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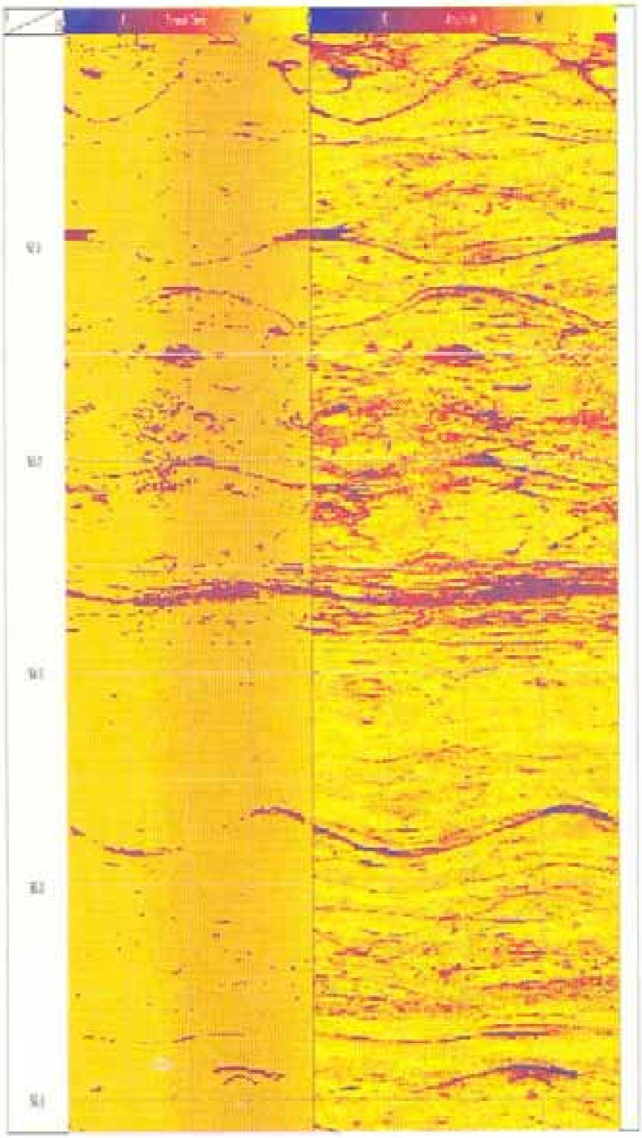
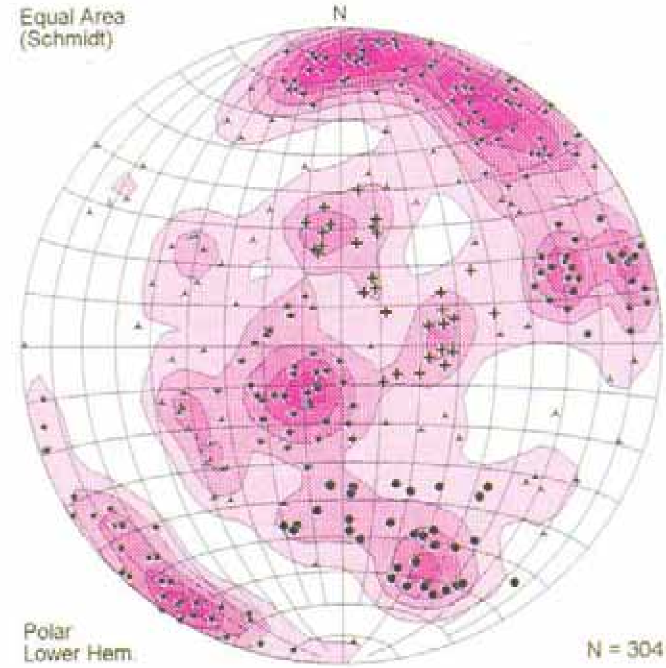
Special Feature:





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Editor's Desk

Conference

The 12th ASEG Conference and Exhibition is over and will, no doubt, be judged a great success. I trust that it was enjoyed by all delegates and that the membership at large will benefit from the dissemination of papers and abstracts through *Exploration Geophysics* and *Preview*. There should also be a trickle down effect as delegates return to their home bases with their own reports and new ideas on the most cost effective ways of applying geophysics.

New Era

Preview now enters a new era with much more responsibility being taken for the publication by our printers, Jenkin Buxton Printers Pty Ltd. Advertising becomes their responsibility and routine contributions will be sent directly to them, but your editor will continue to oversee the final production. The job of attracting feature and other technical articles remains with your editor so please keep them rolling in. The reduced routine workload should give your editor more time to explore new sources of interesting geophysical material so, hopefully, you may expect a broadening of the information base.

I would like to thank all of our advertisers and contributors over the past year for their efforts in keeping the magazine both useful and interesting to the membership. Unfortunately, commercial reality dictates that advertising prices must rise, although they will still be at the low end of market range. We hope for your continuing support as we forge ahead into the new era.

Membership

We missed the membership column last issue because of the conference so there has been a big backlog to catch up, both in new membership and changes of address. It is pleasing to see the number of new members now supporting our society.

A few errors are now emerging from the Membership list published last year. If you have not already done so please check your details and let us know if there are any more problems. The database and methods of interrogation and presentation will be reviewed thoroughly this year so timely advice from members on mistakes and perceived problems is very important.

Letters to the Editor

Steve Mudge, with his inimitable style in 'Excitations', has provoked letters in this issue with the promise of more in the next. We welcome letters on all subjects so don't neglect to have your say.

Mike Shalley, Editor

President's Piece

Bigger, Brighter, Better

The 12th ASEG Geophysical Conference and Exhibition continues a history of successful professionally run conferences. In my conversations with delegates and exhibitors, I was universally congratulated on its success. After allowing myself to bask in the reflected glory, I had to admit my and the society's, indebtedness to Roger Henderson and Wes Jamieson's committee. Well done guys.

I know in Brisbane in 1992 we were fairly daunted by having to follow the previous Sydney conference but I believe we were able to come up with something fresh and I have every confidence that Mike Asten and Craig Dempsey will also produce a great conference for us in 1998.

John McDonald of the West Australian branch caused quite a stir at the Council meeting with his bullish attitude towards the ASEG's future. He made the suggestion that the ASEG should move towards an annual conference, finding a permanent slot in the crowded calendar of worldwide geophysical conferences. John received a fairly cool reception to this suggestion and several people approached me later with misgivings. The continued growth of our conferences suggests that the current formula is not failing to attract people but what else of his suggestion.

What are the main objections. Our conferences takes at least two years to plan and annual conferences would lead to overlapping Conference Organising Committees (COC), shortage of papers, burnt out editors and referees.

Certainly if we continue with our current COC structure these arguments are valid. We would need to rethink our strategy. APPEA manage to run annual conferences very successfully. The key difference here is the bevy of full time staff at APPEA.

The ASEG is not about to have full time staff but annual conferences will require a permanent/long term Professional Conference Organiser (PCO) on top of a permanent secretariat.

The reuse of the PCO from conference to conference offers much more than our current Conference Guidelines can. Many COC final reports contain recommendations that have previously been suggested. I know in my own case I didn't fully understand the guidelines until after the conference. Thus the PCO can retain the knowledge and save the local COC from reinventing the wheel. Another advantage that I see is a more consistent approach to sponsorship and in particular the packages offered to our largest sponsors. Currently this is at the discretion of the local COC.

I am not convinced that we should avoid out of state PCO's because of the increased associated costs. We think nothing of sending data to Singapore for processing if that gives us the best result. All PCO's are not the same. The ASEG is way beyond using the cheapest PCO available. In fact we don't even ask them to tender.

Does an annual conference need to be as big as a sesquiannual one? Initially perhaps not but we appear to be heading for bigger brighter and better times (touch wood) and the conferences could grow to match this. Smaller conferences offer the opportunity to have a more strict thematic flavour.

There is a concern that our conferences, indeed our society, is mainly for the hard rock people. This represents a challenge for the petroleum members. The exhibition has a strong petroleum profile and certainly our largest sponsors have come from that sector. We owe it to them to improve the petroleum profile but definitely not at the expense of the mineral sector.

One idea that I saw at the SEG convention was the use of some of the best presentations from the AAPG convention . In Australia the PESA Journal is published once annually and some 8 to 10 refereed papers are published. We should consider inviting these authors to give a presentation at our conference. It is often the case that they may not otherwise get presented. With a PESA theme day we could also attract petroleum geologists who are blissfully unaware of what an ASEG conference has to offer them.

It was a great honour for me to present the awards to Don Emerson, Bob Smith and David Boyd in Sydney. These last two gentlemen were lecturers when I was studying at the University of Adelaide in 1976 and thus I can truly say they led me to my current career. I got a note from Peter Brooker, my course coordinator, to the effect that Bob was disappointed with my exam results (so was I) but he would be prepared to offer me a reference. I wasn't smart enough in those days to take up the offer but I kept the note just in case...

Henk van Paridon
ASEG President

Preview - Forthcoming Issues

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

Unipulse – History of Geophysics at the University of Tasmania

Excitations – Forces, Responses and Methodologies: Some Fundamental Concepts in Geophysics.

Geophysics and Black Shale – an Historical Perspective

Executive Brief

Sydney Conference

Congratulations to the Sydney COC for a very successful conference. Already, preliminary figures show a substantial profit to the society due to industry support and the strong attendance. I managed to make it to Sydney for one day and spent all my time milling around the booths. The exhibition area was well set up and all I spoke to agreed that Darling Harbour was an excellent venue.

Membership

Several new members joined our society during the Sydney conference, in particular overseas geophysicists. Our thanks go to Janine Cross, ASEG Secretariat, who "manned" the ASEG booth at the conference and took new memberships and general enquiries. All this in the week before her wedding!

Preview

Mike Shalley is retiring from the *Preview* editorship this month to pursue a rural lifestyle in Western Queensland. However, he hopes to maintain some links with the magazine as time permits. On behalf of he Federal Executive I'd like to thank Mike for his tireless work in producing an excellent publication and wish him all the best in the bush.

Financial Report

An approximate summary of the current status of the society's bank account is as follows:

Cheque Account balance (approx)	$32 000
Cash Management Account balance	$75 631
Term Deposit (CBA commercial bill)	$150 415
Cash Management (Sands) Account balance	$8 296
Term Deposit (Sands) Balance	$40 000
Net Cash (approx)	$306 300

The Federal Executive discussed ways in which the growing society funds may be used to benefit members. One suggestion was to award the Best Paper Winner at our conferences a trip to the next SEG conference to present the paper. This may encourage more and better papers for our conferences and promote the quality of the ASEG to SEG members. Similarly, a selection of "distinguished papers" may be chosen and presenters sponsored to tour the state branch meetings to give their papers. Other ideas included elecrtonic journals and distinguished lecture tours. Any ideas from the membership will be welcomed and discussed at future meetings.

Robyn Scott
Honorary Secretary

Calendar Clips

June 1-6 1997
CSPG-SEPM Convention, Calgary, Alberta, Canada

July 7-10 1997
Istanbul '97International Conference and Exposition Istanbul, Turkey. Sponsored by SEG, Chmb. of Geoph. Engineers of Turkey and EAGE

September 4-5 1997
Funafuti to Mururoa
Stability or Chaos in Coral Reef Research - A Symposium Sydney NSW Australia

September 14-18 1997
Exploration '97 4th Decennial Conference on Mineral Exploration. Toronto Canada

Sept. 28 - Oct. 2 1997
The Fifth International Congress of the Brazilian Geophysical Society (Call for Papers). Sao Paulo Brazil

November 2-7 1997
SEG 67th International Exposition and Annual Meeting. Dallas, Texas, USA.

November 8-11 1998
Australian Society of Exploration Geophysicists 13th International Conference and Exhibition. Hobart Tasmania Australia

Details and more events on Page 39

Preview Deadlines - 1997

June	**May 15**
August	**July 15**
October	**September 15**
December	**November 15**

ASEG Branch News

Western Australia

The Annual General Meeting of the WA Branch of the ASEG was held at the Celtic Club on 11th December 1996. Approximately 30 members were present.

President Graham Elliott reviewed the past year's meetings and noted that, among the speakers' topics, Case Histories clearly drew the largest audiences. The new committee and office bearers were elected (see below) following which Graham presented engraved Swiss Army knives as prizes to Curtin University students for the following:

Best Presentation Award:	Christopher Bishop
Best Technical Content Award:	Paul Mutton
Leonardo Award:	Simon Kawangle

1997 Office Bearers and Committee Members

The following office bearers and committee members have been elected for 1997 by the Western Australian branch.

Office Bearers:

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Graham Elliott
Vice President
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Bob Groves
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Andrew Foley
Treasurer
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8 Kings Park Road,
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Committee Members:

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Andre Lebel,
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Mahogany Creek, WA 6072
Tel: (09) 298 8348
Fax: (09) 298 8348

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World Geoscience Corporation,
Locked Bag 6,
Wembley, WA 6014
Tel: (09) 273 6400
Fax: (09) 383 7166

Technical News

In March, two speakers were scheduled.

1. Terry Higgins, from ROBERTSON RESEARCH Australia Pty Ltd, presents a distillation of thirty years in the Oil & Gas industry with

   Much Ado about A.V.O. – a Midsummer-Night's Nightmare

2. Jayson Meyers, Senior Geophysicist & Geologist from ASTRO MINING N.L., with a slide presentation of

   Tectonophysics of Lihir Island & its Siblings, Papua New Guinea

... the month of May offers to us petroleum speakers Matthew Lamont and also Adam Craig, of WMC Resources, with a slide presentation of his APEA paper on the East Spar Gas Field.

Interstate visitors are welcome to the WA branches Technical Meetings. They are convened on the third Wednesday of each month at the Celtic Club, 48 Ord Street, West Perth. Come and socialise at 6 pm, for a start at 6.30 pm.

People News

The location for a Radiometric Calibration Range has been selected near Carnamah but efforts to formally investigate the site and calibration methodology have stalled due to lack of support.

ASEG members, David Abbott and David Howard, are planning the joint ASEG and PESA Corporate Golf Day to be held at The Vines on the first Friday in December.

