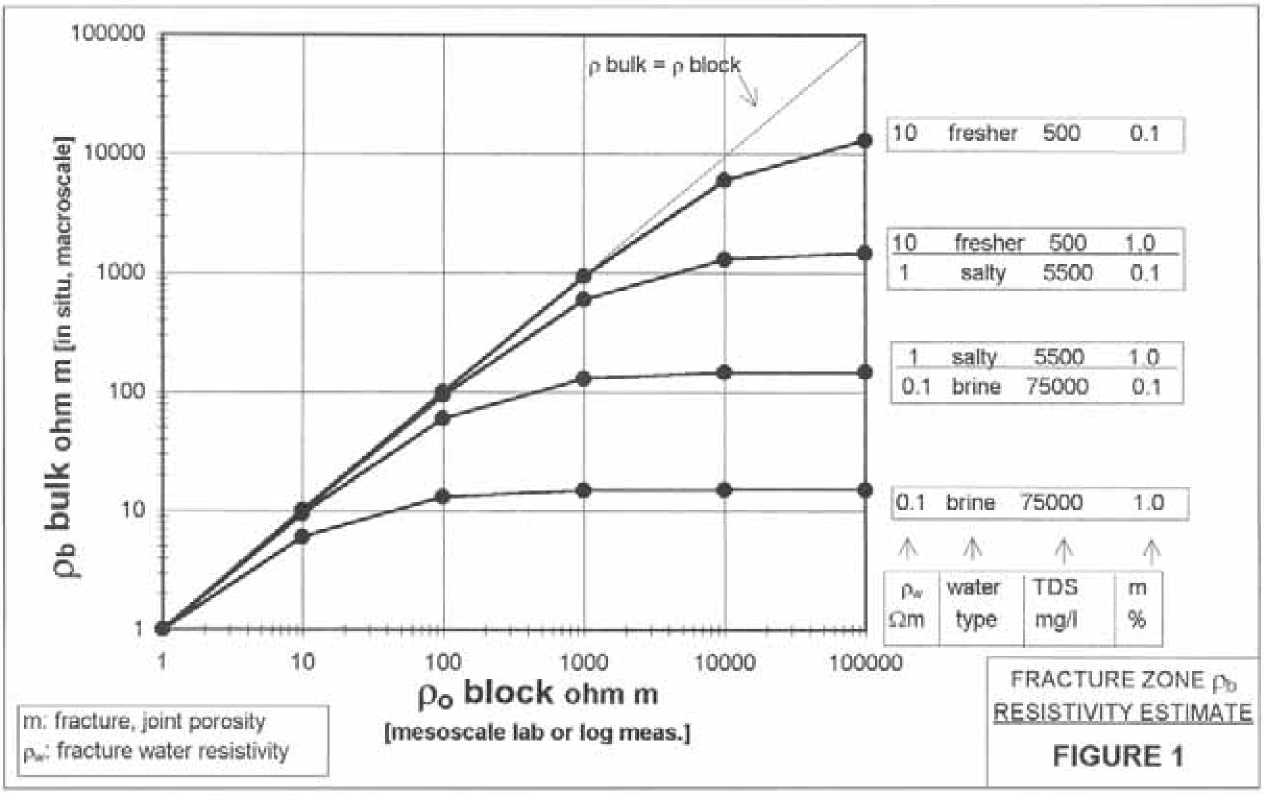
In Figure 1 the Nechai equation is graphed as ρ_b vs ρ_o for a range of water resistivities (ρ_w nominal 25°C) and joint porosities; 0.1% is a poor and 1.0% is a good porosity for a joint or fracture system.

Note that a curve has not been supplied for a very fresh water, say ρ_w=100 ohm m, because surface conduction in the boundary layer of a narrow fracture may become quite important in a dilute solution thus rendering the effective ρ_w much less than the nominal ρ_w=100 ohm m, indeed it may approach 10 ohm m. Also, in the case of a brine saturated medium where the rock block matrix porosity communicated with the joint porosity, it is unlikely that ρ_o would attain the 100,000 ohm m level unless the matrix porosity was extremely low. Furthermore, it is assumed that current in the system is in the conduction domain at frequencies of energisation where displacement currents are negligible. The second term in (2) is of minor consequence for highly resistive blocks, so for high ρ_o the curves can be regarded as approximately reflecting the ratio m/ρ_w from 0.01 to 10.

Equation (2) shows that the macroscale bulk resistivity can adopt a value much less than that of the more resistive matrix blocks especially for saline water and a high joint porosity. There are significant effects even for fresher waters when matrix blocks are highly resistive.

