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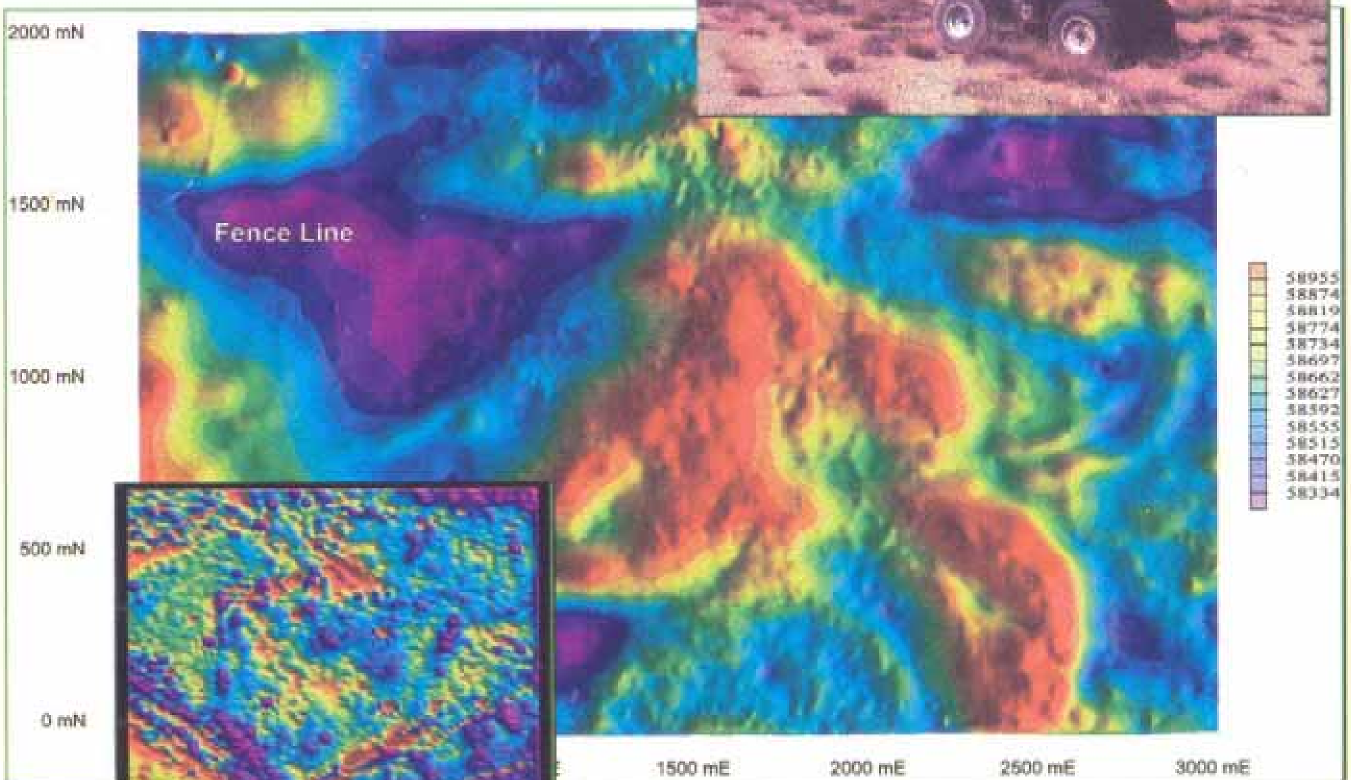
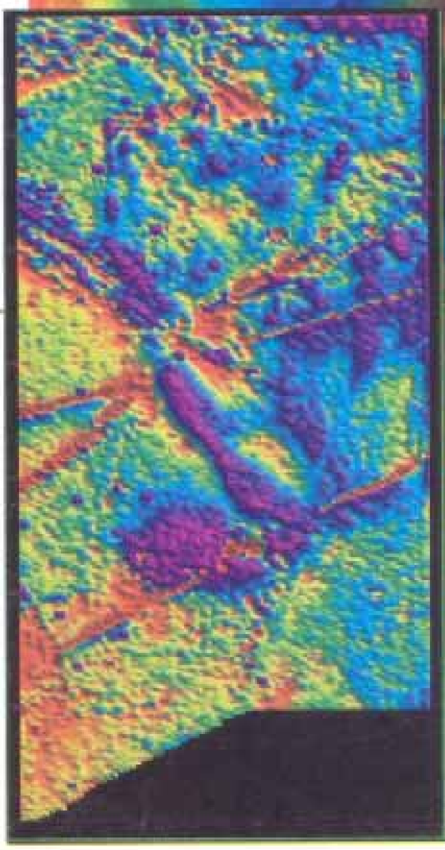
Special Feature:





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Preview Deadlines - 1996

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December	**November 22**

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Editor's Desk

Well - it's happened. The Federal Executive of your society has moved from Melbourne to Brisbane (more of that from the retiring executive) and your new editor is installed, beginning his tenure with a certain amount of trepidation.

My first task is to pay tribute to the huge contribution of my predecessor Geoff Pettifer who, with earlier editors, has taken Preview from humble beginnings to its present sophisticated format. Geoff has been largely responsible for the quantum leap in quality seen over the last few years. We have to thank him for the very hard work he has put into the job, including the design of the magazine and the recruitment of advertising to support it. There is more on p.5 from our Retiring President, Kathy Hill.

I thank Geoff for his help in my apprenticeship to the job and also Janine Cross for her un-ending patience and help in getting this, my first issue to press. There are two groups of people who make this magazine possible by providing the raw material that constitutes its the heart and soul. The first group comprises the contributors - authors and news hounds - who supply the information and create the interest. The second comprises the advertisers whose loyal support, through thick and thin, gives us financial viability as well as supplying a service to the membership. I look forward to a productive and continuing relationship with all of you.

I must also thank the Retiring Executive for their help and support in coming to grips with the new job. It was very clear from my involvement in recent meetings in Melbourne during March and April that this has been a very hard working executive, taking a long term view of the Society backed up by research and serious consideration of the way ahead.

I see my job as maintaining the standard that Geoff has set and continuing the development of the magazine in the most cost-effective way. New directions recommended by the retiring executive will be reviewed and views of the membership will be welcome in guiding the new executive to sound decisions on the future of our publications. We are very interested in what you think about your magazine; why not write and let us know. There does not appear to be a strong tradition of letter writing associated with Preview so improvement in that field is easy. Branch News is another forum available to the membership. After a long drought the NSW Branch has surpassed itself with a flood of sparkling news (it's a bit like the weather in SE Queensland) but we hope for a steady, reliable flow in the future. Thankyou to all the branches for your continuing support.

In this issue we remember Bill Stuart whose death in April ends a major contribution to the education and development of young petroleum geophysicists in South Australia.

Mike Shalley, Editor

President's Piece

INTRODUCTION: A slightly modified version of this report was presented to the 1996 Annual General Meeting in Melbourne on April 30. It included several other submissions of the Federal Executive as follows:

1. A review of a membership census and opinions on publications compiled by committee member Ciaran Lavin
2. A summary report from the Publications Committee by First Vice President Mike Asten recommending several fundamental changes to the Publications policy to the incoming Federal Executive.
3. A summary of a six year projection of the Financial position of the Society by Committee member Dave Gamble under an unchanged and changed publications policy.

Having identified that the Society could deplete its financial assets to nil within 5 years if it did not effect greater control over costs, the Executive compiled reports reviewing the membership's views on publications (see p.9), the Publications Committee's response to those views and a projection of the financial consequences of implementing various options. As a result of the survey the outgoing executive has recommended the following:

1. That Exploration Geophysics and Preview are combined into a single bi-monthly publication.
2. That the Conference issue of the publication is limited to approximately 360 pages.

These await review and ratification by the incoming executive which will operate from Brisbane.

As a late-comer to the Federal Committee I would like particularly to thank members of the current and past committee on behalf of the Society, for their assistance during the Melbourne residency. Particularly to be singled out are Lindsay Thomas, Mike Asten, Hugh Rutter and Geoff Pettifer.

ASEG PUBLICATIONS: Currently the Society publishes the technical journal Exploration Geophysics quarterly (and thanks to the efforts of John Denham and others the lag in publications has been made up) and Preview Society news magazine bimonthly. As you know, for this and most societies, the largest financial commitment is for publications and this has been an area of concern and attention of this executive for the past year.

I would like to particularly mention Geoff Pettifer for his efforts over three years, in bringing Preview up to an international standard society news magazine that compares favourably with The Leading Edge and the AAPG Explorer. Indeed at the SEG conference leading Edge Meeting the editorial staff were astounded that the magazine was the product largely of one man's efforts. TLE has asked for several reprints from Preview.

CONFERENCES: The highlight, without a doubt, was the 11th ASEG Conference held September 3-6, 1995 in Adelaide. The Conference Committee, led by Craig Gumley and David Tucker is to be commended for providing over 600 attendees with one of the best conceived and executed conferences I have had the pleasure of attending. Planning for our next conference in Sydney is well under way (see Roger Henderson's report in this issue).

I represented the Society in Houston at the SEG conference in October 1995 attended by over 10,000. One of the real highlights for me was seeing Derecke Palmer accept the Reginald Fessenden Award (see report, this issue) and join the ranks of Hubral, Treitel and many other luminaries of geophysics.

The SEG, the Indonesian Society (HAGI) and the European Society of Exploration Geoscientists and Engineers agreed to assist the Indonesian Society with the conference in Jakarta, April 27- May 2, 1996. Norm Uren, SEG Vice President represented the ASEG in Jakarta. This is a small step towards implementing Hugh Rutter's vision of making the society more international in its view. John Jackson reports in this issue.

ACCREDITATION: This past federal executive has not seen ASEG's role as an accreditation agency. We believe that it is our role to try to keep the membership informed of this area but not speak on behalf of the membership unless it is through coordinating a poll. I personally believe that the Society should embrace all those with an interest in the application of Geophysics with their experience and expertise reflected in their type of membership (full, associate or student).

There is no doubt that the changing industry structure from large companies to more individual consultants and small firms does suggest that some form of guidance and protection for clients is required. I am not convinced that the accreditation processes proposed are as yet adequately focussed towards protecting the interests of the customers.

ACKNOWLEDGMENTS: If I've learned anything from this past year it is never try to be in charge of anything without some form of an apprenticeship. Having not served on the executive before, and then heading it up, was truly baptism by fire. But the patience and tolerance of the committee made a difficult job much easier and I must thank them all for bearing with me.

Please welcome and support Henk and his fellow members of the incoming Federal Executive. They have already demonstrated plenty of enthusiasm and good sense and will enrich the Society by their representation.

Kathy Hill, Retiring President

Preview - Next issue

- *More on Petroleum Data Management*
- *Specifications for Airborne Surveys*
- *Full Report on ASEG Membership Survey*
- *ASEG Five Year Plan*

Executive Brief

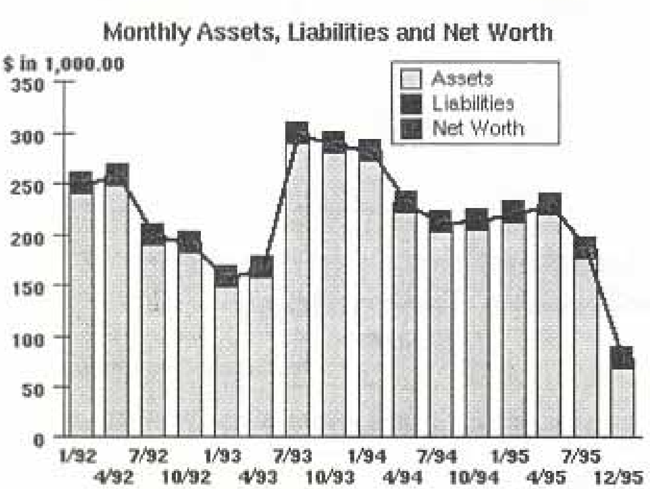
Welcome to this my final Executive Brief as Secretary of the ASEG Federal Executive. At the AGM, held on the 30th April this year, the following were elected to form the 1996/97 Executive to be based in Brisbane.

President	**Henk van Paridon**
First Vice President	**Steve Hearn**
Second Vice President	**Wayne Stasinowsky**
Secretary	**Robyn Scott**
Treasurer	**Peter Fullagar**
Editor Preview	**Mike Shalley**
Committee	**Noll Moriarty**
	Koya Suto
	Andrew Mutton
	Peter Hatherley

I wish the new committee all the best for the future. Please note that the secretariat remains in Melbourne so you should continue to address all inquiries and membership information to Janine Cross at the ASEG Secretariat, 411 Tooronga Road, Hawthorn East, Victoria, 3123.

The latest un-audited statement of income and expenditure for the year to the end of 1995 shows a depletion of assets from $245 460 in 1994 to $127 141 in 1995. These figures are not final as the treasurer has still not received all the 1995 cash books and related details from the eighteen individual bank accounts around the country. While at first glance it appears that the Society has run a deficit of over $100 000, this deficit would not be apparent had the Adelaide Conference surplus, estimated at $130 000, been finalized before the year end.

Interestingly, the following graphic shows the "changes in net worth" of the federal executive accounts since the beginning of 1992. The cyclicity associated with income and outgoings related to the conference is obvious and little has happened to the Society's financial position over the last four years.



However there is little room for complacency. Dave Gamble and Mike Asten have finalised a five year business plan which shows that the Society would deplete its existing reserves within five years (draw-down of $214 000) if it continued its existing path. This assumed a conservative conference profit of $40 000 every eighteen months. The depletion would be less if Exploration Geophysics and Preview were combined (deficit -$70 000) while increasing advertising revenue would allow a surplus to be reached. Consequently, there has been a strong recommendation to the incoming executive to combine the two publications and to produce a more streamlined (and less expensive) Conference Volume.

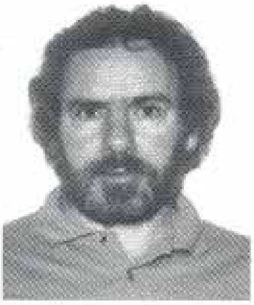
The planning for the Sydney Conference and Exhibition, to be held in Sydney from 23-27 February 1997, is progressing smoothly. Please note that the deadline for receipt of papers for technical and editorial review, and the poster synopses, is 15th June 1996.

Finally I would like to thank my colleagues on the executive and various committees for their support and help during my term as Secretary.

Greg Blackburn, Retiring Secretary

ASEG People Profiles

Your New President Henk van Paridon



Henk van Paridon graduated from the University of Adelaide in 1977 with a BSc in Exploration Geophysics and Physical Chemistry. Amongst the staff at UA were Professors Boyd and Rutland. Other mentors were Bob Smith, Mike Etheridge and David Isles.

Following graduation Henk spent three years overseas working in all manner of non-professional jobs including cooking, labouring and turkey farming. Returning to Adelaide in 1981 he found that his geophysical qualifications were in demand and sought fame and fortune in the oil patch, joining Delhi as an operations geophysicist. Within Delhi he worked mostly on the Queensland sector of the Cooper Basin and moved to Brisbane with them in 1985.

In 1988 Henk joined Crusader where he remains today, working on Australian and overseas projects, including the Gippsland, Otway, Bonaparte and Nuequen basins. He also completed a Graduate Diploma in Computing Science at the Queensland University of Technology.

Within the ASEG he has been on committees more or less continuously since 1984 and has filled most positions in the Queensland Executive, most recently as Branch President. He was also Co-chairman of the 1992 Gold Coast Conference and served on the Continuing Education Committee for two years.

Editor's note: More ASEG People Profiles of the incoming Executive will be published in the June issue of Preview.

ASEG Membership Survey - An Overview

Geoff Pettifer and Ciaran Lavin

The ASEG membership survey targeted at determining members interests in technical methods and topics, and their attitude to ASEG publication options for the future, was well subscribed, with 687 responses from the 1250 distributed. This is an extraordinary result for questionnaires, which typically attract a 10% response or less. Members are definitely keen to influence the ASEG publications content and format, which augers well for the health of the society and its publications. As a result of this survey, and financial and other considerations, the ASEG publications committee have made recommendations to the new ASEG Federal Executive in Brisbane to consider for implementation.

This brief overview gives some particular results of the survey - a full analysis will be featured in the June Preview. Results have been collated by Ciarin Lavin and analyzed by Geoff Pettifer, both of the outgoing Executive.

Membership: ASEG membership breakdown by industry sector (Figure 1) shows a healthy mixture between petroleum (26-29%) minerals (35-41%), academia (13-14%), environmental/groundwater/engineering (7-12%) and consultants/contractors (9-12%). The society is not as strongly mineral oriented as some may have thought, however it is certainly more so than the SEG. The spread of percentage values depends on whether one considers first preference, involvement of any kind, or weighting by preferences indicated.

The one in eight membership figure for academia reflects both the success of the ASEG student membership scheme and the high R&D nature of exploration geophysics.

A detailed analysis also shows that 26% of the membership are involved in more than one sector of geophysics, with this figure highest in the following groups: consultancy/contractor (74%), academic (69%), environmental/groundwater/engineering (48%). This is of interest in the professional registration debate (see February Preview) where registration is required for each sector in which a geoscientist works.

Technical Interest: In Figure 2 overall interest in technical articles in ASEG publications is shown.