P. Robert GROVES
Branch Secretary

Queensland

The Christmas function held in December at the Gazebo Hotel was well attended, and as usual an excellent time was had by all. Special thanks go to Kim Chatfield, our ex-Treasurer, who organised the Christmas function. Kim has since decided to leave the sunshine state to pursue a career in Perth. On behalf of the local Branch I would like to thank Kim for her efforts as treasurer over the last year. I would also like to thank the following companies who sponsored the Christmas Function:

Digicon Geophysical
Oil Company of Australia
Schlumberger Geco-Prakla
Schlumberger Geoquest
Velocity Data
Velseis

Due to the holiday season and the Sydney Conference, only one technical meeting has been held to date in 1997. Noll Moriarty from Oil Company of Australia presented the "Nunga Mia-1 Story", an interesting case history demonstrating the benefits of non-seismic geophysical methods in fast-tracking oil exploration in sparsely explored areas.

The local Branch has scheduled an AGM for Wednesday 2nd April 1997. Nomination for positions on the local Branch committee are being sought prior to this date. President Gary Fallon and Secretary Andrew Davids have indicated willingness to stand again for these roles, but the role of Treasurer is vacant, and general committee positins would be welcomed.

It is intended to distribute Branch notices by e-mail as much as possible. For those members who have an e-mail address and have not yet received notices by this media, please advise Andrew Davids (Andrew.Davids@oca.boral.com.au) so that mailing lists can be updated.

Andrew Davids
Branch Secretary

ACT

A large group of ACT members attended the recent conference in Sydney and presented several papers and poster papers. The conference was enjoyed by all ACT members, who made the most of a week in Sydney.

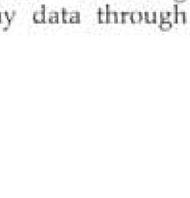
On 3 March 1997 the ACT branch held their AGM. The newly elected executive is as follows:

President:	Kevin Wake-Dyster
1st Vice President:	Mike Sexton
2nd Vice President:	Peter Gunn
Secretary:	Tim Mackey
Treasurer:	Peter Milligan
Committee Members:	Ted Lilley
	Prame Chopra
	Jane Mitchell
	Alice Murray

The guest speaker at the AGM was Dr. R. Grasty (Exploranium), with a seminar titled "Reducing statistical noise in airborne gamma-ray data through spectral component analysis".

Tim Mackey
Hon. Secretary
ACT Branch ASEG

South Australia



Christmas 96 came and went – and with a noteable highlight for those who attended the traditional branch president's backyard BBQ. It was good that the out-of-town Hills location brought a few faces that we don't always see at ASEG gatherings. Conversely we had a few drop off too. The regular punters celebrated in the way they are accustomed to.

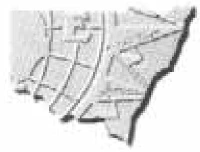
SA Branch held an AGM in January. The incoming committee is: Mark Taylor (Boral) continuing as president; Andrew Shearer (MESA) as new secretary. Dave McInnes (RTZ-CRA) as new treasurer (& wine subcommittee). The general committee is Mike Hatch (ZONGE) Preview scribe, Andy Mitchell (NCPGG) student liason, Greg Pass (BORAL) wine subcom, Paul Walshe (BORAL) wine subcom, Neil Gibbins (SANTOS) Mel Cup organiser, Andy McGee (SANTOS) ASEG rep on Aust Geoscience Council, Alan Appleton (MESA), Samanda Bell (SANTOS), John Caon (NORMANDY), Nick Dunstan (BEACH), Craig Gumley (SANTOS), Richard Hillis (UNIV ADL), Leslie Huggard (SANTOS), Rod Lovibond (BORAL), Peter Wickens (WGC).

The committee has great representation across sectors and companies – so we look forward to another full technical and social program this year for SA. For out of state visitors meetings are usually around mid month after work on a Tuesday or Wednesday. Check with Andrew Shearer at MESA if you're passing through.

We are very sorry to lose Grant Asser from SA – he has been very supportive of the ASEG. Grant has moved to work for OCA in Brisbane. Thanks also to outgoing secretary Samanda Bell for a substantial contribution of her time.

A few career thoughts were hopefully planted in March at an evening for tertiary student's information. Three volunteers (Doug Roberts, Mike Hatch and Samanda Bell) gave personal accounts of working as exploration geophysicists. The event continued with a BBQ tea on the university lawn to give students a chance to mingle with and ask questions of members.

New South Wales



Activities in the NSW Branch have been dominated by the 12th Conference & Exhibition at Darling Harbour in February. As most delegates would agree, it was a very successful conference, particularly with the exhibition in the larger space provided by Exhibition Hall 5. One particular highlight was the awarding of the ASEG Gold Medal to Don Emerson.

Because of the Conference, the AGM for the branch has been delayed. However, the existing executive will not seek re-election, and a new broom, wielded by the redoubtable Tim Pippett is a likely outcome. Now is probably an opportune time to review my last few years as branch president.

I have greatly appreciated the support and assistance of our past president Nigel Jones and the resources of Bridge Oil-Parker and Parsely, as well as the team from GeoInstruments. In addition, Command Petroleum could always be relied upon in a pinch to provide a speaker. It was always a pleasure to listen to Jim Montalbetti, and it was no surprise to see him on the short list for best presentation at the Conference.

Our secretary, Mark Russell did a great job, and as with other branch secretaries, he has vanished to Perth. That of course brings to mind, one of our more notorious annual dinners, which in turn prompted Nigel Jones to take over the arranging of those functions. They have been an outstanding success.

Although stepping down from the executive, I will still be part of the branch committee. I will continue with my preoccupation of rejuvenating our membership, on which an article will appear in Preview in due course.

Derecke Palmer
NSW Branch President

Letters to the Editor

Dear Sir

Stephen Mudge's "Excitations" column on Magnetic Photography (Preview, August 1996) was a stimulating look ahead, but I have my doubts about a future devoted to flying ever tighter and tighter grids. His description of the way in which line and tie-line spacings are now being steadily reduced reminded me irresistibly of the time, some twenty years ago, when 3D surveys were coming in to use in offshore seismics. There too, spacings on both dip lines and strike lines had been reduced and reduced again, as areas were slimmed down and targets were defined, but the process didn't go on for ever. When the spacing between adjacent dip lines became less than the maximum spacing which could be tolerated between individual traces on the strike lines, it became possible to dispense with strike lines altogether. Instead they could, if required, be constructed by selecting appropriate traces from the dip lines.

Admittedly, diurnal variations in the magnetic field present us with problems unknown in marine seismics, but there are probably better, and cheaper, ways of controlling aeromag surveys along very closely spaced lines than by flying two equally detailed grids at right angles. After all, tie lines were not a spectacularly successful solution to the levelling problem even when 5 gamma contours were the limit of our ambitions. I would guess that there are many ASEG members with memories of at least one bruising occasion when tie lines which intersected flight lines in an area of high fields and strong gradients proved worse than useless. GPS systems do now allow us to monitor relative changes of aircraft position with phenomenal accuracy but it is still difficult to get equivalently accurate absolute positions for fast moving vehicles. However, it is absolute positions which concern us when we are trying to locate crossovers. The success of 3D seismics should at least make us consider the possibility of abandoning tie lines altogether in some aeromag work. Control in very detailed surveys could instead be based on direct and continuous observations of diurnal field variations at one or (probably) more sites within the actual survey area. If we are going to routinely fly much lower than we do today (another of Stephen's predictions) then we will need to worry that much less about whether our ground diurnal observations are actually applicable to our airborne data.

Seismic analogies suggest another prediction. As 3D line separations shrank, so it became possible to acquire data on two or more adjacent lines in a single pass. With lines spaced at 25m we are close to being able to do the same in aeromagnetics. Wing-tip sensors in a "drone" with high aspect-ratio wings might provide coverage very efficiently, and accurate monitoring of wing flexure might come to be as essential a part of an aeromag survey as it is in wing-tip EM.

Yours

John Milsom
Department of Geological Sciences
University College London
Gower St.
LONDON WC1E 6BT, UK

Reply from Stephen Mudge:

Dear Sir,

It was pleasing to receive John Milsom's letter of 26 November 1996 in which he relates his experiences with close-spaced 3D seismics to current trends in close-spaced low-level aeromagnetics.

The effective use of tie lines and diurnal monitoring magnetometers is now one of the major concerns in planning airborne magnetic surveys and in processing the data. As John correctly points out, the accurate absolute positioning at line cross-overs is important and so is the requirement to pass through the cross-over point at the same absolute terrain clearance, a difficult call on any pilot's flying skills, particularly in rugged terrains. I agree with John's concerns that two survey-line grids, dip lines and strike lines, would present non-trivial data processing problems when attempting to make levelled 2D images of the data. I admit to having several 'live skeletons' rattling in my cupboard: contour maps and images of miss-levelled survey data from mountainous Papua New Guinea, Borneo and Western Tasmania!

On first impressions it seems that abandoning tie lines would be a sensible reaction to solving all the levelling problems. However, as far as the diurnal drift component is concerned, many years of survey experience by many purists has shown that a single base-station diurnal monitoring instrument is often unable to accurately record the diurnal drift of the Earth's magnetic field all over the survey area. Multiple base-stations seems the obvious answer - distributed around the survey area to provide a 2D image of the time varying field. But the problem with this arrangement is that nobody has worked out how to combine the individual spatially distributed time-based records to correct the time based measurements of a single survey instrument that is continually moving around the survey area. We await a solution to this problem before seeing improvements in survey resolution. This also raises the questions of how many base-station instruments need to be deployed and the optimum locations for them. Also, would explorers be prepared to meet the extra cost of their deployment and recovery? So in some areas, tie lines may be necessary for correcting diurnal drift of the magnetic field.

The use of close-spaced magnetic sensors on aircraft wing-tips is now a reality with several Australian survey contractors. The current installations appear to be used for horizontal gradient measurements in widely spaced surveys to improve the 2D mathematical gridding process. The main problem with this configuration however is the monitoring and correcting of aircraft roll (a more extreme geometric distortion than flexure of the airframe as suggested by John). I presume the roll-induced noise level is lower enough for the gradient to be effective in the gridding process (I have no first-hand experience with this use of gradients). We await a solution to this problem before routinely abandoning tie lines and specifying close-spaced dual-line surveys.

Despite all of these concerns, which are of importance when making high resolution 2D images and contour maps of the survey data, there is one very vital factor (neglected in our discussions so far) that supports the concept of a second tie-line. Often there are geological structures oriented parallel to the survey (dip) line direction whose magnetic signatures are best defined by the tie (strike) lines (the tie lines are actually dip lines to these structures). Pseudo tie lines could be constructed from very close-spaced survey lines (as John recalls from his seismic experiences) however this would assume that acceptable horizontal resolution could be obtained, possibly from wing-tipped sensors. But given the present practical limitations of these arrangements, tie lines are a perfect way of resolving these structures. I often look at tie line profiles for this purpose. But moreover, I'm a keen advocate of horizontal derivatives and analytical signals computed along line profiles (non-gridded) in order to maximise the resolution of survey data. However the resolution of horizontal derivatives is directionally dependant - you have to traverse perpendicular to strike to maximise the derivative response of a magnetic structure. So in the interest of increased survey resolution, I'm keen about two close-spaced survey line patterns - I'd hate to miss the subtle response of the ever-elusive mother lode! Furthermore, the horizontal derivatives are immune to levelling errors - their computation along profiles is independent of neighbouring survey lines.

Tie lines can be very useful for interpretation in rugged terrains. It is often the case that the survey aircraft can pass over a point with different terrain clearance on different headings. Flying tie lines along the face of a mountain often guarantees a closer terrain clearance than flying across the mountain.

I like to think that the drones can provide us with bi-directional surveys at an affordable cost, either with or without wing-tipped sensors and make magnetic photography a reality. Having said this, I think John's observation that shrinking line spacing '....didn't go on for ever' accurately predicts a reality for high resolution airborne geophysics (lower survey terrain clearance is also implied). It has yet to be demonstrated that drones can do the sorts of terrain-hugging flying we wish for but, above all, the terrain-hugging altitudes we operate in are generally aerodynamically very turbulent skies. Can low-cost drones operate in these harsh environments without making unscheduled contact with the ground?

Flying our surveys higher would solve all the levelling problems and aircraft roll errors in gradient measurements would be very small compared to the survey height. So maybe we should be looking at more sensitive magnetometers and better use of gradiometers to detect lower amplitude anomalies, because it seems that life close to the surface wasn't meant to be easy!

Yours,
Stephen Mudge

International News

Chilean Society of Geophysicists

Meetings of the Chilean Society of Geophysicists held in 1995/96, with guest speakers and their topics, are listed below. Time and space did not allow their publication in the last issue of Preview.

Ed.

25 September 1995
Nick Sheard
MIMEX: Geophysical Case Histories for Selected Deposits in the Mount Isa Inlier

6 November 1995
Ricardo Fernandez
Geodatos: Ground Conductivity Imaging - Case Histories

11 December 1995
William Witham
World Geoscience: Airborne Magnetics and Radiometrics in Porphyry Copper Exploration

29 January 1996
Richard Hosscroft
LCT Inc: LCT's Advanced Airborne Gravity Systems

1 April 1996
Peter Kowalczyk
Placer Dome: 3D Magnetic Modelling and Downhole Susceptibility Measurements

13 May 1996
Tim Dobush
Geosoft: New Release of Geosoft

8 July 1996
Jan Klein
Cominco Exploration: The Discovery and Delineation of the Kuds Ze Kayah Zn-Cu-Au Deposit

15 August 1996
David Isles
Consultant: Airborne Magnetics – The Last Ten Years

16 October 1996
John Bishop
Mitre Geophysics: The Geological Setting and Geophysical Signatures of Australia's Base Metal Deposits

30 October 1996
Tony Howland-Rose
Consultant: MIP Revisited

27 January 1997
Jeremy Barrett
Zonge: Two Dimensional Inversion of Resistivity and IP Data with Topography

Terry Harvey
South American Correspondent

Conferences

The ASEG 12th Geophysical Conference and Exhibition

Co-hosted by: SEG and PESA

Conference Report

The ASEG held its 12th sesquiannual Conference and Exhibition in Sydney from February 23 to 27, 1997 with the theme being Asia Pacific Exploration.

The conference was the biggest since the last one held in Sydney in 1991. The final delegate count reached 762, including 160 international visitors, mainly from the USA and Canada, but representing a total of twenty-six countries. Interestingly there were more delegates from Perth than from Sydney and this is part of a continuing trend to the west.

Generally there were three parallel sessions with one dedicated to petroleum and the others to minerals, engineering, groundwater and related topics. As well as the conventional case histories and research themes, unusual topics included Government initiatives in exploration and, even more unusual, forensic geophysics. Fred Hilterman of the SEG announced some exciting new initiatives that should benefit us here in Australia.