A comparison of equation (1) and (2) shows that bulk resistivity is lower for equation (1) as it represents the more favourable case of all the porosity being arrayed as sheets parallel to the current direction. A significant amount of porosity in equation (2) is not so arrayed.

Equation (2) and Figure 1 may be used in an approximate and general sense to estimate bulk resistivity when ρ_o, m and ρ_w are known by measurement or by reasonable inference or by interpretation. Conversely an approximate idea of a zone's fracture porosity might be otained if ρ_b was interpreted from field data or borehole surveying device with a large radius of investigation, and ρ_o and ρ_w were known or properly estimated, *providing there were reasonable grounds for assuming or suspecting the occurrence of a fracture zone of the type described by equation (2).*



FRACTURE ZONE ρ_b RESISTIVITY ESTIMATE

FIGURE 1

Discussion

Clues to conductive fractures would depend on the circumstances in, and knowledge and experience of exploration areas and lithologies. If samples of rock from a formation of interest are demonstrably extremely resistive, e.g. solid massive quartz, then some indication may be had from field survey results especially those sensitive to the effects of displacement currents (e.g. Fraser et al, 1990).

Sometimes fracture control can be noted in earth tide induced cyclic fluctuations (twice daily) of groundwater levels in bores tapping rigid very low porosity formations. Davis et al (1992) observed such effects in a zone of the Cahill Formation schists at Koongarra NT where Emerson et al (1993) had measured extreme ρ_o's of the order of 100,000ohm m. An ρ_b value about an order of magnitude less than this was suggested by Figure 1, after noting the fresh nature of the groundwaters and considering fracture density and aperture information from a borehole television investigation.

The Archaean of southern Western Australia has a range of water salinities broadly decreasing to the north so the ρ_w's increase from about 0.1ohm m south of Kalgoorlie to about 10 ohm m north of Laverton and Leonora. Consider the case of a tough tight metabasalt with ρ_o=100,000 ohm m. A fracture zone in such a metabasalt could have an ρ_b of about 15ohm m if fractured heavily and openly in a very highly saline groundwater area, but if fractured similarly in a fresher groundwater regime it could have an rb of around 1500 ohm m. Such ρ_b values in the low thousands of ohm m range might also be expected for the wet, fractured basalt deep leads in south eastern Australia.

Conclusions

The possible occurrence of fracture zones and their effects should be carefully considered in electrical or electromagnetic surveys in boreholes, between boreholes, on the ground or from the air. Appropriate models can be formulated for specific fracture features and the equation and graph presented here should only serve as a general guide only. In any exploration area of it is useful to enquire as to likely fracture and water conditions in pits, mines and borefields. The difference between the ρ_o and ρ_b for a formation is a source of useful geological information in geophysical studies.

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Acknowledgements

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AWARD OF THE ASEG GOLD MEDAL TO PROFESSOR S. WARREN CAREY

HOBART 10th November 1998

Johnathon Knight

The Australian Society of Exploration Geophysicists Gold Medal is awarded for distinguished service to Geophysics, and is the highest award offered by the society. It has only been awarded twice before, in the 25 years of the society's existence; in 1989 to Dr. Ken McCracken, and in 1997 to Prof. Don Emerson.

This year the society is awarding the Gold Medal to Professor S. Warren Carey, in recognition of his contribution to geophysics.

Many people know him as Sam. As one of his students, dare I say disciple, I will always know him, and refer to him as Prof, or Prof Carey. Prof's early life and career are worthy of novel, a precipitous entry to the world after his mother toppled off a horse and over a fence, childhood in a large family in the country, a brilliant student at University in Sydney, a pioneer in oil exploration in New Guinea, a paratrooper and "who dares wins" specialist in unconventional warfare during the Second World War - you can read an excellent description of all of this in the Australian Geologist (Geological Society of Australia) March 1992, on the occasion of a previous prestigious award.

Since we are in Tasmania, I would like to start this citation by mentioning some of Prof's local achievements.

Prof. Carey introduced geophysics into the Geology Department , University of Tasmania, in the early 1950's, having founded the department in 1946, at the request of the State government. Throughout his time as head of department, he expanded the department's undergraduate and graduate geophysical activities by the appointment of two full time geophysical lecturers, one of whom, Dr. Dudley Parkinson, I am very glad to see amongst us today; provision of a comprehensive set of equipment, and several technical support staff. Many geophysical theses were inspired, in various fields of geophysics, such as gravity, crustal seismic, electromagnetics, and magnetotellurics (indeed one of this conference's co-chairmen produced a first class honours thesis in magnetotellurics at the Uni. of Tasm.)

