VOLUME 36 NUMBER 6

June 2011

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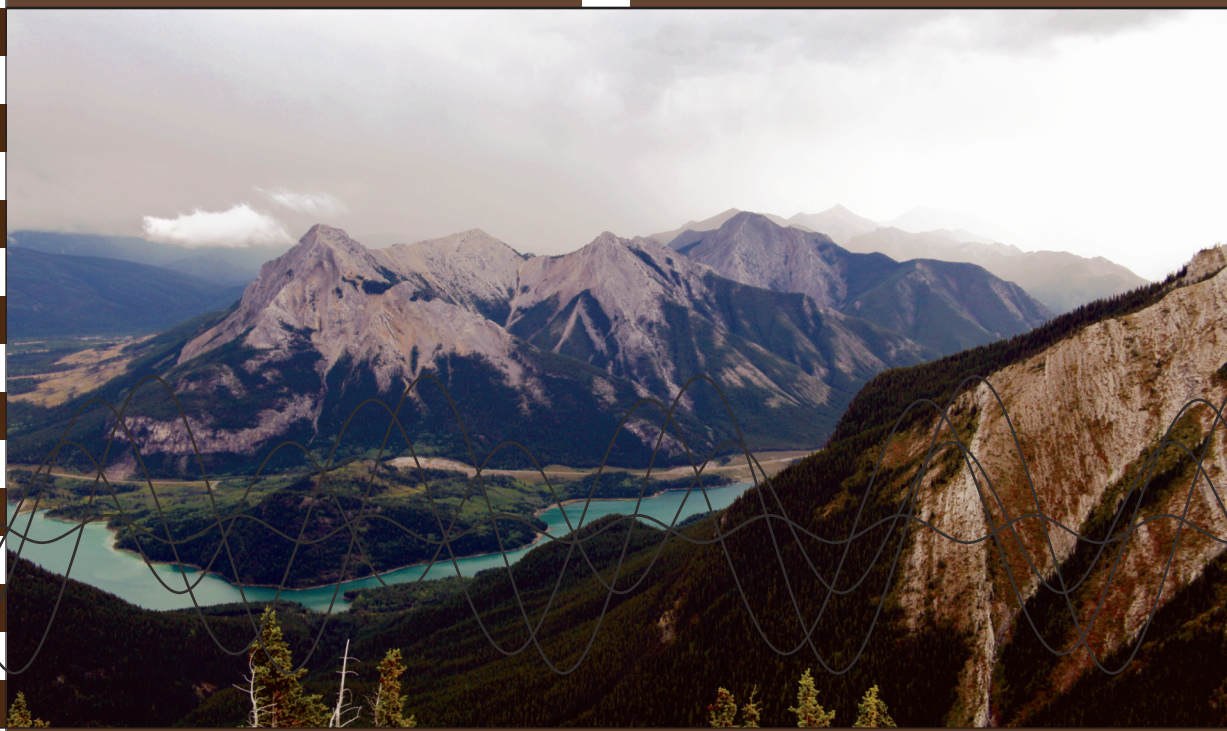



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Volume 36, Number 6

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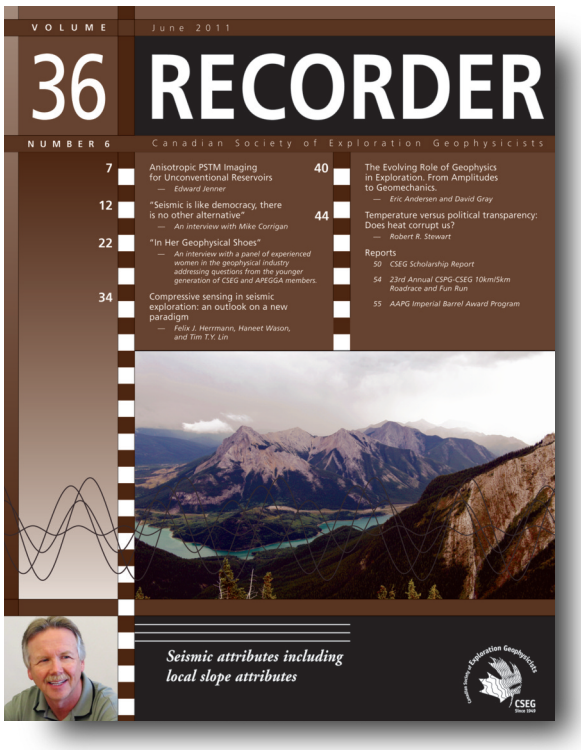

RECORDER is published ten times per year (July and August being the exceptions) by the Canadian Society of Exploration Geophysicists (CSEG), Calgary.

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Letters to the Editor: All your written comments are read by the editor. We reserve the right to edit all submissions; letters must include your name and address. Direct all correspondence to the Editor, CSEG, 600, 640 - 8th Avenue SW, Calgary, Alberta T2P 1G7.

Reprints: Address all requests for reprint orders and permission to use editorial material to the CSEG office.

Advertisers need to contact the Managing Director or the CSEG office for relevant information. CSEG, as publisher, reserves the right to reject advertising which is not in keeping with the publication standards.

All submissions, advertisements and articles must be received by the CSEG office no later than 30 days prior to publication month.

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June 2011
Volume 36, Number 6

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Cover Photo: Kananaskis Valley: Storm clouds approaching Barrier Peak, Kananaskis, Alberta (Photo courtesy: Rob Taerum.)

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PRESIDENTIAL COLUMN



Will Spring ever arrive?? Hopefully by the time this edition of the RECORDER is delivered, we will be basking in the sunshine and dusting off our cowboy boots and hats (or leaving town) in preparation for Stampede week.

What a convention! Hats off to the many volunteers who worked tirelessly to make the 2011 joint convention a success! I have heard many kudos from the attendees offered to the various committees for jobs well done, and I want to pass on my personal thanks as well as from the CSEG Executive to each and every one of the volunteers headed up by the Steering Committee of General Co-Chairs and their respective technical Co-Chairs Rob McGrory and Laurie Bellman (CSEG), Paul McKay and Per Kent Pedersen (CSPG) and Satyaki Ray and Simon Corti (CWLS). Our Exhibits Chair Judi MacDonald, and Sponsorship Chair Carmen Swalwell and their assistants were responsible for exceeding budget for exhibit and sponsorship revenues, and our convention staff Aileen Lozie and Alyssa Middleton tied everything together. There were countless others who contributed in no small part to the success of this year's convention, and we thank you.

As the committees wrap up their post-convention accounts, preliminary numbers look good. 4401 attendees participated in the convention, higher than 2009 but lower than last year when we had 8 societies participating. We had a lot of good feedback regarding the free exhibit hall pass available in the days leading up to the convention – most thought that this contributed to a more vibrant floor. (or was it the increased business optimism?) More detailed statistics to follow as they become available.

As best they can gauge it at this time, the Earth Science for Society committee estimate that 700 general public and 2000 students and teachers attended the Earth Science for Society exhibition as part of the convention. Yukon Dan and the Resources & You exhibits were tied for the most popular, and Gil Tucker from Global did a nice piece on the ESfS event in one of their news spots. A standing ovation to Rick Wierzbicki, Annette Milbradt, Helen Isaac and scores of other volunteers who made it happen. There was a lot of energy when all of those kids hit the floor.

Look forward to next year's Convention – "Vision"

Satinder Chopra will be co-chairing the event along with John Cody (CSPG) and Roy Benteau (CWLS). John Fernando will be the CSEG technical co-chair, and at the time of writing the other society's technical co-chairs have not been designated. The CSEG will be operating the 2012 convention and staffing considerations are in progress.

We're moving... for sure!

The paint is drying and the end of June will see the CSEG office move to the Roslyn building. We're putting the final touches on the office improvements, and Jim and Sheryl can't wait to move into the new digs. Make a point of coming in to the new office on the 5th floor of 400, 5th Avenue when you have a chance to say "Hi".

The CSEG Foundation

I promised last month that I would outline the CSEG Foundation in this month's column. Many of our members don't know what the Foundation is or what they do. I hope to shed some light on this for you – and please go to the Foundation website at http://www.cseg.ca/about/cseg-foundation.cfm for additional information.

Basically, the Foundation is the CSEG's registered charity that provides funding to geophysical related activities in support of the development of geophysical knowledge, education and public awareness. While relatively young, their goal is to become completely self-funding by growing their corpus – the funds that generate their income stream – to a sufficient size to accomplish this. Efforts are currently being considered that would see the Foundation undertake a major funding drive to reach that goal sooner than the founders had originally anticipated.

The Foundation operates as a registered charity with a Board of Directors: Brian Russell (Chair), Neil Rutherford, (Treasurer), Larry Herd (CSEG Pres.), Perry Kotkas (Sec.), Annette Milbradt, Hassan Odhwani, Matthew Klukas, and Sarah Cutten (Non Voting). Laurie Ross and John Boyd have just recently elected to the Board and by time of printing should be instated at the Foundation's AGM.

The mandate of the CSEG Foundation is to encourage and support scientific, educational and charitable activities that benefit geophysicists through the solicitation of contributions aimed at promoting the development of geophysical knowledge, education and public awareness. The activities of the Foundation are intended to supplement and support other CSEG committees by creating and increasing the Foundation's endowments:

- Liaise with other geophysical foundations throughout the world (e.g. SEG Foundation)
- Establish programs supporting education in geophysics and the earth sciences;
- Support post-secondary education in geophysics and the earth sciences, including the continuation of the CSEG scholarship programs;
- Support continuing education of geophysicists through the development of courses relating to developing technology, publications relating to the geosciences and by establishing education programs;
- Support scientific activities by providing seed funding of academic research programs;
- Develop and support non-profit programs designed to further the development of geophysical techniques aimed at improvements in geophysical applications in the earth sciences;
- Support the preservation of the history of geophysical exploration.

The CSEG Foundation manages the **CSEG's Scholarship Program**, awarding scholarships to successful University students who apply. The Foundation also issued $10,000 in travel grants and education subsidies to worthy applicants.

Continued on Page 43

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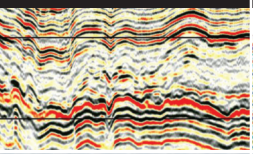

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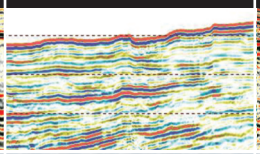

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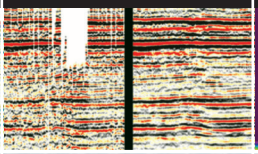

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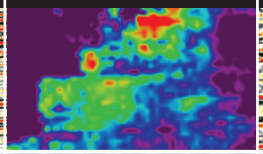

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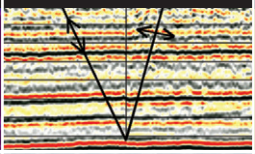

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EXECUTIVE MESSAGE



This executive column marks my final act as your Past President (though in actual fact, due to the vagaries of the publishing schedule, I write this as Past Past President). Over the last year, one of my key responsibilities was to chair the Honours and Awards Committee. This year, in addition to nominating the award recipients we also reviewed the honours the society currently bestows and whether they meet our continuing needs.

This review was motivated from feedback from our members and discussions we had at our long range planning session in June of 2010. Prior to this review the society gave out three awards; the CSEG medal, Honorary membership and the Meritorious Service award. In comparison the SEG gives out ten awards, the CSPG gives out more than eight, APEGGA gives out twelve Summit awards plus numerous volunteer awards. As President, I was asked on a number of occasions to nominate our members for these other societies' awards. It struck me as odd that we had not recognized these same individuals within our own society. Part of the issue was the narrowness of scope of our 3 current awards. Further, these awards honour a sum of contributions and by consequence are given to people relatively mature in their careers. In reviewing our awards we wanted a way to honour some of our younger energetic members who have made an impact on our society. Further, it was recognized that with today's global economy people may work in a number of locations around the world and that we should recognize people who are making a contribution while they are still in Canada.

To address these issues we proposed three new awards to the CSEG Executive and all three of these were accepted by CSEG executive. The first of these is the technical achievement award. It is to recognize geophysicists who have made a significant impact on Canadian geophysics over the last 5 years. This could be someone early in their career or later, the primary criterion is that they have made a significant technical contribution over the previous 5 year time period. This award should give the society the chance to recognize contributions of a different nature than that honoured by the CSEG medal. The wording of this award is…

> The **Technical Achievement Award** is awarded to a person who, in the unanimous opinion of the Honours and Awards Committee and the Executive Committee, has made an outstanding contribution to the advancement of Canadian Geophysics as manifested during the **previous five years**. The contribution may be of a technical or a professional nature.

The next award introduced is the special commendation award. This gives the society the ability to honour CSEG non-members who have made a significant impact on the society. This was identified as a current limitation of the Meritorious Service award. It is envisioned that this would be awarded to someone who has made a specific notable achievement such as championing a new CSEG initiative.

> The **Special Commendation Award** is to recognize and honour individuals who have made a significant contribution to the CSEG, the public and/or the industry as a whole. This award may be for recognized community leadership, professional leadership, or for contributions outside the main stream of geophysics.

It is viewed that this award would be given in recognition for services of a more limited scope than that of the Meritorious Service Award. The Meritorious Service award is thought to be more for a body of work and as such to further differentiate the two, the wording for the Meritorious Service award was changed striking out the "or" between prominent and lengthy. Thus the new wording reads…

> The **Meritorious Service Award** is given to members of the CSEG who have made a prominent and/or lengthy contribution to the Society and/or the industry as a whole. Current practice is to make a maximum of two of these awards each year.

Lastly the CSEG Foundation needed an award to honour benefactors. The wording of this award is…

> The **Benefactors Award** may be given by the unanimous approval of the Awards and Executive committees to individuals who have made a significant contribution in support of the goals of the CSEG Foundation. This award shall confer life membership on its recipients.

The strength of the CSEG rests with the strong spirit of volunteerism that exists within our Society. While people do not volunteer for awards, it is nice to be able to honour them. With these new awards I hope we can honour a few more individuals who have helped make our society great. With this I bid adieu. I have enjoyed serving as your President, and look forward to serving in new roles in following years. *R*

Jon Downton
CSEG Past President

CALENDAR

June			
13	**CSEG Technical Luncheon** *Edward Jenner, Manager, Research and Development (ION Geophysical, Denver):* *"Anisotropic PSTM Imaging for Unconventional Reservoirs."*	TCC, Calgary	www.cseg.ca
20	**CSEG T-Wave Golf Tourney**	Calgary	www.cseg.ca
23	**CSEG GIFT** (Geoph.Industry Field Trip)	Calgary	http://www.cseg.ca/students/
26-30	**2011 SEG SRW** (Summer Research Workshop): *"Inverting the Reservoir"*	Quebec City	www.seg.org

Anisotropic PSTM Imaging for Unconventional Reservoirs

Edward Jenner
Manager Research and Development, ION Geophysical, Calgary, Alberta, Canada

Introduction

Exploration and drilling efforts in onshore North America have increasingly moved away from conventional reservoirs and toward unconventional ones. Although advances in drilling technology have been the primary factors in achieving economic viability in these tight reservoirs, 3D seismic data has played an increasingly important role in development success.

The economic viability of unconventional reservoirs is primarily due to advances in horizontal drilling and hydraulic fracture stimulation technologies. The ability to drill long laterals allows more reservoir rock to be in contact with the well bore, whereas, hydraulic fracture stimulation creates the necessary permeability pathways in these very tight reservoirs. A key factor in economic success is the ability to create as extensive and complex a fracture network as possible. The fracture network created during hydraulic stimulation is strongly affected by the in-situ stress field, any natural fracture systems present, and the geo-mechanical properties of the rock. Although seismic data was initially considered to be of little use in unconventional reservoirs, over time operators have realized that 3D seismic data can provide significant value by helping to optimize the results obtained from horizontal drilling and hydraulic stimulation.

As operators started to drill non-vertical wells and increasingly longer laterals, without the benefit of 3D seismic data the drilling engineer often had trouble staying in zone and encountered drilling hazards such as faults. 3D seismic data allows the mapping of the structure and the thickness of the reservoir unit and the identification of possible drilling hazards. Thus, 3D seismic data has helped to optimize the results of horizontal drilling.

Anisotropy

Land environments in which the rocks have been buried, compacted and subjected to various tectonic stresses are often highly anisotropic. Wide azimuth seismic data provides an excellent sampling of source-receiver azimuths and offsets which enables the measurement of VTI and HTI anisotropy effects in the seismic data. VTI anisotropy caused by horizontal layering in the geology results in seismic velocities that vary with source-receiver offset or angle and produces the well known "hockey stick" effect on the far offsets. On the other hand, HTI anisotropy, which can be an effect of unequal horizontal stresses and/or vertical aligned fractures, results in seismic velocities that vary with source-receiver azimuth. HTI anisotropy produces a sinusoidal time shift signature on azimuth sorted CMP data (Figure 1).

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Edward Jenner – Manager, Research and Development, graduated from Birmingham University, UK with a B.Sc. in Physics with Astrophysics and from Leeds University, UK with a Masters in Geophysics. In 2001 he completed his Ph.D. in Geophysics at the Colorado School of Mines in Azimuthal velocity and AVO analysis. Since 2002 Edward has been manager of land research and development for ION with particular interests in the areas of anisotropy, AVO and imaging. Prior to 2001, Edward worked for BP investigating amplitude preserving multiple removal, at Conoco working on statics and pre-stack depth imaging and at CGG developing a technique for converted wave pre-stack depth migration. In 2003, Edward was awarded the SEG Clarence Karcher Award for his work in the field of azimuthal anisotropy.

CSEG June Luncheon sponsored by:

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JUNE LUNCHEON

DATE:	Monday, June 13, 2011
TIME:	11:30 A.M. Lunch
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SEPTEMBER LUNCHEON

September 12, 2011

"The Use of 3-component Seismic Data to Identify Sweet Spots in Fractured Bakken Reservoirs"

Scott L. Stockton, *Vector Seismic Data Processing, Inc.*

The CSEG September Luncheon is sponsored by APEGGA.

Anisotropic PSTM Imaging...

Continued from Page 7

Azimuthal analysis of wide azimuth 3D seismic data allows the measurement of the variation in velocity (and amplitude) with azimuth and the determination of azimuthal anisotropy attributes which provide information about stress fields and natural fracture systems. Schlumberger and Devon (JPT, 2008) have shown that during hydraulic stimulation a wide fracture fairway is best achieved under a low differential stress environment and that the measurement of seismic anisotropy can help predict areas most likely to have an optimal stress environment for hydraulic stimulation (Figure 2). In addition, when hydraulic stimulation is required to enhance the recovery of naturally fractured reservoirs, the interaction between the in situ stress field and any existing natural fractures becomes an important issue. Gale et al (2009) show evidence from the Barnett Shale for a reactivation of natural fractures during hydraulic stimulation that resulted in a widening of the induced fracture fairway (Figure 3). Thus, the ability to characterize natural fractures systems using seismic anisotropy and relate this information to the in situ stress field can help operators to optimize the results of hydraulic fracture stimulation.

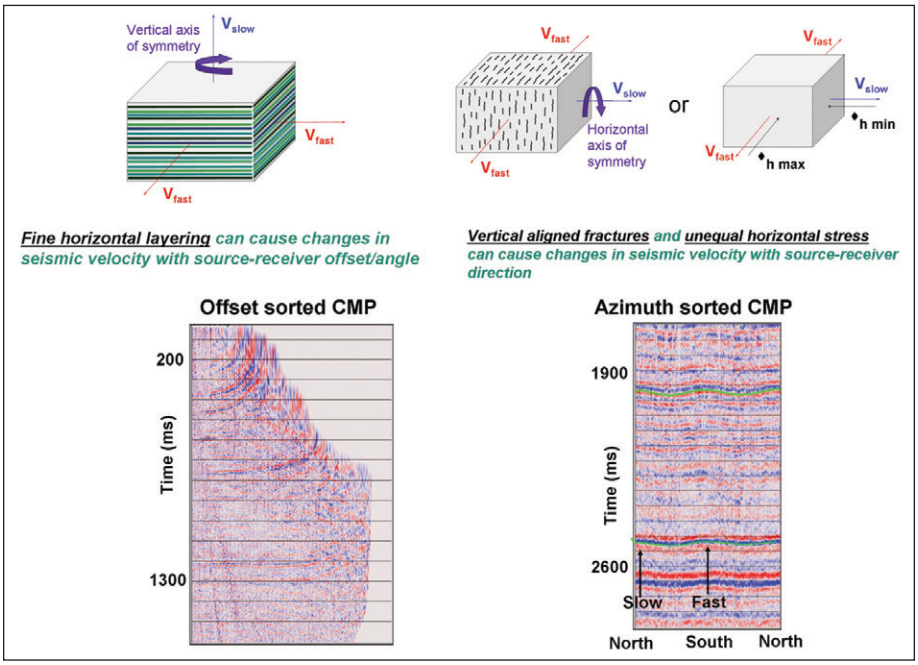

Figure 1. Vertical Transverse Isotropy (VTI) and Horizontal Transverse Isotropy (HTI).

Geo-mechanical Rock properties

Rock brittleness reflects the tendency of a rock to fail under stress and maintain a fracture. Brittle rock is more likely to be naturally fractured and also more likely to respond well to hydraulic fracturing treatments than a ductile rock. Seismic inversion allows the estimation of geo-mechanical rock properties related to brittleness which strongly influence the effectiveness of the hydraulic stimulation (Figure 4). However, the ability to obtain reliable rock properties from seismic inversion is dependent upon preserving the far offset data and adequately correcting for the VTI and HTI effects in the data.

PSTM Imaging

Accounting for the effects of anisotropy as well as geologic dip in P-wave data processing can significantly improve the

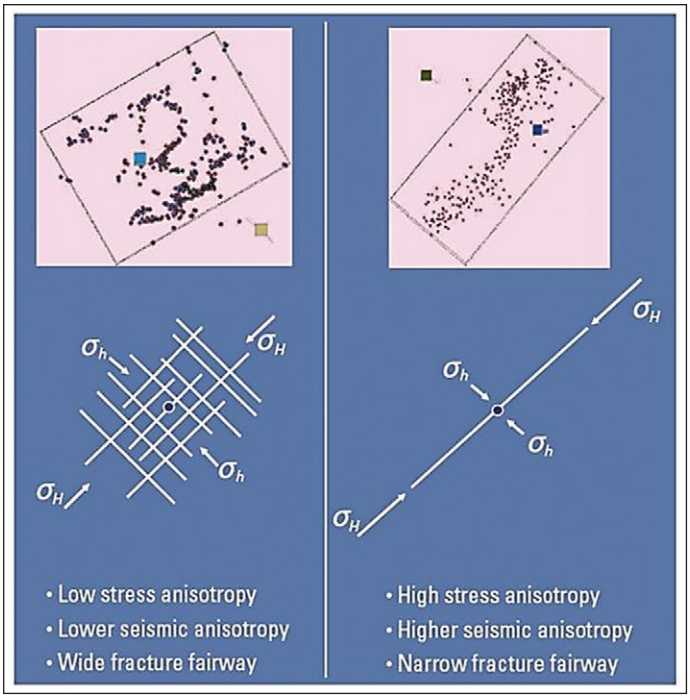

Figure 2. In-situ stress, seismic anisotropy and fracture fairway width (Journal of Petroleum Technology, September 2008).