Not only was the conference big, the exhibition was also the biggest ever with 133 booths occupied by some 70 exhibiting organisations. Some of the booths were not booths at all; instead they were much more elaborate structures with all singing and dancing multimedia presentations. However the old faces were still there, but with new, improved sales pitches.

One thing I'd never seen before were job advertisements posted on the back of booths. Nearly all of these were in Perth with promises for a bright of a bright future, at least for geophysicists. Geologists who have never been to an ASEG conference should try to make it next time. All the major software vendors are there and also many of the smaller, more specialised companies who are beginning to see Australia as a reasonable place to market. The opportunities for a hands on demonstration are better at the ASEG than at APEA.

Students who were invited to browse the exhibition should have come away impressed by the seismic vibrator and the aeromagnetics helicopter parked out the front. They were certainly pleased with the handouts thet managed to glean from the booths including T-shirts, mouse mats, chocolates and cappuccinos.

The next ASEG conference and exhibition will be held in Hobart from November 8 to 11, 1998 with theme 'Crossing the Borders'. It will be a joint organisational effort by the Victorian and Tasmanian Branches. Mark it on your calendar now; we look forward to seeing you there.

Conference Awards

Best Paper: Chris Dauth
Airborne Magnetic, Radiometric and Satellite Imagery for Regolith Mapping in the Yilgarn Craton of Western Australia

Best Presentation (equal): Shanti Rajagopolan
The 3D Analytical Signal: A Creative Solution or a Waste of Time

Best Presentation (equal): Richard Smith
A New Regional Method for Detecting Hydrocarbon Alteration Plumes: The ALTREX Method

Best Poster: Mark Duffett and David Leaman
McArthur Basin Architecture: A New Perspective from Geophysics and GIS

Best Exhibitor: ER Mapper

Presentation of ASEG Gold Medal to Don Emerson

Citation by Derecke Palmer on the occasion of the presentation at the 12th ASEG conference and Exhibition.

The ASEG Gold Medal is awarded for distinguished service to geophysics. It is the highest award made by our society. This meeting marks the second occasion in our twenty-seven year history on which the award has been made.

Today the recipient is Don Emerson. He has a distinguished record of service to the mineral and petroleum exploration industries through teaching, publication and research.

After a brief apprenticeship at the New South Wales Geological Survey, Don accepted a position at the University of Sydney. He established the first undergraduate course on exploration geophysics in Australia, where previously there had been a solid earth emphasis. Other universities soon followed suit and now undergraduate courses in exploration geophysics are commonplace across the country.

Don spent twenty-eight years at Sydney University, and he was Head of Department and Director of the Earth Resources Foundation at various times. He has been an inspiration to both undergraduate and graduate students alike. One only has to look through our membership list to realise that many current leaders in exploration geophysics in Australia and internationally, have been taught by Don at some time in their careers.

Perhaps the activity most widely associated with Don was his extended tour of duty over a fifteen year period as editor of Exploration Geophysics. An integral factor for the advancement of any profession is the codifying of its knowledge. Don's efforts as editor, especially with the various conference and special topics volumes, have been a major factor in Exploration Geophysics now being one of the three most recognised journals in all aspects of exploration geophysics in the world. Furthermore, the fact that Australian mineral exploration geophysics is widely regarded as the best in the world can be attributed in part, to his role as editor, in addition to his teaching, research and consulting activities.

His research has covered many aspects of geophysics. In recent years, he has advanced the cause of petrophysics, which is one of the most important interfaces between geology and geophysics. It is through the efforts of Don and other workers that its significance is being more widely appreciated.

Don has been a member of the ASEG since its inception in 1970. As well as his many years as editor, he has held other positions, including that of President. In 1981, Don was awarded Honorary Membership of our society, and in 1993, he became a Member in the General Division of the Order of Australia.

I call on our President, Henk van Paridon to make the presentation of the ASEG Gold Medal to Don. I ask you all to join with me and congratulate a most worthy recipient of our society's highest award.

Derecke Palmer

Honorary Memberships

Honorary Memberships were awarded to Professor David Boyd and Mr. Bob Smith after years of service to the geophysical industry in Australia and abroad. The citations will be published in the next issue of *Preview*.

Ed.

Society of Exploration Geophysicists International Exposition and Sixty-Sixth Annual Meeting. November 1996 Denver, Colorado

Ned Stolz, CRC AMET, Macquarie University

The Denver SEG was six day celebration of exploration geophysics. Over 8000 delegates indulged themselves in the veritable feast of fifty three oral sessions, twelve poster sessions, seven special work-station sessions and fourteen pre and post convention workshops.

The exhibition is an eye opener for any ASEG regular, indeed at a rough estimate at least four ASEG exhibitions would have fitted into the area covered in Denver. Exhibitors such as Schlumberger and Haliburton erect fair sized pavilions which include small theatres to display their latest workstation gizmoes. Enormous vibroseis trucks and airboats are also on display although test drives are not permitted.

Despite the overwhelming numbers and dollars of the petroleum industry, this years conference featured a diverse and vibrant mining geophysics stream, thanks largely to the persuasive powers and organisational skill of Colin Barnett of Newmont. In-mine and high resolution geophysics, particularly radio and seismic tomography were highlighted in a well attended workshop, as well as in oral and poster sessions which generated a great deal of interest throughout the conference.

The other highlight from the mining viewpoint was the mining exploration oral session on Tuesday morning. This featured a number of highly relevant, cutting edge papers including a scrutiny of airborne radiometrics data quality by our own Bob Smith! Doug Oldenberg of UBC presented some impressive examples of magnetic and IP inversion while Terry Crabb's case history of the Voisey's Bay base metal discovery finished the session on a very up beat, positive note.

Another notable aspect of the conference was the high turnout from Australian geophysicists. Undoubtedly all those who made the journey found that the long haul across the Pacific and the hideous jet lag was more than justified by the sheer volume and variety of people, techniques and ideas that only an international conference can offer. The large groups congregating in the lobbies and around the coffee shop also testified to the un-equalled scope for networking and deal making that the SEG offers.

The next 'mining enhanced' SEG is scheduled for 1998 in the Sands Hotel, Las Vegas. This is the largest hotel in the world and will allow the entire conference, exhibition and 10,000 delegates to be housed under one roof. Start writing that abstract and making unsubtle hints to your manager now!

Industry Briefs

This is a new column which is intended to keep the membership informed of developments in the industry. Material for the column will be extracted from Press Releases or from direct requests from companies, but will be restricted to short paragraphs (approx. 100 words) which are not purely advertising.

The success of the column will depend on the flow and nature of submissions from interested companies. We look forward to hearing from you.

Mike Shalley, Editor

VISTA for Windows

Seismic Image Software Ltd. of Calgary, Alberta, Canada is pleased to announce a significant new release of their 2D/3D seismic processing system *VISTA for Windows version 1.1* has powerful Q.C. capabilities enabling both location and correction of data errors. Ideal for field crew use it is also a useful tool for processing of 2D seismic data. *VISTA* runs on PC's under Windows95/NT and on SUN and IBM UNIX platforms.

OMNI 3-D Design Software

Seismic Image Software (1995) Ltd. is pleased to announce significant changes to their industry leading OMNI 3-D Design systems. The new OMNI-Design, Modelling, Analysis and Nosie – form a complete suite. OMNI Design and OMNI Analysis have 32bit versions available. OMNI runs on PC's under Windows95/NT and on SUN and IBM UNIX platforms.

Geoimage Opens New Perth Office

Geoimage Pty Ltd, an Australian owned, independent image processing consultancy, have recently opened their new Perth Office at:

Unit 1, 66 Mill Point Road
South Perth WA 6151
Tel: (09) 367 6700
Fax: (09) 367 6745
Email: geoimage@tpgi.com.au
Contact: Max Bye

You can contact Max for your Australian and world-wide satellite imagery requirements and geopysical processing or visit the Geoimage web site on www.geoimage.com.au

Geo Instruments Gains Large Airborne Survey

The helicopter division of Geo Instruments is pleased to announce that it has been awarded 80 000 line km. of magentic, gamma-ray and digital terrain surveying in Fiji, by the Australian Agency for International Development (AusAID). The project will take four months to complete using two Aerospatiale 'Squirrel' helicopters fitted with Geo Instruments' own designed magnetometer booms. Sister company, Kevron Geophysics, will also survey 80 000 line km. of fixed wing flying with one of their aerocommander 500S 'Shrikes'.

(Continued on page 19)

OBITUARY

John C. (Jack) Templin 1921-1996

One of the true pioneers of the airborne geophysical industry in the USA, Canada and Australia passed away in Melbourne on Tuesday 12th November 1996 after a short illness.

Jack joined the photogrammetric department of Aero Service Corporation in Philadelphia USA in 1941 and except for two years war service in the US Army was intimately involved in the management, processing and mapping of airborne magnetics (especially) until his retirement in the late 1980s. To the best of my knowledge Jack was a crew member on the first commercial magnetometer surveys flown (but Jack kept no records). The last twenty five years of his working career being in Australia.

Jack was seconded from Philadelphia to supervise the geophysical data compilation at Canadian Aero Service in Ottawa in 1949 and he remained there until 1963; he was Data Production Manager of Aero Service Ltd in Sydney 1963-65; Data Production Manager of GRD Co in Sydney 1966-72 and until his retirement in the late 1980s was an independent data processing contractor. Millions of kilometres of data passed through his hands.

Jack was a hands-on manager, a gentleman, a great teacher, coach, mentor and visionary to many hundreds of people, but most of all he was a true artisan and an excellent hand contourer. His work, which in most instances predates the invention of the computer, will survive us all - government and international oil and mining house archives are testament to that. I must add that gridding and contouring programs of today (1996) still cannot emulate his technically and geologically precise work. All his work was manual - he didn't believe in filtering - and would have considered the use of such just an excuse anyway!

Many, many people will mourn his loss - with Jack went the passing of an era.

Doug Morrison

Polar Reversals, Cooling Magmas and Aeromagnetic Anomalies

by Joe Williams

Introduction

It is probably reasonable to state that palaeomagnetism came of age with the acceptance of its role in seafloor spreading (Vines and Matthews, 1963), so that about this time, knowledge of polar reversals emerged to become a valuable tool in studies of stratigraphy.

In more recent years, palaeomagnetic techniques have been applied to problems associated with exploration geophysics. For example, a study of part of the McArthur River Basin (Indrum et al., 1993) produced in an apparent polar wandering curve that Wyborn (1993) considered to have potential as a relative time scale with which mineralisation events could be associated.

The role of polar reversals, however, appears to be confined largely to magnetostratigraphic implications. The aim of this paper is to illustrate a direct application of reversals to geophysical mapping in another situation. The basic concept of the paper was presented at a palaeomagnetic seminar in Canberra (Williams, 1993).

Hypothesis

A passing remark by a colleague on a QUT field trip, that granites may take upwards of twenty million years to cool, led the author to conclude that similar intrusions or magmas may well contain magnetic reversal signatures. Obviously there are several conditions to be satisfied:

- the magma must contain magnetic material;
- it must have cooled from above the Curie point of the magnetic mineral, normally magnetite;
- the time span of reversals must be relatively small in relation to the cooling rate above the Curie point;
- the mass of the magma must be sufficiently large to allow the time constraints to occur.

There are several other constraints that will emerge as the basic premise is outlined.

Consider a magma cooling from above the Curie point of constituent magnetite. In the case of a simple homogeneous body with an upper surface approximating a dome or semisphere, there would be a temperature wavefront at the Curie point that would contract inwards with time. This could result in concentric shells of normal and reversed magnetism with thickness and frequency depending on cooling rate and the relevant geological time. With subsequent exposure of the granite by erosion, a circular pattern of normal and reversed magnetism should be evident (figure 1). The geometry can be likened to slicing the top off an onion. This onion ring effect can be equated with the mid oceanic magnetic stripes. In that case the magnetic stripes are due to mechanical plate movements that recorded the time varying events (reversals). In this case the magma is essentially stationary but the shrinking Curie point wavefront has produced the mechanism to record the reversals.

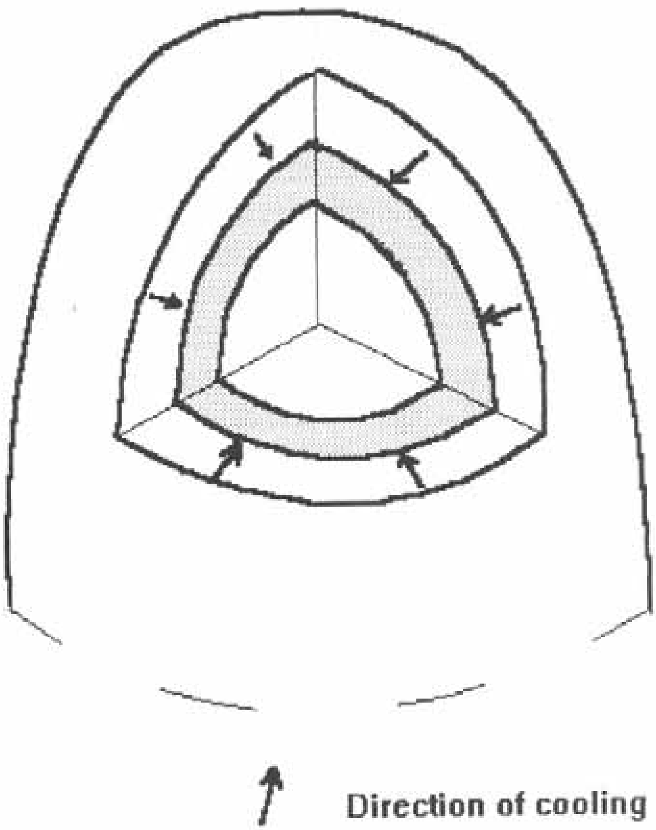


Figure 1. A pluton with normal and reversed magnetism.

Many exposed intrusions exhibit complex magnetic signatures. Some of these are obviously due to complex intrusions, but there are many that could be explained by polar reversals or at least remanent magnetism including overprints. There is at least one circular anomaly in the Charters Towers region that may be due to such effects.

Evidence of required parameters

"Magnetite is one of the most abundant and ubiquitous oxide minerals in igneous and metamorphic rocks ..." (Deer et al., 1966). Most geophysicists would agree with this and concur that most exposed magmas have a magnetic signature normally due to one or more of the minerals in the magnetite series.