Inspired partly by the need to monitor seismic risk around the developing Hydro Electric system, Prof established the Tasmanian Seismic Net in 1957, and continued development of it to incorporate a network of World Standard seismometers in stations across Tasmania. This net is continually enhanced, and if you've got time, take a walk up to the Geology Department, just ten minutes away, and you will see the big seismograph rolling around in the foyer, on its 24 hour cycle, as it has done for more years than I care to remember.

Perhaps less known is the work that Prof did as a mentor and friend to students, in particular Legacy students. His door was open every Tuesday at 5 pm for students, for a drink and a chat. As president of the Geology Students' Club I found his willingness to listen to, and encourage new ideas, such as the club manning the department library several evenings a week, particularly accommodating.

Prof S.W. Carey receiving his ASEG Gold Medal from President Noll Moriarty.

Prof. Carey's major, serious contribution to Geophysics is a consequence of his life's work in tectonics. He has been the most vigorous proponent of continental drift, starting more than fifty years ago with the belief that Wegener's hypothesis of continental drift was essentially correct. As his analysis developed, he came to the conclusion that continental dispersion had been caused by the accelerating expansion of the earth. He rejected his initial assumption that ocean floor spreading was compensated for by crustal swallowing, as this did not fit with his global reconstructions. He has steadfastly resisted the concept of subduction, despite the popularity of plate tectonics, and has boldly tackled the geophysical conundrums that are raised by his observation that the earth has nearly doubled its diameter since the Permian. His exhaustive analysis of paleomagnetic, paleontological, tectonic and other geophysical and geological data provides compelling support for this concept, and I am not alone in this room in supporting earth expansion.

This work has been documented in a number of books published since 1976, the most recent of which was released two years ago, happily on the fiftieth anniversary of the Geology Department he founded. In this latest work, currently being revised for a second edition, Prof. Carey has devoted space to the consideration of expansion, not only of the earth, but of the other members of our solar system, and indeed to universal expansion. He observes that as the earth doubled its diameter since the Paleozoic, without a significant change in surface gravity, then its mass must have increased by a factor of about four. The search for an internal mechanism for this has inspired Prof to present a comprehensive discussion of the geophysics of the whole solar system, and ideas such as the gravitational "constant", G, is not constant.

Professor Carey has made a fundamental contribution to geophysics over more than fifty years, through his teaching, his research and tireless promotion of his far-reaching concepts. Another of his colleagues honours him with the claim that Prof Carey has raised more questions requiring fundamental geophysical answers that anyone else he can think of. Prof is already the recipient of numerous medals and awards from prestigious scientific organisations worldwide, as well as being an Officer of the Order of Australia. The ASEG is now justifiably proud to add its highest award to Prof Carey's collection; The Australian Society of Exploration Geophysicists' Gold Medal for distinguished service to Geophysics.

ASEG 13th Conference and Exhibition

Key Note Address by Peter Watson at S.W. Carey Lunch

Peter Watson makes a point during his 'Realisations' Key Note Address.

Realizations

Good afternoon ladies and gentlemen, Professor Carey, ...

That title "Realizations" is probably just about vague enough and ambiguous enough to cover what I'm actually going to talk about, which might be termed - Knowledge, - Meta-knowledge, - what are they ? - and does it matter ? And in case that sounds like "here comes another technical presentation", let me reassure you.

I'll start out with a scurrilous assertion which I think you'll find both satisfyingly insensitive and tasteless. This assertion is aimed at those of you who are in the petroleum exploration business like I am. And it's this - 'The next prospect that you drill, is probably going to be .... a dry hole'.

Now that's a simple and inescapable statistical fact, whether we like it or not. No matter how good a job we do as explorationists, the odds are going to be stacked against us.

Speaking of odds, I don't know what the odds are like here at the Wrest Point Casino, although I did overhear one punter going in the door declaring that he hoped he broke even, because he badly needed the money.

In petroleum exploration, if we can achieve a success rate as good as one in five we're doing extremely well. In effect, when the petroleum geophysicist goes to work, it's with the knowledge that he or she is going to waste at least four-fifths of their time (as a friendly accountant once took the trouble to point out to me).

In mineral exploration things are a little different. The petroleum geophysicist's success rate may look pretty bad but at least they have some idea of just how bad. Most geophysicists working in minerals, though, have only the vaguest idea of how successful they are being - maybe 30% of their efforts lead to failure, maybe 50%, maybe 90% - who knows? Now I reckon this is even scarier than the petroleum picture, but let me come back to that.

What we have to remember is that a low success rate doesn't mean we can't win. Even if each of our petroleum prospects were to have only, say, a 1 in 10 chance of being a discovery (that is, a 10% geological risk) - if we drill enough of them, and if they're big enough, we make money. That's why it's worth spending so much on something as dodgy as exploration. But: if those prospects we thought had a ten percent chance have in truth only a four percent chance of being a discovery, then we'll probably find ourselves going out the door backwards. Knowing what the risk really is can be every bit as important as minimising the risk.