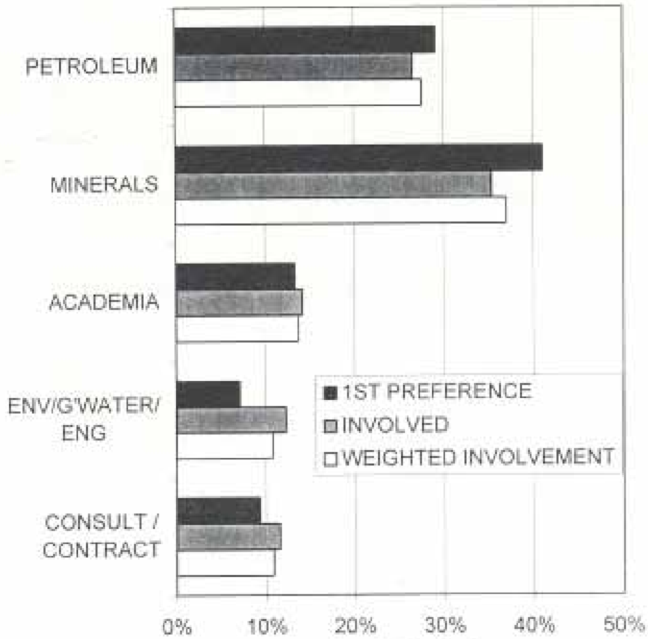


Figure1. ASEG Membership by Industry

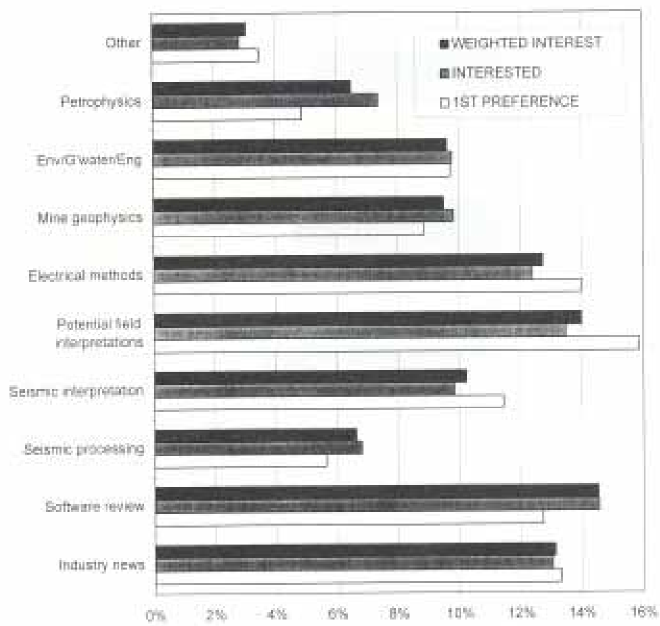


Figure 2. Interest in Technical Articles

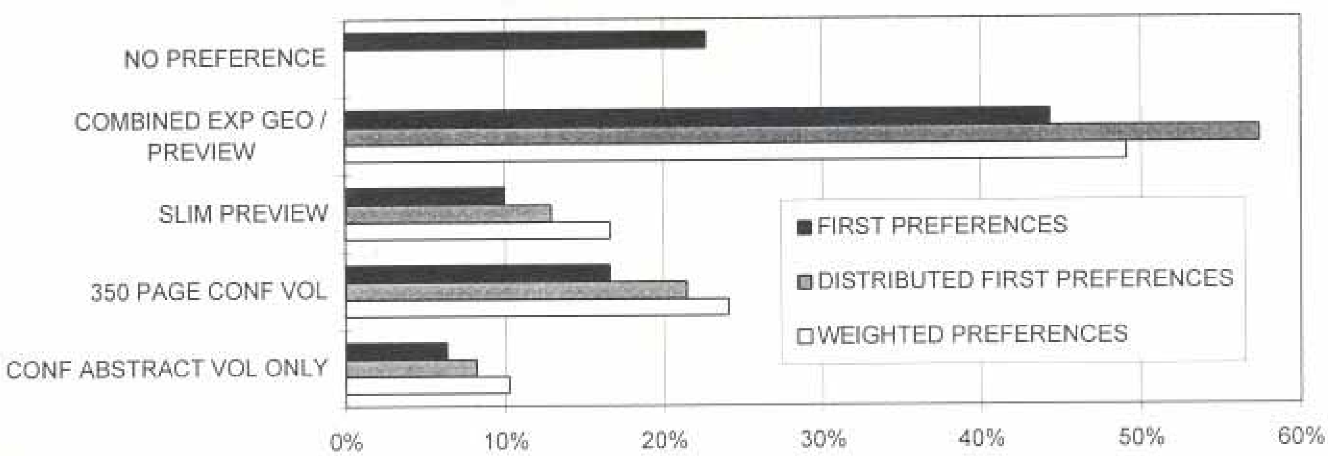


Figure 3. Voting patterns for ASEG Publications

Potential field, software reviews (a surprise), industry news and electrical methods are the leading contenders. Environmental/groundwater/engineering, mining geophysics and seismic interpretation show equal medium support, with petrophysics and seismic processing having lesser support. A list of "other" article topics will be given in the more detailed follow-up analysis article.

Publication Options: The most contentious matter in the survey was the future of the ASEG publications: Exploration Geophysics, Preview and the Conference Volume. Figure 3 shows the overall results. Some 22% were unconcerned and indicated no preference. The return to a Conference Abstracts only volume was poorly supported (7-11%) as was a slim Preview volume (10-17%). The combined Exploration Geophysics/Preview option was clearly the most supported option (40% first preference, 58% excluding no preference votes and 48% weighting for priorities), with the limited size Conference Volume having reasonable support (16%, 22% and 24% respectively).

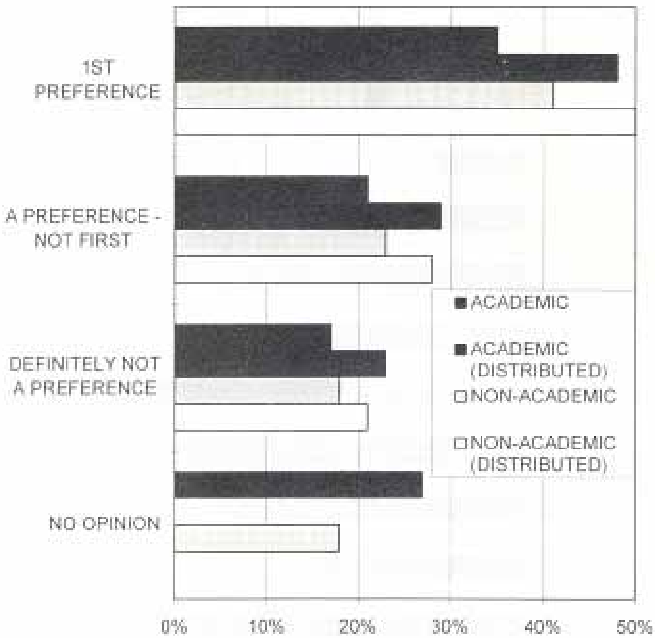


Figure 4. Academic vs. Non-Academic voting patterns for a combined Exploration Geophysics / Preview volume.

A concern was raised that combining Exploration Geophysics and Preview would lower the academic standing of the former. As the academic sector has most stake in this concern, a breakdown of preferences for this option, by academic versus non-academic geophysicists is instructive (Figure 4). Academic ASEG members appear to be less for a combined option, less against it and more likely to have no preference, compared to non-academic members, allaying concerns of a possible boycott of exploration geophysics by academic contributors.

Conclusion: This rudimentary survey has been very useful and needs to be repeated in the next membership renewal round in a more sophisticated way. The cooperation and interest of all respondents is most heartening and soundly appreciated.

ASEG Branch News

Queensland

The arrival of the federal executive in Queensland has provided the opportunity for the local committee to accept some new blood into its ranks. The 1996 Annual General Meeting was held on 21st March 1996 with the following office bearers being elected:

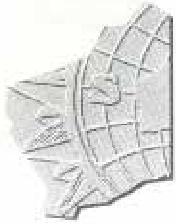
President	Gary Fallon University of Queensland ph. (07) 3365 1674
Vice President	Howard Bassingthwaite Velseis Processing ph. (07) 3279 0400
Secretary	Andrew Davids Oil Company of Australia ph. (07) 3858 0652
Treasurer	Kim Chatfield Santos ph. (07) 3228 6583

The outgoing local president, Henk van Paridon, presented a review of 1995 activities, the highlights being seven diverse presentations and two well attended workshops. These, coupled with some sponsorship, allowed the branch to produce a small profit for the year. The review was followed by our first speaker for the year, Easton Wren, who extolled the virtues of greater sampling to improve signal to noise characteristics for seismic acquisition.

I would like to take this opportunity of thanking Henk and his committee for all their efforts in 1995 and to wish himself and his new federal committee all the best in 1996.

Gary Fallon
Branch President

Western Australia



Technical News: At the last technical meeting, on 17 April 1996, our speakers were Terry Allen of Western Geophysical and Mike Jones and Adam Hender of World Geoscience Corporation. Terry gave a talk entitled "Wave Equation Layer Replacement" while Mike and Adam spoke about "Geographic Information systems for Geophysicists". The next two technical meetings will be held at the Celtic Club, 48 Ord Street, West Perth, on 15 May and 19 June, starting at 6.30 pm.

Social News

Bob Groves of our branch's Social Sub-committee organised a very successful evening "on the town".

It started with Italian food and South-West WA wines at the Piazza Restaurant and was capped with entertainment from the movie "Cosi" at the Astor Cinema, next door.

Andre Lebel
Branch Secretary

New South Wales

"Digging deeper beyond the dirt": Well, it seems some time since the NSW Branch has managed to publish some news of its dealings but rest assured, the Sydney "Mafia" is well and truly alive and kicking. Perhaps its been that so many of its committee members are also very busy with the 12th ASEG Organising Committee that its been very much a case of 'heads down, tails up' for the past six months or so, in preparation for Feb'97, which promises to be an ASEG extravaganza!

Technical talks in the latter part of 1995 included: August 1995: "Seismic Aquisition in the Papua Thrust Belt - Insight or Insanity", by Robert LaRue, Technical Advisor, Command Petroleum Ltd.

September 1995: "Wide Angle Seismic Reflection Profiling Petroleum Exploration and Crustal Studies", by Jannis Kakris and Brian Rumph. WOW, another petroleum talk!!

Wide-angle reflection profiling (WARP) is a seismic mapping tool that is developing as a new tool for petroleum exploration, although usually used for crustal and earthquake studies. It has the potential to solve problems in areas where conventional normal incidence seismic reflection data is ineffective or prohibitively expensive.

Professor Jannis Makris was born in Greece, and originally studied geophysics in Clausthal, Germany. He obtained his PhD in 1971, and attained the position of Professor of Geophysics and Chair at the University of Hamburg in 1978.

October 1995: "Looking Round the Corner", a joint symposium by the ASEG, AIG, AusIMM and SMEDG on the recent developments in geophysical applications in mineral exploration and development was held at the Observatory Hotel in The Rocks, Sydney. It was very successfully organised by Mike Smith (Auspac Gold) and Tony MacFarlane (Nord Resources).

Also during October, the 1995 Reginald Fessenden Award was presented to Derecke Palmer by the Society of Exploration Geophysicists at the SEG's Annual Meeting in Houston, Texas. He was the first Australian geophysicist, and one of very few outside the USA to receive the award. Our congratulations to Derecke.

November 1995: "Getting High Cheaper and Staying Up Longer - a Geophysicist's Christmas Message", by Jim Macnae, Professional Fellow at Macquarie University and responsible for the EM interpretation program of the CRCAMET.

Eleven autonomous aerosondes (UAV's or Unmanned Air Vehicles) were flying at this time over Bathurst and Melville Islands in the Northern Territory, investigating the internal structure of thunderstorms. These rugged 14 kg flying data acquisition systems have the potential for a four day flight or 7000 km range on any pre-programmed flight path and may be ideal for detailed low-level magnetic data acquisition, especially in difficult areas. Commercialisation is now in progress in Australia to produce these devices at a "fully loaded" cost of around $25 000. A brief outline of the technology and its exciting potential to geophysical exploration was given.

The November meeting was the last formal meeting for the year, as we attempted to find a topic that reflected the outrageous, pie-in-the-sky time of year we were about to enter. A time when we could bathe in the glow of our glories of the past year, and more importantly, think about how we could each light the path to a future of bigger exploration budgets, more research funds, more publications, greater job security, and most importantly, fewer complaining clients!

December 1995: The Christmas festivities were highlighted by the annual SMEDG/AIG Harbour Cruise, organised by the honourable Lindsay Ingall of Wongela Geophysical, which has continued to exceed itself and next year might be a good time to hire a bigger boat! The weather was perfect for an afternoon cruise on the world's most beautiful harbour and much wine, beer and the usual excellent food (including delicious BBQ tiger prawns) were consumed by the ravenous party goers (hard to think of them as geoscientists at times like this!).

Unfortunately, the annual Students' Night for 1996 seemed to slip by unnoticed, however I hope to make amends in 1996 by offering decent prizes, not just free alcohol! Speaking of students and prizes, the Geo Instruments Prize for the most outstanding Year 3 Geophysics student entering Geophysics Honours was presented to Kristan Reiman of Sydney University by Roger Henderson (actually presented at the Earth Resources Foundation Ceremony on April 18th, 1996).

February 1996: February saw the AGM and a good showing for the first meeting of 1996. The committee was re-elected in its entirety with the following as office bearers:

Derecke Palmer	President
Nigel Jones	Past President
Mark Russell	Secretary
Greg Skilbeck	Treasurer

The Feb. talk was titled "Registration - What's in it for Geoscientists?" by Mike Smith, President of the AIG. Mike is Exploration Manager for Auspac Gold, Marketing and Sales Manager for Geo Instruments Airborne Division, a certified fisherman, a baseball player and an entertaining speaker!

The rather unusual timing for this meeting was a result of the Australian Geologic Congress in Canberra in the third week of the month, which is the preferred time for our branch meetings. Some of our members, including our illustrious treasurer, will be at the AGC, and as many branch members are keen to scrutinise his annual report, we had to introduce a ninety degree phase shift in our timing.

March 1996: This month's meeting was a combined SMEDG, GSA and ASEG extravaganza. The technical presentation "Airborne Geophysical Surveys and Exploration Opportunities in Namibia", was given by Dave Hutchins, Chief Geophysicist, Geological Survey of Namibia. Namibia is one of the emerging African countries with significant potential for new discoveries. The Government and the Geological Survey are working to attract foreign investment. Dave's talk outlined some of the new initiatives and opportunities available.

From our Branch President:
"Wanted - An Attractive Image for the Geosciences in a Green World". Most of our members will be aware that university enrolments, particularly in the science faculties, are down. The numbers applying for positions in the earth sciences are also less than the quotas at most campuses, and quite frankly, the standard is not as high as when we geriatrics were students. The demand is firm, with many exploration companies unable to obtain sufficient numbers of good students. Furthermore, most geoscience graduates would like employment with an environmentally correct company, rather than with a resource company. Unfortunately, the problem of low student numbers means that there is not enough talent to replace our icons like Roger Henderson, Steve Webster, Ted Tyne or Bob Whitely. While some might see that as a good thing, it is essential that our profession, along with other geoscience groups, develops a strategy which ensures an adequate supply of professionals to the industries which contribute much to our standard of living and which are the equal of any in the world. Essentially, we have an image problem. What is your solution?

Parker & Parsley Australasia Pty Ltd: Parker & Parsley Australasia, the current incarnation of Bridge Oil Limited, which was founded in 1969, has had a strong presence as a Sydney-based oil and gas exploration/ production company with a major focus on the Surat Basin. A tandem float/trade sale process by Texas-based owners, Parker and Parsley has culminated in the purchase of a majority of the Australian assets by Adelaide-based Santos Ltd for approximately $220 million. Santos have signalled their intention of closing the Sydney office in two months, thus writing the final chapter of a significant oil and gas presence in this city.

Mark Russell
Branch Secretary

South Australia

Technical News: March 1996: Dr. Tony Belperio, Chief Geologist, Regional Section, MESA, presented "The Success of the SA Exploration Initiative". This presentation had specific reference to the recent gold discovery in the Gawler Craton.

Complementing this, members were also invited to attend a MESA meeting where David Hutchins, Chief Geophysicist with the Geological Survey, Ministry of Mines and Energy, Republic of Namibia, presented "Airborne Geophysical Surveys and Exploration Opportunities in Namibia".

April 1996: Mr. Rolf Klotz, Area Geophysicist with Western Geophysical (Perth) presented a talk entitled "Wave Equation Layer Replacement". Our thanks to Western Geophysical for their sponsorship of this evening.

Personnel News: After many years of service as an active ASEG SA-Branch committee member Terry Crabb has resigned from both his job at MESA and the ASEG SA-Branch committee. Terry is moving to Canada to take up a position with Scintrex. Our thanks to Terry for all his enthusiasm over the years and especially his stalwart efforts in the publication of the Society's journals. Nick Dunstan from MESA will take Terry's place on the SA-Branch committee; Mike Hatch from Zonge Engineering is also now on the committee.