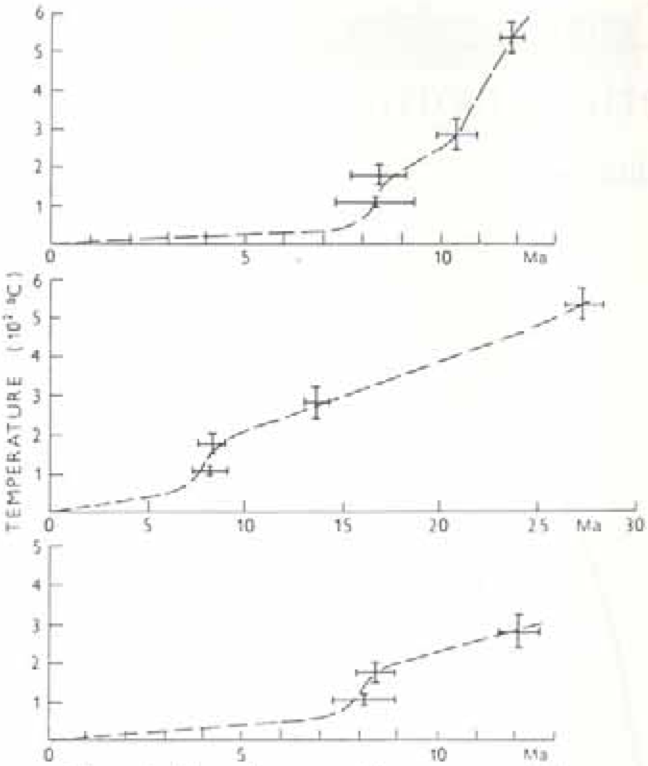


Figure 2. The cooling rate of three magmas, (after Degens et al., 1990).

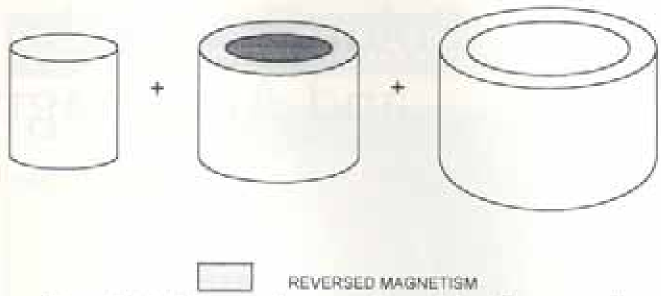


Figure 3(a). A composite magnetic model with a reversal.

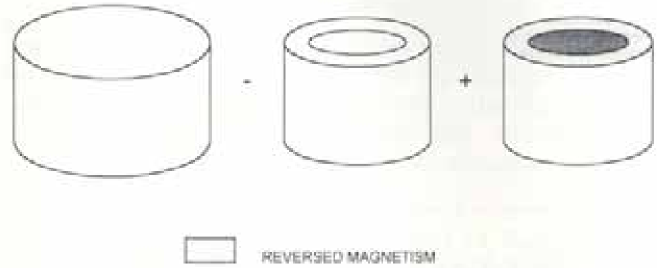


Figure 3(b). An alternate composite magnetic model with a reversal.

The Curie point of magnetite is 578°C so that a magma must have cooled from above this point to satisfy the temperature conditions stated above.

A review of plutonic and volcanic processes, (Degens et al., 1990), covers many aspects of intrusions such as rate of emplacement, rising rate of plutons and cooling rate. An example in figure 2 shows a cooling time of over 20 million years, though much of this is below the Curie point. A rule of thumb given in this review is that 'the rate of cooling is directly proportional to the square root of the size of the body (i.e., the diameter of spherical bodies, or the thickness of plate-shaped bodies)'. A point not at issue in this review is the final depth of emplacement of the body prior to stripping of the overlying material. This is important because, deeper than about 5 kilometres, the surrounding material would also be above the Curie point. Any effects would then be controlled by differential rates of cooling.

The time span of a reversal is critical to this argument. Generally speaking, it is probable that durations of the reversal process extend over around 10,000 years. Recording of shorter reversals are limited by measuring procedures. Moreover, the reversal process is not simple in the sense that the principal parameters may have different time scales. Jacobs (p49, 1984) cites a case where the directional change was estimated to have taken 1000-4000 years, while the intensity change took 10,000 years. Bearing in mind the problems of estimating cooling rates etc. the estimates cannot be related to an absolute time scale. However, the order of magnitude will not change significantly.

Pesonen and Nevanlinna (1988) describe two successive reversals in Crete. The time frames are similar. Their observations are based on detailed palaeomagnetic measurements over a relatively small stratigraphic section. They have illustrated the behaviour of the various magnetic components over both spatial and time frames. More importantly, they have included model results of a double dipole system which is in fair agreement with the observations. This model has one dipole in the earth's core and one on the core-mantle boundary. According to the double dynamo theory, one dipole can cause the other to flip, producing a reversal. In this case, *the absolute field never reaches zero*. In the cases reviewed the first reversal was symmetrical, but the second was asymmetrical.

On frequency of reversals, McFadden (1993) states that there have been 258 of them in the last 160 million years giving an average period of approximately 620 000 years per reversal, although there may be considerable variation from one to another. Measuring techniques preclude similar documentation for earlier geological times, but it seems reasonable that similar frequencies of occurrence should have existed.

Computer models

The model results in this paper contain only one reversal. This was found to be sufficient to illustrate the expected effect. The initial model was a vertical system comprising an inner cylinder and two shells (figure 3a). The inner cylinder and outer shell were given normal magnetism with the mid-zone or shell having reversed magnetism which was achieved by reversing the magnetic inclination.

A 3D Talwani algorithm was utilised to produce the magnetic patterns shown in figure 5. The effect of demagnetisation was not included. Observation height was one tenth of a unit. A susceptibility of 0.001 (cgs units) was chosen for ease of conversion. Fortran programs were written to generate the cylindrical contours for a cylinder with radius and depth extent of four units each, and shells of radii 2 and 3 units

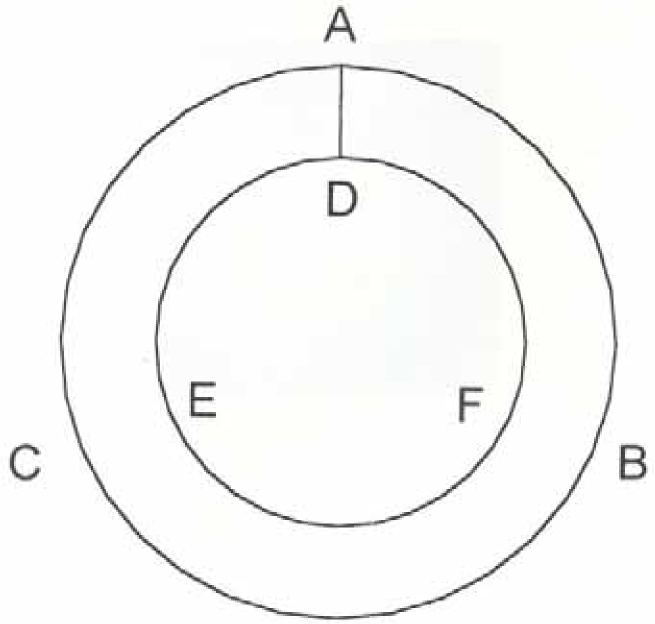


Figure 4. Shell contours. Contours follow the path ABCADEFDA. Here AD^+ and AD- cancel to produce a shell as the total line integral for AD becomes zero.

respectively (figure 4). The magnetic latitude of -52° was chosen to allow comparison with circular anomalies in the Charters Towers region of Queensland, Australia. However, a zero declination was used to eliminate the asymmetry that would have complicated the expected results. The model, then, was representative of an exposed pluton of approximately eight kilometres diameter observed from a datum one hundred metres above the base of the weathered zone at mid latitudes.

The most logical and efficient way to produce a combined anomaly would have been been to compute an inner cylinder with normal magnetism, a reversely magnetised shell and an outer shell with normal magnetism as additional shells could then be added in a programed series (figure 3a). However, to test this hypothesis, it was practical to calculate the overall cylinder, subtract the effect of the inner ring, then add the ring of reversed magnetism. Although inefficient, this was essential to demonstrate the veracity of the algorithm. The results are displayed in figure 5 . It can be seen, for example, that the normal and reversed shells are symmetrical as one would expect. The combined results clearly illustrate the worth of reduction to the pole.

Discussion

The cylindrical model with one reversal is extremely simple, but the combined result does not represent the simple symmetry of the model. The normal and reversed rings have a dominant high pattern. This is because the magnetic response of the N-S components of the dyke is always positive due to the effective inclination, and also because the E-W components produce positive peaks although they are laterally transposed with respect to the adjacent negative peaks. One would expect even more complex results with different remanent declinations and inclinations. In the case of an actual magma, the shape of the boundaries would further complicate the response possibly leading to an erroneous interpretation of an intrusion of mixed composition. Reduction to the pole of the combined model restored the simple geometry that should lead to a correct interpretation.

This modelling was performed for mid latitudes. The problems associated with low latitudes especially with reduction to the pole (MacLeod et al., 1993), have not been considered, but would surely lead to further complications.

Because the body considered is relatively large and the magnetism comes into effect from the perimeter towards the centre as a function of time, there exists the possibility that the outer shells could have a shielding effect on the inner zones thereby reducing the intensity and hence the number of reversals that could be recorded. Schweizer (1962) developed formulae for the shielding effect of one, two and three shells, although this was for a very different application involving high permeability shells. The theory outlined was developed to study the effect of high permeability materials for shielding effectiveness. It is assumed that the formulae are valid for low permeabilities also.

In the case of a single shell, the shielding factor (SF) is given by:

$$S_F = \{9\mu+2(\mu-1)^2 \, . \, (1- (r_1/r_2)^3)\} / 9\mu$$

where μ is the magnetic permeability and r_1 and r_2 are the inner and outer radii.

For normal susceptibilities encountered in the field (say 2000 X 10^{-5} S.I. units), the shielding factor is of the order of 1.00006 which is negligible. It would appear that, as with demagnetisation, shielding presents no problem except in the case of magnetic mineralisation with high susceptibility.

The aim of this paper is to demonstrate that complex anomalies may have a single, mineralogically homogeneous source. This is especially important in interpretative mapping of aeromagnetic data which is commonly a first stage of an exploration program. Also, any remanent component of a ring structure may not be immediately evident.

In areas where strong remanent magnetism is known to exist, reduction to the pole seems almost mandatory. Modelling of suspected remanence should then be included in preliminary interpretations. In many areas in Australia, there is magnetostratigraphic information available from statutory authorities that would assist such modelling. In the case of detailed ground surveys, physical remanent measurements may be necessary to allow an accurate interpretation.

Acknowledgements

The early part of this work was carried out whilst I was associated with the Schools of Geology at Queensland University of Technology and the University of New England. Nick Sheard and Andrew Lockwood of MIM Exploration produced the colour magnetic imagery. Steve Mudge gave assistance with the Talwani algorithm. All this help is gratefully acknowledged.

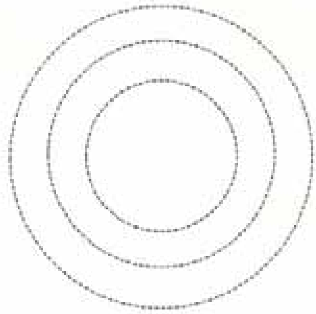


Figure 5a. Plan of the cylindrical model with an inner shell of reversed magnetism.

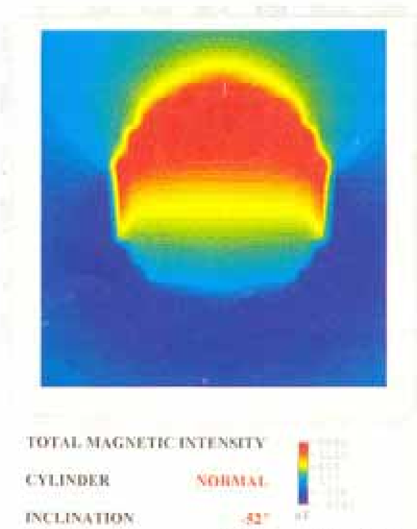


Figure 5b. The response of the overall cylinder with normal magnetism.

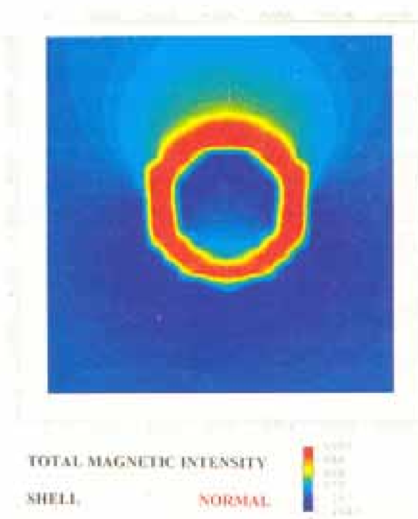


Figure 5c. The response of the inner shell with normal magnetism.

Figure 5d. The response of the inner sheel with reversed magnetism.

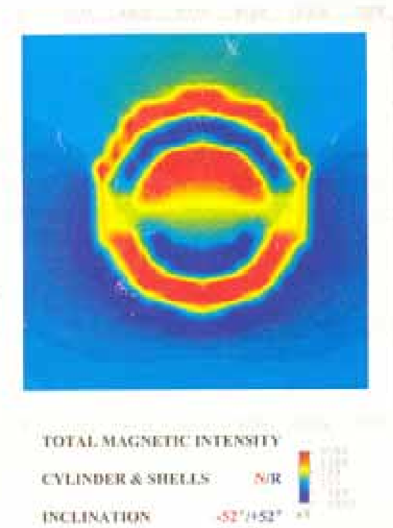


Figure 5e. The composite model.

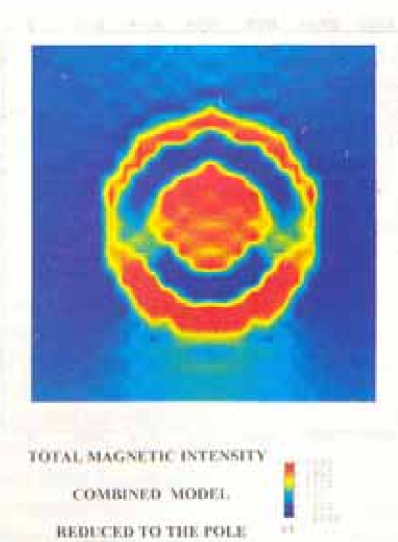


Figure 5f. The composite model after reduction to the pole.

