Three cheers for these unsung heroes

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Since the 1960s, the Society of Exploration Geophysics (SEG) has taken a proactive approach to, and served as a forum for, discussion of geophysical developments in which standards for acquisition and processing of geophysical data need to be identified, created or improved.

For those of you who do not know, formats such as SEG-Y and SEG-D are 'Society of Exploration Geophysics' formats, hence the SEG part of the name. The work of the SEG in this area originally started with data standards, mainly in seismic acquisition, starting in 1967 and then in the 1970s it backtracked a little into a more low level analysis and development of standard sets in the areas of basic data recording (not really associated with the data type being recorded – just how data should be recorded on tape in terms of polarity etc.).

Between 1967 and 1975 the SEG collaborated with industry and produced standards for SEG-A, SEG-B, SEG-C, SEG-D, and SEG-Y, with each format being appropriate for its time and related to the seismic acquisition equipment capabilities and compute power of the day. Many of the formats are still recorded today by industry using these same format specification documents.

Between 1975 and 1980, the SEG produced two new standards on units of measure and also polarity. Both of these standards were then used, moving forward, for the other documents they produced and were adopted by industry. During the 1980s the SEG moved into creating positioning formats, map data interchange, seismic streamer and marine source standards.

The 1990s were a prolific time for the SEG producing numerous new standards and also updating past standards to conform with new technology and equipment coming onto the market. These included a new recording format for GPR and Shallow Reflection data, updates to the original polarity document of 1975, two new revisions of SEG-D to allow for 'demultiplexed at acquisition' formats, the creation of the monolithic RODE specification format with an update two years later, as well as various 'Ancillary Data Exchange' formats for trace attributes, navigation etc. (I had to look up the word monolithic to be sure the choice of word was right and found 'carved of a single piece of stone, massive and rigid' – yep perfect).

Since 2000 to present day, we have seen a significant drop in the volume of standards documents being produced. During this period, the SEG handed over navigation and positioning formats to the International Association of Oil and Gas Producers (OGP). In the main, the 2000 to 2012 period saw revisions to existing formats to bring them up to date with modern technology, acquisition and processing systems. Incredibly, in 2002, SEG-Y (the most prolific seismic exchange format in the industry) saw its first facelift since 1975 – lasting almost 30 years. Quite an amazing accomplishment for the team of Barry, K. M., Cavers, D. A. and Kneale, C. W. who wrote the original standard in 1975.

For me, when I think of the SEG, I think of standards. They have guided me in my work since I started in the industry and continue to pave the way for us as we move forward. The work they have done, while certainly not glamorous, has produced one of the most valuable bodies of work for the industry, while going unnoticed by many who use these standards on a daily basis to do their jobs. Without these standards, data exchange, data loading, interpretation and so many other challenges we face on a day to day basis – would be far more challenging than they are right now.

Copies of all of the standards produced can be found here: http://www.seg.org/resources/publications/misc/technical-standards and the people we owe our thanks to can be found here: http://member.seg.org/Committees/tabid/320/Default.aspx?cn=technical+standards.

It should be noted that the ASEG (our Aussie version) has also created standards and maintains an active interest in further developing solutions to problems specific to our region.

Editor's note: The work of the ASEG Technical Standards Committee is described on the ASEG website: www.aseg.org.au/aseg-technical-standards. The Chair of the ASEG Technical Standards Committee is David Robson and his email address is: technical-standards@aseg.org.au.

Seismic volume interpretation

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Last month I attended the EAGE Conference and Exhibition in Amsterdam. This is a huge event with several thousand attendees and hundreds of exhibitors. Papers were presented in 10–12 concurrent sessions. Far too many and no matter how much I studied the abstracts to help choose a session, I invariably found the content was trivial or no actual data was shown. So, I decided to spend time in the Exhibition area to see how the industry is progressing.

Usually there is something new and interesting in seismic acquisition and processing but this year I found the advances were in seismic interpretation. Several software packages such as Seisnetics, OpendTect, PaleoScan and, to some extent, DownUnder GeoSolutions Insight are now tackling volume interpretation or automatic picking, which has the potential to make life easier for seismic interpreters. The old ways of picking a few horizons on lines and time slices are being replaced by volume interpretation where hundreds of surfaces are picked by a machine and the interpreter merely has to sift through all this information and select whichever is most useful. Anyone who spends time in the exploration department of an oil company can see why this is necessary – we are all fully occupied yet over the last ten years the annual amount of seismic data acquisition has increased by 5 times (that is new data, we still have the old data as well).