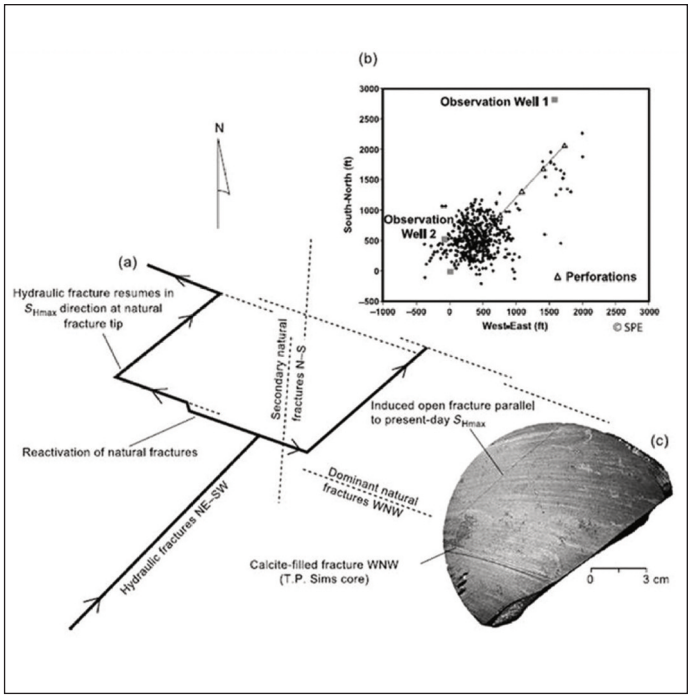

Figure 3. Natural fracture systems and induced fracture fairway width (Gale et al, AAPG Bulletin, April 2007).

Continued on Page 9

Anisotropic PSTM Imaging...

Continued from Page 8

quality of the seismic image and the estimation of anisotropy-related attributes and geo-mechanical rock properties. Recently it has become standard practice to perform Prestack Time Migration (PSTM) prior to azimuthal velocity analysis to account for dip and provide improved imaging. By performing the PSTM in the Common Offset Vector (COV) (otherwise known as Offset Vector Tile) domain, offset and azimuth information is preserved allowing for successful post-migration characterization of the azimuthal anisotropy. In addition, both VTI and HTI anisotropy can be incorporated into the PSTM resulting in improved imaging.

An example of incorporating VTI and HTI anisotropy into a COV PSTM is shown in Figure 5. In Figure 5a data from a wide-azimuth land survey are imaged with a conventional PSTM and an isotropic velocity field. Figure 5b shows the same data imaged with an azimuthally anisotropic PSTM also incorporating a VTI component. The imaging of the steep dips is clearly improved as is the imaging of the flatter reflections, mostly due to incorporating the azimuthal velocity variation. In this talk I shall show several field data examples of the two forms of anisotropy on wide-azimuth land seismic data and discuss in more detail the processing and imaging steps necessary to both correct the data and obtain anisotropic attributes. I will also discuss the potential use and interpretation of the azimuthal anisotropy attributes.

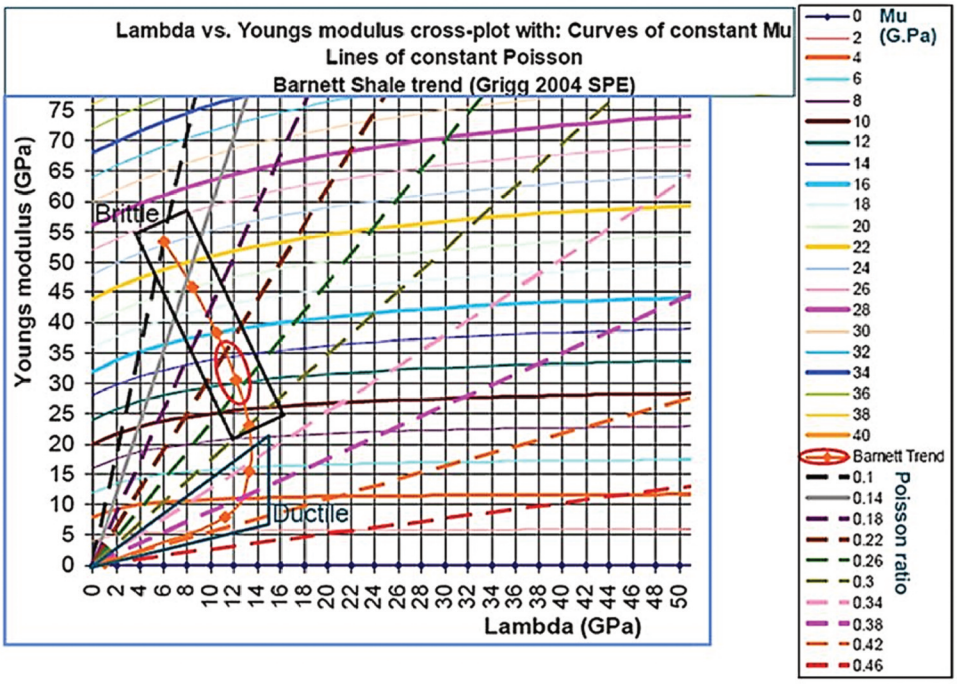

Figure 4. Relationship between brittleness and geo-mechanical rock properties (Goodway et al, CSPG CSEG 2007).

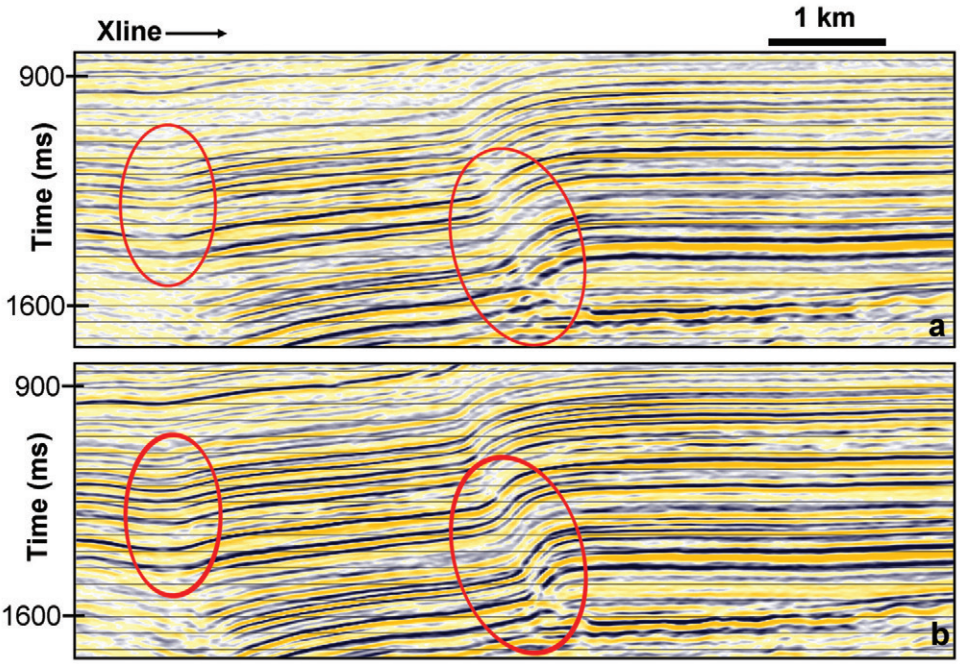

Figure 5. PSTM stacks using: a) isotropic velocity field and b) anisotropic velocity field.

Summary

Azimuthal anisotropy is becoming increasingly used as a tool for characterizing subsurface stress regimes, rock brittleness and natural fracture systems. These subsurface properties can help optimize hydraulic fracture treatments which are particularly important for unconventional reservoirs. In addition, accounting for seismic anisotropy in seismic data processing results in improved imaging and therefore enhances the ability to accurately place wells and keep horizontal well bores in the reservoir zone. R

Acknowledgements

The author would like to thank ION Geophysical for permission to present this material.

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"Safety is not proprietary. And for this reason ExxonMobil shares its best practices within our industry and across other industries. We seek to learn from others." **Testimony of Rex Tillerson, CEO of Exxon Mobil, Hearing before the National Commission, November 9, 2010.**

The Gulf of Mexico oil spill (also referred to as the BP oil spill, the Deepwater Horizon oil spill or the Macondo blowout) resulted from the explosion of the well platform on April 20, 2010. Eleven lives were lost and seventeen others were injured. It highlighted the dangers that can be associated with extraction of resources. It shone a spotlight on the Industry in both the sense of safety and of the environment. Much has been written about the environmental aspects of such a spill or others than came before, such as the grounding of Exxon Mobil's Exxon Valdez in 1989 off of Alaska. So for the purposes of this article I will write about the safety aspect and the implications to Industry as a whole.

One of my members has often said (in relation to safety) "You're working with money or you're working for money". His meaning as it relates to safety is that some clients pay you for a service (i.e. turnkey) and leave the parameters of your operations to you whereas a few will walk the talk; do more than just pay lip service to safety and standards; and will pay for extra costs as it relates to higher levels of safety and standards. Keep in mind the majority of clients (and contractors) operate somewhere in-between these two goalposts.

The USA National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling released their final report on January 1, 2011. The URL link is here: http://www.oilspillcommission.gov/final-report . Of particular interest is Chapter Eight titled "Safety is not proprietary" Changing Business as Usual (see the quote at the beginning of this article for full reference).

The chapter examines how petroleum companies have been managing the risks associated with finding and producing oil and how they can do it better, individually and as a responsible industry overall. The record shows that without effective government oversight, the offshore oil and gas industry will not adequately reduce the risk of accidents, nor prepare effectively to respond in emergencies. However, government oversight, alone, *cannot reduce those risks* to the full extent possible. Government oversight (see Chapter 9) must be accompanied by the oil and gas industry's internal reinvention: sweeping reforms that accomplish no less than a fundamental transformation of its safety culture.

In March 1980, the Alexander Kielland—built as a drilling rig but under lease to Phillips Petroleum Company to house offshore workers at the Ekofisk Field in the Norwegian North Sea—capsized, killing 123 of the 212 people on board the "flotel." Two years later, during preparation for an approaching North Atlantic storm, the Ocean Ranger Semi-submersible drilling the Hibernia field for Mobil Oil of Canada, sank off the coast of Newfoundland; all 84 crew members were lost in the freezing-cold waters. And in July 1988, the Piper Alpha production platform operated by Occidental Petroleum 120 miles northeast of Aberdeen, Scotland, exploded and sank, killing 167 people, including 2 rescuers. Although the causes of the accidents varied, they all involved international operations of U.S.-based oil and gas companies. Common contributing factors included inadequate safety assurance, worker training, and evacuation procedures. Poor communication and confusion about lines of authority amplified the death toll in at least two of the accidents.

All these foreign regulators—the United Kingdom, Norway, and Canada—had previously relied on the kind of prescriptive approach used in the United States, but in the aftermath of these fatal accidents in harsh, remote offshore environments, authorities elsewhere concluded that adding a risk-based approach was essential. They faulted reliance on the "prescriptive regulation with inspection model" for being fundamentally reactive. And therefore incapable of driving continuous improvement in policies and practices.

According to Magne Ognedal, the Director General of the Norwegian Petroleum Safety Authority, the prescription-only model engendered hostility between the parties and put the risk—legal and moral—onto the regulator to accommodate changing technology, geology, and location, rather than onto the operator, where the responsibility rightly belonged. Under the new safety-management model, minimum standards for structural and operational integrity (well control, prevention of fires and explosions, and worker safety) remained in place. But the burden now rested on industry to assess the risks associated with offshore activities and demonstrate that each facility had the policies, plans, and systems in place to manage those risks. In the United Kingdom, such risk management plans were called a "Safety Case."

For years, the American Petroleum Institute (API) also led the effort to persuade the Minerals Management Service (MMS) not to adopt a new regulatory approach—the Safety and Environmental Management System (SEMS)—and instead has favored relying on voluntary, recommended safety practices. Safety and environmental management systems are used in similar forms in other parts of the world and many credit them with the better safety records achieved outside U.S. waters (see Chapter 3). Beginning early in the last decade, the trade organization steadfastly resisted MMS's efforts to require all companies to demonstrate that they have a complete safety and environmental management system in addition to meeting more traditional, prescriptive regulations—despite the fact that this is the direction taken in other countries in response to the Piper Alpha rig explosion in the late 1980s. Indeed, many operators in the Gulf were used to this safety-based approach on their rigs in the North Sea and Canada.

Another example: The nuclear (subs) USA Navy. Turning from the skies to the sea, between 1915 and 1963, the U.S. Navy lost about one submarine every three years to noncombat causes. In 1963, when the nuclear-powered USS Thresher was lost during a deep test dive, 112 naval personnel and 17 civilians perished. The Navy investigation found that a deficient silver-braze joint in a piping system had failed, flooding the engine room. The investigation went

Mike Doyle is the President of the CAGC – the Canadian Association of Geophysical Contractors – representing the business interests of the seismic industry within Canada. The CAGC website may be found at www.cagc.ca



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"Seismic is like democracy, there is no other alternative"



An interview with Mike Corrigan

Mike Corrigan is one of Calgary's more experienced geophysicists, a veteran of over thirty years in the industry. After a few years in mining exploration, he entered the oil and gas industry as a geophysicist. Since then he has worked for nine companies in full time positions, and is currently an active consultant. Outside of work he has a passionate love for fishing, and has caught over thirty different species of fish, and had stints as a professional guide and as a professional fly tier. RECORDER editors Satinder Chopra and Oliver Kuhn were privileged to spend time with Mike gaining his fascinating perspectives on work, life and family.

(Photos courtesy: Joyce Au.)

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"Seismic is like democracy..."

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S: ***Mike let's begin by asking you to speak about your educational background and your work experience.***

M: Okay. I graduated from High School in Ontario in 1973. I attended Sault College in Sault Ste. Marie, Ontario taking the Geologic Technician Program, and graduated in 1975. Upon graduation I started working in the Mineral Exploration end of the business, working both exploration as well as within both open pit and underground mines, and in 1977 I decided that it was time to go back to University. I graduated from the University of Waterloo in 1981 with an Honours, B.Sc. in Earth Sciences. At Waterloo the degree is more an all encompassing degree in which you are exposed to geology, geophysics, groundwater, engineering – a little bit of everything. My graduating class was about 50 people and I think 48 of them ended up in Calgary and two of us stayed back East. I got a job with Hudson's Bay Oil and Gas (HBOG) Mining Division, and that's basically where I started my career.

O: ***I have known you for a while Mike – would it be fair to say that your career has reflected the changing face of the Calgary Oil Industry?***

M: I would say so Oliver. As I said, I graduated and took a job in mining, and in 1982 Hudson's Bay Oil and Gas was taken over by Dome Petroleum and our Toronto office was effectively shut which was symptomatic of what was about to happen in Calgary with the merger mania; a lot of mergers ended up working out very poorly for the oil companies.

Personally, I was transferred to Calgary and Dome asked me to be re-trained as a geophysicist. With my mining background we worked kind of soup to nuts. We did the geophysics but we also did the geology. We logged the core, planned the drilling locations, we did everything; our job titles with HBOG were as project managers. So making the transfer into geophysics was a no-brainer for me. It was something I was always very, very keen on. The mining business was totally different from oil and gas though and so I arrived in Calgary in 1983, with a pregnant wife and with the industry in a bit of upheaval. It was post – NEP and to answer your question in a round-about-way, the first part of my career was not only learning to interpret seismic data, but also learning to roll with the punches. There were wave after wave of layoffs, several rounds of pay cuts, a lot of staff movement within the industry (lots of beer buyouts at the old King Eddy) and a lot of the "older" people packaged out of the industry. So it was a time of change but a time of challenge and learning and that's kind of been what I found throughout my career. Calgary is such a dynamic city. Like most employees, Calgary seems to be able to roll with the punches as well. As a Geophysicist you have to always be up for a challenge and be adaptable. In order to survive for 30 years in this business one needs to constantly prepare for change.

O: ***So, if you had to break your career into phases would the first phase be big companies, down-sizing, merging etc., the second phase would be more juniors and start-ups and the third phase consulting perhaps?***

M: I think that would be a fair way to put it. Looking at the industry itself, a lot of the larger companies back in the 70's and 80's, had work-forces of thousands of people; some even had company jets, and nurses and doctors on staff. A lot of people left the larger companies to go to the smaller ones; a lot of my colleagues at Dome and other companies ended up doing the start-up thing and it was a totally different game, a lot more hands on and I think a lot more challenging than what people expected. There were rewards all along the way, some financial and some were more technical or personal rewards.

The consulting part of my career has been the most rewarding for me personally because of the challenge. When you are a consultant, you are essentially a team of one. You are responsible for everything that goes on in your consulting practice, from computer problems to learning new software, new plays, new people and learning everything about dealing with different people's styles and expectations. It is a matter of having the confidence to succeed. The early days of my career I wouldn't trade for anything. There were hard economic times at Dome and we were a very young and very inexperienced group of geophysicists, but we drilled a lot of wells and we learned from our mistakes and had a lot of success despite what we didn't know. A lot of those young geophysicists have gone on to very senior/leadership roles in Calgary and around the world. It was kind of baptism by fire and I think that really helped a lot of the professionals back then.

O: ***So when you went from working within a team environment at a small company to be a consultant, did you miss the team aspect of it?***

M: That's a good question because that was the one thing I missed when I left Canadian Hunter (Burlington), and I'd spent twelve years there, Hunter was all about teams. When you go to the start-ups it's all about making money and it's not so much about doing the good technical work anymore. And that was difficult. As it turned out, I ended consulting for a lot of ex-Hunter start-ups which was very satisfying. There were a lot of other opportunities out there that I looked at and just felt it wasn't going to be satisfying enough from a career point of view.

S: ***Let me ask you this Mike, so choosing between the stability of a national oil company or a very big company, where once you get in you just simply retire from there, or a fast pace of work at a small company, private company, which one would be better from your perspective?***

M: From my perspective the fast paced, definitely. You know, our job is all about making money for our employers but it's also about testing ideas and I don't know that that opportunity is there in the larger companies. You have to make mistakes and you learn from your mistakes and the only way to do that is in a fast paced environment where you are testing your ideas a lot.

S: ***As you just said, you spent half your career at Hunter and you look back fondly on those years, so tell us what made your long stint at Hunter so enjoyable and satisfying?***

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M: Hunter was a very unique company to work for. It was a place where you were constantly challenged to do better. You were challenged by the people you reported to but more importantly, by yourself. We were doing a lot of things on the "bleeding" edge and a lot of things on the leading edge and so you got to see people thinking out of the box and a lot of very good intellectuals at Hunter at that time. Jim Gray and John Masters were basically funding every good idea, which almost led to Hunter's downfall. We regrouped in 1995 and went from 450 people to 150 and became a self sufficient oil company (our parent Noranda Mines mandated that), one that had to learn how to survive on its own cash flow.

The turning point for me was sitting in a post-layoff meeting with Senior Management and they stood up in front of us all and said – we know we have to take this company in a different direction, we have some ideas but it's the people in this room that are going to make it happen. That seemed like a daunting task, but the reality was that everybody brought their game up a little bit and we became a company that was focused on making money. The end result was a career that was a lot of work, but a lot of fun. Our attrition rate over the next number of years was basically nil which says a lot about Hunter. We lost maybe a handful of people in the next five to six years and there were no goofy ideas. We didn't do them all but we talked about them and it was important to have everybody's input in the decision making process, it wasn't just one person making the decision anymore. From a job satisfaction point of view it was probably the best environment that anybody could ever ask for.

O: ***So if you view the Canadian Hunter style culture as almost the perfect type of work environment, how do you feel about the trend towards companies using temporary workers, consultants – I believe contingent work-force is the term? How do you see that both from the company point of view and from the employee view?***

M: Well, if you go back to when a lot of us started in the industry, because of salary constraints, a lot of the senior staff were let go. Nowadays, a lot of the senior staff are consulting and so the expertise is still out there. Personally, I think that not enough consultants are being used properly and I am thinking more from a mentorship point of view as opposed to pure, "down in the trenches" interpreting. I honestly believe there is a real role out there for mentors right now for the young geophysicists because you know there is a saying that, "A good geophysicist is expensive, but an inexperienced geophysicist is very expensive," and I firmly believe that we've all made mistakes in our career that others can learn from. Our daughter is a geophysicist now and when I sit with her I realize how much I have learned over the past thirty years while she is just touching the tip of the iceberg on very basic stuff.

O: ***I suppose what you are saying is that the more creative use of the workforce is a good way to transition from the baby boom period to the post baby period, if we do it properly.***

M: Right, I agree with that. However, there are a lot of companies out there that just do not like consultants because of the perceived extra costs.

O: ***You have been through several upturns and downturns as we all have – what are your thoughts on the whole up – down cycle now that it appears that we are coming out of this most recent downturn (we hope)?***

M: The upturn obviously brings a lot of good people into the industry but I think it brings too many people into the industry, and then the downturns kind of flush a lot of that out. I think it's difficult in terms of a morale point of view. The reality is good people always will find jobs and so I don't see the cycles as being a bad thing.

O: ***That brings to mind a funny little saying – "If the wind blows strong enough even turkeys can fly." I guess during the upturns a lot of things happen or people are employed or whatever that are less than desirable.***

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"Seismic is like democracy..."

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S: ***Mike you always made it a point to find a balance between career, family and hobbies. Talk to us about how important you feel it is?***

M: I think twenty years from now I would like to be remembered not by the jobs that I had but by the person I am. I would like to be remembered as a Geophysicist, fishing guide, fly tier, husband, father, and whatever else the future holds, but I think without balance in your life, stress and dealing with stress is a real problem for a lot of people. Those who are remembered by only the working facet of their lives will have difficulty transitioning to retirement. This is a very high stress city, extremely high stress. With the amount of money that we spend or commit to spend on the work that we do, and the reality that we are wrong more times than we are right, and that people have to get back on the horse and go again – I think some sense of balance is vital, and I am talking both ways, you can work too hard but you can also play too hard too. So I think it's just finding a happy medium in there that allows you to be a high performer in your job but also to have a family life as well.

S: ***Well, it seems you have led a good life on your terms, professionally and personally, so is there anything you wish you had done differently or achieved differently?***

M: Honestly, life is about making choices but also life is about rolling with the punches and I really don't have any regrets. Everything we do is about taking a risk. We took a risk coming to Calgary in 1983, basically starting all over again. Changing jobs was always a risk and sometimes the changes were better than others, but I just look at the way my career has unfolded and honestly wouldn't change anything about it.