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Keywords

Polar reversals, cooling magmas , reduction to the pole, shielding effect of a shell.

Industry Briefs *(continued from page 14)*

The project was awarded to parent company, Kevron Pty Ltd, by AusAID in collaboration with the Fiji Mineral Resources Department and is supervised by the Australian Geological Survey Organisation.

Northern Exploration Services Introduces Reflex EMS

Reflex EMS (electronic multi shot) is a detailed drillhole deviation magnetic vector service, now offered exclusively in Eastern Australia by Northern Explorations Services (NES). It is capable of providing highly accurate dip and azimuth readings at any interval in any type of drill hole. Other parameters measured include temperature and the strength and dip of the local magnetic field relative to the the tool axis, helping to define lithography, structure and mineralogy. Using industry modelling packages, the Reflex EMS can locate and size magnetic bosies not intersected by the borehole. Results can be displayed as soon as the insrument is recovered from the hole. Contact Peter Brown, Tel: (077) 72 7226.

Geoterrex-Dighem appoints new Manager, Data Processing and Interpretation

Geoterrex-Dighem is pleased to announce the appointment of Roger Kennedy as Manager, Data Processing and Interpretation. Roger is a graduate of the University of New South Wales and started his career working with CRA Exploration in Karratha, Western Australia during a summer vacation before completing his honours degree under Professor David Boyd at the University of Adelaide. Roger then took up a position with BHP Minerals Exploration at their Brisbane office and, during his time there, he worked with the exploration team involved in the discovery of the Eloise copper-gold orebody, and the silver-lead-zinc discovery at Cannington. Later he was transferred to BHP's Toronto office, predominantly working in the Abitibi looking for Volcanogenic Massive Sulphides, using ground and downhole electromagnetic techniques. Prior to joining Geoterrex-Dighem, Roger completed an MBA at the Australian Graduate School of Management.

CAMESE.ORG E-mail Domain

Jon G. Baird, Managing Director of CAMESE - The Canadian Association of Mining Equipment and Services, is pleased to announce the activation of the new e-mail domain camese.org. This new domain provides even more access points for CAMESE to help with your mining equipment and service needs.

All addresses are in the format of lastname@camese.org. if you are unsure of what you need you can send general inquiries to minesupply@camese.org.

CAMESE is a non-sales trade association with over 190 corporate members existing to help Canadian mining suppliers to export to world mining markets, and to assist foreign buyers, dealers and others in finding suitable Canadian business partners in the mining supply sector.

Anyone requiring more information should contact CAMESE at 101 - 345 Renfrew Drive, Markham, Ontario, L3R 9S9, Canada, tel: 905-513-0046, fax: 905-513-1834, E-mail: minesupply@camese.org,
Web: http//www.camese.org.

Introducing a New Slimhole Acoustic Televiewer Wireline Acquisition & Interpretation Service for the Mineral, Geotechnical and Groundwater Industries

Duncan Cogswell & Nicholas Harvey. Downhole Surveys Pty Ltd, Kalgoorlie, WA.

Summary

Borehole imaging tools, acoustic and electrical, have been providing high resolution data for the petroleum industry for a number of years. With an increasing demand for high quality, quantitative data from boreholes, Downhole Surveys Pty Ltd, an Australian company, have been offering a fully integrated slimhole acoustic televiewer wireline acquisition, processing and interpretation service (*HYDRA*™) for the mineral, groundwater and geotechnical industries over the past 18 months. Excellent orientated borehole image data, in both diamond core and reverse circulation (RC) boreholes, have been acquired. The service is now available commercially throughout Australia.

Technique

The acoustic televiewer, as its name suggests, provides an orientated 360° image (in both a transit time and amplitude format) of the borehole wall within the fluid filled section of the borehole. (Figure 1) The tool can record data in either diamond and/or RC boreholes. It achieves this by measuring the return echo transit time and strength (amplitude) of an ultrasonic sound emitted by a transducer in the tool. The 360° coverage of the televiewer log is achieved by a rotating mirror within the tool, which also acts as a focusing device enabling greater vertical resolution. The rotation rate of the sensor device and the length of the scan time can be varied according to resolution required and the borehole conditions. In every revolution of the measuring window (approximately one revolution per 7.5mm vertical displacement) a maximum of 288 samples can be acquired to create the 360° image.

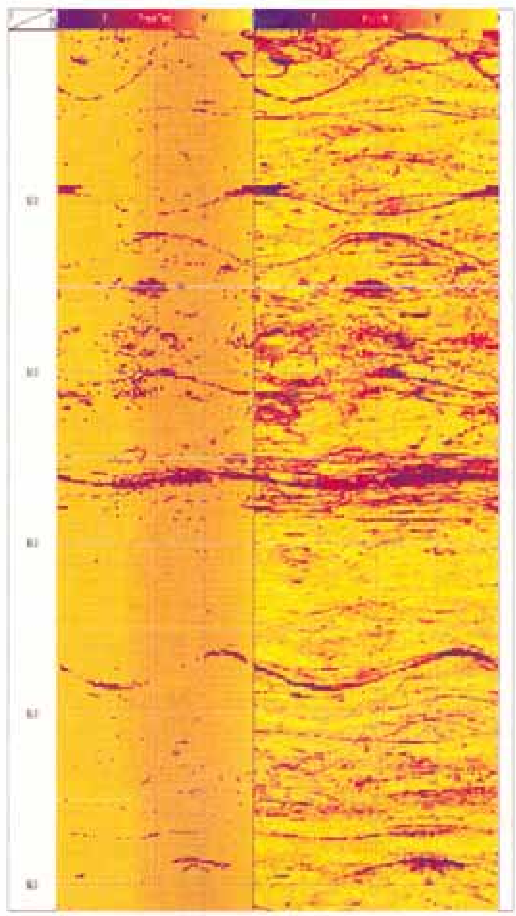

Figure 1 : Fully processed and orientated borehole image from Western Australia.

Acquisition

Downhole Surveys uses the interactive ALT logging software (ALTLOG and WELLCAD) to produce high quality image data for the minerals, geotechnical and groundwater industries which can be viewed in real time. Data is digitised downhole and a 4 conductor telemetry system is used to transmit data to the surface computer which is able to use the full multi-platform facilities of Windows^{NT}. The logging equipment is purposely mounted within all terrain, 4X4, Landrover Defender vehicles which have been equipped with the standard Australian Mines Department Field Safety Equipment.

Acoustic televiewer data can be used to identify the following :

- Generic Rock Fabric (such as bedding)
- Fractures (open and/or closed) and their frequency.
- Faults and associated stress fabrics.
- Anomalous Features (such as veins)
- Orientation of core.
- Regional stress analysis.
- Dynamic rock strength.

HYDRA™ Acoustic Image Processing & Interpretation package.

The *HYDRA™* package has been introduced to provide full processing and interpretation of acoustic televiewer data by dedicated professionals.

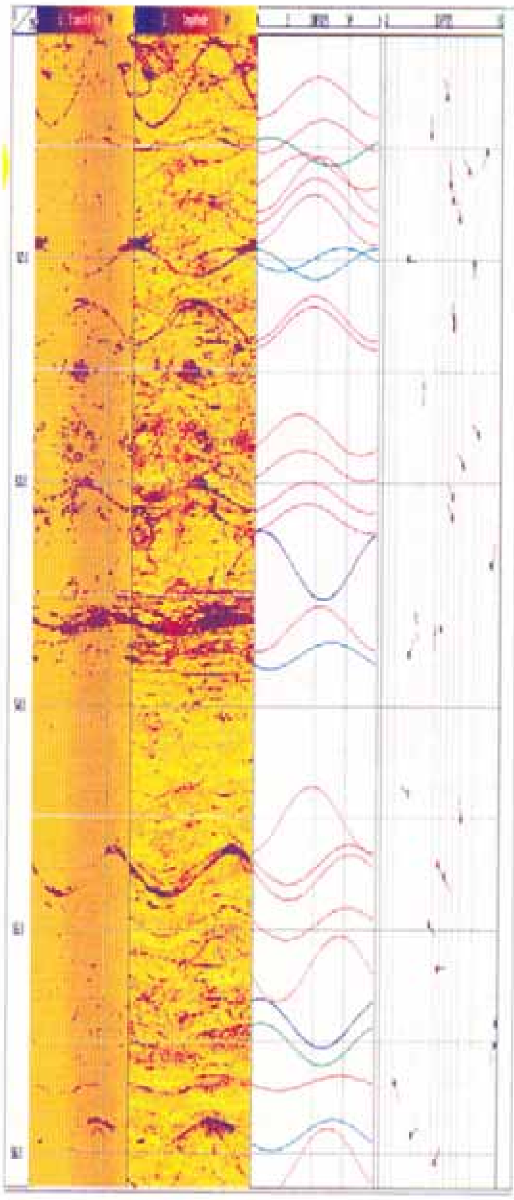

Figure 2 : Interpreted Acoustic Televiewer log.

The *HYDRA™* package is able to provide fully interpreted acoustic televiewer logs, where the planes are highlighted and processed for true dip and azimuth in either projection or tadpole format. (Figure 2) Note, structural sets identified by the stereograms can be colour coded on the final log output. For inclined boreholes, calculated dips and azimuths can be re-orientated to the vertical plane. A range of presentation and interpretation options can be provided to suite the needs of the client. Bureau services are available in Kalgoorlie for in house interpretation or interpretation by client's personnel.

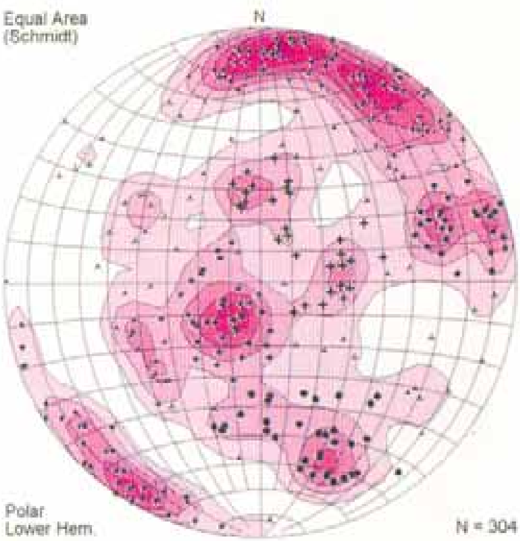

Figure 3 : Equal area stereogram produced from acoustic televiewer data

The final interpreted data can be exported into proprietary software to produce Schmidt equal area stereograms (Figure 3) and/or rose diagrams (Figure 4). Advanced stereogram analyses which are based on rock unit depths can also be performed.

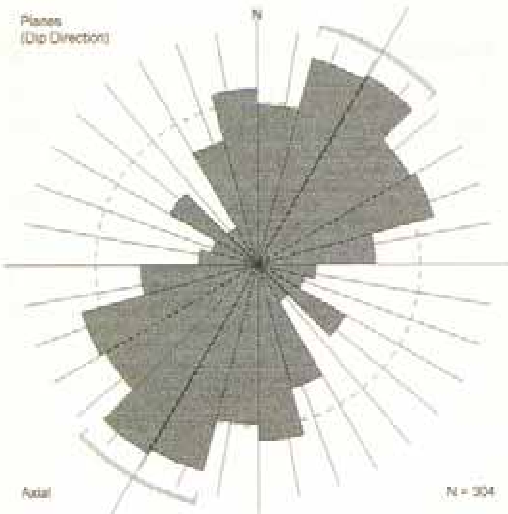

Figure 4 : Rose diagram produced from Acoustic Televiewer data.

As standard, the acoustic televiewer data is orientated to magnetic north, however re-adjustment of the azimuth values to a local grid north can be achieved. For data acquired over magnetic intervals, non magnetic borehole geometry (e.g. MAXIBOR or gyroscopic) azimuth data can be imported for orientating the acoustic televiewer images and interpreted products.

Downhole Surveys Pty Ltd have developed a semi quantitative log of rock hardness from the acoustic televiewer data. The rock hardness have been calibrated against and normalised to, the measured strength of 78mm diameter steel casing. Four rock hardness logs or an average rock hardness log can be computed which give an axial representation of the rock hardness around the borehole.

Future developments of the rock hardness logs include the incorporation of density data to produce quantitative rock hardness values for geotechnical projects.

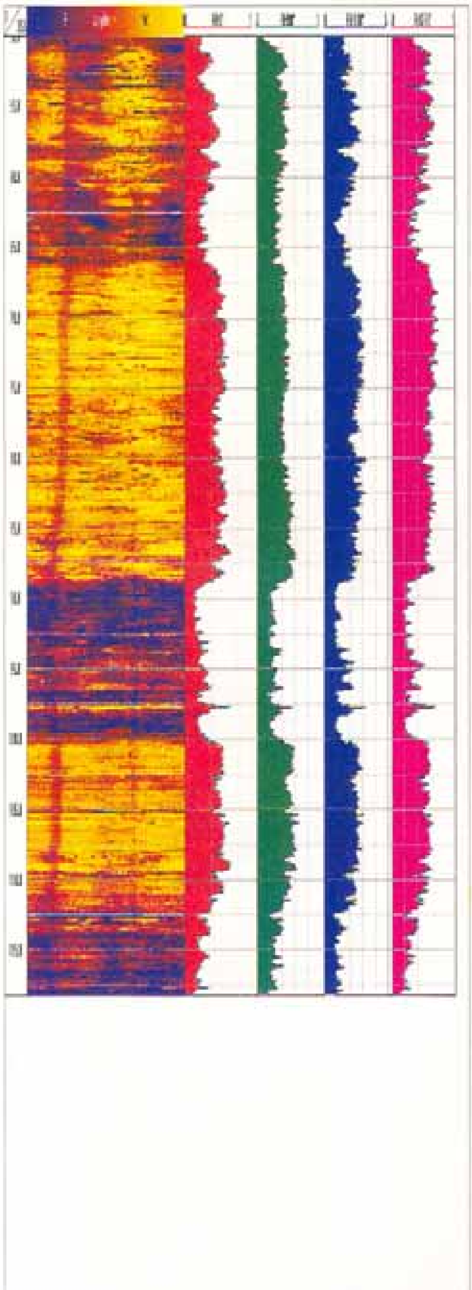

Figure 5 : Axial rock hardness logs produced from acoustic televiewer data.