In a recent review of the US industry professions, the average experience of geophysicists was 27 years in 2012 and 28 years in 2013 and the numbers of geophysicists had remained unchanged. More data with the same number of interpreters without some automation can only result in a less detailed interpretation, but today's workflows require more detail not less. Automatic horizon picking has been around for some time but volume interpretation (Hoyes & Cheret, 2011) takes things a step further and picks every event in the data. The interpreter doesn't have to use every event but they are available if required.

Figure 1 is a recent example from the offshore NW Shelf of Australia. I had spent some time trying to map some channels across an oil field. The project geologist also mapped a channel event but the two maps had differences. We then sent the data off for processing with Seisnetics software and when the results were ready it took only 15 minutes to identify the channel extents. And, because this was done by a machine, there was no interpreter bias. Unlike a human, the machine picks the same event every time.

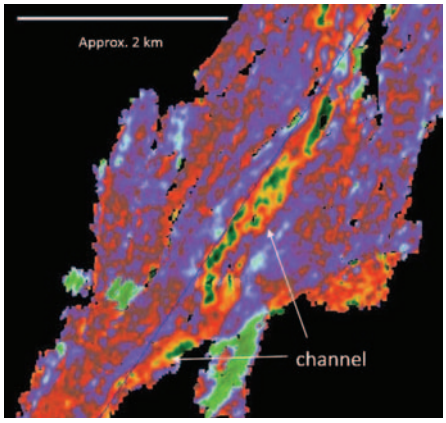


Fig. 1. *Seisnetics example showing a channel (green). Total interpreter time required to identify the extents of this channel was only 15 minutes.*

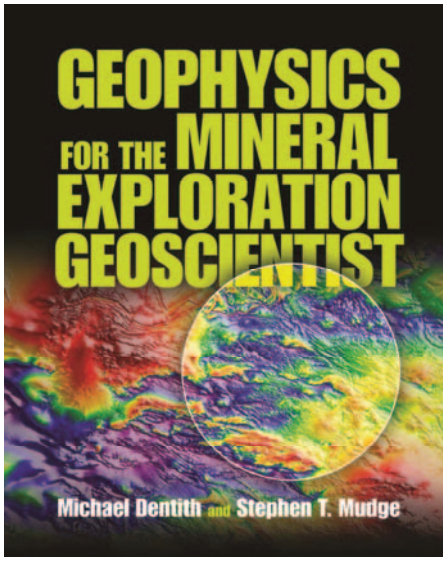
Of course the data quality needs to be pretty good for results to be useful … and less faults works better than heaps of faults. The good news from the EAGE Conference involved advances in automatic fault picking and I will be testing this over the next few months. I hope it works.

Reference

Hoyes, J. and Cheret, T., 2011, A review of 'global' interpretation methods for automated 3D horizon picking. *The Leading Edge,* **30**, 38–47.

Geophysics for the Mineral Exploration Geoscientist

By Mike Dentith and Steve Mudge



Publisher: Cambridge University Press, 2014, 438 pp. + seven electronic appendices.
www.cambridge.org/dentith
RRP: $75 (hardback), US$60 (ebook)

This book is a once-in-a-decade achievement where the authors have delivered a comprehensive textbook addressing an educational need in the resources industry. It represents a decade of effort by the two authors, both leading members of the ASEG, one from academia (Prof. Mike Dentith at the University of Western Australia) and one from the mineral exploration industry (Steve Mudge, who has worked for a wide range of companies as geophysicist, Chief Geophysicist, and consultant geophysicist).

The production of the book is of a very high quality, with all figures re-drawn to a uniform standard, and reproduced in colour. We should add our thanks to six Australian industry sponsors, Carpentaria Exploration, First Quantum Minerals, MMG, Rio Tinto Exploration, AngloGold Ashanti and St Barbara, who facilitated the quality production.