Samanda Bell
Branch Secretary

Excitations

Stephen Mudge
RGC Exploration Pty Ltd

Out with AMG and in with MGA - A New Mapping System for Australia.

On 1st January 2000, Australia will adopt a new mapping system. The new Geocentric Datum of Australia (GDA) and the Map Grid of Australia (MGA) will replace the Australian Geodetic Datum (AGD's 66 and 84) and the Australian Map Grid (AMG) which have served us well since 1966. Why the change, how will it be implemented and what does it mean for Explorers? With the assistance of some geodetic history, I'll attempt to present a 'map users' understanding of this very important development in geodesy and Australian cartography.

Introduction

A notice appeared in the Commonwealth of Australia Gazette on 6 September 1995, see Houghton (1995), declaring the adoption of the new Geocentric Datum of Australia (GDA) by Federal and State Surveying and Mapping Authorities by 1st January, 2000. This is of fundamental importance to all surveyors, explorers, navigators and map users.

Firstly I will have to assume that the reader is familiar with such terms as Reference Spheroid (Ellipsoid), geoid and map projections, see Figure 2. I refer the reader to the excellent description of these fundamental elements of geodesy published in PREVIEW by Manning and Steed (1994). Their paper is essential reading for a proper understanding of this topic.

In order to ascribe a system of geographic co-ordinates (latitude and longitude) to locations on the Earth it is necessary to define a 3-dimensional mathematical surface, a datum, upon which to reference these co-ordinates. This surface is known as the Reference Spheroid, geodesists also use the term ellipsoid. Defining a spheroid that fits the whole Earth with minimum error has been a major challenge to geodesists throughout history. The basic idea is to describe a smooth mathematical surface that approximates the undulating geoid.

A brief history of Geodesy

Surveying techniques available to early geodesists were land-based and therefore restricted their measurements to local areas of the Earth.

Famous geodesists such as Sir George Everest (a Briton who served as India's first Surveyor-General and after whom Mt Everest is named) defined the Everest 1830 spheroid based on meridian arc measurements he made in India at the time. It is used in India and neighbouring areas. The German astronomer Friedrich Bessel (Director of the Royal Konigsberger Observatory and after whom a class of mathematical functions are named) defined the Bessel 1841 spheroid which found early use in America but was used extensively in much of Europe and, Indonesia and surrounding areas. This was followed by the work of British geodesist Sir George Airy (Professor of Mathematics at Cambridge and Director of the Cambridge Observatory, he also set up the magnetics department at Greenwich Observatory) who defined the AIRY 1849 spheroid which is used in Britain. But it was British geodesist Col. Alexander Ross Clarke (Chief of Trigonometrical Operations of the British Ordnance Survey) who made major contributions to geodesy by defining, not one, but three spheroids. Clarke made meridian measurements in western Europe, Russia, India, South Africa and Peru, and is responsible for the Clarke 1858, 1866 and 1880 spheroids. The Clarke 1866 spheroid has been used in North America and some areas of the Pacific (eg The Philippines) and the Clarke 1880 spheroid is used in France and most of Africa. The Clarke 1858 spheroid was used in Australia prior to 1966.

A significant milestone was reached in 1924 when the International Association of Geodesy (IAG) adopted the spheroid defined in 1909 by the American geodesist John Fillmore Hayford (a civil engineer who became a geodesist with the US Coast Guard, he was responsible for the United States Standard Datum which, after Canada and Mexico adopted it, became the North American Datum 1927). Hayford used measurements made throughout the USA but importantly, he applied Pratt's theory of isostasy in his calculations. After ratification by the IAG the spheroid was renamed the International 1927 spheroid. It has been used in many parts of the world including central Europe, Antarctica and New Zealand. It is the basis for world-wide navigation charts. The former Soviet countries use the Krasovsky 1940 spheroid.

These and several other attempts have been made at describing a suitable reference spheroid however all of them can be described as 'local spheroids' as they are only 'good fits' to the region of the Earth where geodetic observations were made to determine the spheroid parameters. The use of a spheroid in areas distant from the observation area is purely historical - it seems that colonisation of 'distant lands' took various geodetic standards with it. Because they are local spheroids they are not global fits and furthermore they are not Earth centred, that is, they are not geocentric.

The geographic co-ordinates, the latitude and longitude, of a location are determined by the spheroid that they are referenced to. So a particular location can have any number of geographic co-ordinates, its just a matter of which spheroid you choose to use, so strictly speaking one should also specify the spheroid. Clearly one spheroid has to be adopted for accurate world-wide mapping and navigation; the International 1927 spheroid was considered adequate for this purpose. The 1931 International Gravity Formula is based on this spheroid.

All spheroids have local origins linked to some physical location on the Earth, usually a prominent geodetic (trigonometrical) station, and they are also tied to Greenwich Observatory, London, by the Prime Meridian, the zero meridian of longitude. The latitude of Greenwich will of course be different for each spheroid. Spheroid specifications and, location and height of the origin define a geodetic datum. Geodetic datums tied to local spheroids are therefore local datums.

Many countries have changed their spheroids and map projections over time so you can see the problems for bordering nations that use different datums, they have to agree upon which datum their border is defined. This creates a problem for modern explorers, and I can personally testify to this, in trying to sort out past mapping standards, changes of spheroid and uncertainty about border locations as a result of different geodetic datums. Problems also arise when trying to integrate existing maps made on discontinued datums with new data located on modern datums. Mapping a country takes many years, usually decades, and in many developing countries mapping at a particular scale is often incomplete. Life at the frontier wasn't meant to be easy!

Things began to change dramatically in the late 1950's with the introduction of the space age. For the first time it was possible to determine the dimensions of a best-fit whole-earth spheroid from the numerous satellite orbits. The satellite derived spheroids are geocentric, in other words, their centres are coincident with the Earth's centre of mass. This is easily appreciated when you recall from High School physics that a satellite moves about the Earth's centre of mass. However the geocentric spheroids do not necessarily provide a good-fit to local areas of the Earth. In 1960, the US Military defined one of the first geocentric models of the Earth, this is called the World Geodetic System 1960 (WGS60). It was revised in 1966 to produce a more accurate model called WGS66. The International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics (IUGG) adopted a new Earth model in 1967 called the Geodetic Reference System 1967 (GRS67). The Gravity Formula 1967 is derived from this. With the increasing number of satellite orbits and the implementation of early satellite navigation systems, the WGS66 Earth model was revised by the US Military in 1972 to define the WGS72 model. Things just kept on improving; in 1979 the IUGG (they met in Canberra that year) adopted a new (1980) model of the Earth called GRS80 from which the Gravity Formula 1980 is derived. This was followed in 1984 by the US Military's adoption of the WGS84 model which is based on GRS80. The origin of these geocentric spheroids is the Earth's centre of mass. Note that Earth models are developed which define various gravitational constants, the angular velocity of the Earth, and spheroid dimensions.

The GRS80 and WGS84 spheroids have (exactly) the same major semi-axis length (a = 6378137.0 metres) but slightly different flattening (f). For GRS80 f = 1/298.257222101 and for WGS84 f = 1/298.257223563. The difference in flattening is due to rounding in the WGS84 dimensions but the semi-minor (b) axes of both spheroids differ by less than 1 millimetre. The difference is trivial so these spheroids can be interchanged with no noticeable effect on most mapping systems.

By the mid 1980's two fundamental elements of modern geodesy had been established. Firstly, in 1980 we had a very accurate whole-Earth geocentric spheroid (GRS80) to reference all Earth locations without the problems encountered with non-geocentric Earth based spheroids. Secondly, the US Military engineered their Global Positioning System (GPS) satellite navigation system around their WGS84 spheroid. So GPS geographic co-ordinates are on the WGS84 spheroid (it is very important to note this as it has important ramifications for all Earth based GPS users). Geodetic datums tied to these spheroids are global datums.

You should now be able to see where things are heading for the whole world, particularly with the ever increasing, world-wide civilian use of GPS systems. In recent decades aerospace technology has (radically) changed geodetic standards, but we must realise what the implications of these changes are for the rapidly increasing number of computer based Geographic Information System (GIS) users. These 'modern geographers' are increasingly using world-wide data bases (surfing the 'net') to interrogate and integrate all sorts of geographically located data. The requirement to reference all data to a common datum is obvious. Most new data is now acquired with the aid of GPS positioning systems but the problem of integrating existing data, located on old datums, and the requirement to relocate these to a world-wide datum is also obvious. The old frontier problem again, but now you don't have to leave home to confront it! Modern surveying with GPS is not only convenient and easy to use, and more accurate, but it is based on a true global datum (so don't leave home without it). You can now see the impetus for new directions in mapping for all countries, and in particular Australia. So now lets quickly review the history of mapping in Australia.

A Brief History of Mapping in Australia

Prior to 1950, very little geodetic surveying and mapping had been undertaken in Australia. The little that existed was confined mainly to the populated coastal areas of the country and areas of interest to the military, but none of this was tied to a national datum (there wasn't one anyway). Most of Australia was just a blank sheet of paper.

The National Mapping Council of Australia (NMC) was formed in 1945 and charged with the task of formulating and conducting a national geodetic survey, a national levelling survey and a mapping program of Australia and PNG. A nation-wide aerial photography program was commissioned in 1947 and the national geodetic survey of Australia commenced in 1954 to acquire latitude and longitude of trigonometrical (trig.) stations, and distances and heights between them.

Up till 1966 Australia used the Clarke 1858 spheroid for mapping. Several datums were used and the spheroid was projected to a flat plane using the Transverse Mercator Projection and the flat plane grid was called the Australian National Grid (ANG). Grid co-ordinates were measured in yards and the projection was made in zones of five degrees width. There are many 1:250,000 and larger scale (eg 1:63,360 or 1 inch to the mile) geological, geophysical and topographic maps from the 1950's and early 60's existent today based on this now redundant system.

With the advent of the IUGG adopting a new Eart model in 1967 (GRS67), NMC decided to adopt a new spheroid in 1966 based on the then to be adopted GRS6 spheroid, but with numerical rounding of the flattening The spheroid is called the Australian National Spheroi 1966 (ANS66). An origin point for all mapping wa adopted at the centre of the continent. It is called th Johnston Geodetic Station (named after Frederic Marshall Johnston, Commonwealth Survey-General an the first Director of the Division of National Mappin Department of National Development) and is located i the Northern Territory, near the South Australian borde The ANS66 spheroid and the location and height of t Johnston origin form the Australian Geodetic Datu 1966 (AGD66). In 1966, all the geodetic data acquir during the previous 13 years were adjusted to this datu to provide AGD66 co-ordinates for the trig. stations. coincide with this it was decided to adopt a new m projection to conform with standards being adopt elsewhere in the world. So Australia adopted the I Military's Universal Transverse Mercator (UTM) m projection, which uses zones of six degrees width project, or map, the spheroid onto a plane grid. The g is known as the Australian Map Grid 1966 (AMG66) w dimensions (easting and northing) measured in met Zone numbers conform to the world-wide UTM g system.

So 1966 was an important year for Australia with introduction of decimal currency and the start of the n famous nickel boom and the stock market frenzy t followed. Both events are well known and had a m impact on life in Australia. The story of Austra mapping on the other hand is not as well known, ye many people in all activities have benefited from work done in preparation for the 1966 adoption of new mapping standards. This story has been recorde

Lines (1992). He tells of the organisational challenges of setting standards, executing the enormous volume of surveying, the problems of working in remote, flat and largely unexplored country (surveyors prefer hills), and the different technologies tested and used during the 1950's and 60's to provide the survey data for the geodetic adjustment that defined AGD66 and the subsequent national height datum AHD71. Lines (1992) says of the geodetic survey '.....and spread over the relatively short period of 13 years, there would be no integrated co-ordinates as the nation enjoys today. It was an achievement without peer world-wide'. Also he says 'the adoption of the AGD and the introduction of the AMG in 1966 were events of major national significance'.

Figure 1. A gravity reading being take at Geodetic Station Condobolin in central NSW. Thousands of trig. Stations across Australia will adopt new co-ordinates by 1st January 2000 with the implementation of the new Geocentric Datum of Australia (GDA).

The production of 1:1 million and 1:250,000 topographic maps was under way with topographical information taken from a large number of uncontrolled aerial photographs. Interestingly it was in 1958 that the first 1:250,000 contoured topographic map based on the Clarke 1958 spheroid was produced, it was the Tennant Creek sheet in the Northern Territory, then an active copper-gold field (earlier maps were not contoured because of lack of accurate heights across the continent). Also the Commonwealth Government in that year redirected mapping priorities to the sedimentary basins to assist with the search for hydrocarbons. These events clearly show the realisation of the national importance of resource exploration. The new priorities also included Australian areas of Antarctic and Australian sub-Antarctic islands. The 1:100,000 topographic mapping program commenced in 1965 and was based on the new datum.

The national levelling survey, to provide a network of established level marks (heights) across the Australian continent, commenced in 1962. Importantly a series of 30 tide gauges were located around the Australian coast and about 2 years of continuous tide levels from 1966 to 1968 were used to determine the Mean Sea Level (MSL) thus providing a zero level for heights. In 1971 the heights of the trig. stations (measured in the geodetic survey) and the bench marks were mathematically adjusted to MSL with geoid and gravity data to define the Australian Height Datum 1971 (AHD71). They are heights above the 1966-1968 MSL. The first geoid map of Australia was also produced showing geoid - spheroid separations. Lines (1992) says of AHD71 'An adjustment on this scale had never been attempted elsewhere, and this was a leader in its field'. Tasmania had its own height datum because of the difficulties in making trigonometrical height determinations across Bass Strait. It is based on the 1972 MSL from three recording tide gauges located around the Tasmanian coast for that purpose. A height adjustment was made in 1983 and is known as AHD (Tasmania).

By 1982 many more trigonometrical and geodetic stations had been installed and several deficiencies in AGD66 had become apparent. So a mathematical readjustment was made of the co-ordinates of all trig. stations in 1982 to produce a new geodetic model of Australia (geographical co-ordinate set) which was adopted in 1984 and known as AGD84. The grid co-ordinates obtained from the UTM projection are known as AMG84. These differ from AMG66 (derived from AGD66) by as much as 5 metres but this is imperceptible on small scale 1:250,000 and 1:100,000 maps, which remained on AGD66 so they have not been reprinted. It was at this time that standards became divided, WA, SA and Qld adopted AGD84, the other states, having existing large data bases on AGD66, continued with AGD66. So large scale maps (eg 1:25,000) do not match at respective State borders (there it is again, the old frontier problem). There was no change in the height datum, AHD71 remained enforced.

The national 1:250,000 topographic series (first edition) of 544 map sheets on the Clarke 1858 spheroid was completed in 1968. Lines (1992) says of this 'This first map coverage of Australia based on aerial photography was a most significant milestone for map users. The series, although much of it already in need of revision when completed, was not only useful for the reliable depiction of geographic features, but also as base material for series of thematic maps associated with geology, geophysics,....'. The revised set on AGD66 and showing the AMG was completed in 1991 with publication of the Warburton sheet (Victoria). The last of the 1646 published 1:100,000 maps was completed in 1986 with Esperance, Burngup, King and Beaumont, all in WA (there are actually 3059 sheet areas covering Australia, the remainders were compiled at 1:100,000 scale and converted to and printed at 1:250,000 scale, concluding in 1988 with the Hermannsburg sheet, NT).

Digital mapping data such as satellite imagery appeared in the 1970's and other digital mapping products came into vogue during the 1980's. The GPS system had been accepted as a base for a wide variety of mapping applications by the early 1990's.

See NMC (1986) and Murphy (1994) for a comprehensive description of AGD66, AGD84, AHD71, UTM and AMG. A comprehensive mathematical description of reference spheroids, AGD66, UTM and other map projections is given by Lauf (1983).

Introduction of a Geocentric Datum

By the late 1980's civilian applications of GPS methods were emerging to become common place in the mid 1990's. Co-ordinates from these systems are based on the WGS84 spheroid. A spheroid-to-spheroid conversion is necessary to transform these WGS84 co-ordinates (latitudes and longitudes) to another spheroid such as

ANS66. Some recent GPS instruments do the grid conversions internally so the user can obtain local co-ordinates without resorting to post-survey processing of survey results. So GPS users need to be cautious about using co-ordinates directly from GPS equipment, you need to check which spheroid these co-ordinates are referenced to.

Many countries are considering adopting a geocentric datum to provide compatibility with GPS systems and to conform to a true global datum. International maritime and hydrographic organisations have resolved to adopt the geocentric datum which means for example, that oceanographic charts will join smoothly to terrestrial maps. International aviation organisations have already resolved to adopt the datum for all aviation charts by 1997 and the Australian Defence Mapping agency has already adopted the new datum.