S: ***Very nice. Still on the same topic, what differences in your personal and professional life did you notice when you turned 30, 40, and then 50 years old? As an example, some people think the 20s are a time of adventure and risk, the 30s a time for experimenting with options, and the 40s a time for introspection; talk to us about that.***

M: That's a tough one. Early on in your life, in your career, you are on a steep learning curve and you know it's all about trying to cram in as much information and ask as many dumb questions as you can to try and understand what the job entails, how to deal with people and the rest of it that goes along with that.

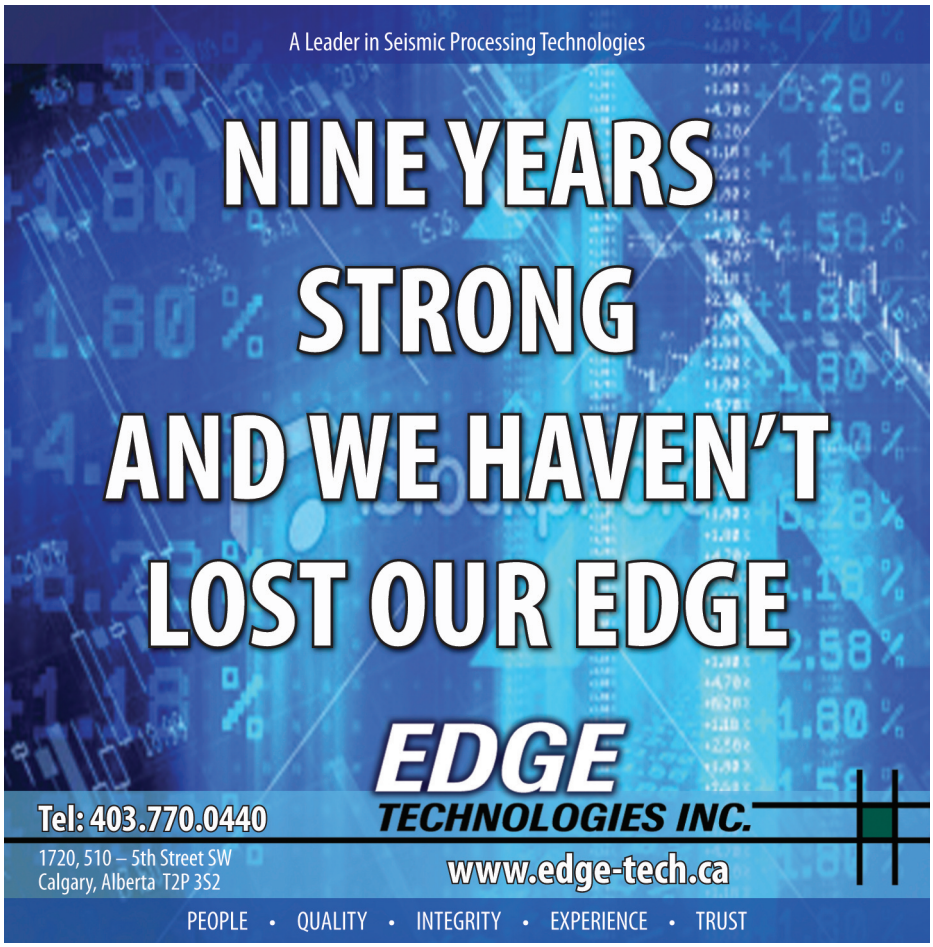
When you are in your 40s I think you kind of hit the point where you are still learning but the job is becoming second nature to you.

I think once you get into your 50s then you are starting to look back on your career, again hopefully without any regrets, but also look down the road and look for new challenges, and you can't stop learning. You have to constantly be asking questions and you have to constantly be accepting of change and of what life is going to bring you. As I head down the road towards retirement, I guess I'd like to cram in a bunch of projects that I am still keen on doing. I don't need to be re-doing some of the things that I have done in my career already. I want more challenges.

O: ***On the topic of continual learning, what technologies and innovations have you experienced in your career that made a particular impact, the really significant ones?***

M: Certainly 3D. I was involved in some of the early 3Ds up in the pinnacle basins and I think we embraced that technology. Once the first ones were shot and you saw the results it was like a whole different world.

The work stations, absolutely. They have allowed us to get through a lot more data and look at things, dozens of ways differently than we could when we were picking things by hand. But I think as we head into the future



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now I think the innovations or the challenges are more related to the geophysicist finding a role in the industry. With a lot of the shale gas/oil plays I have seen – I have been almost exclusively working shale gas and shale oil for the past three years – there is a huge opportunity for seismic but it's getting the word out there and selling it, company by company that there is a need for seismic. I have seen AVO and inversion come and (almost) go, and some of the other technologies that have kind of gained acceptance in some parts of the basin or some parts of the world. I think what we are seeing right now with a lot of the fracture detection work that it is going to be an exciting future and geophysicists, especially the older guys, have to re-train themselves, because it will be the bulk of the work.

S: ***Mike, you have mentioned that you were involved in authoring and presenting several technical papers on reservoir characterization and AVO display techniques in the late 80s during your short lived "geek" phase. So my question is why was your "geek" phase short lived?***

M: That's a great question Satinder! For me public speaking was a real challenge and when I had to deliver my Thesis at University, that was the most difficult week of my life leading up to it. You come to Calgary and it's all about presentation day in and day out with managers, with co-workers, it's difficult. So I found a couple of topics in which I was involved with some other authors on AVO and reservoir characterization, and the opportunity came to present these at the SEG as well as CSPG joint session here in Calgary and I thought – it's time to take the next step, in other words get over that fear, take the leap and so it was a challenge, I think I met the challenge and that was over and done with.

I have been involved in some really interesting projects since then, that I think probably would have been as good if not better from a technical presentation point of view. I saw some amazing differences using pre-stack time migration that we did in some of the Slave Point reefs which would have been a great paper, but I didn't need to do that. I had enough satisfaction just getting the project done and drilling the wells.

S: ***Mike, tell us something about the role you see geophysics playing in the development of unconventional resource plays.***

M: When I was at Hunter, John Masters had an interesting comment for me one time when I was presenting and we were looking at trying to drill some Leduc reefs. As usual we were asking for more money for some seismic purchases and John had looked at some of the things that we had done and he turned to me and he said "Mike, seismic is like democracy, there is no other alternative." Those words are kind of interesting in today's world. With the unconventional plays it's very difficult (impossible in some areas) to see trends solely based on wells.

I mean with a Halfway Sand play or reef play you can see changes laterally based on well control, but with the unconventional plays you can't see fractures in one well and correlate them with another one five miles away or three miles away, it doesn't matter the distance, you can't hook A to B. Regionally you can put a big blob on the map and say this is possibly where my play is. But the reality is when you look at the seismic and some of the work that is being done with attribute analysis, you can most definitely see the trends but, more importantly, you can see the reason for trends. So I think the role of the geophysicist in the future is going to be that initially of a salesperson. Some of the recent work I have been involved in has shown new value for existing 3D's. It is a very expensive tool but the flip side is you can get into a situation where you don't know there is a (hazard) fault coming up on your horizontal well and you hit the fault and now you've got trouble. The seismic at that point becomes pennies on the dollar for what it's going to cost you to get the well under control.

O: ***Just to be more specific, you are primarily trying to detect hazards like faults?***

M: Hazards, but also predict where the fractures are and the orientation of the fractures.

O: ***So, more or less define trends in the fracture characteristics.***

M: Right, which ultimately will lead you to align your wells properly and put your fracs away properly and I believe we are just on the cusp of understanding it right now and I think probably in a few years' time, if my crystal ball is still working, there will be a lot of fracture analysis and it will be done hand in hand with microseismic and 3D.

S: ***Absolutely, that's the trend here.***

O: ***Perhaps this is more mundane, but just keeping the well bore path in the zone, is that something else that you would use 3D for?***

M: Yes, those are no brainer reasons for why you should have 3D. If you are drilling some of the horizontals in areas with a lot of structure, absolutely, because once you pop out of the zone you are pretty much done. I think we will be able to, in a few years time, use the seismic a lot more effectively than just keeping its trajectory where it should be.

O: ***Do you ever anticipate that we would be able to integrate the microseismic with the conventional seismic?***

M: Yes, I believe you can. I think the microseismic is going to help us sort out what a lot of these fracture patterns are that we are seeing on the attribute maps.

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S: ***At Peter Duncan's lunch box talk yesterday, he was showing that micro-seismic integration with seismic is being done already. As they frac at a number of points along the length of horizontal wells, they can show the pattern in which the fractures are propagating, and how some of them line up with the patterns that have already been predicted with seismic. So it's technology that is already coming into the main arena as we speak.***

S: ***Mike, the next question is not technical. A geologist wife and a geophysicist husband – do you ever discuss exploration problems at home?***

M: Honestly, we never did. Work was work, home was home. We would talk about our days but we'd never get into discussions about how to solve geological or geophysical problems, we never did. We were in the heat of the battle with raising kids, when my wife was working, so it was diapers and dinner and hockey and swimming and it was all the other things.

O: ***Continuing on the non-professional front, I know you are a very keen fly fisherman....well other forms of fishing too. I am not a fisherman, but what is it about fishing that gets people so addicted?***

M: I will start out with the work part. As I mentioned at times work can be very, very stressful and it was difficult to shut work off, whereas with fly fishing I could go out on a river and they could be dropping bombs around me and I wouldn't know because it's all about putting yourself in a different place and space and concentrating on that tiny little fly on the water waiting for the fish. It is just a great form of relaxation for me and when I tied flies commercially, it was the same thing. I made no money at it but it was a way of just turning work off for an evening.

O: ***So although the activity in itself is enjoyable, it's more the state of mind that it gets you into. I see.***

Now, because you are a keen fisherman you are probably well aware of the various water management issues, especially down in the Crowsnest where you like to go, and you are also part of the Oil and Gas Industry and sometimes these two sides butt heads. How do you feel about these issues?

M: I think the Water Rights need to trump the Oil and Gas Industry, but having said that I think as an Industry we really have cleaned up our act. I remember in the early years when I'd fly up to Rainbow Lake or up into Grande Prairie to oversee

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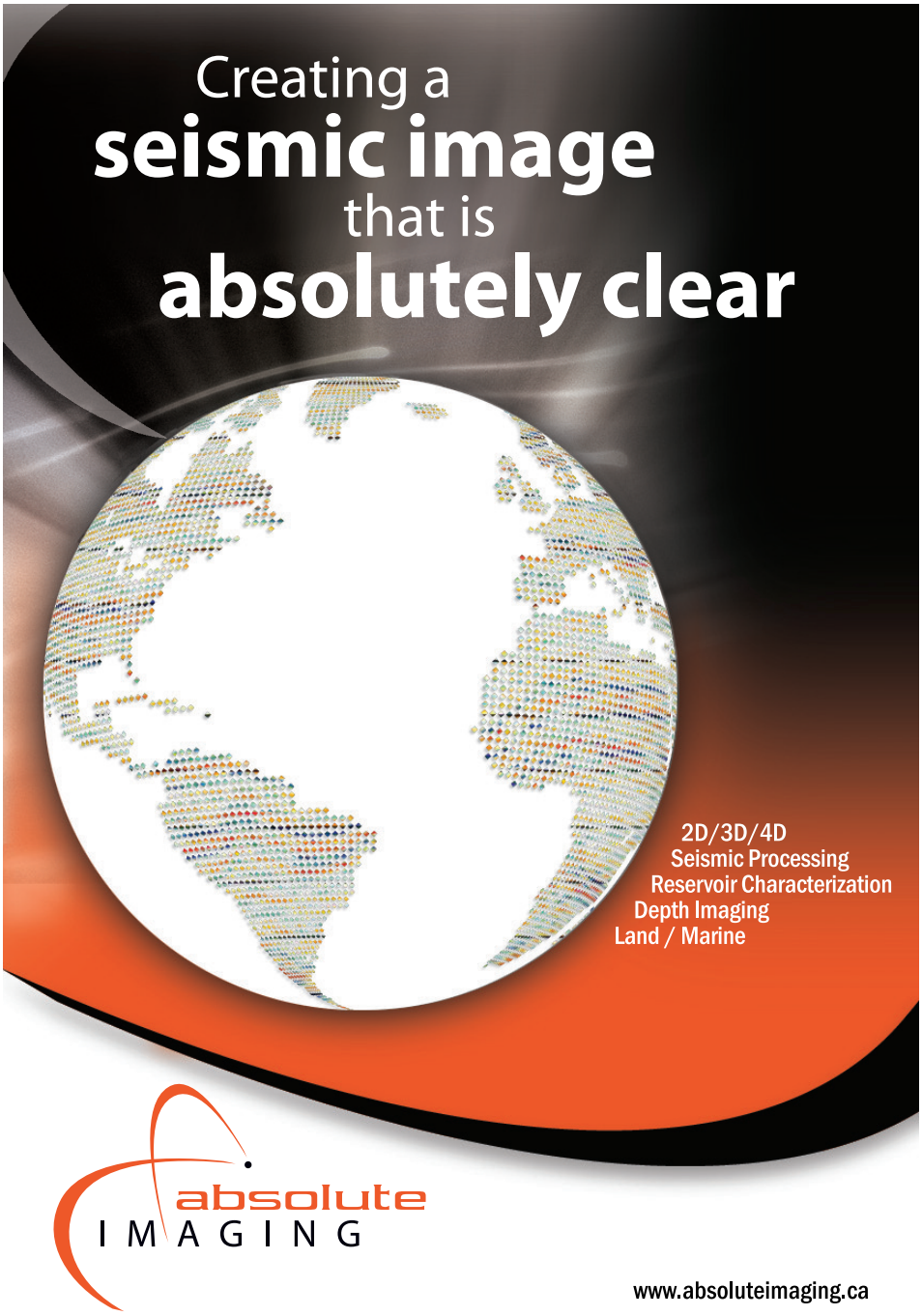

"Seismic is like democracy..."

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some of the seismic crews the scarring of the trees up there was unbelievable and it left a mark on my psyche. I think it left a mark on anybody who went up there, but over time we have become stewards of the land much more than we once were. You know it's not all about taking a D8 cat and just blazing an eight meter wide trail, it's now about doing things the way they should be done and trying not to leave a footprint out there and the same thing with the creek crossings. So I think the industry still has got ways to go but I think it's done a great job of cleaning itself up.

O: ***Now I think there is some kind of development proposal, I am not sure whether it's mining or oil and gas – is it in the Whale Back or somewhere like that?***

M: Yes, there is a mine –

O: ***So where would you stand on situations like that where there are currently protected areas and Industry wants access?***

M: I think protected areas we've got to be very careful with. Would I completely shut it down – I don't know because progress is progress but it's all about making sure that we do things right. Can we ever stop oil and gas drilling? Not a chance. And I think it's way more than just revenues for the Government, I think it's strategic need more than anything. You know we have to heat our homes, we have to drive our vehicles so until we find an alternative, let's just be careful.

O: ***You said that drilling wells can be very stressful and fishing can be very relaxing, but are there similarities between catching a fish and drilling a well?***

M: Geophysicists and lake fishermen use similar technologies. A fish finder uses exactly the same technology as seismic. It's a lot easier to catch fish however….. Let's put it this way, as a young geophysicist it was very difficult to drill a good well. As you get older you know what the pit falls are, your success rate goes up. When you start out with fly fishing it's very difficult to catch your first fish but then it gets really easy after that.

O: ***And the sense of accomplishment, are they the same?***

M: I don't know. I have to think about that one. I still think it's probably more satisfying drilling a good well.

S: ***A good well, ya, because the investment there is huge.***

O: ***And you can probably catch several fish in an afternoon, but you can only drill a few wells every year!***

You have a very scientific family, with your wife being a geologist and your daughter is a geophysicist, and I believe your son is a scientist too, am I right?

M: He is in Psychology.

O: ***Psychology, that's it. What sort of dynamics occur with teenage kids when they get to that age that they are choosing their careers? How did you find that?***

M: Certainly I think we all look at our kids and we all have thoughts about what they could do. We were careful not to direct them into anything specific because I think we felt that we didn't want to live with a situation where they got themselves into being a doctor, a lawyer or whatever because it's what we wanted. So we kind of backed off, we certainly encouraged them if they asked, but beyond that they kind of made up their own minds. With our daughter, I felt right from the get-go that she would make a good geophysicist because basically what we do is solve puzzles with a minimal amount of information. She was always good at solving puzzles as a young child and she has gone on to become a geophysicist, and we are obviously both very proud of her, but we would have been equally proud if she would have taken something else. We are equally proud of the less-traveled path our son has taken.

It has been interesting for me because I've had the opportunity to go in and mentor our daughter. I would spend time with her a couple of afternoons or three afternoons a week or she would email me problems or images and then we'd talk about it on the phone. I found that really interesting especially at this point in my career that I had a chance to give something back.

S: ***Okay, Mike let's ask you –as Oliver says – it's my question. What would be your message for young geophysicists who are entering our profession? I like the quote that you just mentioned, seismic is like democracy, there is no alternative, shall I put it on record?***

M: Attaining a Geophysical Degree is very difficult and I think once you've made the commitment you want to learn and keep learning. What happens after you graduate is probably more important and I think if you can latch on to a working geophysicist while you are going through University and treat that person as a mentor and not only look to them for guidance but also for tapping into their experience, I think that would be my most important message to any new Grad. Don't be afraid at reaching out to somebody and saying, "Would you mind helping me through these first couple of years?", because I think once you get past that part of it, then you've got the building blocks.

The other message is to look at as much seismic data as possible early on during your career once you have graduated. Don't wait for somebody to give you a "box" of seismic to look at, if you have some down time, go grab a bunch of data and figure out what's going on. That's how you learn.

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"Seismic is like democracy..."

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Avoid the auto picker. Pick every line by hand.

O: Because it forces you to actually look at the data properly?

M: However you do it, if you can go through a pile of data you start to see things – as you get those lines flashing before you, all of a sudden the world doesn't appear as random as it often does when you are just zapping the data and looking at the maps.

Another thing is to learn enough about the other disciplines. Find out what the other people do, find out what a geologist does, find out what an engineer and a land man does and an economist, because I think if you have aspirations to run a company some day, you need all that. You can't just become a geophysicist.

O: I think you have also touched on a more specific aspect to that in our industry, and that is that the traditional role of the geophysicist is changing right now and it seems to be moving more towards geomechanics, rock physics and that sort of thing and so that would involve exactly what you just said, learning more about some of the disciplines that touch geophysics and moving in the direction that makes sense.

M: In so many of the plays that we are involved in Western Canada the geophysicist plays the role of an aid.

O: A support role?

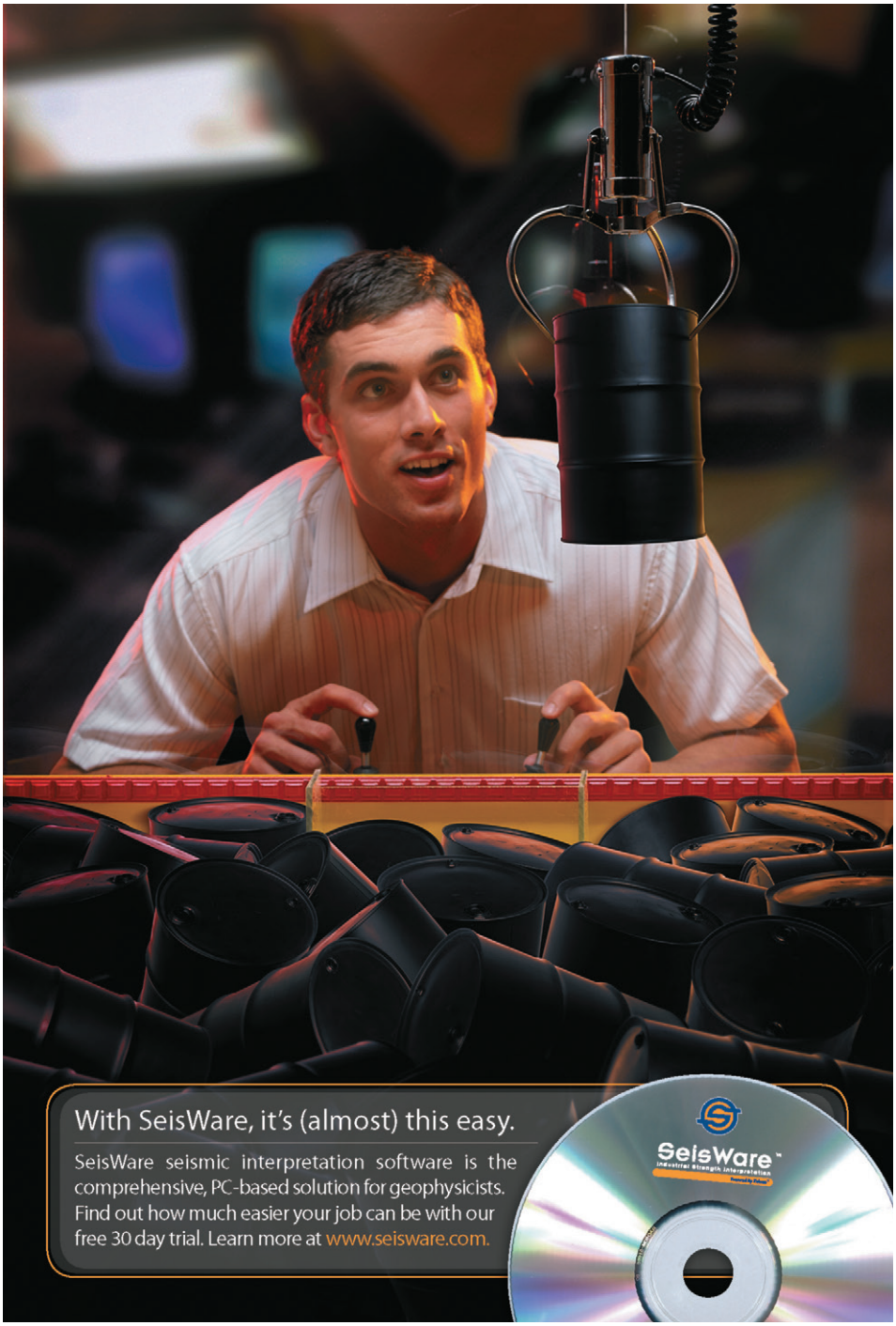
M: Support role, yes, that is a good word, support role as opposed to a lead role. The pinnacle basins were different. Geophysicists were the king because you can't drill a well unless you can see a "bump". In my opinion the next phase of shale gas is going to be driven by geophysics, because the geologists can't see the trend as I mentioned before and the engineers want data, they want to be able to quantify, they want to be able to say, is it northeast – southwest, is it north – south or whatever, and so I see geophysics as taking a lead role.