Did you hear about the statistician who learned that the risk of a car accident is greatest within 5 kilometres of home? To avoid the risk, he moved.

Now we explorationists devote weeks - months - of painstaking effort to minimising exploration risk. Much of what we've been seeing and listening to here at the conference over the last couple of days has in effect been aimed at just that, by means of -

- improving the quality of our technical work,
- devising the best models we can come up with,
- applying creative conceptual thinking

- and hopefully the end result is that we do indeed come up with the best picture that's possible of what lies beneath the earth's surface. When we get to that point though it's so easy to overlook the next logical question,

What does "best possible" amount to?

How good is "best possible"?

We know that we've reduced the chance of failure as much as we can, but what have we actually reduced it to?

This is an example of what I referred to at the outset - Knowledge versus Meta-knowledge - and here I'll make a brief digression. Most of us here, at university we studied geology/geophysics/ physics, whatever. It's not usual for that sort of course to include any units of Psychology so forgive me if I lapse into lecture mode for a moment. Knowledge is what we know. Meta-knowledge is our ability to judge how well we know it. If you like, it's knowledge about knowledge. Humans are naturally good at Knowledge but lousy at Meta-knowledge.

I'll give an example. (This is a real example - promise!)

A mixed group of 50 or so people completed a questionnaire. The questions were things like:

- How many cars are registered in California?
- What is the length of the River Nile in kilometres?
- How many times would the volume of the Moon fit into the volume of the Earth?

In each case they weren't asked to give a precise answer but rather to give a range they were at least 90% certain covered the actual number.

Now I don't know how many cars there are in California, any more than you do, but it seems obvious that it would be a much bigger number than, say, five thousand, and a much smaller number than, say, two hundred million. It's quite easy to come up with a range that would be certain to include the right number. The interesting observation from this experiment though, was that the people almost always chose ranges that were much, much narrower than that. Their guesswork wasn't really all that brilliant, though, because in over half their answers the correct number didn't even come inside the chosen range at all.

So what's going on here? Were the participants in the experiment stupid, or what? No stupider than the rest of us. The questions were designed to force them to make a guess, and, once they'd made their guess, they assigned far more confidence to it than they should have. This over-confidence, this readiness to accept our best guess without recognising how uncertain a guess it is, is a well-proven aspect of human behaviour. For us explorationists, and for the people who pay us to make professional judgements, this is an area that is fraught with peril unless we learn to recognise it and deal with it.

One thing that leads to over-confidence in geophysical judgements is our perfectly natural tendency to focus on what we can focus on, or what we do know, and to lose sight of what we can't focus on, or what we don't know.

A good example of this can be found in the story of an incident that took place right here in Hobart, just last night. Around 2 a.m. I think it was, a police patrol car was cruising along a suburban main road, not far from here, when they spotted a gentleman acting strangely, standing out in the middle of the road, beneath an overhead street lamp. The roadway was well lit but pretty much deserted at that time of night. This fellow had obviously had more to drink than was good for him. He was middle-aged, respectably dressed - the type of person you could easily take to be an exploration manager or something of that sort - and he was staggering just slightly, and bent over. He seemed to be peering down at the road surface, examining it.

So the police car pulls up - "Hey mate! What do you think you're up to?"

The fellow straightens himself up - peers towards the police car, blinking a bit - "Officer, I'm looking for my keys! I dropped them."

"You dropped them here, out in the middle of the road?"

"No,.... I dropped them over there, a little way down that side street"

... ... "So why the hell don't you look for them over there then?!"

"Officer, are you stupid? It's pitch dark over there, I'd never find my keys!"

Now, the guy may be a drunken dill, but that little fable comes uncomfortably close to some of what can go on during an exploration program.

The way we work is that we examine the data we've got. It may be good quality data, and it may point clearly towards a particular conclusion. If that's so, there's nothing wrong with the conclusion, just so long as we recognise that the conclusion, by itself, is only half the story. The question we are ultimately trying to answer is not merely "What does this data tell us", but rather "What is actually down there beneath the surface?" Of course, we don't know, we may never know. What we can do though is examine our meta-knowledge - ask ourselves how confident we should be that our conclusion, drawn from this data, truly represents the state of play beneath the surface.

A few years ago I got involved in developing some methodologies for estimating the confidence of technical judgements. An exploration team had just worked up a new petroleum prospect, somewhere in south-east Asia- the country doesn't matter - but it started with the letter 'V'-and as a test of this new methodology we set about determining the prospect's chance of success (which in turn would be used to calculate its expected monetary value). On the seismic data it looked beautiful - nice strong reflections, continuous, uncomplicated, a perfect picture of a buried coral reef if ever you saw one, and in that region coral reefs were known to be highly attractive drilling targets.