So back to Australia, and in 1988 the Inter-governmental Committee on Surveying and Mapping (ICSM, the successor to the NMC) proposed to adopt a geocentric datum by 2000. In November 1994 the ICSM adopted a new geocentric datum for Australia using the GRS80 spheroid and recommended its progressive implementation by 1st January 2000, see Houghton (1995) and ISCM (1994). This is known as the Geocentric Datum of Australia 1994 (GDA94) and all locations in Australia will adopt new geographic co-ordinates (latitude and longitude) to conform to the new datum. GDA is referenced to eight high precision, recording GPS geodetic stations located around Australia which are referenced to the GRS80 spheroid. The network is called the Australian Fiducial Network (AFN) and it ties Australia into the geocentered international reference frame, see Manning and Steed (1994). Note that the AGD origin, the Johnston Geodetic Station, is not a component of GDA but will nevertheless remain in the geodetic data base as a trig. station.

The UTM projection will remain and projected GDA co-ordinates will be known as the Map Grid of Australia 1994 (MGA94). The UTM projection zones will remain as originally defined for the UTM system ie. zones of six degrees width numbered 1 to 60 around the world with the central meridians maintaining their existing longitudes, except these will be referenced to the new GRS80 spheroid. This means that all maps will be 'out of date' as all locations will move on existing AGD map sheets by about 200 metres in an approximately north-east direction. This indicates that the centre of ANS66 is offset about 200 metres from the Earth's centre. Of course the locations don't move on the ground, its the location of the map sheets that move south-westerly as the corner co-ordinates of the sheets will remain the same, but referenced to the new datum. On 1:250,000 maps the shift will be about 0.8 mm, on 1:100,000 maps it will be about

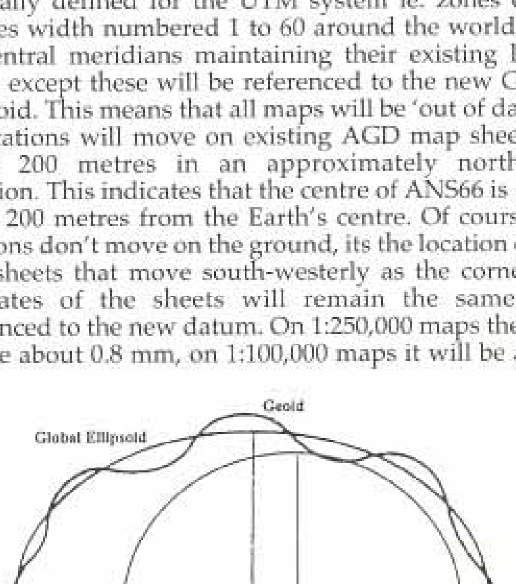


Figure 2. Relationship between local and global datums and the geoid. Reprinted from Manning and Steed (1994).

2.0 mm and at 1:10,000 scale it is about 20.0 mm (just scale these shifts to suit the map scale). Heights will not change, AHD71 will remain enforced.

The introduction of GDA will put Australia on a worldwide/global geodetic datum. GPS users can assume that the WGS84 spheroid is exactly the same as the GRS80 spheroid so GPS co-ordinates are entirely compatible with GDA94. So don't leave home without your GPS unit because the frontier problem in Australia becomes historical with adoption of GDA, but not so elsewhere, at least until the rest of the world adopts GRS80.

Alexander (1995) and Featherstone (1994a and 1994b) give comprehensive descriptions of GDA94 and provide details of the amount of shift for locations across the Australian continent. Also they give a set of temporary conversion parameters (the Higgins parameters) for use with the Bursa-Wolf equations to convert AMG to MGA. An accurate set of conversion parameters will be available from the Australian Land Information Group (AUSLIG, the successor to the Division of National Mapping) when the national GPS geodetic survey, which commenced in 1994, is completed in late 1996. This survey, known as the Australian National Network (ANN) which is tied to the AFN, is a large, high precision GPS geodetic survey designed to allow the re-adjustment of the existing very large geodetic data base (AGD84) to the new GDA94.

The AFN (the GDA tracking stations) also monitor the movement of the Australian continent. You must realise that continental drift keeps the ground moving, so the co-ordinates of all locations are continually changing as the continents move over the reference spheroid, which remains fixed. When we talk of, say, AGD66 co-ordinates we mean the location as it was in 1966. GDA94 is actually set for the epoch 1st January 1994 (1994.0). I presume we can expect to see further geodetic adjustments in the future.

GPS systems are capable of measuring spheroid heights and, when combined with geoid-spheroid separation values, can provide height above geoid (MSL). The AHD may be reviewed sometime in the future.

Using GDA

Explorers are urged to consider their requirements for using GDA and MGA co-ordinates before the adoption date of 1st January 2000. I suggest that GDA and MGA be considered for new projects being established today, as these projects may exist at and beyond the official adoption date, so that they can be 'carried' along with the existing AGD and AMG co-ordinates.

For a period of time it is likely that mapping agencies will overprint existing AGD maps with the new MGA grid co-ordinates. We can expect to see in the future a new series of topographic maps based on GDA, and much of this will probably be in digital format. As far as other types of digital data are concerned, we must, in the mean time, become familiar with the use of transformation techniques, such as the Bursa-Wolf equations, to convert between the different datums (eg AMG to MGA). This will be a common transformation for the foreseeable future whilst existing data bases are converted to GDA, see Alexander (1995) and Featherstone (1994a and 1994b). When using existing AGD map sheets, don't forget the approximate 200 metre shift, approximately north-east, for all locations. GIS users need to be aware of the problems of integrating data based on other datums, and should investigate the appropriate conversions parameters to convert between these and GDA94.

All airborne geophysical surveys and all GPS controlled gravity surveys conducted in Australia today are positioned in GDA geographic co-ordinates, so it should be no problem for survey contractors to apply the UTM projection to provide MGA co-ordinates along with AMG. The geophysical and exploration communities should adopt the new mapping standards now to prepare for projects that extend into the next century.

It is important for all Government geophysical mapping agencies in Australia to consider their adoption of GDA. The very large National and State geophysical data bases will need to be converted to GDA. This may mean that existing gridded data will require regridding from the original (relocated to GDA) line data to ensure that grid intervals maintain their original dimensions and that grid cells maintain their original shape. A direct conversion of AMG gridded data to MGA could prove unsatisfactory for accurate registration of integrated data sets.

Problems may arise in redefining positions of lease boundaries. In some States exploration leases are defined on 1 km square AMG grid blocks and in others a 1 minute AGD block is used. Clearly the various governing authorities will need to formulate policies for future lease definitions that accommodate existing AGD and new GDA definitions.

It appears that the role of permanently marked trig. stations located on hill tops has changed. With GPS methods it is now an easy matter to accurately relocate a position and to accurately measure distances and heights between 'over the horizon' locations. Importantly, all of this can now be done directly on the GDA. We are now using GPS to make geodetic observations, satellite imagery to acquire digital geographical information, computer methods to integrate and scale the maps, and computer networks to transmit final mapping products map users. The story of future mapping of Australia will be a different one to that told by Lines (1992).

Figure 3. Civilian users navigating in remote areas with GPS, and soon on GDA.

Conclusions

The GPS system achieves a fundamental goal in geodesy: the determination of absolute position with uniform accuracy at all points on the Earth's surface. Classical geodetic and surveying methods provide a determination of position relative to a starting point with accuracy being dependent on the distance from this point. GPS therefore offers a significant advantage over conventional techniques. GPS's ease of operation puts modern geodetic standards in the hands of every map user. An understanding of the fundamentals of geodesy, ie reference ellipsoids, the geoid, geodetic datums and map projections, will allow the user to use the technology effectively for a wide variety of surveying, navigation and mapping applications.

The adoption of GDA is a transfer of space technology to every surveyor, cartographer, navigator, explorer, geographer and users of all types of maps.

I trust that this narrative has explained away the mystery surrounding geodetic datums and why a variety of spheroids are used around the world. Also I hope that the historical account has provided a clear understanding of mapping in Australia and, importantly why Australia is moving to a geocentric datum. Did you find the history lesson interesting?

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Advances in High Definition Geophysics

by Andrew Davis, Geophysical Research Institute

With advances in data measurement and processing technologies, as well as improvements to the efficiency of survey systems and methodologies, industry is now making greater use of high definition geophysical techniques in exploration. The benefits of high quality geophysical data to interpretation are now widely recognised, and today's R&D effort is therefore focussed on expanding the range of technologies and applications that make use of high definition geophysics. Three recent developments are featured in this article.

The Geophysical Research Institute (GRI) was formed in 1978 to foster closer links between the then Department of Geophysics at the University of New England and the industry it serviced. Subsequently, it became an autonomous, self-funding research centre within the UNE with a particular focus on the development of high definition geophysical exploration technologies and services. After almost 20 years of evolutionary growth as both a centre for applied R&D and a geophysical service provider, the GRI is now undergoing revolutionary change with the operations of the Institute being restructured and transferred to a new commercial service provider, Geophysical Technology Limited (GTL).

High Quality, Cost-Effective Geophysics - *'Proven philosophies with a new beginning'*

Geophysical data acquisition has often been viewed as labour-intensive and expensive. Budget constraints have therefore tended to drive exploration programs towards wide measurement intervals, and as a consequence, field data are inadequately sampled. The recorded data set is then difficult, ambiguous or misleading to interpret.

The quality of exploration data was traditionally assessed by the precision with which measurements are made. However, it is the interpretability of the data that is of greatest concern, which in turn is dependent upon the measurement spatial resolution rather than instrument resolution.

Through its growing use of High Definition Magnetics (HDM) in recent years, industry has become aware of the full cost of undersampled data, which can be enormous when measured in the context of the life cycle of an exploration program. Such data can, for example, result in missed opportunities; poorly defined drilling programs; or ill characterised engineering and environmental site assessments.

Western Mining Corporation's recent Exploration Report[1] highlights the potential for high definition geophysics in reducing the cost of exploration. In recording the discovery of 5.4 million ounces of recoverable gold, it was noted that the total cost of exploration equated to \$9.30 per ounce of gold. The Report recognised that this extraordinary exploration efficiency was largely due to geophysical advances including "exceptionally detailed magnetic surveys which revealed the concealed geology and tell tale anomalies." The cost of this vital information was a mere \$0.04 per ounce, making a mockery of the view that geophysical data is expensive in the context of its exploration value. Clearly, a very small investment in high definition geophysical data can deliver a massive return through the savings made in the subsequent and much more expensive phases of an exploration program, such as drilling.

1. Exploration at St Ives, Western Mining Corporation, 1994.

Figure 1. The quad-sensor TM-4 system demonstrated at the 1995 UXO technology trials in the USA. This system has been developed to provide the degree of accuracy and resolution required with ordnance detection, while delivering the efficiency of simultaneous data line acquisition.

Since its beginnings in 1978, GRI has focussed its research on the explorationist's need for efficient techniques for acquiring high spatial resolution data. The use of recent advances in microprocessor technology has resulted in the development of instruments which feature faster sampling rates; enhanced data acquisition and signal processing capability; and improved sensitivity. When combined with navigation facilities, such as GPS, and more efficient acquisition methodologies, higher quality surveys are now even more economically viable.

In keeping with GRI's charter, its technology has been transferred to industry, primarily through the provision of sub-surface imaging services. GRI now operates in a wide range of markets, including mineral exploration; engineering site management; explosive ordnance disposal; industrial site remediation; water resource and salinity management; and archaeology.

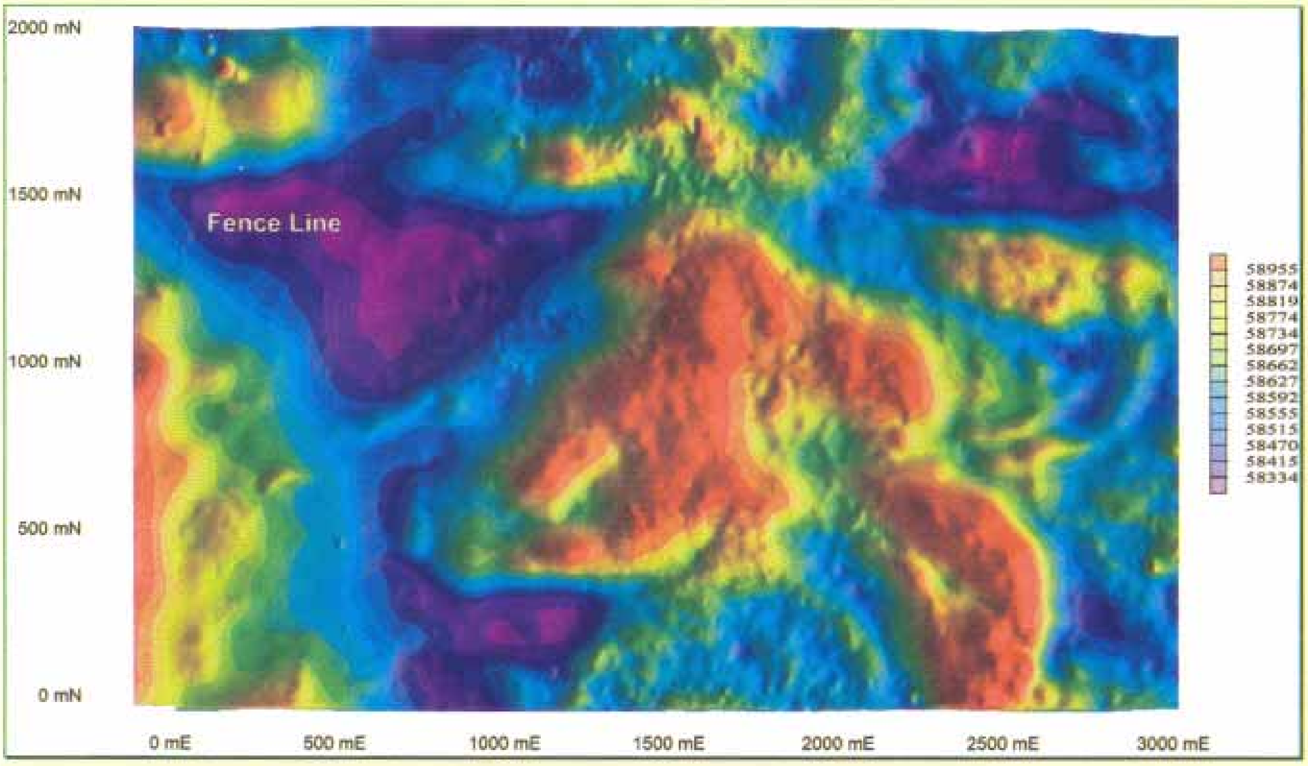
GRI presently has a professional staff of twenty, including geophysicists, electronics engineers and software engineers.

Advances in High Definition Geophysics

Airborne High Definition Magnetics

Figure 2: The *GRI-HELIMAG* system

The system employs a dual-sensor magnetometer enabling efficient high definition data acquisition. A real-time DGPS is used for both navigation and positional logging. The system also features compensation for aircraft orientation effects, and the real-time removal, without aliasing, of the noise from the dynamic components of the aircraft.

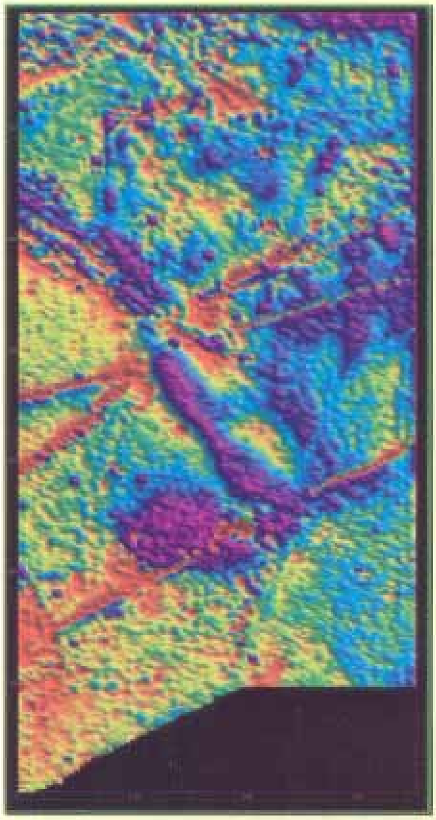


TOTAL MAGNETIC INTENSITY (nT)

Data courtesy of North Limited

Data Line Spacing	10 metres
Flight Line Spacing	20 metres
Line Direction	East - West
Sensor Height	12 metres
Data Recording Rate	10 Hz

Figure 3: Total Magnetic Intensity image of a *GRI-HELIMAG* data set. A fence line, shown in the north-west corner of the image, is clearly evident in the data. This represents a very narrow, near surface magnetic source, rich in the highest frequencies of the geological spectrum. The fact that the data resolves such a feature, is an indication that that all of the geological information available from magnetic field measurements will be evident in the data.



(A)

The Value of High Spatial Resolution

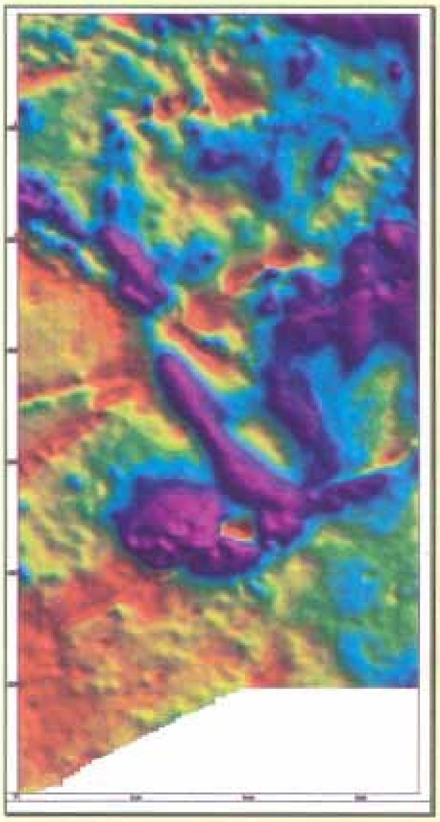
Figure 6: (A) Hand-held TM-4 data from a 700 by 1400 metre area revealing a wealth of geological detail, including shears, very thin dykes (less than 1 metre thickness), and a reverse magnetised plug.