The book clearly aims to be a primer in the basics of geophysics, from the meaning of vectors through to signal processing, from shallow ground-penetrating radar through to crustal magnetotellurics, from the basics of gravity, magnetic and radiometrics through to image processing, and from shallow seismic refraction methods to deep seismic reflection and cross-hole methods for hard-rock targets. The table of contents gives a further indication of the scope of the book.

Table of contents

The book links each geophysical measurement method with rock physical properties by using copious graphs and discussion relating density, magnetic susceptibility, electrical conductivity and seismic velocity back to relevant characteristics of mineralogy and petrology. This is valuable in terms of educating the reader to think in terms of geological causes, not merely geophysical anomalies.

The gravity, magnetic and radiometrics chapters give a thorough treatment of data acquisition, reduction, image display and examples for a wide range of mineral terranes, including clear examples of distortions where remnant magnetisation plays a part. Examples include constrained and unconstrained inversions of potential field data, although treatment of constrained inversion is probably insufficient relative to its importance over the next decade. Spectral methods and recent 'worm' representations fail to get a mention, which may disappoint some.

The electrical and IP methods section is a welcome update to the literature, with comprehensive use of inversion output in addition to pseudo-sections. Given the page restrictions in the printed version of the book I would prefer less treatment of peripheral items such as Wenner and Schlumberger arrays, and self-potential methods, and to have an integrated treatment of magnetotelluric methods included in the book rather than being an electronic appendix. The importance of integrated seismic and MT methods, increasingly in use for geological studies over deep basin and crustal studies in areas of cover, is not mentioned; this too is probably an issue of prioritization of content where the readership may take differing points of view.

The book will be welcomed by exploration geologists, and will probably find a place on every student geologist's book-shelf (sorry about that anachronism, perhaps I should rephrase that to read, 'every student geologist's hard disc'!). In my own endeavours of teaching undergraduates and professional development courses for the exploration industry, I will be recommending this book as an essential item. However, the book may be fairly criticized as attempting too much. I question whether the book should be teaching concepts of vectors which are covered in high-school physics texts, and whether it should be teaching concepts of signal processing, filtering and image processing at the cost of reducing the number of interpretation case histories presented, and at the cost of relegating geophysics topics of importance to e-appendices.

The other difference of opinion I have with the authors is their use of fundamental physics. A book such as this clearly must be qualitative in its approach in order to suit its intended audience, but the lack of physics leads to gaps or errors which will make the book misleading if used in an 'exploration geophysics for geophysicists' course – few though such courses may be in this modern age (alas!). For example, the use of 'strength of magnetic field (B)' confuses the physicists' concepts of magnetic field strength (H) and magnetic flux density (B); the statement 'the FALCON airborne gravity gradiometer produces the vertical gradient of gravity' confuses instrumental and post-acquisition grid-processing concepts; use of the term 'Complete Bouguer anomaly' blurs the important distinction between the precise Bouguer

correction and the terrain correction.

The generally excellent resistivity-IP chapter is lacking in its definitions of the different measures of chargeability for time-domain IP, and in its mention of decoupling methods for frequency-domain phase data. The practising geophysicist will need to look elsewhere for such detail. For the more physics-intensive discipline of electromagnetic prospecting, the challenge of presenting insights without underlying theory becomes even more difficult. The authors do an excellent job of explaining the difference between step and impulse time-domain EM responses, and they introduce the concept of current channelling in addition to conventional vortex currents. However, without a discussion of the physics and relevant boundary conditions, there is no insight available as to how current channelling and induction phenomena are related with respect to sample time or transmitter geometry; such concepts are unlikely to be relevant to the geologist but they leave a large gap in understanding for a geophysicist who seeks to gain fundamental understanding from this book.

The interpretational geophysicist will be troubled with the use of logarithmic amplitude scales for fixed-loop and borehole EM examples of target responses under a conductive overburden. It is axiomatic that correct recognition of target responses in conductive environments demands use of linear scales, but again, in a modern age, perhaps the readers of this book will download data into a computer-based inversion package and let an algorithm do the recognition.

Each chapter of this new text-book for geophysics contains a summary of major points, and a summary set of questions which could easily be used for course assessment. In addition, all figures are available to instructors as a set of Powerpoint files. These features add tremendous value to the book as a resource for undergraduate class teaching. It will undoubtedly run to a second edition, and it is my hope that corrections and amendments will follow which upgrade its accuracy in quantitative geophysics. However I have no doubt that the strengths of the current book are such that it will be widely valued both as a reference text in the exploration industry, and in teaching geophysics in the geological context.