O: There was one question I wanted to ask you, and kind of missed the opportunity earlier. How did you get from the mining industry into the oil industry, was that through a take-over?

M: Yes, through a take-over. Dome Petroleum took over Hudson's Bay Oil & Gas (HBOG) in '82 and transferred three of us to Calgary in 1983.

O: And so when you were doing the hard rock work, was that all in Northern Ontario?

M: I worked from B.C. to Newfoundland. That was the one thing, as a young Grad, the ever changing scenery was the excitement for me, the changing of the opportunities, seeing lots of different things. But I mean a tent in B.C. was the same as a tent in Newfoundland. There were less flies out in B.C. The one thing I think about with my geophysics career is it is



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"Seismic is like democracy..."

Continued from Page 19



constantly changing and constantly challenging.

Interpreting seismic in Saskatchewan is similar but it's very different than interpreting seismic in Northeast B.C. A whole different set of tools have to come out of your toolbox to interpret structural data in B.C.

O: ***What's the 40,000 foot perspective on your career?***

M: Well, it has honestly been an incredible career and I am not ready to pack it in yet and I don't want you guys to think that I am packing it in, but it has been an amazing career. Where else can you live in this great country of ours and walk down the street and know so many people in a city of a million people? You will never get that in Toronto, you will never get that in Montreal. We, over our career, will get to know more people than we realize and I think that is unique.

This city just breeds entrepreneurship. Think of the things that have happened in this city during our collective careers, all the different oil companies that have come and gone, the different service companies, the ideas that have come out of here, – for example, land 3D probably nucleated in part out of this city and that's a huge boon to the industry.

O: ***You mentioned that at this point in your life you are not finished but you don't want to repeat projects, and there are some projects that you still want to do. What would some of those be?***

M: Any new projects have to be challenging. I would like to try a little bit more international work if the opportunity arises. With the new unconventional plays I come to work in the morning, ready to try and challenge myself to try and sort this stuff out because there is no manual to follow. It's make the manual up as you go and there are people like yourselves that have pioneered some of these techniques as well as some of the stuff coming out of the U.S. It really is a beginning point for a lot of other new opportunities but I need to be challenged and I guess the day that I come downtown and I don't see the challenge anymore is the day that I am done.

O: ***I see, so it's not specific projects that you have already earmarked, it's that you are looking for new projects that you haven't even anticipated yet. I understand.***

S: ***Mike, thank you very much for giving us this opportunity to sit down and chat.***

M: You're welcome – I've enjoyed it!

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CAGC...

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far beyond immediate causes and "found deficient specifications, shipbuilding practices, and maintenance practices, along with inadequate documentation of construction and maintenance actions and deficient operational procedures." After the Thresher loss, Admiral Hyman Rickover, then head of the nuclear Navy, told his staff to establish a system to ensure that such an accident would never recur. The new SUBSAFE system was established within 54 days of the loss of the Thresher, and no SUBSAFE-certified submarine has since been lost.

Principles of the Naval "SUBSAFE" System

- Top management commitment to safety
- Clear and written safety requirements
- Education, not just training
- Regular rewriting of requirements
- Separation of powers and assignment of responsibilities
- Emphasis on rigor, technical compliance, and work discipline
- Documentation capturing what is done and why it is done
- Participatory audit approach, and requirements for objective quality evidence
- Program based on written procedures, not personality-driven
- Continual certification of a facility
- Accountability and accompanying responsibility
- Special efforts to be vigilant against complacency

I have gone too long for my word count already so I will continue with some of the interesting portions of the report in my next column. Suffice it to say – for now – that in many ways the concept of the Canadian Association of Upstream Oil and Gas Associations for Safety and Training called Enform is in many ways the epitome of the outcome of this report.

From the Thursday Files

Groups of animals often make what look like wise decisions, even though most of the members of the group are ignorant of what is going on.

– Iain Couzin of Princeton University



DR. DEBORAH A. SPRATT, P.GEOL.

2011 Recipient

APEGGA L.C. Charlesworth Professional Service Summit Award®

The L.C. Charlesworth Professional Service Summit Award® is presented annually to a Member of APEGGA who has served her or his profession diligently for many years and made substantial contributions to the operation of the Association and the advancement of its professional status.

The 2011 recipient is Dr. Deborah Spratt, P.Geol., a University of Calgary Geoscience Professor. An ardent promoter of Professional Geoscientists and compliance with Alberta's laws, she also advises geoscience students on how to choose optional courses that will qualify them for Geologist-in-Training status soon after convocation.

As APEGGA's representative on the Canadian Geoscience Standards Board (CGSB) she helped to set the national geoscience knowledge standards at a level on par with APEGGA's. Dr. Spratt was one of four members of the team that drafted the *Geoscience Knowledge and Experience Requirements for Professional Registration in Canada* and is now part of the CGSB working group developing and harmonizing application procedures for internationally trained geoscientists.

For more information on Dr. Spratt, P.Geol., and the APEGGA Summit Awards® visit www.apegga.org.

APEGGA The Association of Professional Engineers, Geologists and Geophysicists of Alberta

"In Her Geophysical Shoes"

An interview with a panel of experienced women in the geophysical industry addressing questions from the younger generation of CSEG and APEGGA members.

Coordinated by Marian Hanna, P. Geoph.

Contributions from: Marian Hanna, Cheran Mangat, Doris Ross, Carmen Swalwell, Penny Colton, Flo Reynolds, Elaine Honsberger, and Annette Milbradt.



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"In Her Geophysical Shoes"

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Introduction by Marian Hanna

This article came about from a creative brainstorming (or brain stemming) session in the Denver airport after an exhausting SEG 2010 convention. Cheran Mangat and I were both tired from our SEG experience and we also served on the CSEG RECORDER Editorial committee together at the time. I have since rotated my post and Cheran still serves in the capacity of the Director of Communications. We were coming up with some very creative potential articles to write for the RECORDER in the terminal gate. Some of those ideas we will not follow through on because they were just downright silly. But the idea for a panel of experienced women geophysicists in industry was a good one. The intent was to follow up on the 2003 CSEG RECORDER article of a previous panel of women and to expand on other key elements. Following that delightful brainstorming session in Denver, the Junior Geophysicists Forum was held in November 2010 and I found myself talking to a group of young female geophysicists there. I consequently brought up the subject of the idea of an interview for the RECORDER consisting of a panel of experienced women in Industry and asked if they would like to read such an article. There was an overwhelming positive response to the idea of such an article and these young ladies offered a plethora of topics to be included in the article. Thank you, ladies. I've done my best to include all of those ideas from the original group of young women professionals into this article. That same November JGF night, I therefore turned my inquiry to the young and experienced male geophysical professionals to see if they would also appreciate reading an article featuring an interview with a panel of women and again I received an overwhelming positive response. Curiosity made me ask what as males they would like us to share for their benefit. Both the young and experienced male colleagues said that they want to be better team players, that women are on all of their teams and they know communication styles can be improved. The experienced males indicated that they wanted to be better managers, better fathers for their daughters entering this industry and better men overall. The younger males indicated that they realize that the statistics of the female/male population in university and in the geosciences is rapidly changing and that will only impact industry in due time. In fact 60% of this year's population in Alberta universities in the geosciences are women (source APEGGA). This article hopefully serves to benefit all geophysicists in this industry, not just women.

Our intent of this article is to do exactly as requested by sharing our insight and experiences with all of the RECORDER readership starting from questions raised by the Junior Geophysicists at the JGF. Therefore, it is passionately dedicated to all and especially to the future generation of geophysical scientists and potential executives. May you work smart, have fun and make us all proud. No one can do it alone so don't be afraid to ask for help!

Q. How did some of the top women geophysicists manage having families while also pursuing their professional career? Did they take time off to have kids, did they feel that they were held back in their careers by having a family (i.e. – did men or women who didn't take maternity leave advance further in their careers?) What strategies do they have for balancing both work and family and to ensure that they excel in their careers? What can employers do to encourage women to pursue their careers while also managing their family?

Cheran – My experience is from England and when I had my children I was working for a Processing Company. I was in charge of the Special Projects Group. Most of our processing projects required TLC and specialised processing therefore the project deadlines were more relaxed. I more or less took 7 years off for raising my son and daughter. I stayed at home for each of them for the first year (they are 2 years apart in age) and usually went into the office a few hours a day, two to three times a week. Being a Manager, my responsibility was to QC the projects, while time cumbersome tasks were delegated. I believe I was able to keep my hand in the workforce and be at home because I was in a more senior position within the company. To me it was important that my children were well taken care of when not at home therefore we were fortunate to have a private nursery nearby. How one raises their children is a personal matter but my advice is to be in a strong financial position so that there is flexibility in your choices.

Doris – I took 4, 3, and 2 months away for maternity leave as my husband is the stay at home parent. So I can't really say that my career suffered any delays due to childbearing. I do make sure I spent time with my family as this is who I am. Everyone is wired in their own way, but taking personal time is important regardless if that involves family.

Balancing personal time – with family or not – can be achieved if you understand your business goals at hand and fully grasp how to prioritize your work activities. Employers can offer options for people facing family issues from older parents to children, afford ways to work extra time and make up, set up 9/80's (every other Friday off if you work a longer day), etc. Look to work for companies that walk the talk when it comes to work life balance. Look for companies or teams where your business objectives are clear and you can sort out success through an efficient day. I gave up working weekends a long time ago.

Marian – My response is this is a personal choice issue and there is no magic answer. Our choice on the family issue was to have our children early in our marriage and while I was paying my way through university. I had a fantastic support system with my husband, my family and the department at my university. My mother and father often came to get my children when they knew my physics finals or the like were coming up. I went to field camp in Mexico while my family and professors dealt with my husband's emergency gallbladder surgery and juggled the children with my sister and sister-in-law. I would not have finished university if my family

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and my professors did not work together on that particular issue. No one is an island and a great support system is one of the few reasons I have succeeded. There are many policies in place for family-work balance in several corporations. If this is important to you, then seek those companies out as potential employers or suggest that your current employer offer family benefits in order to make them a preferred employer within industry.

Elaine – If I may offer some advice – while balance is important, you will do best to make some kind of choice early as to where you want to go with your career. I think it would be important to plan out whether you would like a predominantly technical role, or perhaps a technical moving into management role, or predominantly a management position. If you can identify this before or when you are having a family, I believe this will help you to focus on the key roles you want to take on whether they are part or full time, to keep you moving forward. A regret I have about my own planning was that I failed to look ahead early on where I wanted to go, and was simply happy to have a job, keep up day to day, and do my best work. This was, in part, a consequence of working through very difficult financial times, where knowing what might happen in the following week could be difficult. My advice is to have a plan, allow the plan to change, but at the very least have a direction in mind. Then do what you need to do to get there, whether you are working part of full time, or through good times or bad. Stay focused!

Q. How can one best manage career/life balance? Might one not be considered for a position because one might get married or have children? (They indicated that they know women make great employees, they've seen it already.)

Cheran – This question is more of a personal nature. Balance in both career and life is really dependent on the husband and wife team through the understanding and respect they have for each other. It can at times be difficult but having extra help through support from external sources, family, friends and each other is important.

Marian – I struggle with this one too because I feel I did the best I could at the time when our children were small. We must all find our own way to balance our lives. Be prepared that you must address your priorities and balance those priorities. There may be career opportunities that do not come to fruition because you may need to readjust priorities in your personal life (kids, husband's career, parental issues, etc.) but you never know what the future holds. Again, the choices are in front of you. They can be difficult choices but the opportunities they represent are yours to make. A good network of support is key.

Flo – I was recently at a women's networking workshop and this topic came up in all sessions. The general conscience was that the balance is different for each person. Having a good support system is really required. I would consider any company that would express such a thought is not worth working for. Being single most of my career I have never had a situation where the possibility of getting married impacted my position or opportunities. Moving to Saudi Arabia in the middle of a contract was a bit of a challenge but it did not impact keeping the contract or completing it.

Annette – Don't be in too much of a hurry. Take the time to do what is important at that time. I left the industry for 11 years and successfully re-integrated. That 11 year break was after two seven month maternity leaves and returning to work at 50% time after each mat leave. I also know of two men who returned after 10 or 11 year absences. If you've left with a stellar reputation, it will be easier to open doors when you return.

Carmen – This question really made me think. I would like to say that it doesn't make a difference, but I know that is not true. But it is a lot better than it was 25 years ago. At one job I was sent for a pregnancy test!

When I started in the industry I had no work/life balance. For the first part of my career I worked for economic evaluations firms. A typical work week was 60 to 65 or 70 hours. Now I have a husband in the same industry, so the line between our work lives and personal lives is very blurred. Most of our personal friends work in the same industry. One thing I would change is that I would have cultivated more friendships with women outside of our industry. I am lucky that I have a couple of close friends outside the industry and they help to keep me balanced. To some degree at least!

Particularly in the last seven years I have worked with and met more women in geophysics. I am continually impressed by their intellect, poise and maturity. They certainly have much more on the ball than I did at their age.

Q. Is there a 'glass ceiling' within our industry? Why are there so few female executives in the oil & gas industry? Is it simply a historical reflection of fewer female candidates due to lower female university graduates and more stay at home mothers from back in the 60's and 70's? Will this change now that female university enrolment is higher, or is male leadership dominance culturally engrained within the industry? Have they ever felt that they needed higher educational credentials and/or experience compared to men vying for the same job positions? (i.e. – would a woman require an MBA to qualify themselves for a leadership position when a man may only need a B.Sc.?)

Cheran – There are fewer women in senior executive positions and I would say this is probably due to a combination of personal choice and a glass ceiling. As one progresses in ones' career into a more senior/managerial role the stress levels can be enormous, amount of time spent at work increases and less time is available for family.

Doris – I hate to say this but until the numbers change it does appear there is a bit of glass ceiling and the more conservative the company is, the more I see it. This is not limited to gender and actually applies to diversity in general by the way.

Marian – My response is there is overwhelming literature and statistics that indicate there is still a glass ceiling in many aspects of life and work for all sorts of people not just women. The truth is that all people have talent to share and managing that with the reward and responsibility of executive positions is complex. Some people simply choose not to go down the executive avenue because of politics and sacrifices to their personal lives. Humans tend to gravitate to those like themselves as we also see represented in the animal kingdom as well. My point here is that even though a group of executives may find themselves comfortable with the management team they have in place, is there something that is missing?

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Forcing ourselves to consider another viewpoint or another person unlike ourselves is uncomfortable for most but that process makes for a very thorough decision in the end. Do you see the choices in front of you and the opportunity it represents? I can't comment on whether a woman really needs an MBA vs. her potential male colleague with a BSc. Again, that is a choice which could possibly open new doors. I would suggest there are quite a few role models out there for a young woman in this industry and the time has come for more.

Elaine – I wonder about "glass ceiling" and what this really means. My perception is that we may impose our own glass ceiling, simply by taking a very different approach than most of the other people in the room. Women and men clearly think about the same subject matter differently, and we communicate differently even with all of us intending to get to the same endpoint. I find the more you can communicate in a way that is elegantly forceful and offer great ideas while doing so, the better you will do. Avoid emanating doubt in your boardroom conversations – even if you are uncertain. Being clear on the uncertainties of a situation is advisable — focusing on your own skill gaps is not. If you can get a coach (professional or otherwise) — someone to observe you and provide meaningful feedback in a way that you can digest, do it. Do what you can to get this early in your career if you wish to progress into management to ensure you have the best feedback at the right time. Good advice is great, but ineffective when it comes too late.

Q. Is there any pay disparity between men and women of equal experience and who hold equal responsibility?

Cheran – Most definitely and this applies to any industry!! The Telegraph and The Times in England published figures a few years ago comparing salaries between men and women. What can be done to change this?—-women have come a long way from the 1900's and I would say carry on as we have been and hopefully this will improve as women move into the workforce more and into higher positions.

Marian – Yes, there is still disparity in pay for not only women but minorities in general. In the U.S., for this industry and others, there was much effort in the past to equalize all pay towards skill, technical work and accomplishments. I knew the statistics and my pay fits well in the appropriate ranges. However, there are other sectors of this industry which seem to have a larger gap in pay between genders but my understanding is that this disparity is highest at the top, not in technical ranks. Is this changing or equalizing? I will also refer our readers to the SEG, AAPG and the APEGGA salary survey on this.

Penny – There are some interesting statistics we can bring to this discussion. The 2010 APEGGA Salary Survey reports the mean salaries for men and women for equal experience and responsibility. (See http://www.apegga.org/pdf/SalarySurve



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Average Total Cash Compensation by Gender, Designation and Responsibility Level All Industries – May 2010

GEOPHYSICISTS

Level	# of Geophs.*	Overall Mean Salary - $	# of Female Geophs.	Female Mean Salary - $	Variance from Mean	# of Male Geophs.	Male Mean Salary - $	Variance from Mean
A-	1	Insufficient Data						
A	11	72,367	6	76,565	5.80%	5	67,327	-6.96%
B	32	84,999	12	86,383	1.63%	20	76,591	-9.89%
C	46	109,740	18	110,782	0.95%	28	109,069	-0.61%
D	41	148,546	15	150,454	1.28%	26	147,445	-0.74%
E	59	194,191	7	194,023	-0.09%	51	194,100	-0.05%
F	45	225,342	2	199,600	-11.42%	43	226,539	0.53%
F+	17	263,025	1	237,900	-9.55%	16	264,595	0.60%

* The total number includes those respondents within each profession that did not declare gender.

Table 20 from page 54, APEGGA 2010 Salary Survey: http://www.apegga.org/pdf/SalarySurvey/VPS2010.pdf

Above table of information for "Geophysicists" was extracted from Table 20 (page 54) of the 2010 APEGGA Salary Survey for Professional Engineers, Geologists, and Geophysicists in Alberta. See: http://www.**apegga**.org/pdf/SalarySurvey/VPS2010.pdf

y/VPS2010.pdf and especially table 20 on page 54 which covers "Compensation by Gender – All Levels, P. Geophs"). The percent differences are greatest in the entry levels A and B (with a range from 1% – 10% difference from the mean for men and women, although these are based on a low number of sample statistics (total of 18 F out of 43 M+F). What is most interesting for this discussion however is that the female geophysicists in levels A to E received ***higher*** (or equivalent) salary for those that responded to the survey. More importantly for the future of geophysics, due to the industry activity and hiring levels right now, many of the new graduates in geophysics, and in geoscience, are not becoming APEGGA members, or Members in Training, primarily perhaps **because many are not yet working in the industry**. For the levels F and F+, with the most experience – and at managerial positions, there are only 3 female geophysicists out of 62 in the reporting sample group for these statistics. That is where our "history" and personal choice to stay in the industry has the most relevance. My experience over the last few decades is that petroleum company policies have provided compensation parity for equivalent staff positions. The different segments of the industry may however have different pay levels between different industry segments.

Q. Any tips on what women can do to stand out in the industry?

Cheran – We are women and we should be proud of who we are. Women generally approach problems from a different perspective than their male counterparts and this is being recognised more and more. Be confident, work hard and grab the" bull by its horns and run with it". We don't need to take Women's Liberation to the extreme in order to be visible, appreciated and successful.

Doris – As women we just stand out anyway. Just do the work needed to be done, show innovation, intelligence, understand and meet business goals, and just be fearless. Stand up and be counted.

Marian – Be reliable and trustworthy. People will count on that in this business. There is much time to shine and other times to listen and learn. Life is a marathon, not a sprint. Enjoy what there is to enjoy and suffer what there is to suffer. *No one* can escape struggle. But it's how you deal with the challenges in life that defines you. Challenges always present to each of us an opportunity where we might want to consider improving. Trust yourself, work hard, play nice with others, smile often, and keep 'em guessing! I'm still learning this too.

Elaine – Be smart, have good ideas, articulate well, get to the point, be confident, know your business, dress like you mean business.

Penny – Our vision and perception of demographic domination and choices certainly needs to be filtered based on the segment of the industry – acquisition, processing, interpretation, management, and on the age group and thus historical career choices being considered. The choice to enter or remain in the industry by long time members was based on previous industry trends, and will not change within those groups. The future is already here in the demographics of the new graduates. They are all already standing out in many of the sectors, and will make their own history. It is theirs to lead.

Q. They recognize the increasing number of women in university in geophysics. What are some ideas on how to promote their ideas, careers, prospects, etc. in our industry? They want to know where their time is best spent technically, professionally and perhaps personally. They don't want special treatment, only a fair chance.

Doris – Figure out what it is that you like about your work. Is it business – do you want to be an asset manager or president of an oil company? Do you want to be a technical leader and be involved in research and consult or work in a research department? Do you want to develop a reputation as a hydrocarbon finder and maybe eventually have your own company developing resources? Once you figure out one of these, work it. Look around see what the successful people – researchers, asset managers, finders, etc do. what them or see if someone will take you under their wing while you learn.

Marian – My response includes several avenues for consideration.

a) Get an internal mentor and an internal sponsor to help you understand the organization you work in. A sponsor is someone that speaks up for you within your organization. A mentor can fulfill that role if internal to your company.

b) Make an effort to network within the organization and get some face time for the ideas you want to put forward and how best to do that. Pick the opportunities where you have something valuable to contribute. Give your boss snapshots of your performance and not just at review time. This should be about how you've added value to the organization. But be clear about what you want known about yourself and your performance.

c) Volunteer and give back to the community you live in. Pay it forward as the saying goes. You'd be amazed at the networking opportunities that are out there.

d) *Listen* to the advice you have been given and see the choices you have in

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front of you. They are opportunities to make choices to be the best you can be. I'm still learning this.

e) Continue to focus on your education post university. My company offers online courses ranging from hard technical to soft skills courses. I have enjoyed the learning opportunities through the online coursework. My husband's 97 year old aunt once told me to never stop learning because if you did, it should mean you are no longer on this Earth.

Flo – I have always felt I have had a fair chance. Rather than be focused on gender perspective I have always been focused on the technology and working as part of a team. Being both a good team member and providing valuable technical information creates respect and opens doors of opportunities.

Annette – Get involved, technically and socially. CSEG has many opportunities to either volunteer and/or attend events. Find something you like doing and offer to help – doesn't have to be in geophysics. Network, network, network. Ask questions – lots of questions. Listen to answers.

In your career (academic or industry), let people know what you are doing. You might know you're smart and that you're doing interesting work, but you need to let your peers and your managers know. They can't read your mind. Sometimes you have to toot your own horn.

Your reputation is your most valuable currency. Do good technical work, ethically and responsibly. Acknowledge others' contributions. You want to be known as someone whose work is trusted and respected.

Stay current with technology. Even when I left the industry for 11 years, I continuously worked on enhancing business and computer skills which helped when I came back looking for work.

The biggest challenge I've encountered is "information hoarders". They keep information close to their chest and don't share with fellow team members (both genders). Men sometimes have an easier time overcoming this challenge because they are more likely to go for beers together or talk to each other at the gym. Young geophysicists will need to develop techniques to overcome this challenge. Schedule coffees for informal updates, ask for technical and/or business mentorship to promote communication.