(B) The data upward continued to 10 metres as might be obtained with an ultra-low level helicopter survey with a stinger mounted magnetometer. All but the thinnest of dykes may be still be recognised.

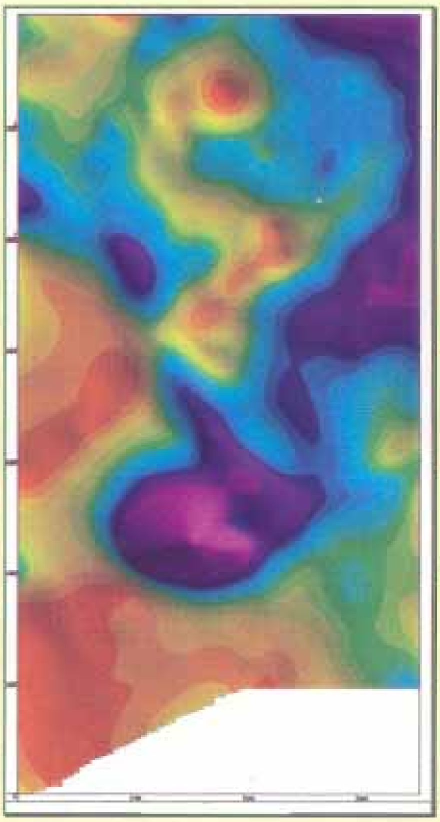
(C) At an elevation of 40 metres, which may be typical of a towed bird magnetometer survey, most of the diagnostic information has been lost.

(D) From data recorded at 85 metres, even the most experienced geophysicist would have difficulty interpreting anything that is meaningful or representing the true geological structure.

Data courtesy of Newlands Coal



(B)



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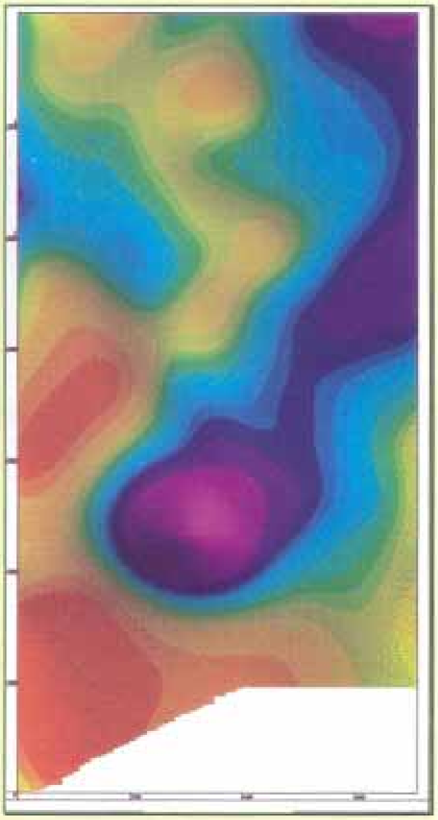
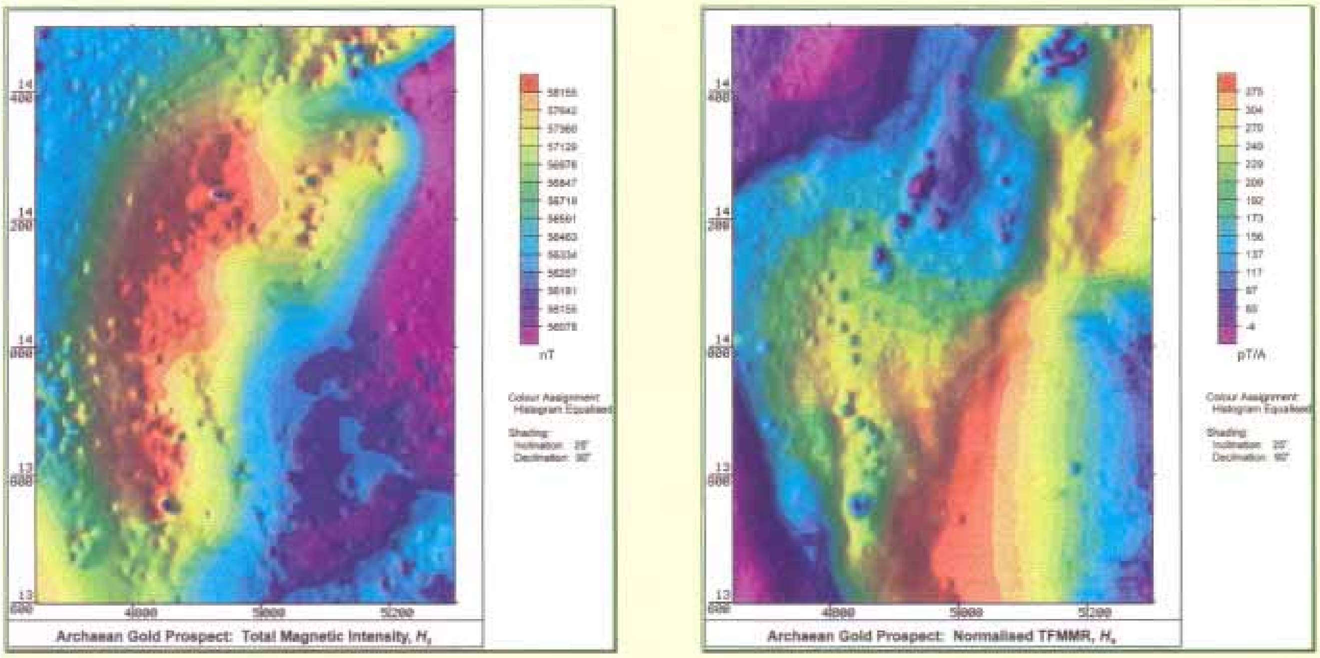


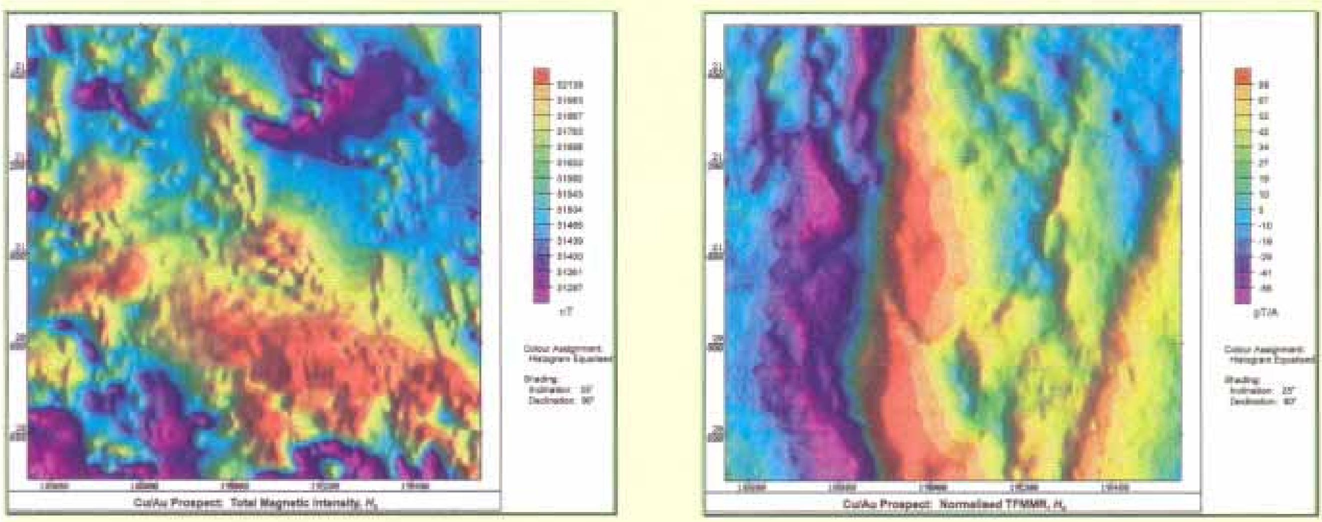
(D)

Sub-Audio Magnetics - Supplementary and Complementary Data Sets



(A) (B)

Figure 10: An example of supplementary Sub-Audio Magnetics data sets, acquired over a Banded Iron Formation-hosted Archaean Gold prospect. Figure 10(A), the High Definition Magnetics image, reveals a magnetic anomaly with a distinct flexure at 14100mN. The normalised TFMMR image shown in 10(B) suggest that the BIF is a conductor, with a second and more intense anomaly lying to the east. In this case, the TFMMR data set confirms and extends the interpretation made on the HDM data alone.



(A) (B)

Figure 11: An example of complementary Sub-Audio Magnetics data sets, acquired over a Copper-Gold prospect. The HDM anomaly shown in 11(A) relates to a barren, near surface structure. Had the interpretation been limited to this data set only, a drilling program directed at a west to north-westerly striking target would probably have been unsuccessful, as the real target of interest was a shear lying beneath the near surface structure and almost orthogonal to it. However, the shear was revealed in the normalised TFMMR data shown in 11(B).

Environmental Site Assessment Technology

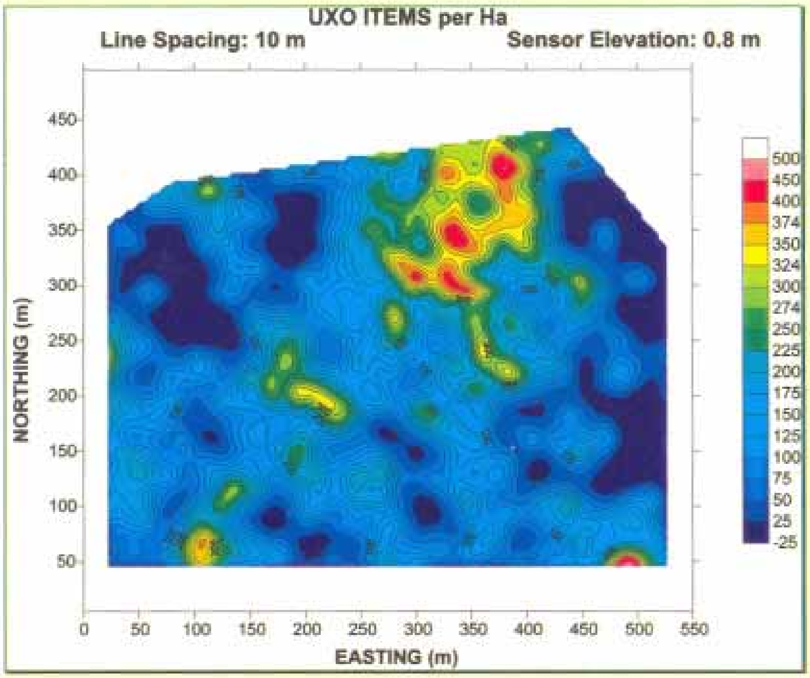


Figure 17: Contour map of ferrous UXO items per hectare, determined from a 10 percent sample.

A line spacing of 10 metres and sensor elevation of 0.8 metres were employed.

The total number of ferrous UXO items determined from this sample was 4,950.

Contamination levels ranging up to more than 400 items per hectare were determined.

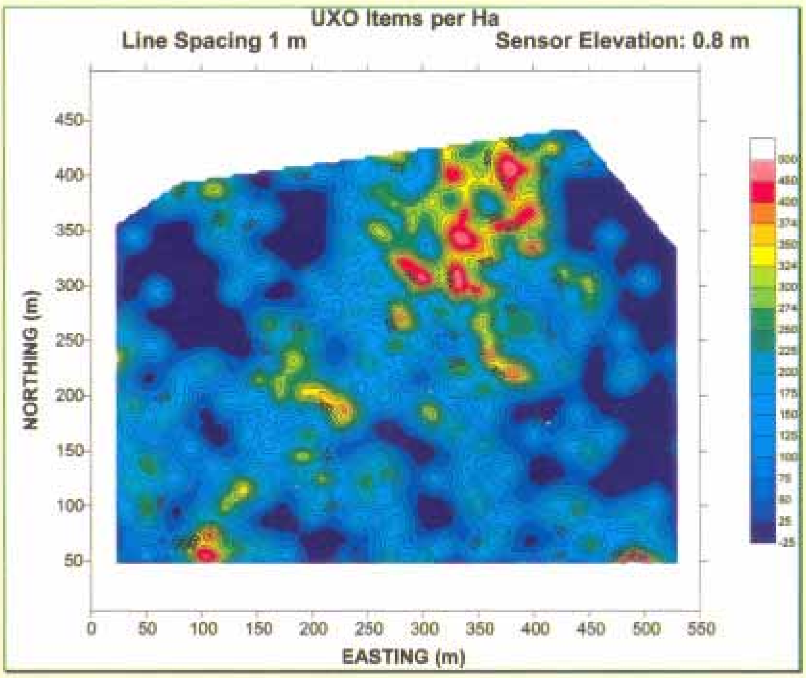


Figure 18: Contour map of ferrous UXO items per hectare, determined from a 100 percent sample.

The total number of ferrous UXO items determined from this sample was 4,809. Hence, the data obtained from the 10 percent sample (Figure 17) were accurate to within 2 percent of the true contamination figure.

The Figures indicate how the statistically based Site Assessment technology developed by GRI can be employed to prioritise areas within a contaminated site for remediation and release. Early release of uncontaminated areas may generate the cashflow required to fund further site remediation work.

Figure 19: GRI single-sensor, vehicle mounted magnetometer system

Figure 20: Instrument panel with DGPS positioning and navigation

Recognising the growth in its technology and service base, the decision has now been taken to transfer the operations of GRI from within the University environment to a new, stand alone commercial service provider, Geophysical Technology Limited.

GRI-HELIMAG - *'High definition magnetics with the efficiency of airborne acquisition'*

Unique amongst helimag systems, the dual-sensor GRI-HELIMAG has been developed to deliver the data quality of ground based HDM surveys, upon which the reputation of GRI was built, with the efficiency of airborne acquisition.

GRI-HELIMAG (shown in Figure 2) uses a Caesium Vapour sensor mounted at each end of a transverse boom fitted to the aircraft, allowing the acquisition of two lines of data with each flight line. This means that a lesser number of flight kilometres is required to meet the defined survey specification when compared with single sensor acquisition systems. With a 10 metre boom, for example, if the exploration company required data at 30 metre line separation, GRI-HELIMAG could be flown at 40 metre flight line separation and deliver alternate data line spacings of 10 and 30 metres. Hence, the specification is in fact exceeded, delivering a larger sample of HDM data and requiring 25 percent less flying than would be required for a single sensor survey.

GRI-HELIMAG employs an Aerospatiale Squirrel helicopter as the data acquisition platform. The Squirrel was chosen because of its excellent noise characteristics; its high lift capacity for conducting other concurrent geophysical investigations; and its ability to operate at high altitudes. Today's DGPS allow accurate data positioning, and in GRI-HELIMAG this is combined with a laser altimeter, not only to accurately measure elevation, but to allow the determination of a digital terrain model.

GRI-HELIMAG makes use of the award winning TM-4 magnetometer. Data are recorded at a frequency of 10Hz, but are actually sampled by the TM-4 at much higher frequencies of up to 200Hz. Sampling at these high frequencies allows the spectral isolation and real-time removal, without aliasing, of the noise interference from the dynamic components of the aircraft. This is demonstrated in Figure 3. This GRI-HELIMAG HDM data set was collected at an elevation of 12 metres with 10 metres data line separations. The image reveals a number of thin linear features, including one in the north-western corner of the area. This anomaly corresponds to a fence line.

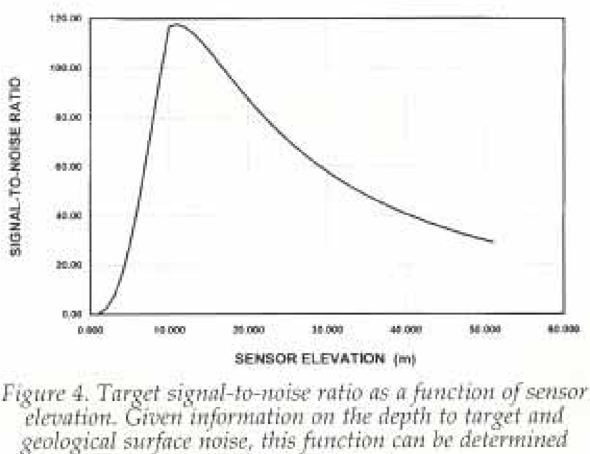


Figure 4. Target signal-to-noise ratio as a function of sensor elevation. Given information on the depth to target and geological surface noise, this function can be determined for individual prospects.