The transit time image is becoming more used at the present day to produce 3 dimensional images of the borehole wall for direct comparison to core. (Figure 6)

Applications

Mineral Exploration, Feasibility & Operations

- Structural orientation, dip and azimuth of planer features (fractures, joints, veins) and bedding using projection and/or tadpole formats.
- Stereograms, rose diagrams and polar plots related to structural families or lithology units (presented individually and/or on the final logs)
- Core orientation.

Geotechnical Investigations (Mines, Civil Engineering Projects : Dams & Foundations Studies)

- Structural orientation, dip and azimuth of planer features (fractures, joints, veins) and bedding using projection and/or tadpole formats.
- Stereograms, rose diagrams and polar plots related to structural families or lithology units.
- Fracture Frequency Log.
- Acoustic Rock Hardness log.
- Borehole cross section: Ovality measurement for stress breakouts.

Groundwater Projects (Exploration & Development, Well Rehabilitation)

- Identification of fractures.
- Screen and plain casing inspection.

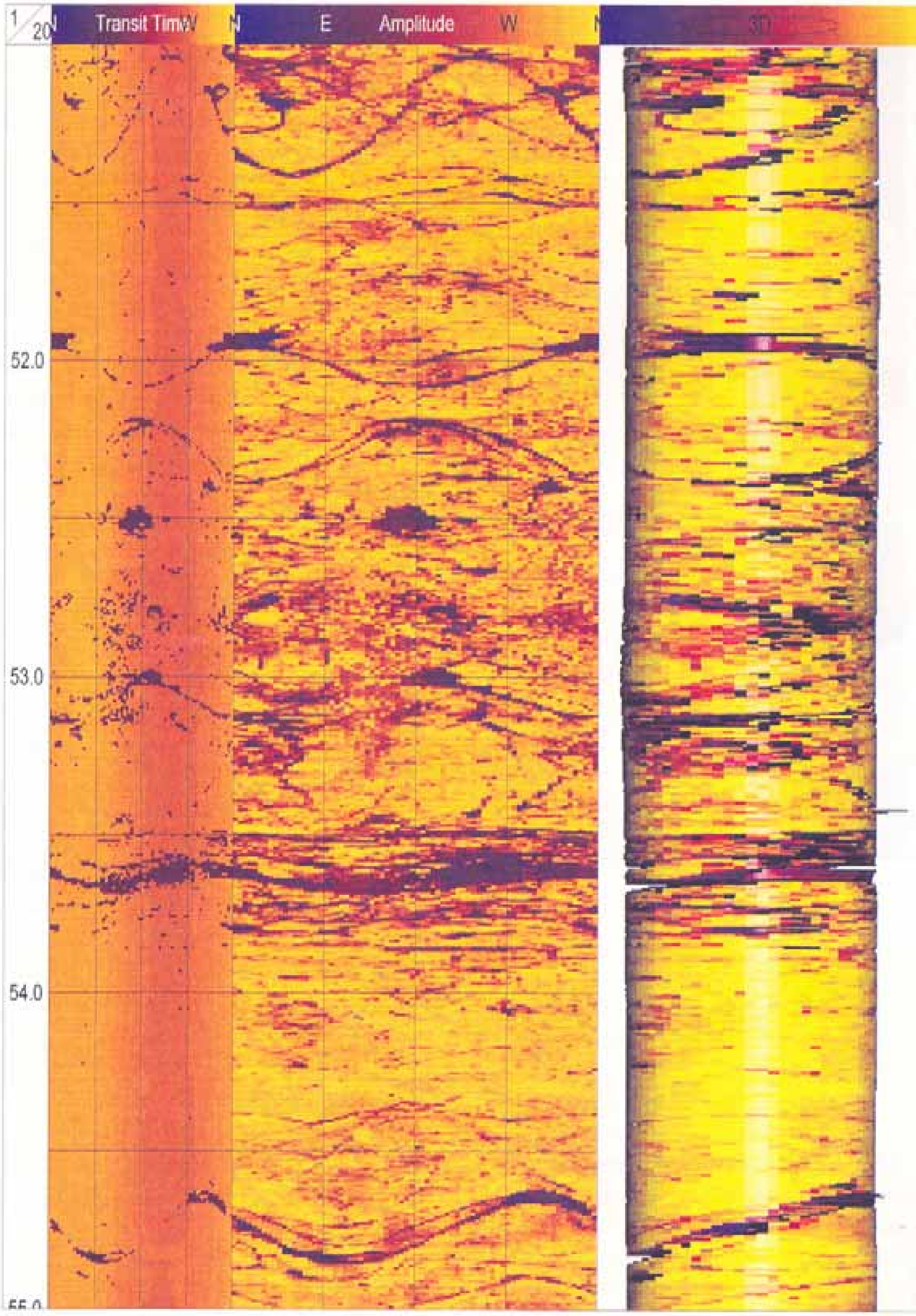

Figure 6 : 3 dimensional borehole image constructed from amplitude and transit time data recorded within a diamond core borehole drilled in Western Australia.

Excellent image quality has also been obtained from RC drilled boreholes enabling a significant increase in structural and/or geotechnical data available to projects which would have previously been too costly to obtain.

Features such as regional stress related breakouts can be identified and allow the determination of the direction main present day stress fields.

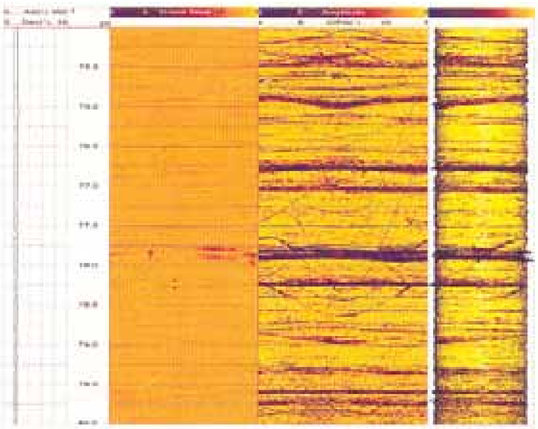

Figure 7 : Borehole cross sections derived from the transit time log to assess borehole ovality and regional stress regimes. Rose and polar diagrams can also be included in the final logs.

For more information on these services provided contact either :

Duncan Cogswell or Nicholas Harvey

- 11 Dugan St, Kalgoorlie WA 6430
- Tel : (090) 218015
  Fax : (090) 912012
- E Mail : Downhole@ludin.com.au

Downhole Survey

Level 2, 35 Ventnor St
West Perth WA 6005

Ph: (09) 322 8026
Fax: (09) 322 8027

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SMARTem: A New Electrical Methods Receiver System

by

Andrew Duncan, Director, ElectroMagnetic Imaging Technology
Peter Williams, Chief Geophysicist, WMC Resources Ltd
Gregory Turner, Mine Geophysicist, Kambalda Nickel Mines
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Keith Martin, Senior Geophysicist, Leinster Nickel Operations
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Introduction

In December 1994, a project to design and manufacture a new TEM receiver system commenced in Perth, Western Australia. The aim of the project was to develop a full electrical methods receiver system that could boost both data quality and survey productivity by applying the following advances in instrumentation:

(i) recognise and remove interference from TEM data, especially cultural noise in the vicinity of mine sites and built-up areas.

(ii) supply graphic evidence of signal and data quality to the instrument operator and

(iii) serve as an easily programmable platform for the research and development of new data acquisition methods.

The project was a joint venture between WMC Resources Ltd and ElectroMagnetic Imaging Technology.

Motivation for this development came from the lack of an existing TEM receiver system that could provide:

(i) high quality data under conditions of significant EM interference, in a short acquisition time and

(ii) user-friendly "real-time" tools for the operator and/or geophysicist to analyse and understand the nature of the signals and interference in the survey.

The proposed system would work effectively underground, as well as in all normal configurations required of an exploration instrument.

Field measurements of typical noise signals from underground and surface sites were made in December 1994 around Kambalda, Western Australia. An analysis of these signatures led to the first version of the signal processing software for the new instrument. The first field trials of a prototype system, called SMARTem, were carried out in June 1995 at Leinster in Western Australia. Several borehole TEM surveys were completed with results comparing favourably with those of commercially available receivers.

The System

SMARTem is based on a custom-made, sealed, PC-compatible computer with 486 processor, 1.6 Gbyte hard disk, in-built LCD VGA display, membrane QWERTY keyboard, floppy disk drive and 16 Mbytes of memory. Data acquisition is carried out by 8-channel programmable A/D converters, amplifiers and analogue filters installed within the chassis of the computer. Newly-developed programmable timing circuitry, using oven-controlled 10 MHz crystal oscillators controls the transmitter and A/D converters. This allows automatic fine tuning of base frequencies and facilitates operation of a synchronised transmitter in an environment remote

Figure 1. SMARTem receiver.

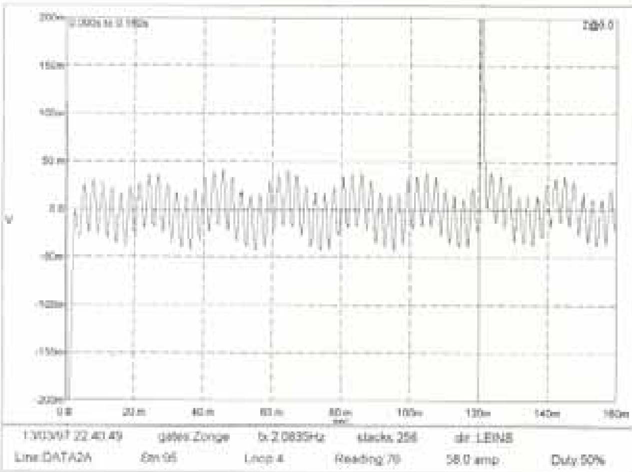

Figure 2a. Oscilloscope presentation of raw digitised SMARTem data. Raw data can be displayed in real time or played back from hard disk at a later time.

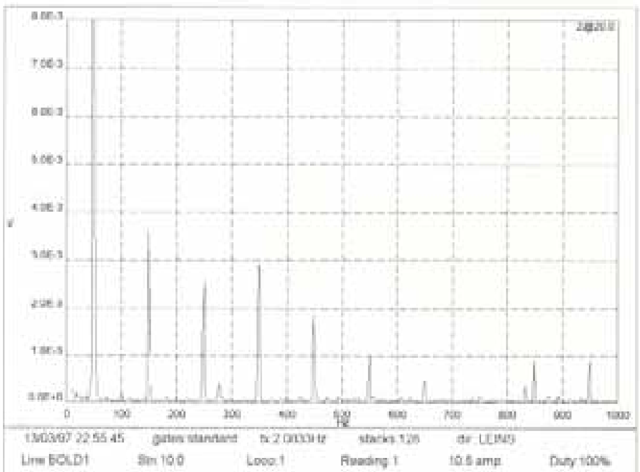

Figure 2b. Spectrum analyser display. Note the presence of 50 Hz and odd harmonics.

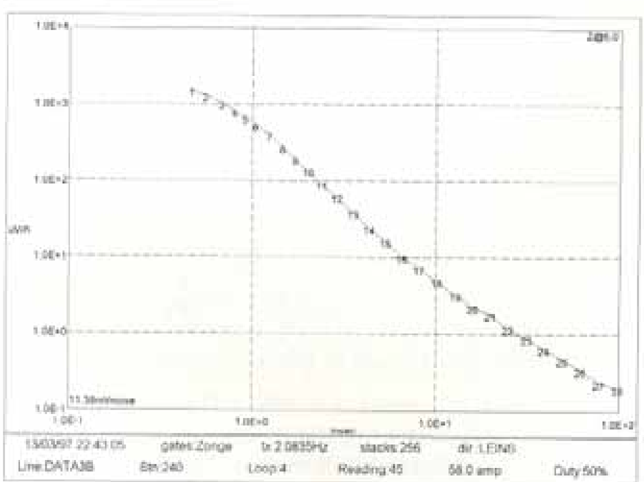

Figure 2c. Transient decay plot in log-log format.

from the receiver. The SMARTem receiver is designed to be used with the Zonge range of geophysical transmitters and any style of conventional receiver antenna.

Figure 1 shows the SMARTem receiver. On the receiver chassis are inputs for eight channels of differential analogue signals and outputs for the control of a local transmitter and synchronisation with a SMARTem remote Transmitter Controller. A printer port, two serial ports and a connector for an external VGA monitor give the functionality of a standard computer. Power for the operation of the complete system, with the exception of the timing circuitry, is provided by an external 12-24V battery. The timing circuitry is powered by an internal battery to allow it to operate and remain synchronised independently of the computer.

Software for SMARTem is written in C++ and runs under Windows 3.1. One large program controls acquisition, display and processing functions. Examples of the graphics screens presented to the user are given in Figure 2 which shows oscilloscope, spectrum analyser and transient decay plots respectively. There are several items to note in Figure 2a - turn-on and turn-off primary field transients (at 0 and 120 milliseconds respectively), noise from an in-mine ELF radio system (approx. 375 Hz, refer later) and 50 Hz power transmission signals. The example spectrum in Figure 2b shows harmonics of 50 Hz in data collected approximately 800 metres from the nearest power transmission line. Note that only odd harmonics are of significant magnitude in this example. Figure 2c illustrates a decay from a SMARTem profile presented in Figure 3b. During acquisition, data can be viewed in all of these formats to improve the likelihood of detecting any survey problems quickly, to aid in recognition of noise types and to give the operator an increased level of understanding of signals presented to the receiver.

Menus allow the modification of all acquisition, display and processing parameters. Fully processed data is stored in AMIRA format on the SMARTem's hard disk and can be copied to a floppy disk. Part of the design criteria for the SMARTem required that raw and stacked waveforms be optionally stored on disk to allow post-acquisition analysis, processing and playback. The internal hard disk drive provides for the storage of raw and stacked digital waveforms. Typically, raw data from 1-3 days of work could be collected before archiving to an external tape drive is required.

Flexible timing circuitry allows software selection of a wide range of transmitter base frequencies and digitiser sampling rates. Base frequencies can be fine tuned automatically to optimise attenuation of powerline interference. The SMARTem receiver and remote Transmitter Controller have identical timing circuitry and the crystal oscillators are synchronised automatically in software. Subsequently, relative crystal drift is likewise calculated automatically.