Associate Editor's note: As opinions on any one book will undoubtedly vary, we would like to invite and encourage the *Preview* readership – including book authors – to discuss and comment on book reviews. If you are also familiar with a book that has been reviewed in these pages, why not offer your thoughts? Such interaction and discussion can only help to build a clearer picture of the documents upon which we rely to keep abreast of, or become familiar with, the discipline of geophysics.

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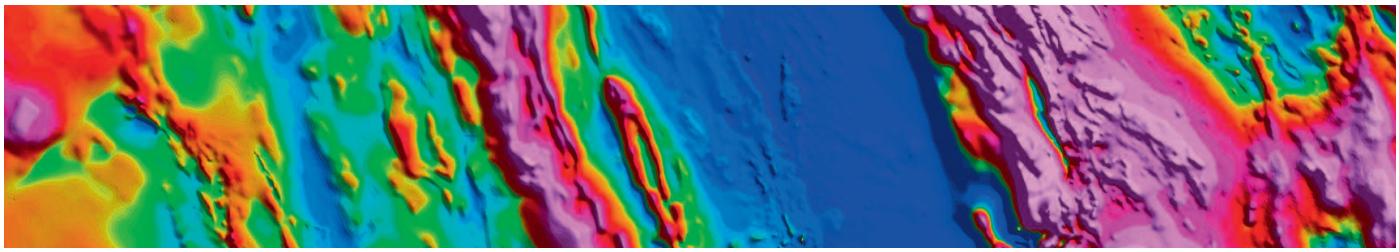

September			**2014**
15–17	EAGE Near Surface Geoscience 2014 20th European Meeting of Environmental and Engineering Geophysics of the Near Surface Geoscience Division of the EAGE http://www.eage.org	Athens	Greece
28–2 Oct	2014 Canadian Geotechnical Conference *Conference website pending. Please email cgs@cgs.ca for additional information or visit the CGS website (www.cgs.ca).*	Regina	Canada (Saskatchewan)
October			**2014**
21–23	131th SEGJ Conference http://www.segj.org	Shizuoka	Japan
26–31	SEG International Exhibition and 84th Annual Meeting http://www.seg.org	Denver	USA
27–29	KazGeo 2014: From Challenges to Opportunities http://www.eage.org	Almaty	Kazakhstan
December			**2014**
3–4	1st SEG/SBGf Workshop on Near Surface Geophysics Applied to Exploration, Engineering and Environmental Studies http://www.seg.org/meetings/Salvador2014	Salvador	Brazil
10–12	The 8th International Petroleum Technology Conference (IPTC) http://www.iptcnet.org	Kuala Lumpur	Malaysia
January			**2015**
11–14	3rd South Asian Geosciences Conference and Exhibition http://geo-india.com/	New Delhi	India
February			**2015**
15–18	ASEG–PESA 2015: *Geophysics and Geology together for Discovery* 24th International Geophysical Conference and Exhibition http://www.conference.aseg.org.au/	Perth	Australia
March			**2015**
18–21	PACRIM 2015 http://www.pacrim2015. ausimm. com.au	Hong Kong	China
May			**2015**
17–22	20th Caribbean Geological Conference http://www.thegstt.com	Port-of-Spain	Trinidad and Tobago
June			**2015**
1–4	77th EAGE Conference and Exhibition 2015 http://eage.org	Madrid	Spain
July			**2015**
7–10	Near-Surface Geophysics Asia-Pacific conference (NSGAP) (website TBA)	Waikoloa Village (Hilton), Hawaii	USA
October			**2015**
18–23	SEG International Exhibition and 85th Annual Meeting http://www.seg.org	New Orleans	USA
December			**2015**
7–9	The 9th International Petroleum Technology Conference (IPTC) http://www.iptcnet.org	Doha	Qatar
October			**2016**
16–21	SEG International Exhibition and 86th Annual Meeting http://www.seg.org	Dallas	USA
July			**2017**
2–17 (TBC)	Near-Surface Geophysics Asia-Pacific conference (NSGAP) (website TBA)	TBA	Australia

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