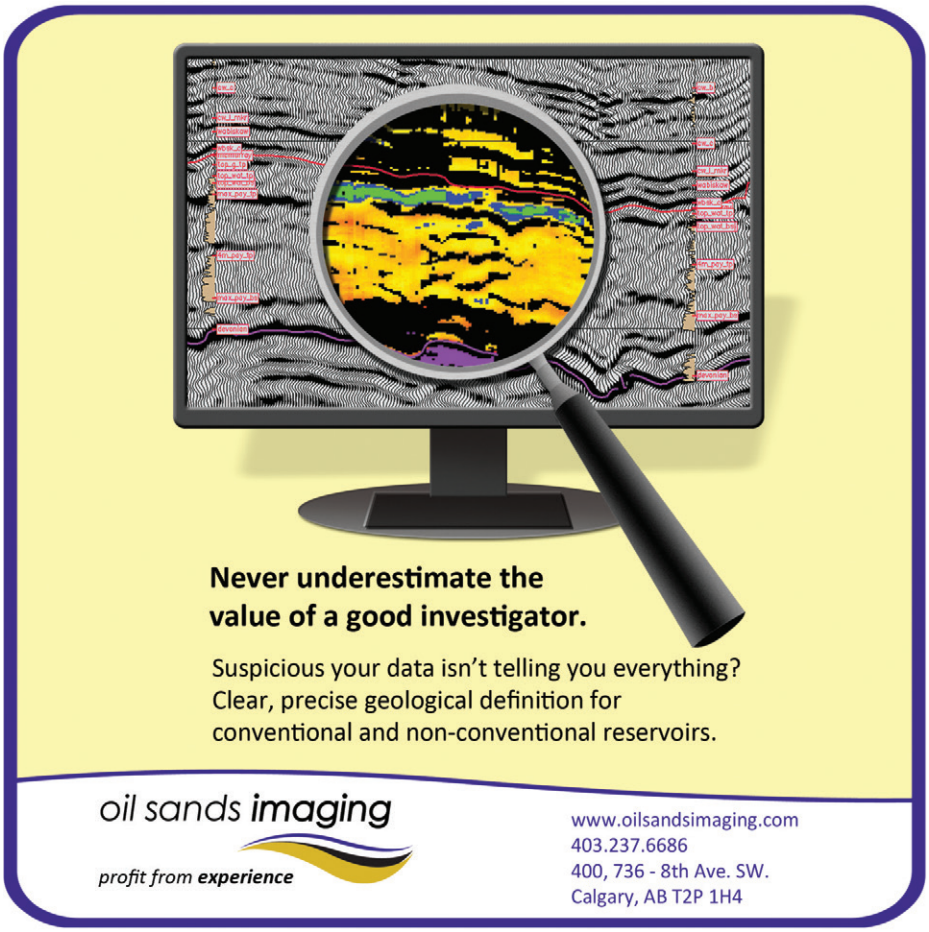
We are lucky to be involved in such an interesting profession. Expect to be treated fairly, but don't develop an unhealthy sense of entitlement. Don't be a clock watcher. Sometimes you'll need to invest some extra time and effort. It won't only benefit the organization, but will be of personal benefit too.

Take personal responsibility for your own career. Be proactive to get to where you want to go. Re-evaluate if you are missing joy and passion in your work.

Carmen – Networking is essential in the oil and gas industry. My advice it to build a strong network, with men and women of all ages. Women do face unique challenges in this industry. When I started working there were very few other professional women. Advice from a more experienced woman would have been very beneficial. But there were no role models or more experienced women to network with. Now there is so I urge young women to take advantage of that. There are so many industry functions, take advantage of it. . Introduce yourself to someone standing beside you and start a conversation. Go to the technical luncheons and sit with people you don't know. Volunteering is also an invaluable opportunity to build relationships. If you are not sure where your skills would fit in, phone some of the people leading committees. Ask them for coffee and get to know them.

Build strong relationships with people in the service sector. Treat people working in the service sector with the utmost respect. The people in the service sector have stronger, larger networks than some of the Chief Geophysicists and Vice Presidents. I have made a lot of sales calls in my time. The higher up the people are the more gracious they are and the majority of them take the time to return calls. Junior professionals can learn a lot from their example.

Penny – Lots of industries have had historical demographics based on previous



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cultural patterns. The future always starts now and will make its own trends. For those future technical and industry achievements, personal and team leadership will be the key.

Q. What are some of the advantages of being a woman geophysicist in the oil and gas industry?

Cheran – To be frank, I think men enjoy working with women and vice versa. In many organisations the males outnumber the females. Having a woman or two adds a bit more flavour to the whole thing because we have a different approach to solving problems and are more inclined to work as team members. I think more men are beginning to respect that, want to hear a different perspective and having different genders working together broadens our outlook to life.

Marian – The truth is that we often have to work twice as hard to get half of the recognition that our colleagues receive. The real advantages are that women in general have a tendency to be better at connecting how one idea/topic influences another. This is helpful at getting a full view approach but only if that skill is valued.

Also, women generally tend to pursue harmony in a group where as men generally tend to look for opportunities to establish a hierarchy in power or control. Just watch children in a playground to see those traits in action. The harmonizing generally leads to an integrated team approach valuing the diversity present which generally makes for better business decisions instead of a power struggle.

With that point in mind, if you need technical help then call an informal peer assist type of meeting, comprised of technical people whose opinions you value. I did this early in my career as an interpreting geophysicist and it lead to frequent technical problem solving sessions within the G,G & E staff that all contributed to and enjoyed.

Flo – I have never looked at my career in that light.

Carmen – I am not a geophysicist, so I am not sure how relevant my answer will be. To generalize, it is sometimes easier for a woman to build relationships. Use that to your advantage in building a network.

Q. Best/significant contribution to date to industry. Technical, personal, or whatever.

Cheran – A balance in my personal and professional life. I got married quite young and it seems like I have been married all my life. I have two wonderful children, a wonderful and understanding husband and this has enabled me to pursue my career. I have worked in a technical and managerial role on both sides of the fence ie. service sector and now in an international oil and gas company. If one gets the opportunity to work in the service sector, please take it. You will get the opportunity to really get your hands dirty with the technology and learn a lot.

Marian – Playing a significant role in teams that have contributed over 1 billion BOE of production. Identifying a 600+MMBOE discovery and successfully predicting other future discoveries (>600+MMBOE) from an outstanding integrated regional work approach (play fairway work) with a phenomenal group of motivated, talented people. Knowing and hearing from lots of folks, young and old that I've made a difference in this industry and in this world. Eventually recognizing when I'm wrong and where I need to change. Helping out as much as I could during post-Katrina New Orleans and emulating the strength and compassion of the women in my family. Watching other people help others after they have seen me lend a hand, makes me smile every time. Makes me smile every time. Personally – staying married to the man I love for 32 years in spite of all kinds of struggles and still being thrilled to come home each day to be with him. Okay, most days. I'm very proud of our sons who are now grown men on many levels. They are both good, caring men that value all people and they never hesitate to help another person. These are the things I think are pretty significant.

Flo – My contribution is in the diversity I am involved with. From designing collaboration rooms to working to improve and better use technical applications I contribute to numerous avenues in the industry. I am, of course, not a cookie cutter geophysicist as a result of this.

Annette – Wonderful family, satisfying technical career, rewarding volunteer efforts (Outreach).

Carmen – I did not start my career in the geophysics industry. I had a career change and joined this part of the industry in 1998. So I have not made any technical contributions to the industry. I believe my biggest contribution is in my volunteer work with the RECORDER, Junior Geophysicists Forum and as Exhibit chair and Sponsorship Chair for various conventions. I have received great satisfaction from my volunteer roles and I have certainly gotten back more than I have given.

I advise women to be flexible and open to a career change. I have had more than one career change within this industry. When I had the chance to become a recruiter I was able to use those different experiences to my advantage.

Q. How can the younger generation be better team players? Both genders.

Cheran – In order to be a good team player, we need to work at this. We need to build a strong relationship within the team and be understanding and respectful.

Marian – Be open to learning more about human nature, the people you work with and how to capture the diversity of technical and personal approaches that can capitalize on the talent pool. This goes for all team players and management. There is a tendency for technically talented people to be promoted into management as a reward for their technical accomplishments, however these promotions tend to not present opportunities to educate those new to management about the issues in handling real people. Managers have to manage both people and the work. A direct quote from Women's Global Leadership Network article by Shari Mackey, "It is no longer enough to have superior "technical" skills – people are looking for inspiration and accountability in their leaders. In terms of responsibilities, strong leaders emphasize the importance and priority of enhancing the skills and knowledge of the people in the organization, creating a common culture of expectations around the use of skills and knowledge, facilitating the ability of the organization to align in a productive way, and holding individuals accountable for their contributions to the collective results." Make the soft skills portion of life's learning a priority for you. This will help in all aspects of life. Keep in mind that this industry is a business and we are here to make money. Be open to listening and learning from everyone especially if you aspire to rise through the executive ranks. All people should learn to be good at giving recognition thereby valuing what others have to contribute. Recognition is a powerful personal attribute.

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Flo – Listen and respect others. Keep your emotions out of the business context.

Annette – Be trustworthy, build excellent communication skills and ask questions, acknowledge others' contributions.

Carmen – Remember, business is business and personal is personal. That is not easy and I still struggle with that. But I try to improve every day. One observation that I can share is the close bond between geologists and geophysicists. Usually a geophysicist will refer to "the" engineer they work with, but when they refer to the geologist they work with it is "my" geologist. I have pointed this out to both geologists and geophysicists and most have paused, agreed and said they never realized that they do this. Maybe by thinking about this bond, and applying it to other team members, we can build stronger teams.

One of my pet peeves is a comment I still hear all the time. I heard it in an elevator last week. A woman said to a group of men co-workers: "I prefer to work with men than women, they are much more difficult". When I hear a woman say that, I wonder if she might be difficult to work with. That is not a statement that a strong team player should make. I have been guilty of this in the past. I have worked with a few difficult women but the majority of women were a pleasure to work with. Let's focus on that. I also wonder what men think when they hear comments like that.

Penny – It helps to participate in CSEG functions, committees, and participate on committees or in team sports during university. There are many "soft skills" type courses and events that are available – through corporate training, or from technical or related societies.

Q. Mentors? They want mentors because they realize that they are sometimes sabotaging themselves, not listening to advice/suggestions and not being supportive of other women.

Marian – There are many formal mentoring programs including APEGGA and CSEG. Seek out mentors and they do not always have to be in your own company. I just read an article on mentoring and sponsoring. A sponsor is someone internal to your organization that will speak up for you. The article suggests that men do this on a regular basis where women do not. Also, get involved in volunteering with APEGGA, CSEG, SEG, your community organizations, etc. You'd be surprised by what those opportunities present to you as a gift to expanding your outlook and experience. Learn to listen and work on understanding another's view point. It's hard but the consequences can get you passed personal road blocks.

Flo – If they are already seeing that they are not listening to advice, what makes them think a mentor will have the magic wand to get them to listen? A lot is required that needs to come from within and this includes being open to listening and assimilating other perspectives. With this perspective everyone you work with and come in contact with becomes a mentor.

Annette – Sign up with CSEG mentorship program which runs Sept-June every year. Be an active mentee. Ask lots of questions. http://www.cseg.ca/students/mentorship.cfm

Carmen – Build your network. During my career my mentors were male and I still have male mentors. But I also receive mentorship from women that are younger than me. When you find someone that you admire ask them if you can go to them for advice. Turn them into your mentor. The CSEG has a mentorship program for students. It was started by a volunteer with a vision. If you feel there is a need for mentorship for junior geophysicists, start one! And don't discount a male mentor; some of the strongest feminists I know are men.

Penny – Ask the "old timers". Who were their mentors? – probably the pioneers of geophysics. We were and are all keen on the geophysics and the people who have developed the solutions.

Q. Tell them our stories because in the stories are lessons to learn.

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Doris – Don't be afraid of any experience! Turn everyday into another step towards where you think you want to be. Be wise enough to know when you have learned enough from a particular area of interest and work and move on.

I started in the oil industry during a big downturn in the industry – the mid 80s. There were no jobs to be had and I latched on to any experience I could get. Not all of them I could count as the most positive experiences but you do learn.

Pretty early on you need to assess yourself as I did to understand what it really is that attracts you to the energy industry.

Is it just the science? Be prepared to give the science a business meaning and be able to effectively communicate your concepts and the value that the scientific information brings to a business.

Is it technology? Again, science and technology are the pillars of our craft but you need to be able to express the business value successfully if you want your projects to go.

Is it managing or owning your own oil company? If you want to be a manager, there are certain elements of being technical you will have to let go as your focus will be on the business rather than the craft. Science is a tool but spreadsheets will take over.

Last, never be afraid to share what you know either to your peers or supervisors. Collective knowledge is the true power behind any successes you will encounter. Learn about other disciplines and teach them what you know. Amazing results will happen.

Marian – I also started in this industry in a severe industry downturn where university colleagues were posting all of their rejection letters outside their lab doors. I got hired from my first interview as an undergraduate but was already working on my master's research and course work at the time. Let me state I was a student, a wife, a mother of 2 small boys and I worked part-time in the Chemistry and Geology departments as well as the local pub. I'm not Super Woman, it's just what I had to do at the time to survive, eat regularly and chase after my dream of being a scientist. There was jealousy from some of my university colleagues suggesting that I was only hired because I was a woman. My professors indicated that this was not true and I was the only student with a glowing recommendation from the Geoscience, Physics and Math departments which was unprecedented at the time. Focus on the positive because no one gels with everyone all the time. There have been many times in my career that I have had to reflect on the positive when I was down.

A few years later I was involved in an integrated team presentation to our offshore production staff out in the Gulf of Mexico about what the geologic story was on a particular field and why they were doing things differently. Shortly thereafter, we had a company picnic which consisted of several of those same offshore personnel and their families. As I was chasing my small son who was running with a fishing rod and his newly caught tiny fish, I was stopped by one of those offshore workers who told me he had worked in this business for 21 years and no one had ever explained to him and his crew why we were doing what we were doing for the field's production. He thanked me for that effort and said it couldn't have been easy for me being the only woman on the platform other than the cook. His wife also told me how excited he was when he came home after that rotation. Consequently, I have chosen to look at my career and life, focusing on the positive. This industry is a roller coaster at times so buckle up and enjoy the ride.

Flo – When I moved to Calgary from a farm in central Alberta I joined a seismic processing company for the only reason that I knew something about seismic – Dad and brothers were currently working in the field and Mom and I visited often. I was already told by teachers that coming from a farm area school you would never make it in University. Some of the teachers did not exhibit a high level of intelligence or understanding of human nature. I decided to prove them wrong. After my first year in Education I had the fortune of a co-worker explaining what a geophysics career would get me. I switched immediately. While working through my degree I made valuable contacts and was able to work at least 8 months of the year.

After graduating I ended up being impacted by merger mania. It is difficult during those times to determine what the best direction to go is. Should one keep with the current company where there may not be much activity or see what the next opportunity holds? I changed jobs around every 3 years due either to another merger I didn't want to ride through (I never did get a package to leave) or to being restless for more challenge. Sometimes it can take 25 years to find the right fit.

Elaine – Some random advice here. Understand organization structure! Women tend to think single level – everyone equal. Men typically think in a very hierarchical manner. Learn this, know when to work with this, and when to attempt to modify this. Title means something. If you are doing a particular job that involves higher level skills, move beyond having the title of Geophysicist. Negotiate the title with the job. Never go over or around your boss, unless you are willing to put your job on the line. And sometimes, it is appropriate to put your job on the line, depending on what is at stake for you otherwise. Know what key responsibilities you have that make money for you and the company. Focus on these, be great at these. Present your recommendations at the beginning of your presentations, don't make the audience wait until the end. Learn who your allies are, invest in these relationships, build more. Learn to avoid energy drain in adversarial relationships.

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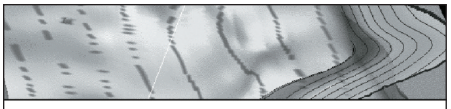

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Take soft skills and business courses regularly, along with upgrading your technical knowledge. Communication savvy will get you far greater places, than simply focusing on how to recite technical details inside and out. People often say have fun — I will suggest that your career path will not always be fun, but you can follow a path doing things you have a passion for. Passion has been a long-lasting motivator for me.

Penny – The Calgary community has made changes – including small changes many didn't even notice. For example we can all now accept invitations for lunch at Calgary Petroleum Club. Not everyone was aware of their dress code and the men-only policy for their dining room. My supervisor in the late '80's was caught by surprise when the invitation from our manager for the team to join him for lunch at the Petroleum Club actually meant that one of us (yours truly) could not accept the invitation. In a similar situation, at a previous employer, the manager (a geophysicist) had graciously, and with leadership, specifically asked our client / host, to change their "thank-you" invitation from the Petroleum Club to another venue so that the entire team could attend. (That Calgary Petroleum Club policy changed maybe 10+ years ago – and now it is history).

Q. What is our vision for their future?

Cheran – I would like to see a balance of genders in Senior positions because I think having diverse opinions would be beneficial to the future of the organisations.

Marian – Our industry still does not do enough to educate the general public but we are working hard to turn that around locally through our CSEG Outreach and other programs. However, individual oil and gas companies can do more as well to represent their efforts, in my opinion. My vision is that the general public will become better educated in general and better educated to the energy options they have and vote accordingly. When our industry goes to other countries we often build schools, hospitals and/or educate the local people. This concept of helping to make folks better educated and informed should apply everywhere. Therefore, I ask the readers, what is the Canada we want for the energy sector in the future? Does the company you work for support your continuing education? The more we advance our industry the more each of us will need to learn and know.

Also, the recent graduate statistics in science and engineering suggest that the male enrollment/graduation levels are declining where the female version of the same is increasing. It could be easily concluded then that it is just a matter of time until those statistics present themselves in the workforce, swinging the pendulum to a more female dominated industry outlook. One could come to that statistical conclusion that the industry may see more female executives however there is the overwhelming historical statistic that women in the past have left industry due for various reasons including frustration. We will see where all this goes.

Women however, do need to work better with other women. We need better coordination, less gossip and more of the great effective communication that is a strong female gender quality. I am always curious of the reasoning behind any person who says they don't like to work with any particular group of people, be it men, women, geologists, engineers, accountants, doctors, lawyers, construction workers, plumbers, different ethnic groups, or whatever. My question to that person then becomes, what is it that is driving your self-imposed segregation?

There is another encouraging blip of news in the February PEG (p.19) that quotes a story from *Mechanical Engineering* (New York) that girls are as good as boys and women are as good as men at math. Woohoo! I believe in the power of people and that we can do anything we set our minds to accomplish. And I believe in the power of women especially in the face of adversity.

Flo – Technology is making great strides in communication and accessibility to your workspace. This will be a great impact on the work/life balance enabling parents especially to work from home as needed – handling sick children, etc. and still being able to meet deadlines and be productive. I even take advantage of this for myself when I feel a cold coming on and I don't want to share the bugs. I get a lot accomplished. Companies are investigating remote access more to reduce time required for commuting – do we need to be in the office every day? Applications like Skype, remote desktop access, sharing of screens all enable remote interaction.

Annette – The easy-to-find stuff has been found. Geophysics will continue to be needed in order to high grade and find remaining resources. We will all need to promote the benefits of using geophysics and be able to communicate concepts in an easy to understand, straightforward way. Earth Science literacy is important, not only for those of us in the industry, but the public so they understand how our work contributes to society.

Elaine – I see the opportunity to work in companies that have a different communication style overall, as women show up at more levels of a company and take on the running of them more frequently.

Carmen – Things have changed so much for women in the last 30 years and for the better. I hope that the efforts of women of my vintage have made things better for this generation. My vision is that this generation will make it even better for the next.

Penny – Geophysics has already played a role in development of the knowledge of the earth (continental drift, planetary exploration, digital processing, hardware advancement, (including the integrated circuits, computers, imaging), and now imaging for resource development. Perhaps the future of geophysics needs a new "discovery" and a new challenge.

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Conclusion by Marian Hanna

We have questions for the young geophysicists:

1. *What do **you** see in your future in industry? Where is it that you want this career to take you?*
2. *How do you see that your generation(s) will impact the energy industry for the better? Where will you potentially leave your mark?*
3. *Have you volunteered lately? What do you want to work on to pay it forward?*

If one wants to venture down the self-education path, there is a plethora of reading material out there to help with career choices. For example, the following insert is from the November 2010 newsletter from business coach, Donna Leibham's website, which can be found at http://www.leibhamandcompany.com/

"Here are 6 organizational markers – what you can look for in your company to see how the advancement of women is managed."

- *Ratio of Men to Women: Look at the number of women in your organization who are in senior management, on the board of directors or who are officers of the company – what is the ratio of men to women? (see the previous Leibham & Company newsletter for some interesting data on what's happening in some organizations in Calgary).*
- *Career Path – Ask your manager or HR representative what the typical career path to senior management is.*
- *Company Champions – Look inside your organization. What senior managers support the leadership development and promotion of women? How do you know this? How verbal are these leaders in advocating for women?*
- *Leadership Development Program – Does your company have a leadership development program targeted for women?*
- *Balance – What is the company's view on work-life balance? Are there perspectives that reflect a desire for flexible work arrangements? If so, are these captured in a policy?*
- *Career Building Experiences – What kind of experiences are women encouraged to include in their career repertoire? Is there a strategy to include profit and loss? The management of people? Is there a strategy to support leaders when faced with adverse conditions? How are women selected for positions of greater responsibility?"*

According to executives I interviewed in 2006, there are a number of key work experiences that women had that facilitated their advancement. These experiences included assignments that required her to work outside her technical expertise, managing a project that was a success, a project that brought visibility or a challenge that was resolved successfully, to name a few. Women also reported a number of positive experiences that contributed to their leadership success. In addition to the aforementioned, these included having a large scope project, contributing to the turnaround of a department or team that was struggling, having a supportive relationship such as a mentor, and positive role models, including their boss. And finally, recognition was mentioned 16% of the time. This ranged from simply feeling valued to acknowledgement from management, being perceived as having credibility and having support from colleagues."

In Canada, women represent half of the workforce and more than half of university graduates. However, women represent 14% of board seats, 17% of senior positions and 21% of Canadian MP's pre-recent election positions. Harper's previous cabinet consisted of 26% women which was down from Paul Martin's cabinet which consisted of 30% women. However, several studies have concluded that Fortune 500 companies with women on the board saw 25% higher returns on equity, 34% higher shareholder's return and 56% operating income increase. Why? Those boards ask the critical questions and the board is less likely to fall into a group mindset.