The only fly in the ointment was the niggling question "What if it's not a reef? What if it's a volcano?" The two can be quite similar in their morphology. Velocity studies in this case weren't diagnostic, and what little gravity and magnetics there were, gave non-definitive answers but tended to favour a reef. Perhaps really high-resolution gravity and mag might have helped but that wasn't practical in the time available. What that lovely seismic imaging amounted to then, was in effect the nice bright street light for us to stagger about underneath.

Anyway once the uncertainty was recognised, its effect was to reduce confidence in the reef model to barely half of what it would otherwise have been, from about 55% chance of discovery to about 25%.

The important factor here was meta-knowledge. The reef model was clearly the best model, based on the data. By quantifying the degree of uncertainty in that model, though, the explorers approached this prospect with their eyes open, and took a realistic, calculated risk.

As it happened, unfortunately this one did turn out to be a volcano, although another similar prospect nearby subsequently proved to be a reef.

The great benefit of knowing what confidence we should apply to our model is that it enables us to compare different opportunities by assigning risked dollar values to them, and then to rank them in order of value. It's not enough to merely have a good model of each prospect - we also have to have a realistic appreciation of how good that model is, how likely it is to represent the actual truth of what lies beneath the surface. A giant oilfield that has only a two percent chance of existing may be a far less attractive opportunity than a modest little field with a forty percent chance.

This sort of approach has become standard practice in oil exploration, but it's yet to really catch on, in mineral exploration. I'm not quite sure why this should be so. Certainly the geological and geochemical models for predicting mineralization and ore emplacement can be rather more complex and variable, and perhaps less clearly understood than for a petroleum system; and the risk-reward equation is different; but the underlying principle is exactly the same.

So if I leave one message with you today it's this - In any kind of exploration, it's not just what you know that counts, but what you know you know!

Ladies and gentlemen, thank you very much.

* Prof Sam Carey was awarded the ASEG Gold Medal at this function.

Calendar of Events

1999

April 18-21

APPEA Conference & Exhibition Perth Concert Hall

Contact: Lynda Gordon or Lyn Alexander

Tel: 02 6247 0960
Fax: 02 6247 0548
Email: appea@appea.com.au

April 21-23

Murray Basin Conference, Mildura

Hosts AIMM, GSA, AIG

Theme Rutile, Zircon & Ilmenite.

Contact Rebecca Norton
Tel: 03 5332 6864
Fax: 03 5333 6516
Email: goodingg@rats.agvic.gov.au

Oct 31 - Nov 5

SEG Convention Houston

Call for Papers
www.seg.org/seg99

2000

March 12-16

Australian Society of exploration Geophysicists
14th Conference and Exhibition, Perth

"Exploration Beyond 2000"

Address: PO Box 890
Canning Bridge WA 6153

Tel:(+61) (08) 9332 2900
Fax:(+61) (08) 9332 2911
Email: promaco@promaco.com.au

1998 Conference Honors and Awards List

GOLD MEDAL

The ASEG's Highest Honor, For Distiguished Service to Geophysics

Sam Carey AO

HONORARY MEMBERSHIP

For Distinguished Contributions to the Profession of Exploration Geophysics

Hugh Rutter
Norm Uren

SILVER MEDAL

For Extraordinairy Service to the Society over many years

Geoff Pettifer
Lindsay Ingall

SERVICE CERTIFICATE

For Oustanding Service to the Society

Lindsay Thomas
Terry Crabb
Doug Roberts
Henk van Paridon
Steve Webster

GRAHAME SANDS

For Innovation in Applied Geoscience

Andrew Duncan

LARIC HAWKINS

For The Most Innovative Use Of A Geophysical Technique From A Paper Presented At The Conference

Application of Microseismic Monitoring to Characterise Geomechanical Conditions in Longwall Mining

X. Luo and P. Hatherly

BEST PAPER AWARD

The Calculation of Magnetic Components and Moments from TMI: A Case Study from the Tuckers Igneous Complex, Queensland.

P. Schmidt and D. Clark

BEST PRESENTATION (JOINTLY AWARDED)

Improved NASVD Smoothing of Airborne Gamma-Ray Spectra

B. Minty and P. McFadden

Simple versus Complicated Seismic Processing in the Exmouth Sub-Basin

G. Duncan

BEST POSTER AWARD

3D Seismic Survey in Reclaimed Land

M. Minegishi, N. Aoki, T. Matsuyama

BEST EXHIBITOR

Landmark Graphics

Notes from the 1998 SEG Meeting

Roger Henderson

This meeting which is in fact the 68th meeting of the SEG was held in New Orleans which may account for the higher than usual attendance as it is more of a fun city than Dallas although I suspect no less murders per day.