A fence represents a very narrow, near surface magnetic source, rich in the highest spatial frequencies contained in the geological spectrum. Data quality that faithfully resolves such a feature will honour all of the geological information available from the magnetic field.

The GRI-HELIMAG system was designed to fly at the low elevations usually associated with crop-dusting - terrain, vegetation and man-made features permitting. Flying as close as practical to the ground provides two major benefits when it comes to interpreting the survey data.

1. *The target signal-to-noise ratio is optimised.* While there is some increased system noise with stinger mounted magnetometers, as opposed to bird or fixed wing systems, the target signal strength obtained by flying at very low elevations is increased by a substantially greater factor. Hence, the most important variable, the signal-to-noise (S/N) ratio, is increased - except when the target depth is very great.

   GRI has developed a technique for determining the optimal S/N ratio for a given target depth and geological surface noise. Figure 4 shows the S/N ratio as a function of sensor height, showing in this case that the optimal elevation would be 10 metres. GRI's research has shown that elevations of this order often deliver the optimal S/N ratio.

   Further, Figure 5 compares various airborne survey systems. Again, it shows the benefit in terms of S/N ratio derived from flying at low elevations.

2. *The spatial resolution is optimised.* As a rule, two features will not be resolved if the distance by which they are separated is less than the height of the sensor above them. Hence, the lower the survey flight elevation, the greater the ability of the system to resolve between two targets of interest. If high detail geological mapping is desired, then the ability to resolve the signatures associated with fine stratigraphy can be of paramount importance.

   The increased spatial resolution obtained is evident in the images given in Figure 6, which compare the results obtained at elevations associated with a GRI-HELIMAG survey at 10 metres elevation (B); a towed bird survey at 40 metres (C); and a fixed wing survey at 85 metres (D). The increased definition obtained with the lowest elevation is obvious, as is the benefit that this brings to interpretation and, therefore, subsequent phases of the exploration program.

Hence, the two factors combine to give a highly resolved data set for interpretation, with anomalies being better delineated and defined. Such quality data can pay for itself many times over in subsequent exploration phases by permitting the more accurate planning of those phases with less ambiguity and, hence, fewer expensive drill-holes!

Continued next page

Survey Technology	Survey Elevation	Normalised S/N Ratio	Sample Interval	Spatial Resolution	Price per Measurement
GRI-HELIMAG	10	1.00	4 m by 10 m	10 m x 20 m	$0.08
Towed Bird Helimag	40	0.56	5 m by 100 m	40 m x 200 m	$0.15
Fixed Wing Aeromag	60	0.40	7 m by 200 m	60 m x 400 m	$0.10

Figure 5. Table showing typical S/N ratio and spatial resolution for airborne magnetics systems. Actual survey specifications and prices will vary with location and exploration target. Spatial resolution is the minimum separation (along and across lines) at which two adjacent features may be resolved.

Sub-Audio Magnetics - *'High definition magnetic and electrical properties'*

The Sub-Audio Magnetics (SAM) method is perhaps one of the most exciting developments in geophysical exploration in recent years, and was recognised as such by the ASEG with the 1995 Grahame Sands Award for Innovation in Applied Geoscience. Not all geophysical methods are suitable for high definition application. SAM provides the explorationist with a new tool that enables electrical properties to be mapped with the resolution and efficiency previously associated only with magnetics mapping.

The exploration industry has been utilising High Definition Magnetics with great success in recent years, benefiting from both the increased data quality and acquisition efficiency now available. However, techniques which measure the electrical properties of the ground, such as resistivity, magnetometric resistivity, induced polarisation, magnetic induced polarisation and electromagnetics, have not enjoyed the same improvements in survey efficiency, because of their need for grounded electrodes or precisely oriented sensors. GRI set out to overcome these limitations by developing a technique which, through the rapid measurement of total magnetic field intensity, would efficiently deliver high definition electromagnetic data.

The resulting SAM technique is now revolutionising electrical prospecting. The technique makes use of the same TM-4 instrumentation as used by GRI for HDM data acquisition. This system permits efficient data acquisition; on foot, from a ground-based vehicle or from an airborne platform. The capability to simultaneously acquire high definition electrical and magnetic data is responsible for the exploration efficiency obtained through this method. With the data fusion capacity of today's image processing systems, high definition multi-parameter data provides a wealth of quality information to the interpreter.

In the SAM application, an enhanced TM-4 total field magnetometer is used to measure the electromagnetic field associated with the electric current induced in the ground by either galvanic or electromagnetic means. The technique requires a constant current transmitter operating at a fundamental frequency in the sub-audio range. The electromagnetic signal that results from the time-varying current flow is then measured simultaneously with the earth's spatially-varying magnetic field. Using the rapid sampling capacity of the TM-4, the combined signals are measured at a sufficiently fast rate to adequately sample the full spectrum of the waveform. Real-time spectral analysis then allows the derivation of a suite of geophysical parameters, including:

- total field, High Definition Magnetics (HDM);
- total field, Magnetometric Resistivity (TFMMR);
- total field, Magnetic Induced Polarisation (TFMIP); and
- total field, Electromagnetics (TFEM).

Over the past year, GRI has been providing SAM services to the mining industry, routinely acquiring and processing HDM and TFMMR data, with the TFMIP product not yet commercially available. The SAM survey configuration being used (see Figure 7) closely resembles that adopted for traditional MMR and MIP, except that in the SAM method, the total field is measured rather than a horizontal component.

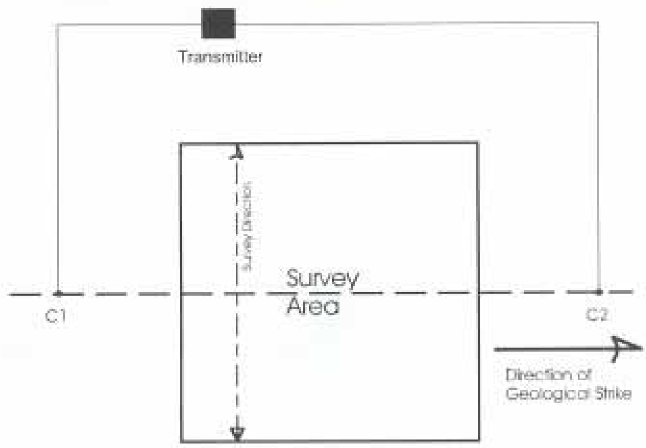


Figure 7. Layout of a typical SAM survey layout using a galvanic source, with electrodes at C1 and C2.

A simple walk-through of the recorded and processed signals given in Figures 8 and 9 gives a guide to the path used to derive the HDM and TFMMR data.

Figure 8(A) gives an example of the time-varying, total magnetic field intensity recorded for a single traverse over a conductor. This is the raw signal and is fundamentally made up of the spatially varying magnetic field (B), and the modulation on this component brought about by the transmitted signal (C). With the rapid sampling rate of the TM-4, these components are spectrally distinct and can therefore be separated without aliasing through Digital Signal Processing. Hence, (B) gives the HDM output and (C), the SAM signal, is further processed to deliver the other geophysical parameters required.

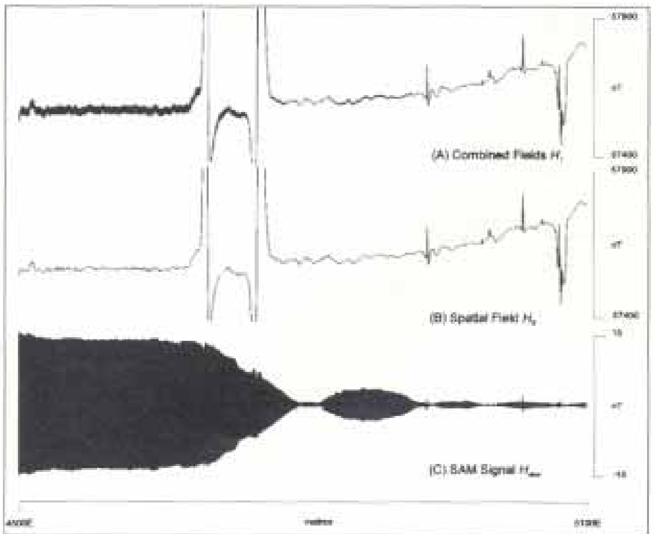


Figure 8. (A) A sample raw data profile recorded over a conductor; (B) The spatially-varying magnetic field data set; and (C) the SAM signal.

The "Raw TFMMR" is defined as the peak-to-peak amplitude of the SAM signal, shown in Figure 9(A). The Raw TFMMR signal is the sum of the "Primary Field" (B) due to the current in the wires feeding the electrodes and the field associated with the current flow in the ground. As the position of feed wire is known, the Primary Field may be calculated and subtracted from the Raw TFMMR data. The "Normal Field" (C) due to the current that would flow in a homogenous earth is also calculated and subtracted from the data. This then leaves the "Normalised TFMMR" (D), which is the signal associated with the anomalous current flowing through the geological structures of interest. In this example, the Normalised TFMMR anomaly is dipolar indicating a thin conductive sheet structure at 4800mE and dipping a few degrees to the west.

The use of SAM in both field trials and commercial programs has delivered a significant insight into this new exploration tool, particularly the value to interpreters of independent, high definition data sets. Obviously, the SAM method is an appropriate tool for use in geological environments where both magnetic and electrical contrasts are anticipated. The interrelationships between these vary greatly, but can be characterised as "supplementary" or "complementary".

Figure 10 gives an example of supplementary data sets, where the TFMMR data provide information confirming and extending the interpretation that would have been made using the HDM data only. The example is taken from a Banded Iron Formation (BIF)-hosted Archaean Gold prospect. The electrodes were located to the north and south of the survey area, which measured 900m by 650m. The magnetic anomaly due the BIF is evident in the HDM image. A distinct flexure is visible at 14100mN. The TFMMR image suggests that the BIF is a conductor. A second more intense anomaly lies further to the east, aside the BIF. Such associations were detected with other BIFs in this region. The TFMMR image also exhibits several displacements in the north of the area which suggest faulting.

With complementary SAM data, the introduction of the second data set delivers a new and, apparently, differing view of the geological structure to that offered by the first. The potential for a 'blinkered' interpretation through a dependence on a single data set may prove costly to the exploration company. Figure 11 shows an example of complementary data sets.

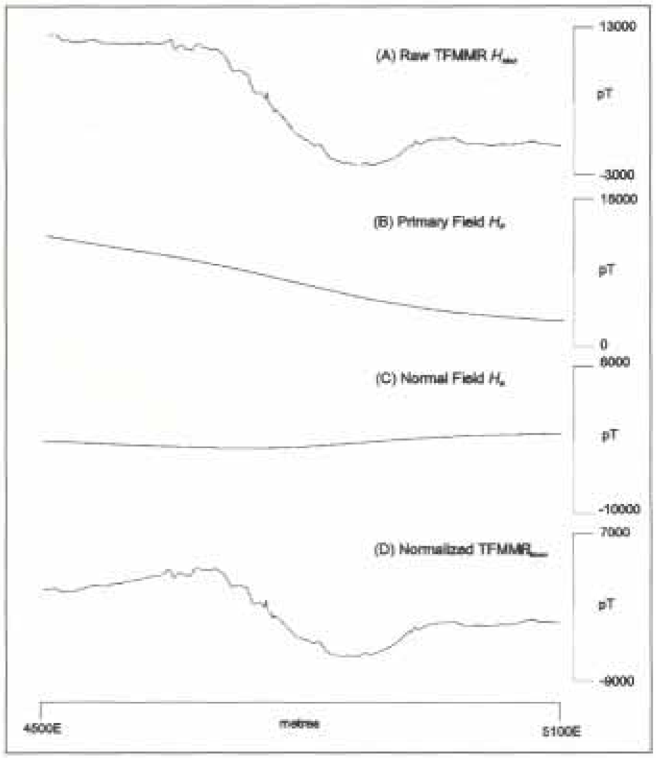


Figure 9. (A) Peak amplitude of the SAM modulation; (B) the calculated Primary field; (C) the calculated Normal field; and (D) the normalised MMR data.

The survey was conducted over a Copper-Gold prospect, identified from anomalous geochemistry. The HDM image shows a strike trend running west to north-west. Targeting a drilling program at such a geometry would prove expensive because, in fact, the magnetic picture related to the barren, near surface structure. The TFMMR data, on the other hand, reveal a dominant underlying north-south trending anomaly, interpreted as a shear. A review of the previous geochemical investigation showed that the results were more closely aligned with the TFMMR than the HDM data, and drilling the shear revealed the source of the mineralisation.

In this case, it is clear that the two data sets reflect completely different aspects of the same geology. The HDM data only confirmed what was already known about the near surface geology. The target of real interest lay beneath this. Reliance upon the HDM data alone could have led to misdirected drilling and, ultimately, relinquishment of the exploration licence. However, with the complementary evidence of an underlying structure, the jigsaw was complete, permitting exploration to be concluded efficiently and successfully.

Magnetics is now the most commonly used and valuable geophysical tool in mineral exploration. With cost-effective, high definition techniques now available, the industry's ongoing use of this method seems assured. However, the SAM experience has shown that an over-reliance upon single type data sets may lead to misleading or ambiguous interpretation results. Multiple data sets reflecting independent physical properties can significantly reduce the interpretational bias. SAM delivers such data sets simultaneously and in a cost-effective manner.

The SAM method also offers substantial increases in survey productivity. Figure 12 compares typical survey specifications for the SAM, electrical induced polarisation (EIP) and magnetic induced polarisation (MIP) methods, assuming these are conducted on foot. It highlights that

Survey Technology	Property Measured (m)	Sample Interval (Samples/km2)	Spatial Density (m x m)	Spatial Resolution Day)	Prod. Rate (Samples per
Sub-Audio	HDM	0.5 × 20	102000	1.0 × 40.0	30000
Magnetics	TFMMR	3.0 × 20	17000	6.0 × 40.0	5000
	TFMMIP	3.0 × 20	17000	6.0 × 40.0	5000
Induced	ER	25 × 100	440	50.0 × 200.0	84
Polarisation	IP	25 × 100	440	50.0 × 200.0	84
Magnetic	MMR	25 × 100	440	50.0 × 200.0	105
IP	MIP	25 × 100	440	50.0 × 200.0	105

Figure 12. Comparative survey specifications for the SAM, electrical induced polarisation and magnetic induced polarisation methods.

the continuous-sampling SAM system is capable of resistivity and IP production rates of 50 to 60 times that obtained for EIP or MIP surveys. In addition, SAM delivers HDM data at approximately 150 times the rate of production of the EIP and MIP methods.

Of course, the application of SAM is not limited to on-ground acquisition. Airborne acquisition will further increase survey productivity. The integration of the SAM technology into a helicopter platform is a key objective of the current SAM development program, as are the routine derivation of MIP data, and the use of a large loop EM source.

Recognising the value of this Australian development, the SAM method is the subject of international patents.

Environmental Site Assessment - *'Cleaning up the World's back yard'*

The clean-up of contaminated military and industrial sites represents an enormous and growing challenge for the governments of the world, spanning the full spectrum of public concern. The management and, if feasible, remediation of these sites reflects today's social, cultural and political imperatives to provide a safe and healthy environment for the future. It also represents the desire to again make use of this economically valuable land, while balancing all of these needs with sound fiscal management.

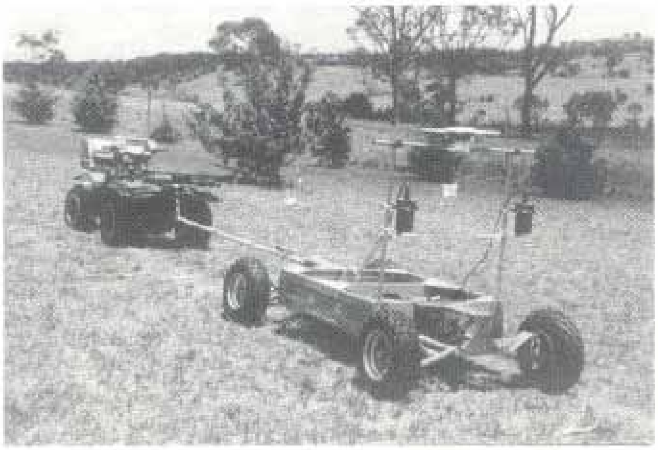


Figure 13. The dual-sensor, towed array TM-4 system developed for UXO and industrial contaminant mapping. This system features DGPS positioning and navigation, and compensation for orientation effects.

The scope of this challenge is only made greater by the paucity of data on the level and distribution of contamination on these sites. Even on managed defence and industrial sites, historical records of site usage are typically of insufficient quality to be solely relied upon with confidence.

In recent years, GRI has diversified its use of high definition geophysical techniques and instruments into new markets and new acquisition platforms. The TM-4 system has been enhanced for application in the Environmental Services market, particularly unexploded ordnance (UXO) detection. In fact, after a series of trials conducted for the US Department of Defence in June 1994, the TM-4 system was assessed to be the best available in the world for this application, based on its ability to detect, accurately position and characterise targets of interest. As a consequence, the enhancements necessary to resolve contaminants to the environment are now reflected in higher standards of resolution in geological mapping.

Quality Assurance in UXO Mapping

Traditionally, UXO detection work has been performed with analog instruments that produce an audio tone or display a deflection on a meter in response to perturbations in the magnetic field. The effective use of these instruments was wholly reliant upon the diligence and experience of the operator.