*It is interesting to note that there have recently been many articles about women in our industry here in Calgary and in Canada. **Oilweek** did several articles on "Women in Industry" in their April 2011 issue including a message from the editor, Dale Lunan; **Avenue** did an article on "Women's Work – Why we need more women in the boardroom" in their April 2011 issue, the **Financial Post Magazine** did an article on "Canada's Most Powerful Women" in their December 2010 issue and many more. All this recent attention seems to indicate that we have not yet fully addressed our gender issues in this industry or in Canada but we are further along than our mother's generation. Other industries do not see big differences in gender statistics and are sometimes in the reverse such as health care, education, finance, human resources, the arts, entertainment, recreation industry, etc. Statistics would indicate that the increasing numbers of women graduating in the technical fields of the oil and gas industry will only relate to more women in management and executive positions in the future.*

We are very optimistic that this article provided all of the RECORDER readers with some insights that will be interesting, entertaining as well as something to ponder over. There is no perfect answer, no perfect person and no perfect solution. There is neurological, biological and organizational research that indicates gender differences do exist and that those differences represent opportunities for any company to leverage those gender related strengths to everyone's advantage. So, has your company thought outside its norm to capitalize on the potential benefit? R

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ARTICLE
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Compressive sensing in seismic exploration: an outlook on a new paradigm

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Abstract

Many seismic exploration techniques rely on the collection of massive data volumes that are subsequently mined for information during processing. While this approach has been extremely successful in the past, current efforts toward higher resolution images in increasingly complicated regions of the Earth continue to reveal fundamental shortcomings in our workflows. Chiefly amongst these is the so-called "curse of dimensionality" exemplified by Nyquist's sampling criterion, which disproportionately strains current acquisition and processing systems as the size and desired resolution of our survey areas continues to increase.

We offer an alternative sampling method leveraging recent insights from compressive sensing towards seismic acquisition and processing for data that, from a traditional point of view, are considered to be undersampled. The main outcome of this approach is a new technology where acquisition and processing related costs are decoupled from the stringent Nyquist sampling criterion.

At the heart of our approach lies randomized incoherent sampling that breaks subsampling-related interferences by turning them into harmless noise, which we subsequently remove by promoting sparsity in a transform-domain. Acquisition schemes designed to fit into this regime no longer grow significantly in cost with increasing resolution and dimensionality of the survey area, but instead its cost ideally only depends on transform-domain sparsity of the expected data. Our contribution is twofold. First, we demonstrate by means of carefully designed numerical experiments that ideas from compressive sensing can be adapted to seismic acquisition. Second, we leverage the property that seismic data volumes are well approximated by a small percentage of curvelet coefficients. Thus curvelet-domain sparsity allows us to recover conventionally-sampled seismic data volumes from compressively-sampled data volumes whose size exceeds this percentage by only a small factor. Because compressive sensing combines transformation and encoding by a single linear encoding step, this technology is directly applicable to seismic acquisition and therefore constitutes a new paradigm where acquisitions costs scale with transform-domain sparsity instead of the gridsize. We illustrate this principle by showcasing recovery of a real seismic line from simulated compressively sampled acquisitions.

[1] Part I of this paper is adapted from Randomized sampling and sparsity: getting more information from fewer samples. Geophysics 75, WB173 (2010); doi:10.1190/1.350614.

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1 Outline

In Part I, we showed by means of carefully designed experiments that the theory of compressive sensing can be successfully adapted to seismic-data acquisition. The experiments confirmed that accurate recoveries are possible from compressively sampled data volumes that exceed the size of conventionally compressed data volumes by only a small factor. In this part II, we adapt these findings to the recovery of a real seismic line from compressively-sampled 'Land' and 'Marine' data. Because compressive sensing combines transformation and encoding by a single linear encoding step, this technology is directly applicable to seismic acquisition and therefore constitutes a new paradigm where acquisitions costs scale with transform-domain sparsity instead of the grid size. We illustrate this principle by showcasing recovery of a real seismic line from simulated compressively sampled acquisitions.

2 An academic case study

Now that we established that high SNR's are achievable with modest oversampling ratios, we study the performance of our recovery algorithm on a seismic line from the Gulf of Suez by comparing two simultaneous-source scenarios with coincident source-receiver positions:

- **Land acquisition with random amplitude encoding:** Here, sequential impulsive sources are replaced by impulsive simultaneous `phase-encoded' sources. Mathematically, simultaneous measurements are obtained by replacing the sampling matrix for the sources—normally given by identity matrix—by a measurement matrix obtained by phase encoding along the source coordinate. Following (Romberg, 2009) and (Herrmann et al., 2009b), we define the measurement matrix by the following Kronecker product

$$\mathbf{M} \stackrel{\text{def}}{=} \left[\mathbf{I} \otimes \overbrace{diag(\boldsymbol{\eta})\mathcal{F}_s^* diag(e^{i\boldsymbol{\theta}})\mathcal{F}_s}^{\text{Gaussian matrix}} \otimes \mathbf{I} \right]. \quad (1)$$

In this expression, conventional sampling, which corresponds to the action of the identity matrix **I**, is replaced by a 'random phase encoding' consisting of applying a Fourier transform along the source coordinate (F_s), followed by uniformly drawn random phase rotations $\vartheta \in [0, \pi]$, an inverse Fourier transform (F_s^*), and multiplication by a random sign vector (i.e., multiplication by with diag (η) with $\eta \in \pm 1$ with equal probability). As shown by (Romberg, 2009), the combined action of these operations corresponds to the action of a Gaussian matrix at reduced computational costs (see also Herrmann et al., 2009b). Application of this matrix to a conventionally-sampled seismic line turns sequential impulsive source into a simultaneous "supershot" where all sources fire simultaneously with weights drawn from a single

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Gaussian distribution. As before, the restriction operator selects a subset of n'_s "supershots" generated by different randomly-weighted simultaneous sources. After restriction along the source coordinate, the sampling matrix has an aspect (or under-sampling) ratio of $\delta = n'_s/n_s$. An example of this type of sampling, resulting in a seismic line consisting of n'_s/n_s supershots, is included in Figure 1. In this Figure, n_s single impulsive-source experiments (1(a)) become n'_s simultaneous-source experiments (juxtapose Figure 1(a) and 1(c)). While this sort of sampling is perhaps physically unrealizable—i.e., we typically do not have large numbers of vibroseis trucks available—it gives us the most favorable recovery conditions from the compressive-sensing perspective. Therefore, our `Land' acquisition will serve as a benchmark with which we can compare alternative and physically more realistic acquisition scenarios.

- **Marine acquisition with random-time dithering:** Here, sequential acquisition with a single airgun is replaced by continuous acquisition with multiple airguns that fire continuously at random times and at random locations. In this scenario, a seismic line is mapped into a single long `supershot'. Mathematically, this type of acquisition is represented by the following sampling operator

$$\mathbf{RM} \stackrel{\text{def}}{=} [\mathbf{I} \otimes \mathbf{T}]. \tag{2}$$

In this expression, the linear operator **T** turns sequential recordings (1(b)) with synchronized impulsive shots (Figure 1(a)) into continuous recordings with n^*_s impulsive sources firing at random positions (Figure 1(e)), selected uniformly-random from $[1 \cdots n_s]$ discrete source indices and from discrete random time indices, selected uniformly from $[0 \cdots (n^*_s - 1) \times n_t)]$ time indices. Note that **T** acts both on the shot and the time coordinate. The resulting data is one long 'supershot' that contains a superposition of n^*_s impulsive shots. For plotting reasons, we reshaped in Figure 1(f) this long record into multiple shorter records. Notice that this type of Marine acquisition is physically realizable as long as the number of simultaneous sources involved is limited.

Aside from mathematical factors, such as the mutual coherence (discussed in part 1) that determines the recovery quality, there are also economical factors to consider. For this purpose, (Berkhout, 2008) proposed two performance indicators, which quantify the cost savings associated with simultaneous and continuous acquisition. The first measure compares the number of sources involved in conventional and simultaneous acquisition and is expressed in terms of the source-density ratio

$$\text{SDR} = \frac{\text{number of sources in the simultaneous survey}}{\text{number of sources in the conventional survey}}. \tag{3}$$

For Land data acquisition, this quantity equals $\text{SDR}_{Land} = (n_s \times n'_s)/n_s = n'_s$ and for Marine data $\text{SDR}_{Marine} = (n^*_s \times n_s)$. Remember that the number of sources refers the number of sources firing and not the number of source experiments. Clearly, Land acquisition has a significant higher SDR.

Aside from the number of sources, the cost of acquisition is also determined by survey-time ratio

$$\text{STR} = \frac{\text{time of the conventional sequential survey}}{\text{time of the continuous and simultaneous recording}}. \tag{4}$$

Ignoring overhead in sequential shooting, this quantity equals $\text{STR}_{Land} = n_s/n'_s$ in the first and $\text{STR}_{Marine} = n_s \times T_0/T$ with T_0 the time of a single sequential experiment and T the total survey time of the continuous recording. The overall economic performance is measured by the product of these two ratios. For Land acquisition this product is proportional to n_s and for `Marine' acquisition proportional to $n^*_s \times T_0/T$.

As we have seen from our discussion on compressive sensing, recovery depends on the mutual coherence of the sampling matrix. So, the challenge really lies in the design of acquisition scenarios that obtain the lowest mutual coherence while maximizing the above two economic performance indicators. To get a better insight in how these factors determine the quality of recovered data, we conduct a series of experiments by simulating possible alternative acquisition strategies on a perviously traditionally recorded real seismic line.

First, we simulate `Land' data for δ - 0.5 (64 simultaneous source experiments with all sources firing) and study the recovery based on 2-D and 3-D curvelets. The former is based on a 2-D discrete curvelet transform along the source and receiver coordinates, and the discrete wavelet transform along the remaining time coordinate:

$$\mathbf{S} \stackrel{\text{def}}{=} \mathbf{C}_2 \otimes \mathbf{W}_1. \tag{5}$$

We conduct a similar experiment for the `Marine case'. In this case, we randomly select 128 shots from the total survey time $T = \delta \times (n_s - 1) \times T_0$, yielding the same aspect ratio for the sampling matrix.

Figures 2 and 3 summarize the results for Land and Marine acquisition using recoveries based on the 2-D and 3-D curvelet transform. The following observations can be made. First, it is clear that accurate recovery is possible by solving an l_1 optimization problem using SPGl_1 (Berg and Friedlander, 2008) while limiting the number of iterations for the 2-D case to 500 and the 3-D case to 200. Second, the recovery results for 3-D recovery of Land data show an improvement of 1.3 dB by exploiting 3-D structure of the wavefronts. Similarly, we find an improvement of 3.9 dB for the Marine case. Both observations can be explained by the fact that the 3-D curvelet transforms attains higher sparsity because it explores continuity of the wavefield along all three coordinate axes. Second, Land acquisition clearly favors recovery by curvelet-domain sparsity promotion compared to Marine acquisition. This is true despite the fact that the subsampling ratio, i.e., the aspect ratio of the sampling matrices, are the same. Clearly this difference lies in the mutual coherence of the sampling matrix. The columns of the sampling matrix for Land acquisition are more incoherent and hence more independent and this favors recovery. These observations are confirmed by the SNRs, which for Land acquisition equal 10.3 dB and 11.6 dB, for the 2-D/3-D recovery, respectively, and 7.2 dB and 11.1 dB, for Marine acquisition.

Unfortunately, recovery quality is not the only consideration. The economics expressed by the SDR and STR also play a role. In the above setting, the Land acquisition has a SDR = 64 and STR = 2 while the Marine acquisition has SDR = 1 and STR = 2. Clearly, the SDR for land acquisition may not be realistic.

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3 Discussion

The presented results illustrate that we are at the cusp of exciting new developments where acquisition workflows are no longer impeded by subsampling related artifacts. Instead, we arrive at acquisition schemes that control these artifacts. We accomplish by applying the following design principles: (i) **randomize**—break coherent aliases by introducing randomness, e.g. by designing randomly perturbed acquisition grids, or by designing randomized simultaneous sources; and (ii) **sparsify**—utilize

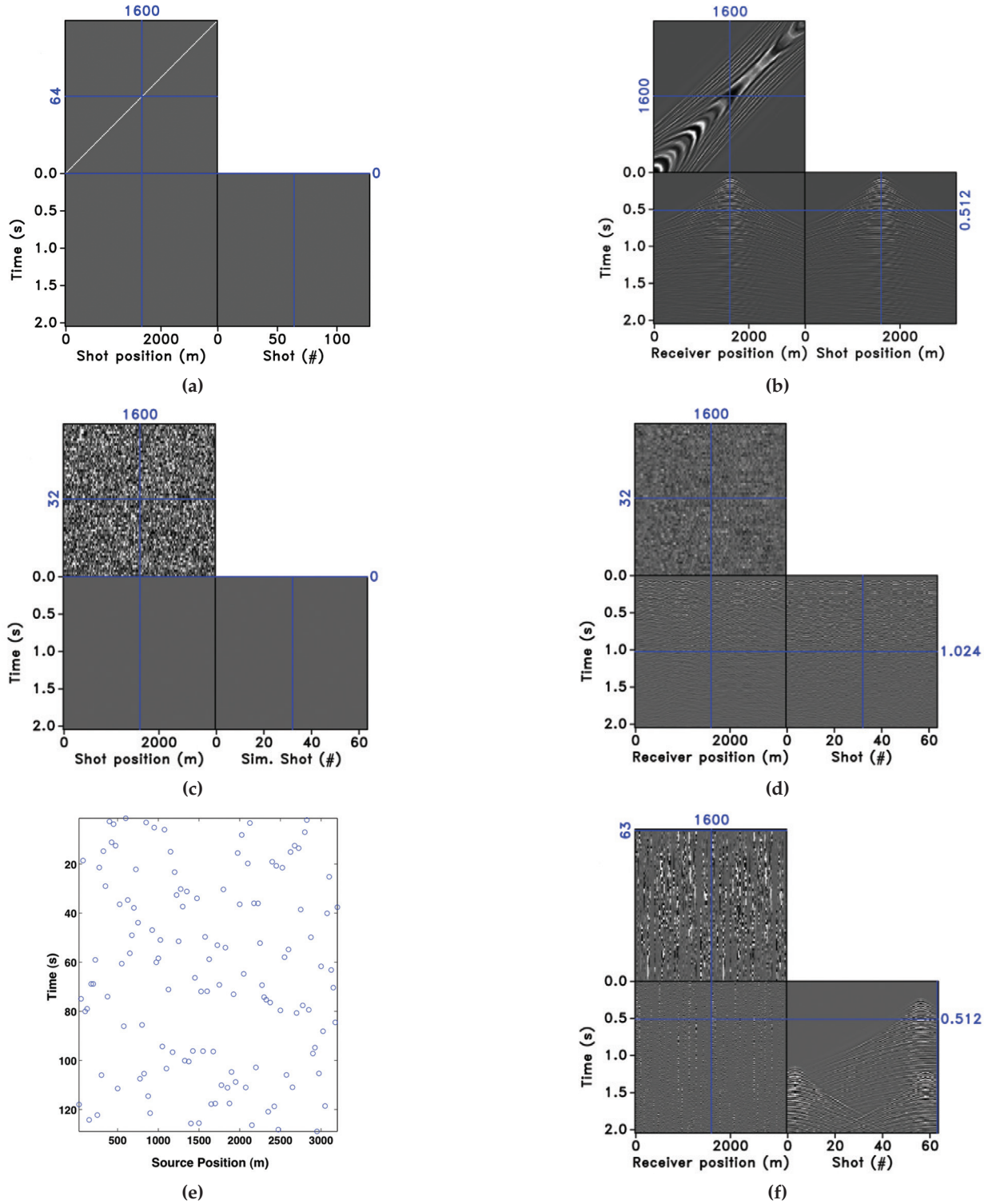

Figure 1. Different acquisition scenarios. ***(a)*** *Impulsive sources for conventional sequential acquisition, yielding 128 shot records for 128 receivers and 512 time samples.* ***(b)*** *Corresponding fully sampled sequential data.* ***(c)*** *Simultaneous sources for Land acquisition with 64 simultaneous-source experiments. Notice that all shots fire simultaneously in this case.* ***(d)*** *Corresponding compressively sampled land data.* ***(e)*** *Simultaneous sources for `Marine' acquisition with 128 sources firing at random times and locations during a continuous total 'survey' time of T = 262s.* ***(f)*** *Corresponding `Marine' data plotted as a conventional seismic line.*

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sparsifying transforms in conjunction with sparsity-promoting programs that separate signal and subsampling artifacts and that restore amplitudes. The implications of randomized incoherent sampling go far beyond the examples presented here. For instance, our approach is applicable to land acquisition for physically realizable sources (Krohn and Neelamani, 2008; Romberg, 2009) and can be used to compute solutions to wavefield simulations (Herrmann et al., 2009b) and to compute full waveform inversion (Herrmann et al., 2009b) faster. Because randomized sampling is linear (Bobin et al., 2008), wavefield reconstructions and processing can be carried out incrementally as more compressive data becomes available.

Indeed, compressive sensing offers enticing perspectives towards the design of future Land and Marine acquisition systems. In order for this technology to become successful the following issues need to be addressed, namely the performance of recovery

- from field data including all its idiosyncrasies. This will require a concerted effort from practitioners in the field and theoreticians. For Marine acquisition, recent work by (Moldoveanu, 2010) has shown early indications that randomized jittered sampling leads to improved imaging.
- from discrete data with quantization errors. Addressing this issue calls for integration of digital-to-analog conversion into compressive and recent progress has been made in this area (see e.g. Gunturk et al., 2010);
- from Land data that has the imprint of statics. Addressing this issue will be essential because severe static effects may adversely affect transform-domain sparsity on which recovery from compressive-sampled data relies.

At the UBC Seismic Laboratory for Imaging and Modelling (http://slim.eos.ubc.ca/SLIM), we hope to report progress on these important topics in future publications.

4 Conclusions

We successfully demonstrated that compressive sensing can be used to recover seismic lines from simultaneous and continuously acquired data. This observation is a direct consequence of the fact that compressive sensing combines sampling and

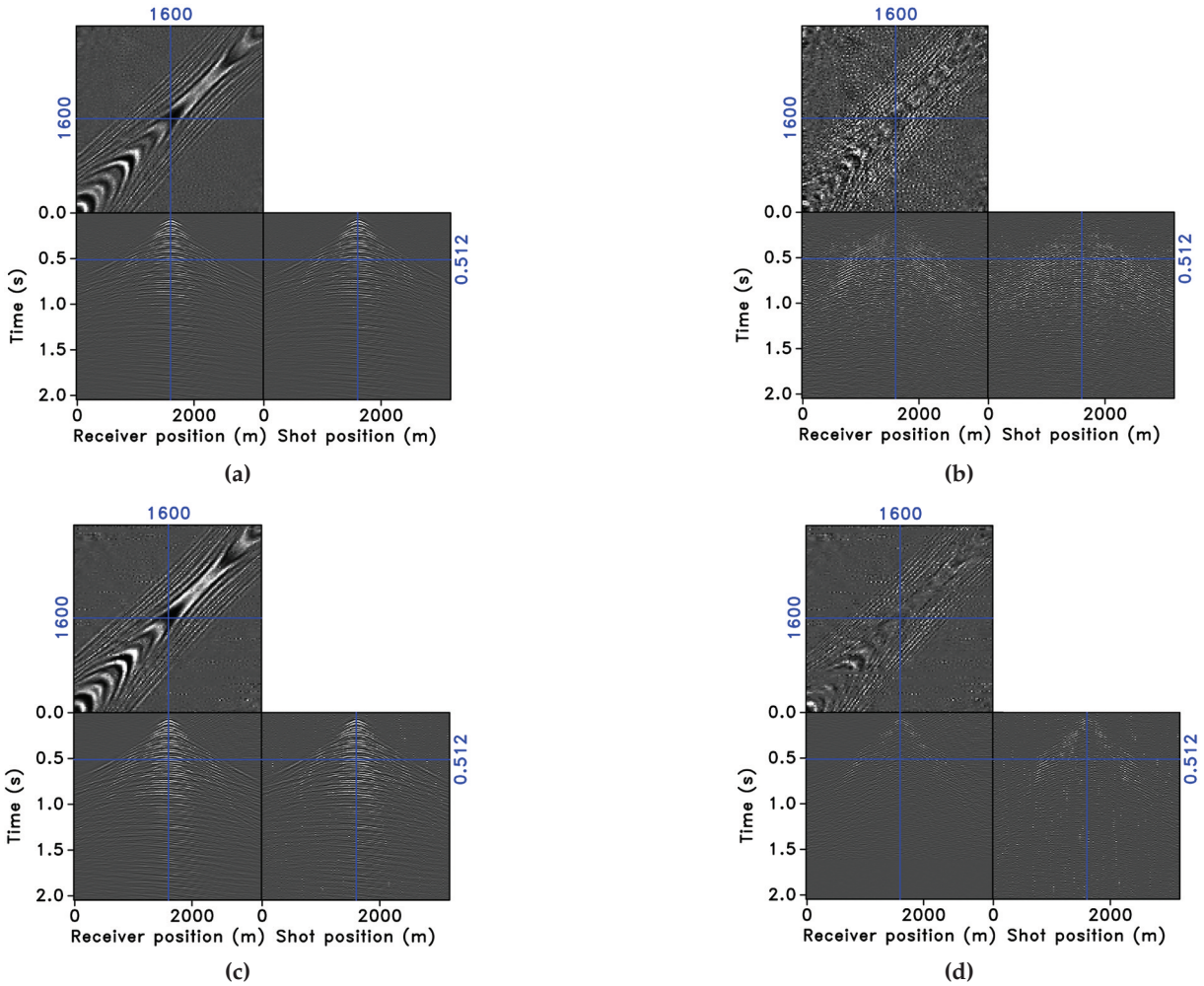

Figure 2. Sparsity-promoting recovery with $\delta = 0.5$ with the 2-D curvelet transforms. ***(a)*** *2-D curvelet-based recovery from `Land' data (10.3 dB).* ***(b)*** *The corresponding difference plot.* ***(c)*** *2-D curvelet-based recovery from `Marine' data (7.2 dB).* ***(d)*** *Corresponding difference plot. Notice the improvement in recovery from `Land' data.*

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compression in a single linear encoding step. Because simultaneous and continuous acquisition can be identified as an instance of compressive sampling, this has profound implications for exploration seismology that include: a new randomized sampling paradigm, where the cost of acquisition are no longer dominated by resolution and size of the acquisition area, but by the desired reconstruction error and transform domain sparsity of the wavefield, and a new paradigm for randomized processing and inversion, where dimensionality reductions will allow us to mine high-dimensional data volumes for information in ways, which previously, would have been computationally infeasible. ***R***

Acknowledgments

This paper was written as a follow up to the first author's presentation during the ``Recent advances and Road Ahead'' session at the 79th annual meeting of the Society of Exploration Geophysicists. I would like to thank the organizers of this session Dave Wilkinson and Masoud Nikravesh for their invitation. I also would like to thank Dries Gisolf and Eric Verschuur of the Delft University of Technology for their hospitality during my sabbatical and Gilles Hennenfent for preparing some of the figures. This publication was prepared using CurveLab, a toolbox implementing the Fast Discrete Curvelet Transform, WaveAtom a toolbox implementing the Wave Atom transform, Madagascar, a package for reproducible computational experiments, SPGl_1, SPOT, a suite of linear operators and problems for testing algorithms for sparse signal reconstruction, and pSPOT, SLIM's parallel extension of SPOT. FJH was in part financially supported by NSERC Discovery Grant (22R81254) and by CRD Grant. The industrial sponsors of the Seismic Laboratory for Imaging and Modelling, BG Group, BP, Chevron, ConocoPhillips, Petrobras, Total SA, WesternGeco are also gratefully acknowledged.