The only one word to describe current SEG meetings is "huge"! On this occasion there were over 10,000 delegates and over 500 exhibitors. 'Huge' is the number of technical papers, over 540 in 68 sessions of up to 8 papers each. Usually there were 9 parallel sessions at any one time. 'Huge' really comes into its own with regard to the exhibition which occupied 50,000 sq. mtrs which is 10 times the area we had for the last ASEG exhibition in Sydney which was probably the biggest area we've had so far. This is also twice the total area of the five Sydney exhibition halls and yet it is only half of the current convention centre at New Orleans which is currently being extended by 50% so that it will end up being 3 times bigger than the entire Sydney Exhibition Centre. The SEG is somewhat unique in requiring such a large exhibition area combined with a large number of delegates. This results in there being only about 5 cities in the United States where the SEG can now be held. The superlatives can continue with the organisation of the conferences and I counted 30 committee meetings which are held in conjunction with a conference.

A feature of SEG exhibitions in the last 10 years or so has been the theatre-like setups on the booths where companies show their capabilities for seismic interpretation and these are repeated at regular intervals. These have become so prominent now that a completely separate area to the exhibition hall was devoted to more of these theatre sessions and further to that they are now using virtual headgear so that one can imagine walking in and around the interpretation sections. In fact there is what is called an emersion environment where the seismic sections are projected onto the 3 walls and the floor of the area so that one can walk around within the room and observe the sections from all angles.

It seems that the SEG receives a reasonable number of delegates from Australia and this year was no exception. In fact it was honoured with the presence of our ASEG President Noll Moriarty, a former President, Nick Sheard and the Co-Chairman of the current ASEG Conference, Mike Asten. Noll and others manned the new ASEG Booth, fielding questions and even were seen signing up new ASEG members. Norm Uren, Brian Evans and John McDonald from Curtin University were there with a Curtin University display and some ex-patriots were seen also including Craig Gumley and Phil Harmon to name just a few. Jim Macnae of Macquarie University and two of his students David Annetts and James Reid also gave papers in the special session on Recent Advances in Airborne Electromagnetic.

The usual social events were held although Australians get very twitchy at the procedure of having to line up to buy beer tickets and then to line up at the bar to exchange them. The SEG has always had a more user pays principal than the ASEG at such social functions which in the past has meant the registration fee was not unreasonable. This year all the proceedings were provided on one CD

The new ASEG booth.

included in the registration fee and a hardcopy of the proceedings was at an extra charge of US$75. I found the bookmart to be very attractive and all the SEG publications were on sale at reduced prices because the postage or freighting of them was not necessary if purchases were taken delivery of from the site. Indeed as well as interesting publications they were also selling very attractive sweat shirts and golf balls with the SEG logo on.

ASEG Council Meeting

HOBART 8 NOV 1998

Resolutions agreed at the Hobart Council were:

- The Federal Executive rotates around Australia, with three years in a State.
- The State organising a Conference receives $10/delegate, replacing the previous surplus-sharing approach.
- The ASEG adopts two types of Corporate Member - Corporate Plus and Corporate.
- The ASEG institutes an Advisory Committee for the Federal Executive.

One further resolution was deferred:

The State capitation amount is altered to $8/member.

Full details of the Council briefing notes and minutes will be posted on the ASEG website in due course. The capitation issue is to be addressed in the formulation of the business plan. Note that elsewhere in this Preview are details of the financial and membership status of the Society. Brief details of the Council resolutions are now provided.

The principal driver for changing to a 15-year cycle with three-year Federal Executive term is it permits regular scheduling of Conferences (every 6-7 years) in a State. With the previous four-year terms, it may be 10 or more years between conferences. Other favorable consequences of the shorter term are decision making will be shared more widely within the Society; furthermore a shorter term would allow the Executive to maintain its enthusiasm.

As a consequence of the three-year term, next April the Executive moves to Sydney. Future Executives are to be Sydney (1999-2001), Perth (2002-2004), Adelaide (2005-2007), Melbourne (2008-2010) and Brisbane (2011-2013).

The conference surplus-sharing formula - based on a flat amount per delegate - is necessary to avoid the difficulties in deciding at what point the surplus is declared. Particular difficulties in the past have concerned conference volume publications (cost and revenue from advertising). It is noted that the forthcoming business plan will address whether the $10/delegate is an appropriate amount.

Two types of Corporate Membership will permit flexibility in distinguishing between the members. The Corporate Plus members will receive more prominence and higher discounts.