With the introduction of digital instrumentation to this market, customers were delivered a yard-stick by which they could measure search effectiveness and, hence, contractor performance. Over the past 10 years, GRI research and field work has led to the development of a detailed database on the magnetic properties of ferrous ordnance and a technology for the quantification of UXO search effectiveness.

Search effectiveness is defined in terms of the ordnance type and the depth to which that type can be detected with a nominated level of certainty. To do so, a detailed understanding of the variability of the magnetic properties of each ordnance type, both between individual items and with orientation of the items within the ground, is required. For example, Figure 14 contains a histogram of magnetic anomaly amplitudes of a sample of hand grenades at different orientations.

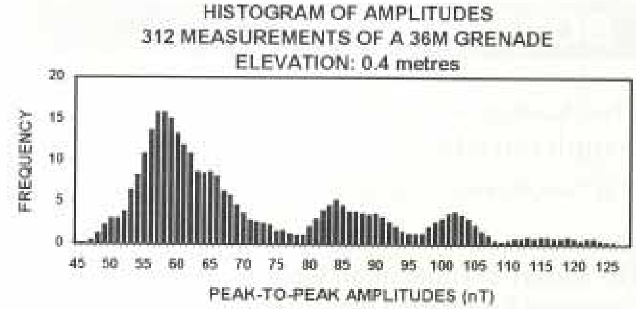


Figure 14. Histogram of magnetic anomaly amplitudes for a sample of hand grenades.

Search assurance levels are then determined on worst case data. For a given magnetic detector type, data acquisition specification and magnetic interference, the search effectiveness may be described by means of a graph of ordnance magnetic properties as a function of their depth below the detector. Figure 15 contains an example of such a graph.

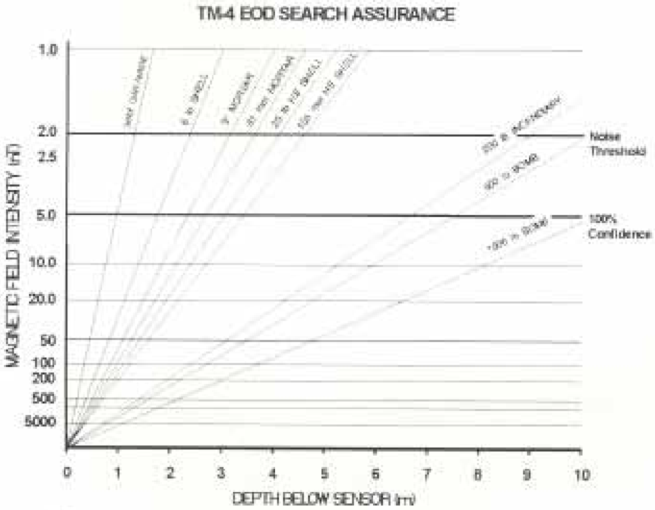


Figure 15. A graph plotting magnetic signal amplitude as a function of depth below the magnetic sensor for a range of UXO types.

The detection assurance technique provides a major benefit to site management authorities, as they are now able to assess the performance of contractors. The same technology that permits the mapping of ferrous contaminants can be employed following site remediation to assess the effectiveness of the clearance.

Site Assessment Technology

Assessments of site contamination have traditionally been based on a review of historical records combined with a series of expensive and time-consuming excavations over small areas within the site. Such excavations give an indication of the level and type of contamination within these small areas, but do not provide data which may be reliably extrapolated between the excavated areas. Hence, the data do not provide a base for the accurate planning and costing of site remediation. Traditionally, remediation contracts have been let on a cost plus basis, providing no incentive for the contractor to improve productivity. The financial risk was borne by the public purse.

GRI's new site assessment technology is reliant upon the same fundamental principles that permit detection assurance to be quantified. These same principles and data may be applied conversely to determine the detection diameter for a particular ordnance type as a function of its depth below the ground and the elevation of the detector above the ground. As the digital TM-4 magnetometer can acquire data at rapid survey speeds, a statistical sample of the number of ordnance items can be acquired over the whole site and used to quantify the distribution and type of contaminants over that area.

The site assessment methodology involves a number of phases.

1. A search of historical records of site usage provides a baseline for the subsequent geophysical investigation.

2. The second phase involves a full site reconnaissance. A TM-4 magnetometer is operated with its sensor at a known elevation above ground, recording data at regular sample intervals no greater than 25% of the sensor elevation.

   The separation between data lines will determine the degree of sampling. Using the measured noise envelope, a detailed knowledge of the magnetic properties of ordnance types and the known sensor elevation, the effective search width of the total field sensor may be predicted for any ordnance item of interest. Usually this will be calculated for the worst case situation involving the smallest item anticipated. For example, with a noise envelope of 1nT and a sensor elevation of 1 metre, a 50 metre data line separation will permit items down to hand-grenade size to be detected over an effective search diameter of 1.2 metres providing a 2.4 % sample of the area. For larger items, the predicted search diameter will be increased.

   At 50 metres line separation, nowhere in the area surveyed is farther than nominally 25 metres from real data ensuring that no target impact area will escape detection.

3. A pattern recognition algorithm then detects dipole and monopole sources within the recorded line data that exceed the determined noise envelope. Figure 16 contains two magnetic profiles; the first shows the low amplitude 'noise only' signature, while the second also contains a pattern of dipolar features characteristic of UXO contamination. Counting such occurrences per unit transect length and dividing by the appropriate search diameter calibration factor provides a measure of ferrous items per unit area.

4. Each signature type will be characterised by the conduct of a "calibration" survey. A small area of typically 0.25 hectares is mapped with a survey designed to detect all items present. These are then excavated and documented as for a clearance operation. This phase allows the characterisation of ordnance types and a ratio of live to inert items to be determined.

5. Finally, those areas where more severe contamination was detected or areas where demolition and waste burial are suspected, should be subjected to in-fill mapping. This may be achieved by reducing the data line spacing to, say, 10 metres. The percentage sample is then increased to at least 12%. With such a line spacing, the probability of missing a significant burial pit is manageable.

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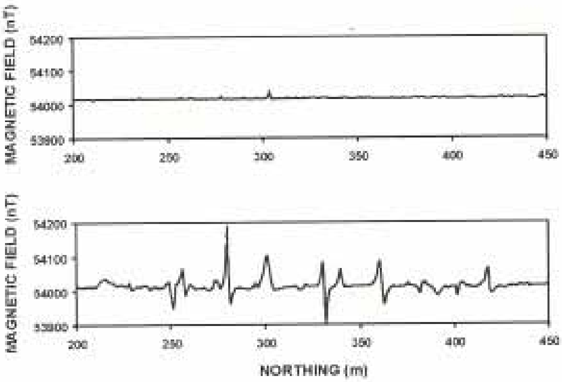

Figure 16. Two magnetic profiles, showing low amplitude, 'noise only' signature (A) and noise plus dipolar features characteristic of UXO (B).

Figures 17 and 18 give an example of the degree of certainty that can be gained through the use of this statistical technique when attempting to plan and cost site management or remediation.

Figure 17 shows a contour map of the ferrous items per hectare from a 10% sample. The total number of items of contamination determined from this sample was 4,950.

Figure 18 shows the results from a survey, in-filled to 1 metre line spacing. The total number of items of contamination determined from this 100% sample was 4,809.

From this data, the 10% sample can be seen to have been accurate to within 2% of the true contamination figure.

The site assessment technology and methodology described has provided a cost-effective solution to the problems associated with determining the extent and type of contamination on large military ranges.

Traditional site assessment methods are costly and time consuming. They do not provide sufficient detail to permit fixed cost tendering, define "clean" areas for early release or define the clearance assurance standard. While costs vary considerably with local conditions, the GRI assessment methodology delivers all of this information at around 10 percent of the cost of traditional methods.

Conclusion

The use of high definitional geophysical techniques offers great benefits to the user in terms of data quality and, consequently, the reduction in the life cycle cost of an exploration program. Born of the mineral exploration market, advances in high definition geophysics have seen its application expand into other sub-surface mapping markets, such as environmental remediation. In turn, developments for these applications have then allowed mineral exploration to benefit from the lessons learnt.

As contractors are held more accountable for the quality of their work in these new markets, will this trend too flow into the traditional exploration markets? The example of the complementary SAM data set discussed previously raises a related question - where will the accountability lie if exploration licences are relinquished and opportunities lost because the best available technologies and methods were not applied?

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12th Geophysical Conference and Exhibition

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This Conference will be the best ever - again!

It has almost become a tradition that each new ASEG Conference is bigger and better than all the preceding ones. The organising committee aims to maintain the tradition and is already bringing to bear the experience of the old hands and enthusiasm of the new-comers towards that end.

Contrary to our outgoing President's comment in an earlier issue of Preview, Roger Henderson did not chair the last Sydney Conference, but the one prior to that. However, as chairman this time he has been able to persuade many of the previous committee to serve again, showing that they have the same masochistic streak that Kathy referred to about Roger. The full committee is shown above and many of you will recognise the old hands who join me in welcoming the support of new-comers Peter Jackson, Katherine McKenna, Mark Russell, Simon Stewart and Mike Moore.

One of the innovative aspects of this conference is the co-hosting by SEG and PESA. SEG are assisting with the publicity of the conference in North America and at other conferences that they are co-hosting. PESA are supporting us with bodies on the committee and financially as well. They will bring a valuable petroleum component to both the technical sessions and the exhibition.

A great boost to our plans was given by some very welcome, early offers of sponsorship, especially by Western Geophysical as Principal Sponsor; Digicon, Silicon graphics, UTS and Schlumberger as major sponsors; and also by Tesla-10 Pty Ltd, Kevron Geophysics Pty Ltd and the NSW Geological Survey. (This is the situation as at the end of March).

The number and quality of abstracts so far received is very heartening and we are assured of a very impressive technical program. We plan to have this program, at least in outline form, publicised in our second announcement in May.

Invitations to exhibitors are being mailed and we are confident that this exhibition will be the biggest and most innovative held so far. A request for expressions of interest in exhibiting, made at the Adelaide Conference, yielded over thirty companies saying they would definitely exhibit and hence we are confident that all 130 booth spaces will be fully occupied. In addition to the standard booths, we are also offering open space for companies to arrange novel and individual displays if they wish. Don't be surprised if you see a full sized helicopter or seismic truck in the midst of the booths.

As part of our publicity we are ensuring that flyers are inserted in the satchels of forthcoming conferences such as the SEG sponsored conference in Jakarta on April 27 and we will also be publicising the conference heavily at the European Geophysical Association Meeting and very strongly at the next SEG Meeting in November.

Roger Henderson
Co Chairman

JAKARTA 96

Report by John Jackson

The Jakarta '96 International Geophysical Conference and Exposition was held in Jakarta from April 27 to May 2, 1996 at the Jakarta Convention Centre. The conference was jointly organised by the Indonesian Association of Geophysicists (HAGI) and the Society of Exploration Geophysicists (SEG). The Australian Society of Exploration Geophysicists (ASEG) and the European Association of Geoscientists and Engineers (EAGE) were co-sponsors. In all some 726 delegates registered for the conference, the great majority of whom were associated with oil and gas exploration followed by geothermal and mineral exploration.

The conference commenced with workshops on 'A Practical Approach to Seismic Imaging of Complex Geology' led by Mathew Brzostowski; and 'Planning and Operating a Land 3D Seismic Survey' led by John Pierce and Andreas Cordsen.

The opening speeches were delivered by representatives of all the sponsoring organisations with the President of HAGI, Pertangkuhen Manik, indicating that HAGI's aim is to hold a conference focussing on Indonesia and South Asia every two to three years. The President of the SEG, Gordon Greve, suggested that the quality of seismic data was largely ignored or implied in the interpretation of that data. This was especially so in the case of 3D seismic surveys and applies to all types of geophysical data. Norm Uren, as the ASEG representative, eloquently addressed the conference on behalf of President Kathy Hill.

The keynote speeches were held after the opening of the conference. Mr. Faisal Abda'oe, the President Director of Pertamina, spoke about Indonesia's outlook on energy demand which has a growth rate of 3-4% pa and, in particular, the impact of this demand on the petroleum business. William French, from the SEG, discussed the correlation of exploration expenditure with petroleum based commodity prices. Worldwide, exploration expenditure correlates very well with the oil price but the correlation does not hold on a regional basis. Dr. Hadi Soesastro, from the Centre for Strategic and International Studies, discussed the economic outlook for countries in South East Asia.

The Technical Sessions had some very interesting papers covering a wide range of topics, with three parallel sessions running for three days. Session topics included Petroleum Seismic, Technology and Business, AVO & Inversion, Wave Theory, Seismic Acquisition, Minerals & Mining, Geodetics, Magnetics, Electric and Near Surface, Geothermal and Case Histories. An Extended Abstracts volume has been published.

The Exposition was well attended with over 100 companies displaying their wares. All facets of the industry were represented including petroleum, minerals, geodetics, universities and professional organisations. Schlumberger Geoquest was one of the most popular exhibitors, and that may have had something to do with the endless supply of soft-serve ice-creams.

On the social side the conference opened with the traditional 'Ice Breaker Reception'. There was a cultural night on Wednesday with the conference dinner and an East meets West choral spectacular. The performance was based on traditional songs of the regional areas of Indonesia crossed with modern Western musicals in the style of Andrew Lloyd Webber.

OBITUARY

Dr. William Joseph (Bill) Stuart (1939-1996)

By staff and students of NCPGG

Bill Stuart was the Director of the National Centre for Petroleum Geology and Geophysics (NCPGG) at the University of Adelaide from 1986 until his death on April 16, 1996. He was also Program Manager for the Basin Analysis program within the Australian Petroleum Cooperative Research Centre (APCRC).

Bill died of cancer at his home in Adelaide, surrounded by his family.

He gained his Bachelor of Science (1962) and Master of Science (1963) from the University of Wyoming, followed by a Doctorate of Philosophy (1970) from the University of Adelaide. During the studies for his doctorate in 1963/64, he was a Fulbright Scholar.

In 1969, Bill accepted a position with Geosurveys of Australia and gained experience in petroleum exploration in Australia, New Zealand and Turkey. In 1973, he moved to Delhi International Oil Corporation, based in Adelaide. There he was responsible for a major study on the genesis of Permian sandstone reservoirs in the Cooper Basin. This study was one of the earliest attempts to arrive at a genetic definition of rock units and to establish a rock framework for this important petroleum province. It is significant that the terminology established by Bill is still in use today.

In 1975, Bill joined Mobil corporation and explored for eight years in Libya and Nigeria where he participated in several large discoveries, including 1.3 billion barrels of recoverable oil in the Edop and Asasa fields in Nigeria. In 1982 he moved to Corporate Headquarters in New York, co-ordinating Far East and African Exploration activities. Later, in Dallas, he supervised regional geological studies and managed teams assessing the hydrocarbon potential of foreign acreage offerings.

In 1986, Bill was appointed the Foundation Director of the NCPGG. He was instrumental in formulating a multidisciplinary petroleum curriculum with support from industry and academia. As a result, the NCPGG training program has an excellent reputation for producing well trained graduates able to contribute without extensive further training to the exploration effort, or to pursue further studies.

Another important achievement was the inclusion of the NCPGG in the Australian Petroleum Cooperative Research Centre, which has expanded and strengthened the Centre's research capacity. During Bill's period as director, researchers under his supervision carried out significant basin analysis projects, including studies on the diagenesis of reservoirs in the Cooper Basin and the structure and stratigraphy of the Barrow Sub-Basin.

Bill was a member of the American Association of Petroleum Geologists, the Society of Economic Palaeontologists and Mineralogists, the Geological Society of America, the Australian Society of Exploration Geophysicists, the Society of Professional Well Log Analysts and the Petroleum Exploration Society of Australia.

Bill was keenly aware of the importance of geophysics to the exploration effort, and was responsible for obtaining funding for much of the computing equipment at the NCPGG. He also initiated and fostered relationships with a number of software vendors, enabling Centre students and staff to have access to modern interpretation software.

With Bill's premature death the petroleum industry has lost a distinguished explorationist, researcher and educator, but his influence will continue to be felt for many years in the work of the many graduates of the NCPGG who are now employed throughout the industry, both in Australia and overseas.

Bill touched the personal and professional lives of his students, colleagues and friends. He will be greatly missed. He is survived by his wife Philippa, his sons Joseph and Lachlan, daughter-in-law Lisa and a granddaughter Emily.

The SEG Reginald Fessenden Award

Derecke Palmer Wins for Australia

The award, originally called the SEG Medal Award at its inception in 1961, was renamed in 1977 to recognise Reginald Fessenden for his role as the originator of the concept of reflection and refraction surveying in 1917. It is awarded to a person who has made a specific technical contribution to exploration geophysics, such as an invention or a theoretical or conceptual advancement, which, in the opinion of the Honours and Awards Committee, merits special recognition.