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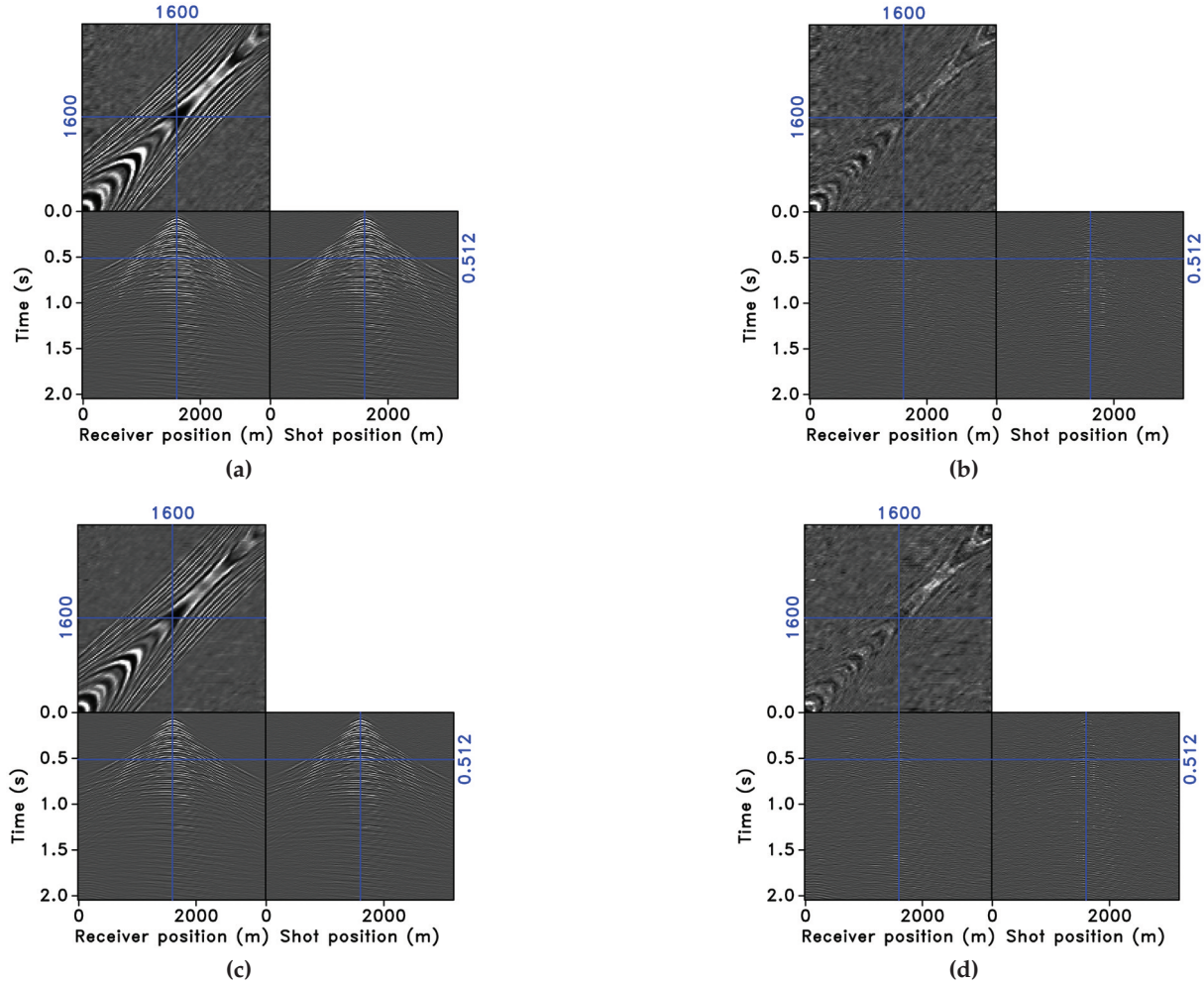

Figure 3. Sparsity-promoting recovery with $\delta = 0.5$ with the 3-D curvelet transforms. ***(a)*** *3-D curvelet-based recovery from `Land' data (11.6 dB).* ***(b)*** *The corresponding difference plot.* ***(c)*** *3-D curvelet-based recovery from `Marine' data (11.1 dB).* ***(d)*** *Corresponding difference plot. Notice the improvement in recovery compared to 2-D curvelet based recovery.*

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ARTICLE

The Evolving Role of Geophysics in Exploration. From Amplitudes to Geomechanics.

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Introduction

Over the last 25 years, geophysical analysis of seismic data has greatly evolved. However, in the routine utilization and daily workflows of many exploration and development teams, geophysical technology is at a standstill. This paper came though our observations and dealings with many geophysicists over time. We've been involved with geophysical technology for over 20 years and we're amazed that after all these years many people are still relying of basic seismic interpretation methods – time structure and amplitude maps. Except a select few, geophysicists do not usually delve into the world of seismic attribute analysis.

Seismic Attribute Analysis can be clustered into distinct topics or headings. These geophysical "innovations" provide an evolutionary road map of geophysical analysis from amplitudes to fluids to rock properties to geomechanics.

We should state now that this is not an all encompassing article. It is based on our perception of the current state and direction of exploration geophysics. The technologies and people we reference is not an end-all list and we apologize in advance for those we do not mention. It is not our intent to ignore or trivialize other people's work.

The purpose of this paper is to review a few of the major milestones of geophysical innovation. The aim is to provide insight into how geophysics has evolved and provide a glimpse into the direction the science and its application is going. With the advent of exploration for unconventional reservoirs, there is a perception that the need for geophysics will decline. On the contrary, it appears that the need for more detailed multidisciplinary investigations will only increase over time.

In school we – geologists, engineers, and geophysicists – learned how reflectivity equations provide us with the basics for what is needed to interpret seismic data. It gives us an understanding of the time required for a seismic impulse to travel to and through a reservoir. It also gives us some understanding of the amplitude we should expect to record by way of acoustic impedance properties encountered by the traveling seismic wave.

This has been the status quo for more than 40 years. Seismic amplitudes were revolutionary in the 1960's (see e.g. Schneider, 1971). Many exploration teams still rely solely on time structure and horizon amplitude maps to present their exploration prospects to management or drilling engineers.

Typically an exploration team evaluates a play for three primary conditions: charge, trap and seal. However, eventually, someone will ask about *Reservoir*. The seismic signal is comprised of three attributes – Amplitude, Phase and Frequency. Each one reveals different nuance to the reflected geologic image. Seismic Attribute Analysis investigates these responses in an effort to provide greater insight to a reservoir's characteristics. It is different than traditional seismic mapping. Now there are hundreds of seismic attributes out there. Most are post-stack, are closely related *and* easily generated by today's workstation.

Pre-stack seismic attribute analysis is more involved, but it is this evaluation that is providing the greatest insight to rock physics and by extension, a greater understanding to developing unconventional reservoirs.

Innovations in Geophysical Analysis

The first innovation came through the simplification of the work of Zoeppritz (1919) by Aki and Richards (1980) and particularly by Shuey (1985). At the same time, Ostrander (1982) observed that seismic amplitudes changed with angle of incidence in the presence of gas (Figure 1). The Zoeppritz equations provide an explanation for this effect, especially through the use of the simplifications introduced by Aki and Richards and Shuey, which resulted in solvable linearized equations, allowing us to easily estimate shear-wave properties in addition to acoustic impedance for the first time.

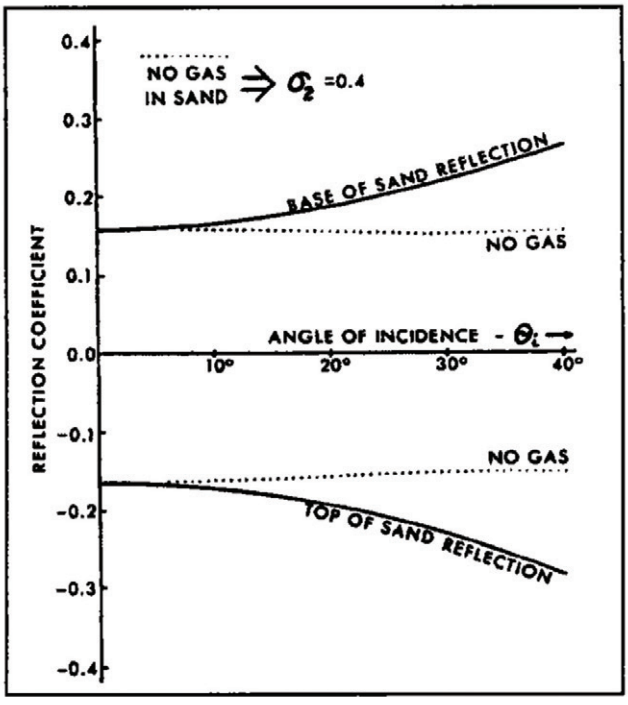

Figure 1. AVO effect in the presence of Gas (Ostrander, 1982).

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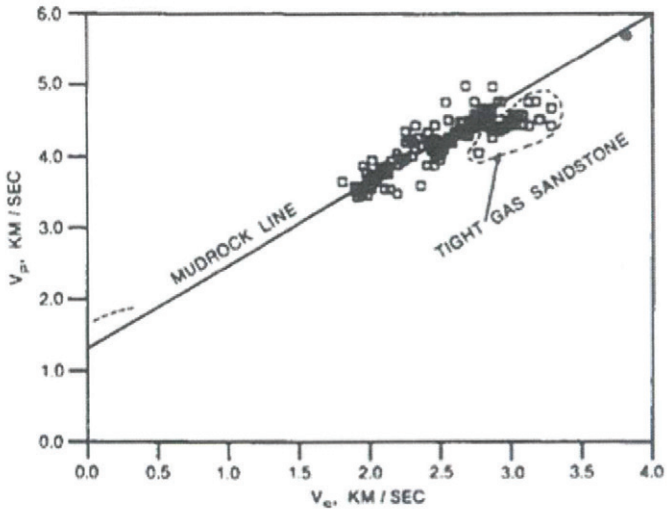

Figure 2. Sonic Log Velocities in Sandstone (Castagna et al, 1985).

Castagna et al (1985) started to quantify this effect with their development of the "Mudrock Line" (Figure 2). This effect was further quantified with the "Fluid Factor" of Smith and Gidlow (1987). The importance of this innovation was the ability to evaluate fluid properties using seismic data.

With seismic being acquired with longer and longer offsets, evaluation methods began to focus on angles and the shear wave component to the seismic ray path came under scrutiny. This brought rock physics into play – the next great innovation. Backus et al (1993) describe the incorporation of petrophysics and borehole properties into seismic interpretation. A further extension of this was the work by Goodway et al (1997) who incorporated these principles with their paper on rock properties – Lambda-Mu-Rho (LMR). This innovation provided for more direct estimation of lithologies and fluids from seismic data using petrophysical parameters (Figure 3).

Thomsen (1985) simplified the concept of seismic anisotropy, the variation of physical properties in different directions, by introducing the concept of weak anisotropy. Lynn et al (1996) showed that these effects could be seen in seismic data and Gray et al (1999) showed that fractures could be detected using 3D wide-azimuth seismic data– the next innovation. This was done, once again, by examining the shear wave component of the seismic response, which is affected differently depending whether it is traveling parallel or perpendicular to the fracture system due to its anisotropy (Figure 4). The impact of this was that engineering decisions could now influenced directly by seismic recordings.

So where are we now? By incorporating the concepts of stress and stain into the anisotropic calculations, we are now deducing Geomechanical properties from seismic data (Figure 5). Stresses, Young's modulus and Poisson's ratio, although present in geophysical algorithms for years for fluid calculations, they are also parameters the engineering teams use for well planning and fracking. Young's modulus can be used as a proxy for brittleness. We are now talking in terms of what a drilling engineer uses. Delivering an amplitude map with 100 milliseconds of closure is of little value in unconventional exploration.

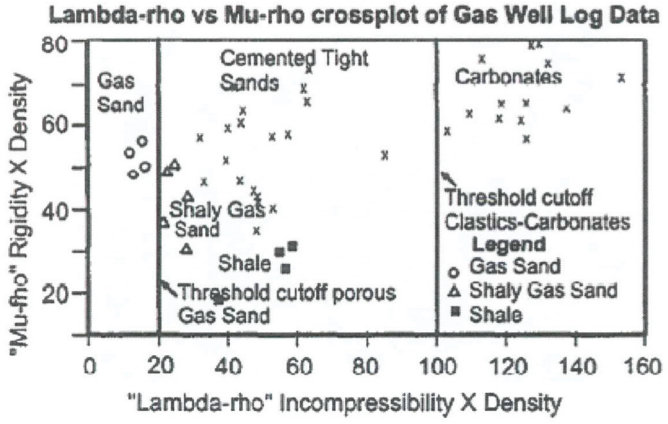

Figure 3. LMR crossplot showing effects of lithology and fluids (Goodway, 1997).

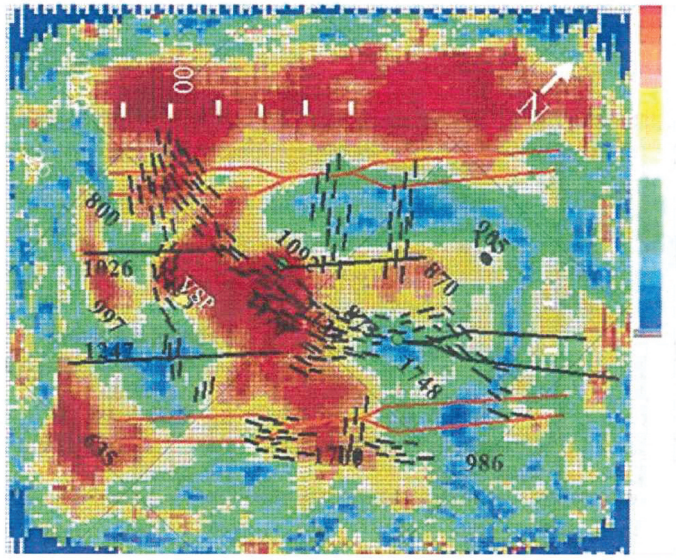

Figure 4. Fracture map using 3D wide-azimuth seismic data. (Gray, 1999).

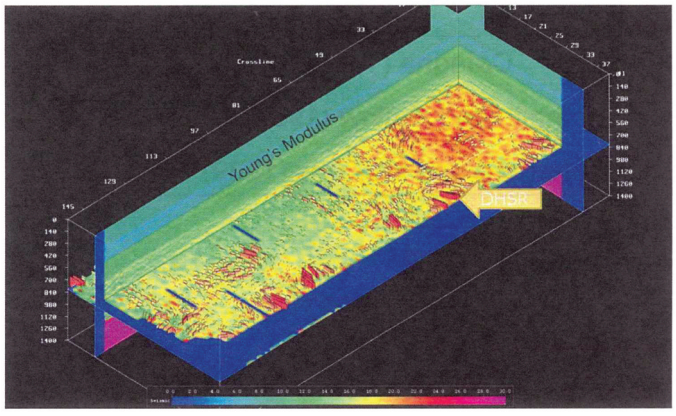

Figure 5. Young's Modulus Cube (Gray, 2010).

Modern geophysicists should consider themselves a partner in the drilling and development of the field. Through a series of innovations (Figure 6), we are no longer just producing structural maps with stacked amplitude conformance. We now have the capability of providing key links between geology and engineering through

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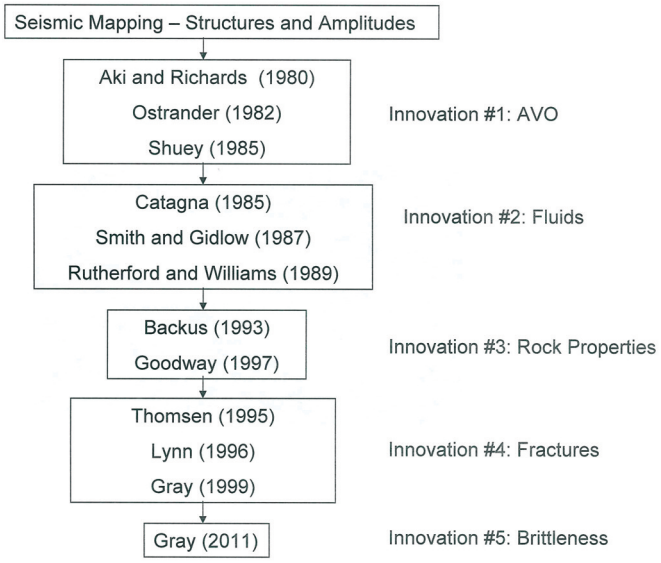

Figure 6. The Evolution of Geophysics from Amplitudes to Geomechanics.

the use of geomechanical insights gained from seismic data. Expensive drilling decisions can be influenced in a positive way with the use of these seismic techniques.

The New Asset Team

The repercussion of these innovations is that the conventional asset team is changing. Historically, they were made up of a Geologist, a Geophysicist and an Engineer. There is a new disciple emerging: Geomechanics. Borehole stability, casing design, lateral well spacing, pore pressure, stimulated reservoir volume, and cap-rock integrity are just a few of the roles of this team when exploring for either unconventional resources or exploration wells in extreme locations like deep water or over pressured regions.

Whether it is an individual or knowledge of the science, Geomechanics is emerging to be the glue that links cross-discipline analysis. Figure 7 shows that the new asset team must share information to be successful. The geologist's thin sections and core analysis, coupled with the engineer's completion and borehole data, provides validation to the geophysicist's anisotropy and rock property studies.

Historically, wells were drilled "on target, on depth and on budget", only to find that the reservoir was not conducive to producing in the direction it was drilled and fracked. Once a template is formed, sound drilling and business solutions can be developed that are based on rigorous multidisciplinary investigations. A 100 ton frack at 200m perf spacing has much different economics that a 200 ton fack at 100m perf spacing.

Conclusion

Exploring for the unconventional is not the same as exploring for conventional resources. Geomechanics drives shale and oilsand development and will be required to assure the success of wells costing in the tens – hundreds of millions of dollars. Amplitudes and structures do not. Geophysical methods are the only laterally extensive method that we have to not only gauge our exploitation impact on these reservoirs, but to potentially understand the nature of the reservoir and geomechanical properties *prior* to drilling.

Geophysicists and Geologists must communicate with the Engineers in terms they understand. Young's modulus, Poisson's ratio, stresses, and pore pressures are used for stimulation modeling and completion optimization. Stimulated Reservoir Volume (SRV) is a poorly understood concept in tight reservoirs and greatly impacts production projections. Geophysics has the potential to facilitate SRV estimation.

Environmental concerns needs to addressed. Geomechanical information on the overburden, derived from seismic, is an important element to investigating the environmental concerns related to fracking such as caprock integrity and ensuring the safety of our drinking water.

Finally, in order to be successful, there is a need to develop a new style of asset team where geomechanical information is shared and incorporated across all disciplines – Geology, Geophysics, Engineering and Geomechanics.

So to answer those that believe that the need for geophysics in an E&P company is dwindling and becoming obsolete, we must state that we cannot disagree more. The evolution of geophysics from Amplitudes to Geomechanics has provided a detailed understanding of rock physics that is providing insights and drilling solutions that have never been available before. R

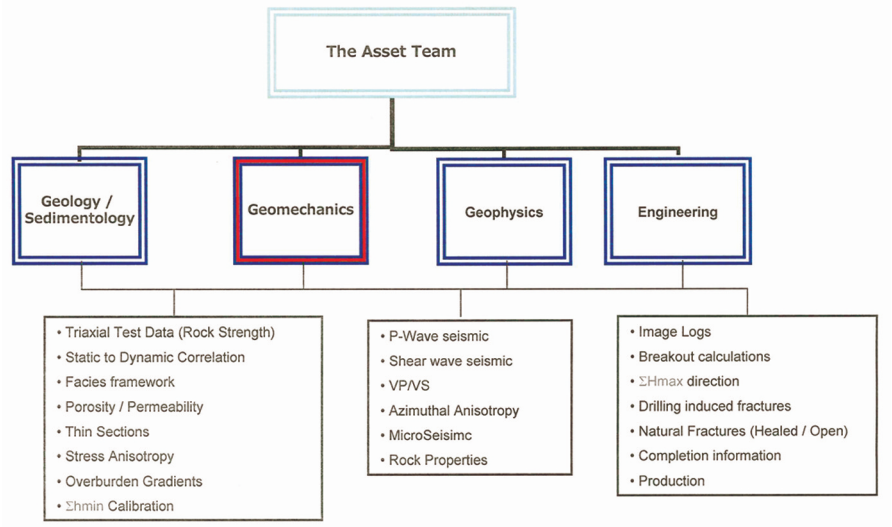

Figure 7. The New Asset Team.

Acknowlegements

We would like to recogize Kurt Wikel and Geoff Rait for their continuous patience for teaching us the finer details of geomechanics.

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Presidential Column...

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The CSEG Outreach efforts are conducted through committees of the Foundation. Helen Isaac chairs **Schools Outreach** and Perry Kotkas leads **Public Outreach**. The Foundation's dedicated and enthusiastic volunteers attended 20 career fairs and assorted exhibitions in 2010 and talked to students and the public about geophysics. They travelled with their booth to Vancouver, Kelowna, Winnipeg, Saskatoon, Regina, Canmore, and Edmonton as well as locally in the Calgary area. They present the science of geophysics with PowerPoint shows, interactive seismic displays and other demonstration materials.

University Student Outreach (USO) is led by Stephen Kotkas. This subcommittee continues to expand its activities and has increased student membership to almost 250. USO activities included sponsoring three and attending two undergraduate conferences with the CSEG Outreach booth, attending two University career fairs, presenting Best Geophysical Paper awards at two undergraduate conferences, maintaining e-mail and newsletter communications with students, making connections between students and the Scholarship committee and the Foundation for travel grants, organizing a student area at the convention, helping to deliver Geoskills 2010 for university students and junior geophysicists, providing networking opportunities, and running a one day summer student field trip in June. CSEG USO also liaises with other organizations for events like AAPG's Imperial Barrel Award, U of C EAGE's student chapter talks, and APEGGA's Alberta Student Energy Conference. The Mentorship program was successfully launched in 2009-10 and in 2010-11continues to grow and be a valuable resource for our university student members.