The Council agreed to implement an Advisory Committee for the Federal Executive. The Committee will be composed of the four most recent past Presidents. This will assist in maintaining "tribal knowledge" of the Society, ensuring the reasons behind previously agreed directions are understood by new Executives. The committee will perform in its advisory role solely through the medium of email, facsimile and telephone. This would remove the expense of physically meeting.

The Council briefly discussed its role, which provides an opportunity for the States to only comment on the actions and directions set by the Federal Executive Committee. The ASEG Council, though, does not have executive power - this is solely vested in the Federal Executive Committee. The Federal Executive and State branches will review the Council's formality during the coming year.

Letter to the Editor

The Federal Executive received the following letter from the SEG.

The SEG Executive Committee is always seeking ways to better serve the membership to promote geophysics. We have long recognized that there is a portion of our membership who appreciate THE LEADING EDGE but feel they get little value out of GEOPHYSICS. We surveyed these members to determine whether they would be interested in donating their GEOPHYSICS issues to support students and professionals who cannot afford the annual dues because of the modest salaries typical in emerging nations. The response has been very positive.

To redistribute these issues of GEOPHYSICS we would like to know if your society has need for additional copies. If you as President would like to receive copies for distribution please let us know how many you could use. We anticipate the program will commence with the January/February issue of GEOPHYSICS and will continue indefinitely. The number of copies actually available will depend on both demand and availability of donated issues.

Please respond to the SEG Business Office whether or not you have an interest in this program. You may phone Marge Gerhart, 918-497-5530, fax 918 497 5558, or email mgerhart@seg.org your response.

Rutt Bridges
SEG President

Seismic Window

Rob Kirk

Facies Mapping

An oft-neglected map is the seismic facies map. This attempts to map the 3D seismic geometries within a sequence. It is quick and easy to do and provides a very useful link between the geologist and geophysicist. The "A-B/C" scheme is a simple but effective method of mapping geometries (Fig 1). The "A" term refers to what is happening just under the upper SB. The "B" term refers to what is happening down onto the lower SB, while the "C" term lumps all the intervening events together. Initially you might A-B/C map the entire third order sequence and then refine the maps by A-B/c mapping individual systems tracts.

This series of figures looks at how we may make a seismic facies map (SFM). These are prograding Tertiary carbonates in Western Australia (Fig 4). In Figure 5 using red we pick all event terminations (after picking out faults, multiples, flatspots, etc.!) (You could set up a red fault on Landmark that you draw the terminations with.)

Figure 6 shows the A-B/C terms for sequence 4. Note I have already broken out two units - one being the prograding facies while the other is the basal mound facies. (I am already thinking about a depositional model.) On Figure 7, each line's A-B/C terms are posted on a map, parallel to a line so that all directions can be represented. Bear in mind that dip facies can be quite different to strike facies, as seen here. You often have "facies misties". On Figure 8 we now map the swathes of A-B/C terms. Note that onlaps are closed arrows while downlaps are open arrows. The final SFM is seen in Figure 9. When we can calibrate the SFM with well data we can attempt to produce a palaeogeographic map (Fig 10). We may use this to comment on reservoir distribution or seal competency (or to help explain the distribution of an anomalous velocity package!)