Processing Algorithms & Example Data Sets

During the development of the SMARTem receiver system several processing operations, with particular noise removal functions, have been coded into the data acquisition software. This software gives processed SMARTem data increased immunity to power transmission line interference, ELF/VLF communication transmission signals and atmospheric transients. As a safety initiative, in several of its Australian mining operations WMC Resources uses an ELF magnetic field

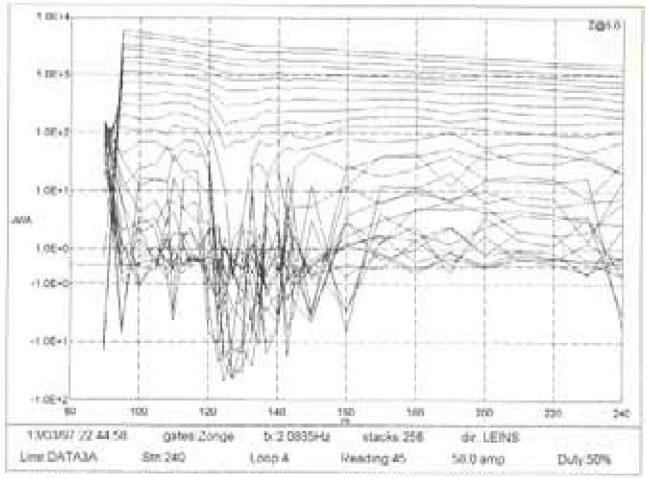

Figure 3a. Profile of "unprocessed" borehole TEM data affected by interference from PED communications system.

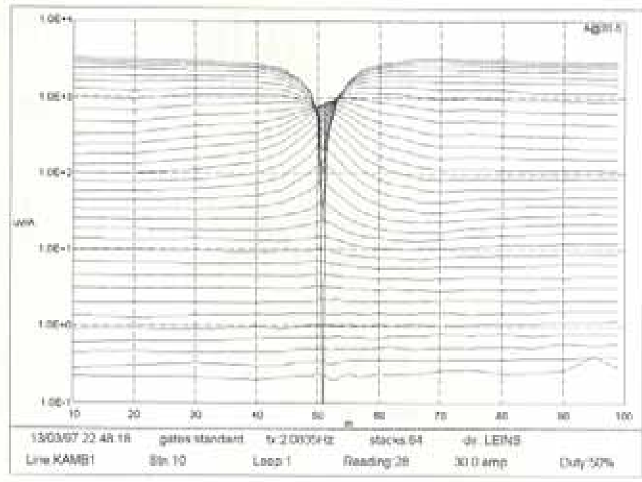

Figure 4a. Profile of borehole SMARTem data collected approximately 600 metres underground. This borehole intersected a small pod of nickel at a depth of 50 metres.

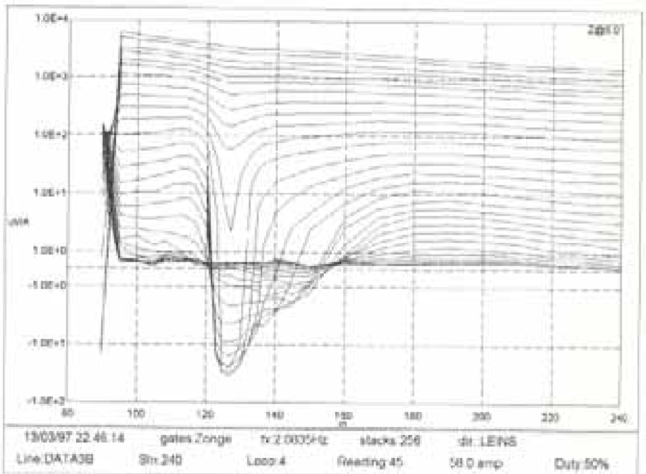

Figure 3b. Profile of processed borehole TEM data from same borehole as Figure 3a. PED interference has been removed during the survey by digital filtering of raw data recorded on hard disk.

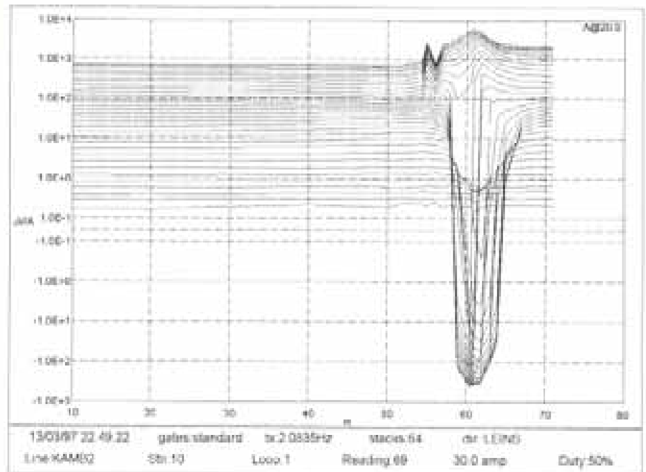

Figure 4b. Profile of borehole SMARTem data collected approximately 600 metres underground.

communications system to send short messages to underground workers. The system, called Personal Emergency Device (PED) continuously transmits a repeating series of tones between 360 and 390 Hz so that underground receivers can establish whether or not they are within range. PED transmissions can generate interference of several tens of millivolts on TEM data acquired up to several kilometres from the PED transmitter antenna (large fixed loop) and more than 100 millivolts if working in the vicinity of the antenna.

Figure 3 shows a SMARTem TEM data set collected in 1995 in a surface borehole in the vicinity of an operating mine. The TEM signals are badly affected by powerline and PED interference - there is approximately 20 millivolts of PED signal amplitude on raw data. In Figure 3a, data displayed has not been treated for the PED interference. Data presented in Figure 3b is the result of digitally filtering out the PED interference which can not be effectively removed by stacking or other conventional filtering techniques used in TEM. The PED interference filter developed does not result in any distortions or phase shifting of the desired TEM signals - a result that could not have been achieved using an analogue filtering strategy. The final product of the processing, which can be carried out either during data collection or afterwards, is a profile with an easily identified anomaly. Data collected under these conditions with other receiver systems resembles the profile in Figure 3a. The TEM signature at around 90 metres depth is the result of steel casing. The SMARTem data in Figure 3 has been optionally windowed to simulate Zonge delay times, the user can choose the default window set or elect to emulate the delay times of other instruments.

Figure 4 illustrates two SMARTem borehole TEM data sets collected in underground mines in 1996 at a depth of approximately 600 metres. These data are part of exploration efforts to map small pods of rich nickel ore in existing mines. A large transmitter loop at the surface (energised by a Zonge GGT-30 transmitter) was used in data collection. Both profiles show good anomalies from conductors in the vicinity of the borehole and a host response emanating some distance from the boreholes. The data in Figure 4a was collected in a hole which intersected ore at 51m. Both data sets were collected

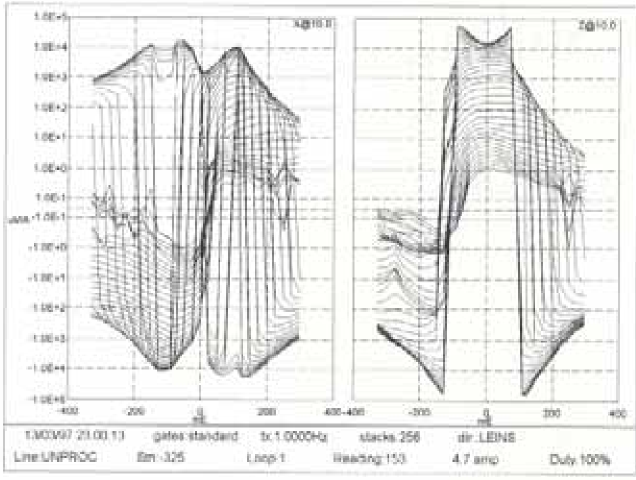

Figure 5. X (East) and Z (vertical) component TEM data collected over a known bedrock conductor at depth of approximately 180 metres using SMARTem, RVR-3C antenna and Zonge NT-20 transmitter. Note the classic smoke ring resulting from a conductive overburden. At long delay times a crossover in Z and negative peak in X define the location of the target.

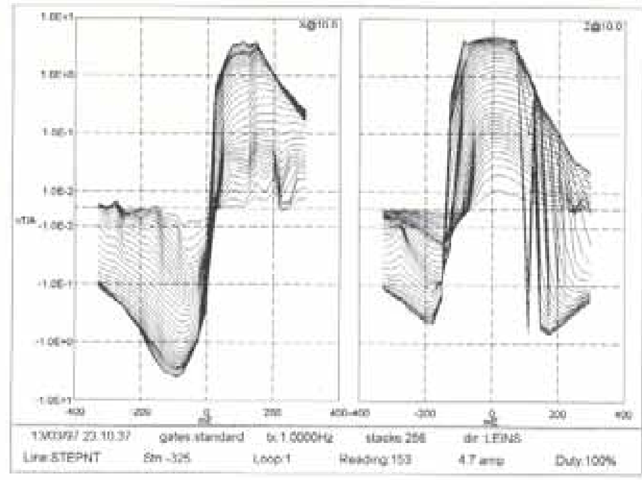

Figure 6. Step response transformation of data displayed in Figure 5. Transformation to step response was carried out using stacked waveforms recorded to hard disk during the survey and digitised current waveform. The step response highlights the bedrock conductor at the expense of the overburden signature.

using 64 stacks and a base frequency near 2 Hz. Total acquisition time at each station was approximately 20 seconds, including time required to automatically set amplifier gains etc., resulting in good survey productivity.

Figure 5 shows SMARTem fixed-loop TEM profile data collected using a 3-component RVR receiver antenna in 1995. This survey was carried out on the surface above a nickel deposit buried at a depth of approximately 180 metres. A portable 24V-powered Zonge NT-20 transmitter was used, yielding a current of 4.7 A into a 200m x 200m loop, with a base frequency of 1 Hz. The TEM response for two components, X = East (left side) and Z = up (right side) are plotted. The survey line crosses the transmitter loop at -100m and +100m, as can be noted on the Z component data. Profiles show a classic migrating smoke-ring style at short delay times. At long delay times, a crossover in the Z component and negative peak in X indicate a steeply dipping conductor at depth near -100m.

Recording of complete waveforms of raw data from this survey makes possible further stages of processing and analysis. Examples of reprocessing that can be accomplished include transformations (such as deconvolution and conversion to step response or frequency domain), re-windowing with an alternative scheme of delay times and post-acquisition filtering of sferic interference. The data set shown in Figure 5 has been converted to step response in Figure 6 as an alternative presentation. In this case, the digitised current waveform was used in the processing, but this is not required. The step response transformation has attenuated the overburden signature at short delay times and gives a clearer picture of the 'bedrock' anomaly at an earlier delay time than in Figure 5. There are subtle but significant differences, between impulse and step responses, in the location of the western Z component crossover and its variation with delay time.

Conclusion

SMARTem has been a successful development of geophysical instrumentation. It has provided a completely new level of information to geophysicists and field operators. In addition, the diagnostic capabilities of the instrument have been used by the developer to advance its signal processing functionality. As a result it has evolved rapidly to become capable of working in environments that preclude other systems. IP, Nuclear Magnetic Resonance (NMR) and other software modules for this receiver system will be available this year (1997).

SMARTem instruments have been operated exclusively by WMC Resources since 1995 and are now available to other groups.

Inverse Gravity Modelling (IGM) - A Perspective of Four Decades

by Indrajit G Roy and Kalyan Chakraborty

Introduction

Over 40 years of research has not provided a solution to ambiguity in gravity interpretation (GI). It is doubtful that an inverse gravity model (IGM) can be found that will provide a unique solution to the observed gravity anomaly (GA). Ambiguity in GI comes from two sources, the first being the non uniqueness in solutions with regards to mass distributions. Any number of plausible density distribution models can produce an identical GA (Skeels, 1947). The second larger factor is the insufficiency of observed data which is intrinsic to the gravity method (Roy; 1962). What is needed is a practical method of GI which provides the interpreter a rapid plausible solution to the available gravity data and known geological constraints.

Though introduced in the 1950s IGM never achieved much acceptance due to insufficient algorithms for computing arbitrary model structures and a lack of computing power. As a consequence the approximate depth rule (Bullard and Cooper, 1948; Bott and Smith, 1958) became the preferable method for interpreting gravity data. At that time, non uniqueness of GI and a lack of ability to discriminate between various IGM models led to disuse of the method.

An early attempt in IGM was due to Hall (1958) utilised the least square approach to fitting computed values of gravity models of bodies with simple geometries with a fixed density contrast to the observed GA. Later, Talwani et al. (1959) and Talwani and Ewing (1960) proposed a method of efficient forward modelling of two and three dimensional arbitrary structures. This provided a more robust method of IGM making it possible to apply inversion to complex model geometries. Corbato (1965) successfully implemented Talwani's scheme of forward computation of gravity response in a 2-D least square gravity inversion. The on going research on IGM over subsequent years has made it the most acceptable option in GI, as it provides a better understanding in selecting a plausible model in congruence with the geological constraints.

Two major approaches in model generation exist. In one case, a suitable model geometry is sought keeping density contrast unchanged, in the second, a model with varying density is considered over an array of cells of fixed geometry. Needles to say, each approach has its own relative merits. We will see shortly their characteristic details in IGM.

Geometry vs. Density Modelling

The main goal of IGM is to delineate anomalous mass distribution in the sub surface from observed GA, for which the model of unknown mass distribution embodies either the arbitrary geometry of a body having a fixed density contrast with respect to the host (geometry modelling) or the density variation in the sub surface over fixed cellular structures (density modelling). The observed GA $\Delta g(x,y)$ at any point on the X-Y plane, defining a horizontal surface and the model function for a mass distribution in the sub surface are related with a closed form expression in terms of integral equation

$$\Delta g(x,y) = \int_{-\infty}^{\infty} K[\alpha,\beta,\eta 1,\eta 2, \ldots]\, \delta\rho(\varpi)\delta\varpi$$

Where, K is a kernel function that generates the GA of value $\Delta g(x,y)$ per unit density contrast of any three dimensional body, parameters $\eta 1, \eta 2, \ldots$ depict the geometrical configuration while $\delta\rho(\varpi)$ is the density variation over the domain ϖ and arguments α and β are the running variables of integration replacing x and y.

Solution of the integral equation (1) is the basis of IGM and is a problem of geometry modelling where $\eta 1, \eta 2, \ldots$ are the unknowns for a fixed $\delta\rho(\varpi)$, otherwise where $\delta\rho(\varpi)$ varies with respect to a postulated geometry, the problem is that of density modelling. Preference of one approach over the other is subjective in practice. However, Bott (1967) indicated that while gravity inversion is nonlinear with geometrical modelling, density modelling is a linear inverse problem.