Award Presentation

At the 65th Annual Meeting of the SEG in Houston Texas, in October 1995, Derecke Palmer was presented with the Reginald Fessenden Award at the Presidential Session, which opens each annual meeting. It is a great honour for Derecke (and Australia) to be recognised by the leading international professional society for exploration geophysicists; he is the first Australian to receive the award, and in his own words it is 'a high point in my professional career'. The citation on the plaque reads ***"For the development of the generalised reciprocal method, one of the most significant innovations in refraction seismology in more than fifty years and the cornerstone of many statics methods so critically important in the processing of land seismic data."***

Derecke Palmer receives the SEG Reginald Fessenden Award from Jamie Robertson, president of the SEG.

Acknowledgements by Derecke Palmer

The development of the GRM (Generalised Reciprocal Method) would not have been possible without the appropriate professional environment or the support and encouragement of my past supervisors at the NSW Geological Survey, namely John Ringis, Adelmo Agostini, Steve Webster and Ted Tyne. The combination of industry involvement as either a client or a collaborator, together with the opportunity or a brief for research, has been a common factor in many successful Australian exploration geophysical advancements such as SIROTEM and the work of John Stanley's group at GRI (Geophysical Research Institute). I only hope that current and future economic imperatives do not destroy such environments which have been so productive for applied geophysical research in this country.

I owe very special thanks to the late Manus Foster who, as editor of Geophysics, facilitated the original SEG monograph on the GRM, and to Joe Odins, who served as a refractory mentor in my tyro days. I am also indebted to Jamie McIntyre, Peter Hatherly and Ross Spencer for the development of the original GRM software. Much of this software was later recycled in various forms in the GREMIX package of Charles Stoyer of Interprex and in the various statics packages which Charles Diggins wrote for Western Geophysical, and Green Mountain Geophysics. However, the first commercially available software was GREMLIN by Robert Lankston, who did much to establish GRM internationally. Last but not least, let me thank Bruce Goleby and Dennis Sweeney for their nomination, and the many others who supported them.

Much still remains to be done to modernise refraction methods, including 3D methods and full trace processing. I am continuing my research with a long overdue PhD at the University of New South Wales, and I look forward to the day when refraction methods will again be a viable tool for deeper targets in petroleum and mineral exploration.

GEOMAP 2005 - AIRDATA: Queensland Airborne Geophysical Survey Update

AIRDATA is a two year initiative to collect airborne magnetic and radiometric data over central coastal Queensland as part of the Geomap 2005 Project (see Preview, October 1995, pp. 21-24). Stage 1 - AIRDATA 94/95 - has been completed and the data are available as indicated below.

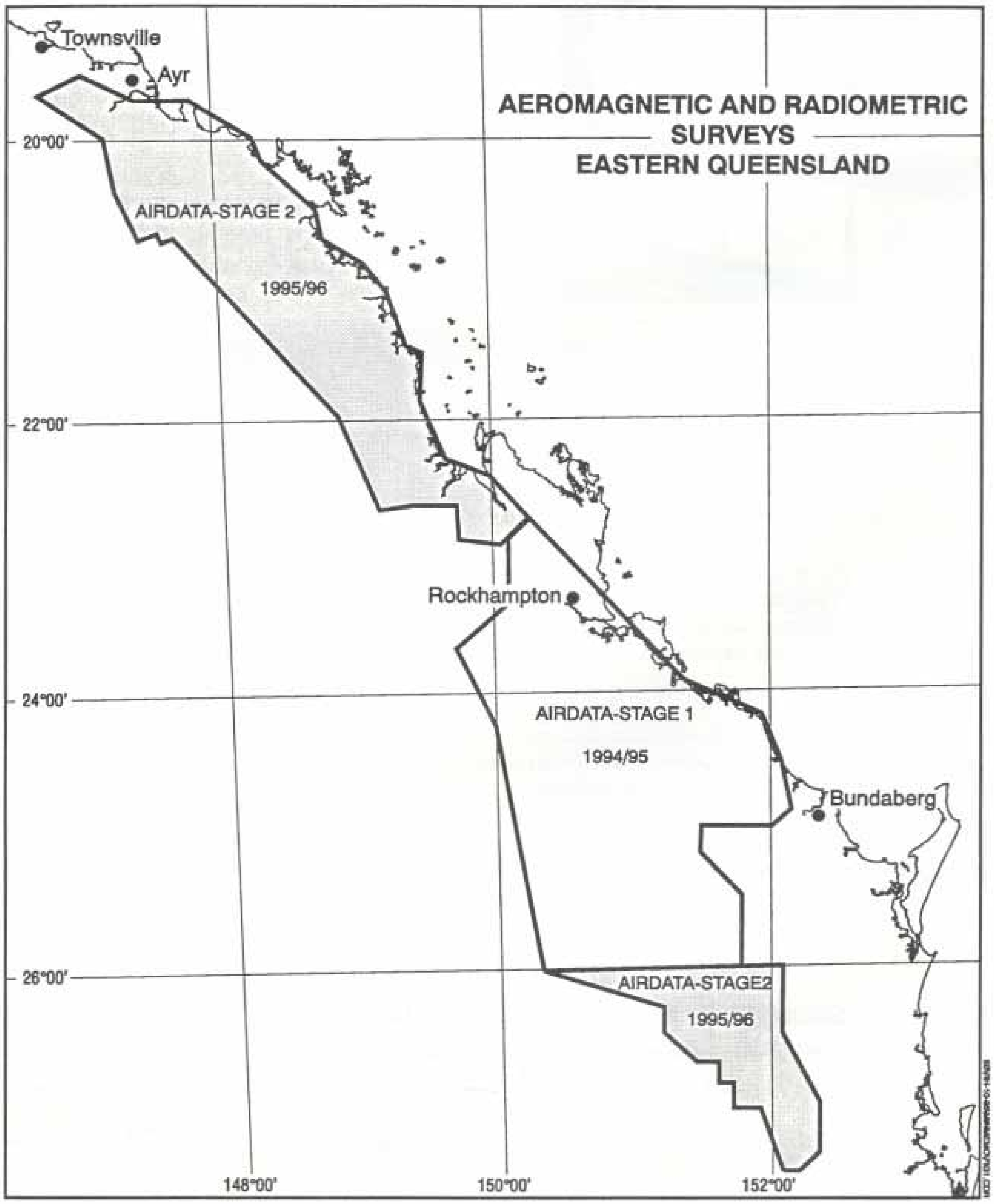
Stage 2 - AIRDATA 95/96 - extends coverage north and south as shown on the map. Stage 2 flying has now been completed and data will be available following quality checks. The data for the southern area should be on sale in June 1996, while that for the northern area should be released by September 1996. These data may be previewed by arrangement with QDME in Brisbane.

PRICE SCHEDULE

AIRDATA 94/95	144 000 Line km.........$14 400
AIRDATA 95/96 north	105 000 line km..........$10 500
AIRDATA 95/96 south	33 000 line km.............$33 00
AIRDATA 94/95,95/96	by 1:250 000 sheet.........$4620
	by 1:100 000 sheet...........$770

CONTACT

Richie Huber
Department of Mines and Energy
GPO Box 194
BRISBANE Qld 4001



Membership

New Members

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

Victoria

Michael SANDERS
PO Box 7435
479 St. Kilda Road
Melbourne VIC 3004

Richard MACRAE
S. Grandview Grove
Frankston VIC 3199

Carol GRGIC
1 Kennedy Avenue
Narre Warren North VIC 3804

Western Australia

Andrea WIEMAN
8 Lloyd Street
Cannington WA 6107

Grant COUSTON
15 Marybrook Road
Heathridge WA 6027

South Australia

Megan SMITH
17 Grevillea Avenue
Athelstone SA 5076

Kylie SHERWIN
12 Edwin Avenue
Collinswood SA 5081
New South Wales

Karl OCKENS
15 Cavendish street
Pennant Hills NSW 2120

Mark BAIGENT
PO Box 9
Avoca Beach NSW 2251

Marcello AIELLO
8/120 Roscoe Street
Bondi Beach NSW 2026

Tasmania

Nicholas DIREEN
c/- University of Tasmania
GPO Box 252C
Hobart TAS 7001

International

Laurent NEYROUD
C/- RTZ Mining and Exploration Ltd.
Calle Manco Capac 551
Miraflores - Lima 18
PERU

Mark GUEST
PO Box 1117
Groenkloof 0027
SOUTH AFRICA

Change of Address

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

Queensland

Andrew McMAHON
From: 3/69 Sandford Street
St. Lucia QLD 4067
To: 7/37 Alexandra Avenue
Taringa QLD 4067

Andrew Mutton
From: Principal Geophysicist
CRA Exploration
2 Kilroe Street
Milton QLD 4064
To: Principal Consultant
Geophysics
Minenco Pty Limited
400 Boundary Street
Spring Hill QLD 4000

Bruce HARRIS
From: WMC - Exploration Division
PO Box 88
Garbutt QLD 4814
To: WMC - Exploration Division
PO Box 7088
Garbutt QLD 4814

Nigel FISHER
From: Digicon Geophysical Ltd
PO Box 984
Kenmore QLD 4069
To: 19 Sophia Street
Kenmore QLD 4069

VELSEIS MANAGER
From: Velseis Pty Ltd
PO Box 118
Darra QLD 4076
To: PO Box 118
Sumner Park QLD 4074

Victoria

Konrad SCHMIDT
From: 353 Corrigan Road
Noble Park VIC 3174
To: 111/23 Queen's Road
Melbourne VIC 3004

Justin WARD
From: Flat 4, 271 Balaclava Road
N Caulfield VIC 3161
To: 5 Beech Street
Camberwell VIC 3124

New South Wales

Wes JAMIESON
From: Parker & Parsley Australasia Ltd
PO Box R98
Royal Exchange NSW 2000
To: 60 Stone Parade
Davidson NSW 2085

Ilie MIHUT
From: Australian Defence Industries
17/121 Burns Bay Road
Lane Cove NSW 2066
To: ADI Limited, Technology Group, Ground Floor,
77 Parramatta Road
Silverwater NSW 2141

Tibor SCHWARTZ
From: Geophysical Research Institute
University of New England
Armidale NSW 2351
To: PO Box U123
University of New England
Armidale NSW 2351

James KEMMIS
From: Unit 5, 8 Moore Street
Bondi NSW 2026
To: Unit 18, 211 Old S. H. Road
Bondi NSW 2026

Nigel JONES
From: PO Box A1195
Sydney NSW 2000
To: 40 Calbina Road
Northbridge NSW 2063

Susanna SCARANO
From: Parker & Parsley
L28 Gateway Bldg
1 Macquarie Place
Sydney NSW 2000
To: 22 Tunks Street
Ryde NSW 2112

Western Australia

John Thoman
From: 125 Ensman Street
South Perth WA 6151
To: 5 Regent Way
Mt. Pleasant WA 6153

Paul McMillan
From: 25/9 Brentham Street
Leederville WA 6007
To: 17 Duke Street
Bentley WA 6102

Jayson MEYERS
From: Box 414 - Geology
Uni - NCD
PAPUA NEW GUINEA
To: 29 Korella Street
Mullaloo WA 6027

Darryl HARRIS
From: Woodside Offshore Petroleum (NSWA)
1 Adelaide Terrace
Perth WA 6000
To: C/- Woodside Offshore Petroleum
1 Adelaide Terrace
Perth WA 6000

David TRIGGS
From: 23 Marbray Drive
Glen Waverley VIC 3150
To: 29 Sixth Avenue
Kensington WA 6151

Russell MITCHELL
From: 48 Regency Drive
Thornlie WA 6108
To: 50 Darley Circle
Bull Creek WA 6149

Ed REEVES
From: 51 O'Connell Way
High Wycombe WA 6057
To: C/- Tesla-10 Pty Ltd
41 Kishorn Road
Applecross WA 6153

ASHTON MINING
From: PO Box 962
West Perth WA 6005
To: PO Box 1068
Cloverdale WA 6105

Daniel SATTEL
From: Earth Sciences
Macquarie University
NSW 2109
To: C/- World Geoscience Corporation
Locked Bag 6
Wembley WA 6014
E-mail:
daniels@perth.wgc.com.au

South Australia

Iestyn BROOMFIELD
From: 57 Edward Street
Magill SA 5072
To: 551 Greenhill Road
Burnside SA 5066

David McINNES
From: Western Mining Corporation
P.O. Kambalda
Kambalda WA 6442
To: CRA Exploration
P.O. Box 254
Kent Town SA 5071

International

George REYNOLDS
From: GEORHO LTD
87 Ryevale Lawns
Leixlip Co Kildare
IRELAND
To: C.S.A. Geophysical Services
Parkview House
Beech Hill Clonskreagh
Dublin 4 IRELAND

Denis REY
From: GATRO GABON
Gencor Group
BP 9773
Libreville Gabon
REPUBLIC OF SOUTH AFRICA
To: GENCOR Limited - Mineral Resources - African Exploration Dept.
PO Box 61820 - 2107
Marshalltown
Johannesburg
REPUBLIC OF SOUTH AFRICA

V. R. VIJAYAN
From: #8 Scrivenor Road
off Sultan Azlan Shah Road
Perak, IPOH 31400
MALAYSIA
To: PO Box 3372
University of Mississippi
University MS 38677
USA

Stefan WANSTEDT
From: Lulea University of Technology
Department of Mining
S-951 87
Lulea, SWEDEN
To: Geosigma AB
Box 894
S-751 08 Uppsala
SWEDEN

James SMETHURST
From: Shell Albania GM
C/- SIPC (ODLC/3)
Shell Centre
London SE1 7NA
England GB
To: C/- Herald International Mailings Ltd
PO Box 10235
London SW19 3ZN
England GB

Where are they?

Does anyone know the new address for the following members?

Geoffrey HINES
Digicon Geophysical Limited
PO Box 984
Kenmore QLD 4069

Gela ARUAI
7/37 George Street
Marrickville NSW 2204

Iain DISON
BPB Wireline Services
PO Box 5465
Brendale QLD 4500

Tully RICHARDS
1/284 Anson Street
Orange NSW 2800

Boyd KOLOZS
Western Geophysical
447-449 Belmont Avenue
Kewdale WA 6105

Anastasia BOYLSON
37 Crase Street
Teneriffe QLD 4005

Roland HILL
C/- Newcrest Mining Ltd
179 Great Eastern Highway
Belmont WA 6104

Eduardo ESCANERO
Macquarie University
School of Earth Sciences
North Ryde NSW 2109

Stephen MASSEY
9 Love Street
Myaree WA 6154

Daniel MORRIS
7 Papaya Street
Mt Cotton QLD 4165

Resignations

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

Wayne THIELE
27 Johnstone Road
Oaklands SA 5046
Stuart HARPER
C/- Wardroom
HMAS Albatross
Nowra NSW 2541

Jane JOHNSTON
MIM Petroleum
PO Box 138
Lutwyche NSW 4030

Sunhee LEE
CSIRO Division of
Atmospheric Research
Private Bag 1
Mordialloc VIC 3195
AUSTRALIA

Calendar of Events

July 23-27 1996
Western Pacific Geophysics Meeting of the American geophysical Union Brisbane
For further details:
Mike McElhinny
Gondwana Consultants
PO Box 5 Hat Head NSW 2440
Tel: (065) 65 7604
Fax: (065) 65 7604

Sept 30 - Oct 3 1996
6th Int'l Conference on Ground Penetration Radar Aoba Memorial Hall, Tohoku University, Sendai, Japan
For further details:
Dr. Motoyuki Sato
GPR '96 Technical Chairman
Dept of Resources Engineering
Faculty of Engineering
Tohoku University
Sendai 980-77, Japan
Tel: +81-22-222 1800 ext 4548
Fax: +81-22-222-2144
eml: GPR96@earth.tohuku.ac.jp

November 10-15 1996
SEG Annual Meeting
Denver, USA (see advert p)
For further details:
SEG, Tulsa USA
Fax: 0011-1-918-493 2074

November 27-29 1996
Nickel 96, Mineral to Market, Kalgoorlie WA
Sponsored by AusIMM, AIG and WASM
For further details:
G. Drew, C/- CRAE Pty Ltd
21 Wynyard Street
Belmont WA 6104

February 23-27 1997
12th ASEG Conference & Exhibition
Sydney Convention & Exhibition Centre, Australia
For further details:
ASEG Conference Secretariat
Conference Action Pty Ltd
PO Box 1231
North Sydney NSW 2059
Australia
Tel: =61-2-9956 8333
Fax: +61-2-9956 5154
email: GEOINS1@IBM.NET

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

September 14-18 1997
Exploration '97 4th Decennial International Conference on Mineral Exploration
Toronto Canada
For further details:
CAMESE
101-345 Renfrew Drive
Markham Ontario Canada
L3R 9S9
Tel: 0011-1-905 513 0046
Fax: 0011-1-905-513 1834
Email: 103214.545@comp-serve.com

ASEG 1995 WINE *RE-OFFER*

Due to a mix-up with ASEG-labelled stock, members who ordered the St Hallett Poachers Blend last year received the winery's regular labelling. As a consequence the winery now has a stock of the Wine with our ASEG label. So there is a unique opportunity for members to order more of this wine at the same price, despite rises in the retail price.
St Hallett will supply wine from this order form until ASEG-labelled stock is gone.

St Hallett

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1995

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Delivery will be to address you supply above.

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c/- Will Adkins
St Hallett Winery
P.O.BOX 120
TANUNDA, SA 5352

Phone 085 63 2319
Facs 085 63 2901