Rob Kirk
Kirk.Rob.R@bhp.com.au

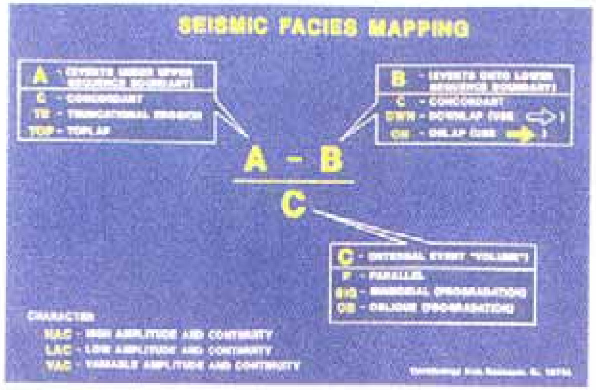

Fig 1

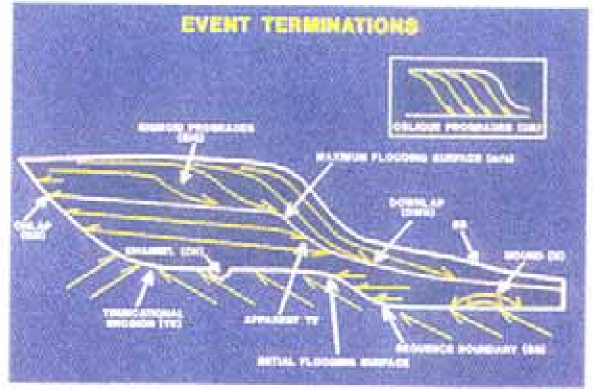

Fig 2

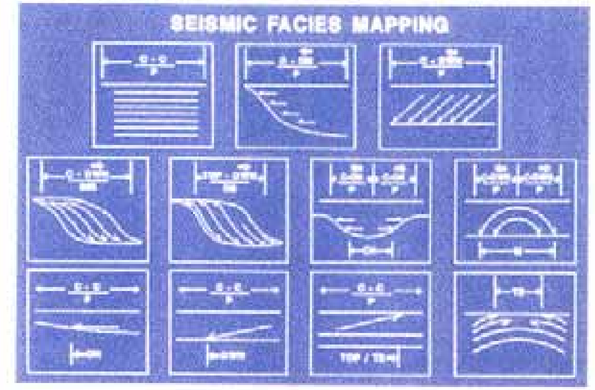

Fig 3

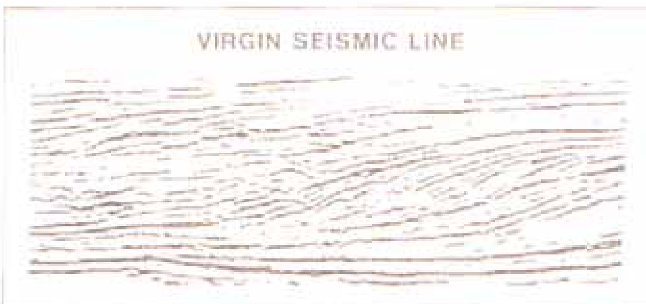

Fig 4

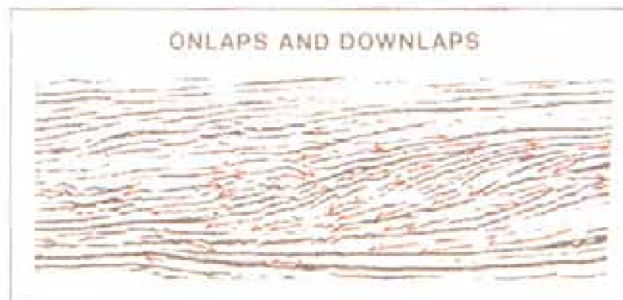

Fig 5

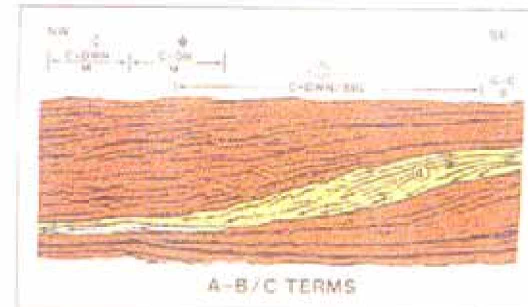

Fig 6

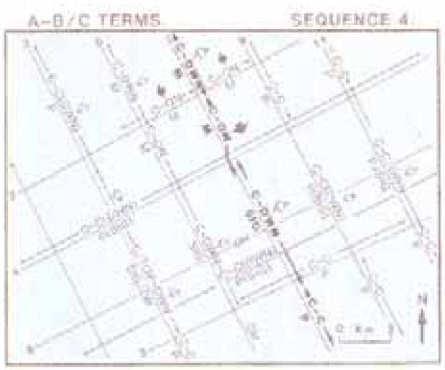

Fig 7

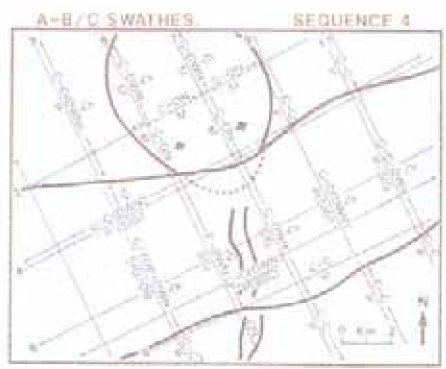

Fig 8

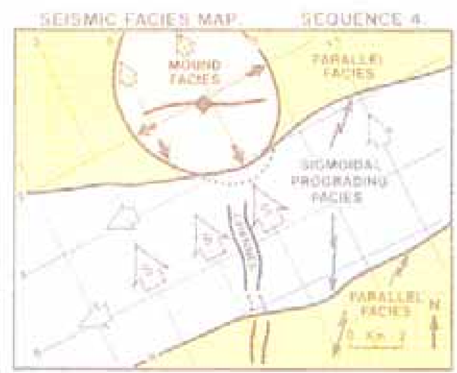

Fig 9

Fig 10

SEISMIC WINDOW by ROB KIRK - FACIES MAPPING