Gravity inversion with geometry modelling is popular amongst gravity modellers and it has been attempted both for space (Dyrelius and Vogel 1972; Al-Chalabi, 1971; Pedersen, 1979) and spectral (Oldenburg, 1974; Bhattacharya and Leu, 1975) domains. The chief reason for its popularity is that in many geologic conditions the model of a homogeneous body of a postulated density is desirable, although lack of flexibility in considering a number of model parameters (usually the depth to the edges of the modelled body) sometimes poses difficulty in model estimation.

Most inverse modelling algorithms are based on the principle of minimizing squared residual error between the observed and computed response by updating the model parameters in an iterative process. The error functional (squared residual error) in geometry modelling is nonlinearly related with model parameters and may possess a number of local minima. This often poses a difficulty in finding an optimal solution, as it may be wrongly defined by any of the local minima, if the minimum seeking scheme is not robust enough to find an appropriate(global) minimum. We necessarily mean that the 'appropriate minimum' is the least of all the minima. Al-Chalabi (1971) argued that ambiguity in inversion of gravity data is not only due to data insufficiency but also due to the presence of instability of the scheme, local

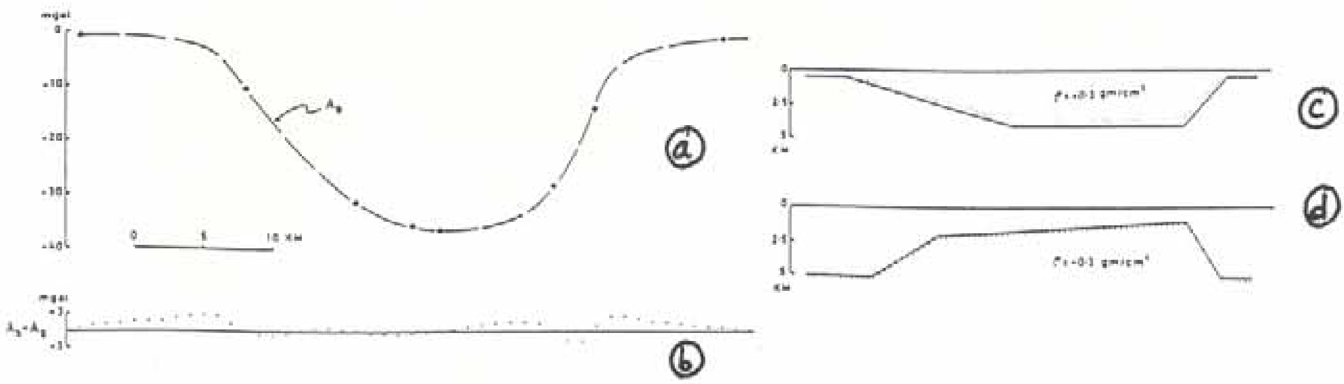

Figure 1. (a) The gravity anomaly due to basin (Fig. 1c), (b) the profile of discrepancy between the anomalies due to basin and batholith - like structure, (c) the basin like structure (after Al-Chalabi, 1971).

minima and measuremental error. He showed that even a small variation in data description may altogether change the model definition (Figure 1).

On the other hand, in density modelling, a model is considered to be comprised of an array of cells of fixed geometry satisfying the constraints of physical validity, such that cell densities are computed for minimum misfit between calculated and observed anomalies. The strong point in favour of this approach is its higher flexibility in considering the model dimension. However, such advantage is offset by the presence of computational complexity arising in incorporating constraints to reduce the ambiguity of the resulting density distributions. In general, the inverse problem through density modelling is under determined as number of model parameters is usually more than that of the observations. An under determined system does not provide a unique solution, instead, one can at best select an optimum solution from a class of possible solutions by ensuring validity through constraints.

Thus, we find, an optimal solution is the ultimate result in IGM. In the preceding discussion while we have emphasized the two major strategies in model generation, we have never indicated any bar to considering a more complex method where both strategies can be suitably combined. In fact, Hammer et al. (1991) indicated the possibility of considering a complicated model of a known arbitrarily shaped body having non uniform density distribution within it.

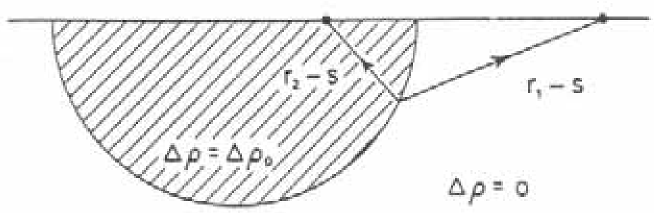

Figure 2. An ideal body generated by two gravity anomaly data (after Parker, 1974).

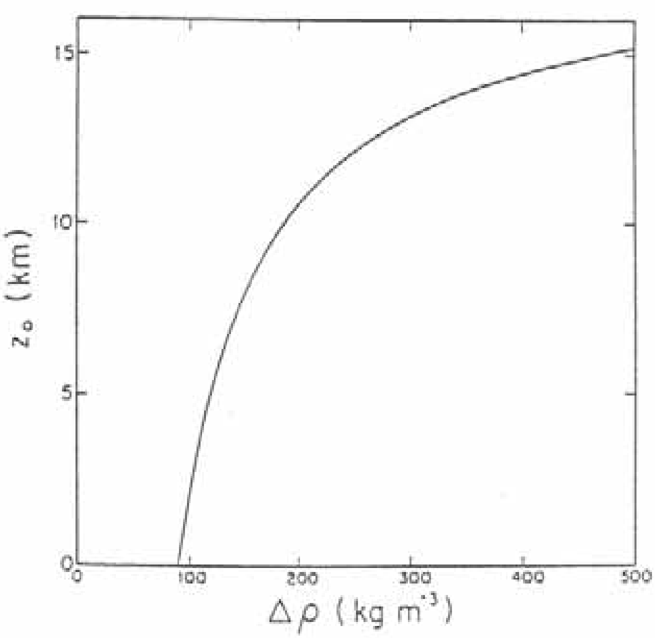

Figure 3. A trade off curve between density and depth (after parker, 1975).

Ideal Body in IGM

Ideal body (IB) theory emerged in the seventies as a new method of interpretation of gravity data where bounds in the model parameters were prescribed in describing a structure below the surface that satisfy a GA. Parker (1974, 1975) proposed an IB where either the depth of burial or the density is bounded irrespective of any structural justification. In other words, a body of least density is an IB described by other geometrical parameters, the shape factors, so that it's computed response fits the observed GA. Ideal body analysis (IBA) is a useful proposition in gravity modelling, as it gives an a priori estimate of the bounds of the two major parameters (density or depth), through examination of the limited data set. This allows an interpreter to handpick a few data points from a gravity map and generate an IB. It is even possible to define an IB bounded by a closed regular hemispherical surface, using only two data points from a gravity anomaly (Figure 2). Though, such a model is too simplistic in realizing a GA in practice, it is useful for a first hand reconnaissance interpretation of gravity anomalies. Parker (1975), Ander and Heustis (1987) showed that a trade off between density or depth bounds (Figure 3) can be made as a preliminary assessment of the geological bounds used to constrain the model initially. As, data insufficiency does not pose a great hurdle to assessing the bounds of the model parameters, an IBA becomes a unique possibility for defining a causative mass in the sub surface from the GA. However, we must not forget that an IBA does not guarantee a unique solution of IGM.

Numerical schemes in IGM

It is well understood that an IGM can only be realized efficiently through a proper numerical scheme. Instability, multi modality, slow convergence etc. are the major problems of concern in realizing a numerical scheme. Pedersen (1977) attempted geometry modelling in a nonlinear gravity inversion through a linearized iterative approach where the matrix equation evolved out of a set of simultaneous equations, generates a stable solution through a generalized inversion of the matrix operator. Generalized matrix inversion accounts for spectral decomposition of the matrix operator. The inversion scheme eliminates notorious eigen values (usually very small) that affect stability of the system. The scheme works well where successive linearization can describe precisely the nonlinear system.

Optimization technique, a leading method in the present day computational world has become increasingly popular in IGM; it works with the principle of maximizing a measure of closeness or in other words, minimizing the residual error between observed and computed responses through an iterative process. Al-Chalabi (1971) proposed an unconstrained optimization scheme in IGM using the variational principle of functional minimization and indicated a possible computational difficulty due to the presence of local minima.

In the class of problem where density modelling is used, constrained optimization technique has recently been applied. Last and Kubik (1983), Guillen and Menichetti (1984) proposed a new form of gravity inversion, considering the constraints of physical validity, minimizing either the volume or moment of inertia of the causative body; this new class of IGM is termed compact gravity inversion. Barbosa and Silva (1994) introduced a generalized form of compact gravity inversion and formalized the problem under Tikhonov's regularization scheme where a modified form of residual error functional is defined as a linear combination of residual error functional and a stabilizing functional, using the method of undetermined Lagrange's multiplier.

In the case of the geometry modelling problem, nonlinearity of the error functional causes it to be multimodal (possessing a countable number of local minima) which poses a great difficulty for a minimum seeking algorithm to track the global minimum. The density modelling problem on the other hand being grossly under determined poses an extra ordinary situation of manifoldness of the solution to the system. Thus, a globally optimal solution in either class of gravity inversion is difficult to find.

The ultimate goal of these algorithms is to define the globally optimal solution. A considerable amount of research on global search of optimization of error functional exists. An account of that research is beyond the scope of our present article. However, we indicate two approaches; one of which is formalized in a deterministic frame work, the other in stochastic. The first approach finds the global minimum of the error functional by constraining the solution domain so as to define the true solution within a narrow feasible region. The second approach works in the principle of randomness of selection of a solution that satisfy some pre-assigned statistical distribution. Simulated annealing is one such example where the residual error functional simulating an energy function is minimized slowly by selecting solutions randomly from the solution domain during each step of an iterative process.

It is the authors opinion that a globally optimum solution in IGM is an unrealizable goal. Unfortunately, there is no single method of gravity inversion reported so far which can be considered as a fool proof method for unfurling the mystery of ambiguity of GI. It seems more logical to express the ultimate solution with some uncertainty bounds considering the variability in terms of statistical measures.

Conclusion

The inverse gravity modelling provides insight into gravity interpretation through model generation and yet is unable to eliminate ambiguity in the solution. Research is leading to inversion of gravity data through information processing paradigm applied across natural and artificial problem solving systems. Neural networks may narrow the region of uncertainty in model building though unstable reverberations produce problem similar to the local minima in the functional minimization scheme. The inverse modelling algorithm will ultimately be based upon numerical schemes which provide computational stability and ensure a global solution in a local framework.

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Relocation of CSIRO Gamma-Ray Calibration Pads

In 1983, the then CSIRO Division of Mineral Physics constructed at their North Ryde site, a caliblration facility for portable gamma-ray spectrometers. This facility comprised five concrete slabs, 2m in diameter and 0.5m thick, with known amounts of potassium, uranium and thorium. The pads were cross calibrated against other, similar facilities in USA, Canada and Denmark. Further details of the cross-calibration and the assigned radioelement concentrations in the pads are given in an article by Dickson and Lovborg in Exploration Geophysics (1984) 15, 260-262.

The pads have recently been relocated to the grounds of the NSW Department of Mineral Resources Core Library at Londonderry, approximately 2 km north of Penrith in western Sydney. Access to the Core Library is by road from Sydney along the M4, then north along The Northern Road and Londonderry Road. The journey takes approximately one hour from central Sydney. As at North Ryde there is no charge for access to this facility.

The change in location has involved a change in the radioelement concentrations of the surrounding soils which are detailed in Table 1. The soil at Londonderry is higher in K and U but slightly lower in Th than at North Ryde. The Londonderry soil is also more uniform in U and Th but shows distinct variations in K.

Table 1. Changes in Soil Concentrations of K, U and Th resulting from the transfer of the calibration facility from the original North Ryde site to the new Londonderry site.

	Pad Ground Concentrations		
	K(%)	U(ppm)	Th(ppm)
Background	0.3 ⇒ 1.0	1.0 ⇒ 2.4	17.0 ⇒ 10.3
Potassium	0.2 ⇒ 0.5	1.5 ⇒ 3.1	14.0 ⇒ 11.0
Uranium	0.1 ⇒ 0.6	1.8 ⇒ 2.5	10.7 ⇒ 10.6
Mixed	0.2 ⇒ 0.4	1.6 ⇒ 3.2	9.6 ⇒ 11.2
Thorium	0.1 ⇒ 0.9	2.2 ⇒ 2.5	12.2 ⇒ 11.0

The pads approximate 93% infinite geometry and only 7% of the received radiation is derived from the pad surrounds. The changes in soil concentrations will result in changes to the radiation received by the gamma ray detector on the pads and hence the assigned calibration values. Table 2 lists revised assigned values, taking into account the variation between the North Ryde and Londerry sites. In all cases the changes are small and less than the uncertainty in the original assigned values.

Table 2: Radioelement concentrations assigned to the five calibration pads.

Pad	K(%)	eU(ppm)	eTh(ppm)
Background	0.23 ± 0.07	0.87 ± 0.06	1.79 ± 1.21
Potassium	3.89 ± 0.04	1.12 ± 0.10	1.03 ± 0.19
Uranium	0.43 ± 0.06	88.7 ± 1.8	1.39 ± 0.34
Mixed	0.18 ± 0.04	40.09 ± 0.9	91.2 ± 1.3
Thorium	0.13 ± 0.04	10.3 ± 0.5	160.0 ± 2.1

Application to use the pads must be made to the Londonderry staff by fax to (047) 77 4397 or phone Stan Kaluza on (047) 24 4997. As staff are not always available at the library, several days or preferably at least one week's, notice in advance is required.

Further information regarding the pads may be obtained from Dr. Bruce Dickson, CSIRO Division of Exploration and Mining (02-9887-8767). For additional access information, please contact Mr. Bruce Clift, NSW Department of Mineral Resources (02-9901-8231).

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Silver Membership Certificates

The following members have been awarded Silver Certificates for 25 years of continuous membership. Name selection has been made by comparing the original membership list with the 1996 list. People who have changed their names (e.g. through marriage or by deed pole) over that period will have missed out and, if they wish to receive a certificate, should contact the executive (Attention: Andrew Mutton) with their details.

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