Mark Lane leads the **Challenge Bowl** subcommittee with Brian Russell and other Outreachers. The dynamic moderator, Peter Duncan, emceed the Challenge Bowl. I attended this year's Challenge Bowl at the convention and our own U of C CREWES team took first place.

Ambassadors are CSEG representatives in cities across Canada and internationally. In 2010, this program included meet-and-greet opportunities for CSEG members and university students in Edmonton, Winnipeg, and Saskatoon.

Seismic in Motion for Students allows Calgary Board of Education high school students to attend the Canadian Association of Geophysical Contractors' Seismic in Motion field trip. This one day field trip showcases seismic exploration activities in the oil and gas industry. Up to 50 participants from different high schools attend on each of the three days, as well as 100 people per day from the petroleum industry. The week before the field trip, a Canadian Society of Exploration Geophysicists Outreach Committee volunteer gives a 'Careers in Geophysics' presentation to the students in their home school to promote awareness of the science of geophysics. Then, the students take part in the one-day Canadian Association of Geophysical Contractor's trip to the field to observe all aspects of seismic operations.

What does the future hold for the Foundation?

- Continued funding of the CSEG scholarship program.
- Increase the legacy/initial endowment of ~$200K to reach the goal of $1 million.
- Investigate the feasibility of conducting a major funding drive.
- Actively administer and distribute donations, such as any accumulated CSEG surplus, to expand outreach Outreach and educational opportunities.

I encourage you to support the CSEG Foundation in whatever way you wish, either personally or through your company. Contact the CSEG office at (403) 262-0015 or cseg.office@shaw.ca for more information. They are always looking for volunteers.

Doodlespiel Memories

In preparation for next year's 40th annual Doodlespiel, this year's committee is looking for information about previous events, particularly those that occurred in the 70s 80s and early 90s. If you were a past Chair of the committee, or have some interesting anecdotes to share, please contact Roger Edgecombe at rogere@boydpetro.com with your scoop. I know I remember some wild and wooly bonspiels that I will be reminiscing about when I was chairman. I just wish I could remember more of them!

Next Month: Our various Social Committees and events. Until then, stay safe and have a great spring!

Larry Herd, CSEG President

ARTICLE

Temperature versus political transparency: Does heat corrupt us?

Robert R. Stewart
Department of Earth and Atmospheric Sciences, University of Houston, Texas, USA

Summary

Human discomfort increases at elevated temperatures (above about 27°C or 81°F). Higher temperatures impact our ability to work accurately and productively as well as to learn. Irritability and inclination to anger can increase, too. Transparency International is an organization that evaluates countries according to their political transparency – a value that attempts to capture the perceived extent of corruption. There appears to be some correlation between transparency and the latitude of the country's capital: countries farther away from the equator are mostly rated as less corrupt (with several distinct counter examples). Ambient temperature is related to latitude and may be an underlying driver of transparency. Human relations and abilities are challenged by heat, and perhaps so is overall governance – which may explain some of the correlation between corruption and temperature. If this is so, there may be a partial cure: widespread use of air-conditioning. The clarity of governance may be associated with temperature and, as such, can be improved.

Introduction

It's almost too obvious to note that people have trouble working and thinking when they become hot. A poll, reported in USA Today, indicated that, "Most people say summer heat or humidity has a negative effect on their mood and temperament." In addition, these conditions affected productivity with 45% of those polled indicating that they worked slower and 20% said they didn't want to work at all (Figure 1).

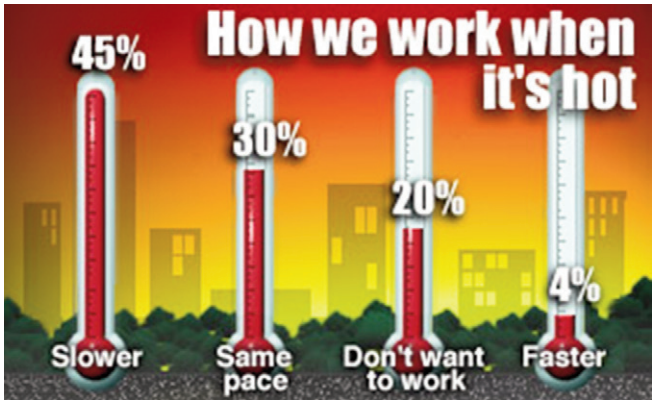

Figure 1. The effect of temperature on work (USA Today, c. 1997).

A more recent poll (Earth magazine, 2011) asked "Do you feel like your productivity decreases when the temperature climbs?" 45% of respondents agreed with "Yes, I can't think as well when I'm hot". Only 13% said, "No, I am not affected by temperatures."

Blumberg (2002) in his book "Body Heat: Temperature and life on Earth" discusses just how striking is the impact of temperature on humans, and virtually every other lifeform for that matter. A human's internal biochemistry works best only in a narrow range around 37°C. This internal range is most comfortably associated with an external temperature of about 20°C-27°C. Numerous studies on learning and temperature (e.g., Pepler, 1971; Schoer and Shaffran, 1973) indicate that students' performance is significantly related to temperature. Students learned and tested better in air-conditioned classrooms at temperatures from 22.5°C-24°C than when in non-air conditioned classrooms at 26°C-29°C. Anecdotally, having taught in locations such as Hassi Messaoud, Algeria (with outside temperatures of 48°C and inside temperatures at 31°C), I can attest to the lack of quality teaching possible (not to mention learning) at these temperatures (Figure 2).



Figure 2. Apartment building in Hassi Messaoud, western Sahara desert, Algeria. Note the many air-conditioners (and satellite dishes) – An attempt to get the heat out and media in (photo by author).

The sciences (IUPAC, 1997) define "standard" temperature and pressure as 0°C and 100kPa (1 bar). This is based on the freezing point of water and the approximate pressure of the atmosphere at sea level. However, many environmental and industrial organizations use temperature standards from 15°C – 25°C (e.g., EPA, 1990) which suggests normal operating ranges of equipment, processes, and personnel. "Room temperature" is roughly considered to be the indoor temperature at which humans are comfortable. It is often quoted to be about 20°C (Allwords, 2006; Aircon, 2006; Tech, 2006). Although, the popular and technical usage varies from about 18°C to even 27°C (300°K).

Six major variables are thought to determine how warm a person feels (Hensen, 1990; CUergo, 2006): his or her activity level, clothing, the air temperature, the mean radiant temperature (average temperature of nearby objects or room elements), humidity, and air speed. Hensen (1990) reports on

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numerous experiments that generally consider the human thermal "comfort zone" at about 25°C. Fowler (2005) suggests that 72°F-78°F (22°-26°C) is the optimal range of 'thermal comfort' for humans indoors. Rosario (2006) outlines numerous examples of bad behavior (from irritability to murder) increasing with ambient temperature. Anderson (1989) states, "Field studies clearly show that heat increases aggression." Read (2006) quoting E. Boyanowsky states that, "The areas of the world where there are the most violent crimes are also the hottest parts of the world." As well, there are many terms or phrases that indicate a negative association of temperature with human attitude (hot under the collar, hot-headed, lose your cool, chill out, etc.)

Bessamaire (2006) reports on how temperature affects working. He quotes a NASA Report (Table 1) that shows when in-plant temperatures rise over 85°F (29°C), output drops by 18% and accuracy suffers from a 40% increase in errors:

Effective Temperature	75°	80°	85°	90°	95°	100°	105°
	(24C)	(27C)	(29C)	(32C)	(35C)	(38C)	(41C)
Loss in Work Output	3%	8%	18%	29%	45%	62%	79%
Loss in Accuracy	—	5%	40%	300%	700%	—	—

Table 1. Work output and accuracy as a function of temperature (Bessamaire, 2006 quoting NASA Report CR-1205-1).

This type of unease is captured by charts of health effects expected for elevated temperatures. A U.S. index (Table 2), which combines the effects of temperature and humidity, is shown below.

Heat Index	Health Effects
80-90°F (27-32°C)	Fatigue possible with prolonged exposure and/or physical activity.
90-105°F (32-41°C)	Heat cramps and heat exhaustion possible with prolonged exposure and/or physical activity.
105-130°F (41-54°C)	Heat cramps or heat exhaustion likely and heatstroke possible with prolonged exposure and/or physical activity.
130 °F or higher(>54°C)	Heatstroke highly likely with continued exposure.

Table 2. U.S. index combining temperature and humidity (from Heidorn, 1998).

A similar index (Table 3) has been designed for Canada which also relates temperature and humidity effects to comfort level.

Humidex	Comfort Level
Less than 29 °C	No discomfort
30 to 39 °C	Some discomfort
40 to 45 °C	Great discomfort; exertion should be minimal
Above 45 °C	Dangerous conditions, exertion should be avoided
Above 54 °C	Heat stroke imminent

Table 3. Canadian index combining discomfort effects of temperature and humidity (from Heidorn, 1998).

We can inquire as to where these temperatures are likely to occur. A map of the average annual temperature over the world (Figure 3) indicates that many equatorial countries are exposed to temperatures that could be classified as uncomfortably hot.

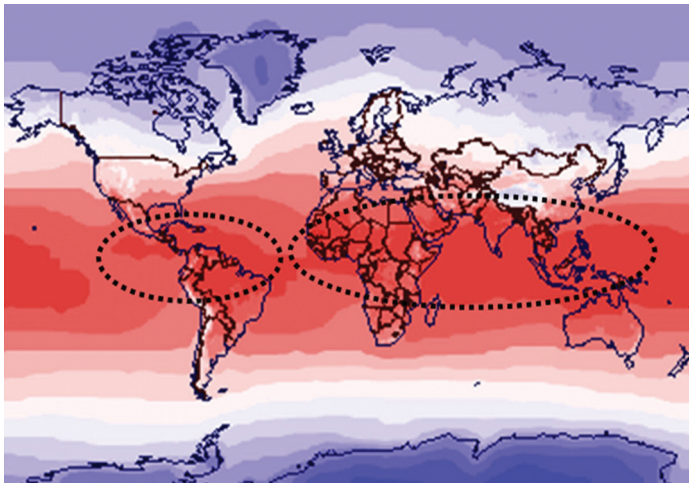

Figure 3. The world's average annual surface temperatures over the years 1961-1990. The blue colors indicate an average temperature below 0°C while the most intense red is above 25°C (from http://globalis.gvu.unu.edu/). Annual temperatures above 25°C (with ellipses) indicate a thermal challenge to some human activities.

Some travelers and workers may have noticed that visiting tropical or equatorial regions can entail an adventure into a less "developed" world. Clearly, there are many wonderful things about equatorial countries (e.g., sunshine, diverse wildlife, foodstuff variety, fascinating histories, vibrant cultures, emergent industries). Furthermore, what constitutes "developed" is certainly controversial. However, daily life may be a grim struggle for many near the equator – for example, a recently released Gallup (2011) poll indicates that a "thriving" well being was generally lowest in sub-Saharan Africa. Transparency International (TI, 2011) is an international non-governmental organization devoted to combating corruption. Its International Secretariat is located in Berlin and it consists of more than 85 independent National Chapters around the world, TI works at both the

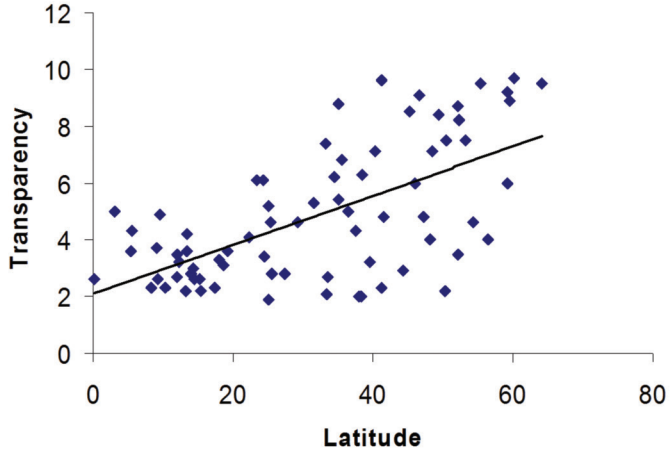

Figure 4. Plot of political transparency of countries (from Transparency International) versus the latitude of the country's capital. Note the general increase in transparency with the distance from the equator.

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international and national level to curb the supply and demand of corrupt practices. TI compiles data on practices in countries around the world and publishes an annual Transparency Index. Key to TI's relevance is that it uses surveys in the countries themselves to self-report on the perceived levels of corruption. That Corruption Perceptions Index (CPI) is used here.

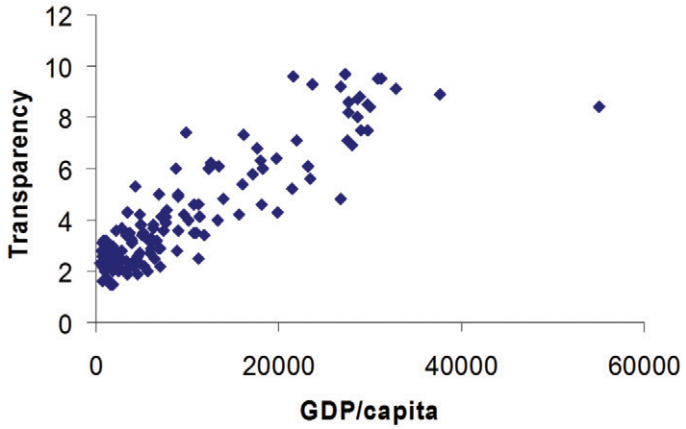

Figure 5. Political transparency very gross domestic product per person from Transparency International in 2006.

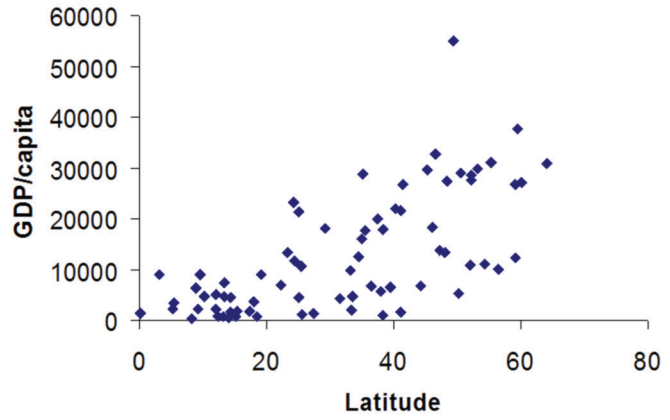

Figure 6. Gross domestic product (GDP) per capita of nations versus the latitude of their capital city.

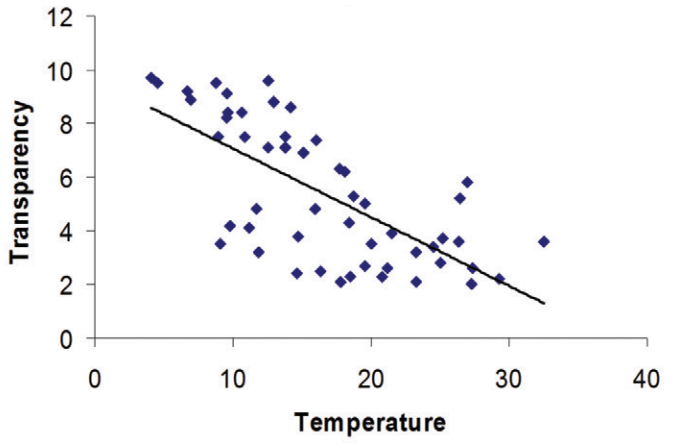

Figure 7. Transparency of a nation versus annual average temperature for its capital city.

Several years ago, Jon Claerbout of Stanford University correlated political transparency (the lack of perceived corruption) with latitude – that is, countries away from the equator were generally perceived to be less corrupt. Some recent values of a country's transparency (from Transparency International) versus the latitude of its capital city are plotted in Figure 4.

There are undoubtedly many influences on the politics of a nation as well as those on individual relationships. The Economist (2006) suggests that "Most clearly, poverty and bribery go together." A plot of national productivity per person appears to support this (Figure 5). The Economist further suggests that while no single factor inclines a country toward corruption, "where there is a lot of government, there is a lot of bribery."

Jared Diamond in "Guns, Germs, and Steel" takes some of these observations farther and proposes reasons for why some countries are more powerful economically and militarily than others. His reasons are generally environmental: geography, relative fortune in domesticatable plants and animals, favorable climate. Economic and political freedom has even been correlated (inversely) with the price of oil (Friedman, 2006). Nonetheless, there does appear to be some association of increasing transparency with higher latitudes. A similar relationship (albeit with scatter) exists when we examine gross domestic product/capita plotted against latitude (Figure 6). Why do more northerly countries generally seem to be more productive and transparent than those near the equator? The question is important as nations struggle to increase their well-being and prosperity.

Latitude is a partial proxy for temperature. From the discussion above, we know that temperature directly affects humans. So, we need to investigate the correlation of temperature with transparency. Numerous factors affect the temperature of a location including latitude, elevation, and local geography (proximity to oceans, currents, mountains, winds, etc). However, in this work, I will take the average annual temperature of the capital city of the country to represent the temperature variable. When we plot our transparency values versus temperature of the country's capital city (itself a proxy for the country), we find another correlation (Figure 7).

Statistical inferences, general statements about nations, and evaluations of corruption are all discussions fraught with danger, sensitivities, and misinterpretation. Correlations are not necessarily causations. Plus, there is considerable scatter in the data as shown. But, it does seem that as average temperatures increase there is less transparency. If global temperatures increase in the future, will that have implications for governance?

Discussion

So heat makes us uncomfortable (possibly irritable), less able to learn, fatigued, inaccurate, and less productive. However, life must go on and some tasks need to be performed. Can thermal discomfort lead people to try to find easier ways to do things; cut corners; not bother to undertake some necessary activities; have others do work for them either by unseemly means or force? All in all, people are not necessarily acting at their best when they are hot. This may lead to questionable practices and corruption.

Now, Singapore is near the equator and so, according to the previous correlations, should have a low transparency, but that is

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not the case. The city-state is reported to be quite transparent. Does this refute the temperature-transparency thesis? Perhaps not. In fact, Lee Kuan Yew, the first elected Prime Minister of Singapore (Figure 8), was famous for his oft-quoted statement that air-conditioning was the most useful invention of the millennium. Lee suggested that air-conditioning, "lifted the tropics out of their traditional torpor to the energy levels of those in the more temperate climates." (Stephens, 2001). Often, where there is advanced work being accomplished in the tropics (Figure 9), it will be in an air-conditioned (that is, cool) office.

On the other hand, Russia should be fairly transparent according to temperature. It is not evaluated as so. Other factors are certainly at work. However, Anderson et al., (1996) have suggested that both hot ***and*** cold temperatures can increase untoward behavior. Uncomfortable cold may have a negative effect as does excessive heat for some countries. However, humans have been able to warm themselves for thousands of years via fires, insulating with heavier clothing, and seeking some kind of shelter. It is generally easier to warm than cool as becoming cooler requires more technical sophistication. Of course, one can rest under a shady tree, swim, shower, or use a fan. However, most of these cooling techniques are short-lived, require effort, or imply forgoing other necessary activities. Sustained cooling had to wait for the advent of refrigeration – an energy-intensive process. Wide-spread heating is taken for granted, but nonetheless, where it is compromised there could be transparency effects.

Sometimes culture or even origin are blamed for sorry practices; the intent of this paper is to further challenge those notions and seek other underlying causes.

Conclusion

Elevated temperatures make us uncomfortable. We are less able to learn, work, and generally perform tasks. Thermal discomfort saps the ability to work on one's own behalf and, perhaps more so, for the benefit of others. Countries toward equatorial latitudes are largely warmer as are their capital cities. The political transparency of a nation is somewhat correlated with the latitude and temperature of the nation's capital. If there is a casual relationship between corruption and elevated temperature, there are a number of possible reasons for it: These could include less comfort, lowered activity, less efficiency, compromised ability to learn, lowered interest or ability do work oneself, more difficult working conditions. Nonetheless, there is considerable scatter in the transparency data. This undoubtedly has to do with a number of other factors, including the other end of the temperature spectrum: Discomfort from cold. However, given the relative ease of heating versus cooling, comfort may be more easily gained in northern environments. If there is a relationship between temperature and political transparency, corruption may well be lessened by air-conditioning. ***R***



Figure 8. Air-conditioned towers in Singapore – a country near the equator with high political transparency (photo by author).



Figure 9. Airline reservation office and terminal in Central America with requisite air conditioning (photo by author).

Acknowledgements

I appreciate the efforts of Dr. Zimin Zhang (formerly of the University of Calgary, now Shell Oil, Calgary) and Mr. Jeff Thurston, formerly of the CREWES Project at the University of Calgary, for helping assemble data used in this paper. This paper is a continuation of an article first published in the 2007 CREWES Research Report. I express my gratitude for the general support of the CREWES Project; however, all of the opinions expressed here are solely those of the author.

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Through the Eyes of a Student



Column Contributor
Roger Smith
Student – First year Geophysics, University of Calgary
email: smithrc@ucalgary.ca

In my previous column I spoke about how impressed I was with the support that the industry provided students of geophysics. I would like to reiterate that notion by telling you about the UofC Earth Science Squash Tournament.

The idea came to me when I was playing in the CSPG tournament. I knew that some students usually organized a small tournament once a year for people in the faculty and I thought it would be fun to become involved. My plan was to generate a few sponsorship dollars by approaching companies and asking if they would like to participate. Little did I know that my little idea would turn into a fully fledged squash tournament followed by a student/industry mixer!

I began by meeting with my known contacts in the industry, asking for advice and possibly a few bucks to help with the tournament. The response was overwhelming. Emails came in on a daily basis from companies offering to help. There were even some unaffiliated personal sponsorships and we achieved three times our sponsorship goal! With such great feedback I decided to organize a mixer after the tournament which would bring industry professionals and students together to socialize under informal conditions. I knew from experience that it was difficult for most students to approach professionals and I figured this would be a perfect opportunity for said student to network, ask questions and possibly make friends.

The tournament came together on April 8th and 9th 2011 at the squash courts on the UofC campus. We had fifty entrants with a healthy turnout of professionals to add to the mix. Food and drinks were provided during the tournament as well as prizes for the winners. Some companies donated prizes, so under the advice of my co-organizer Colin Rowell, an "Industry Challenge" was held where students could challenge professionals to get a shot at some of the hats and t-shirts. We really wanted to promote the coming together of the two groups and it turned out quite well. Over the whole weekend, I saw nothing but smiles and laughter combined with a healthy dose of competition.

On the evening of the 9th all of the participants headed to the mixer where all of the food and drink was provided, as well as a few door prizes. The professionals that attended were completely open to student interaction, and at times acted as instigators of conversation. As I watched the mixer progress, that old familiar feeling of excitement came over me. I thought to myself, theses people really care about newcomers. They have a genuine interest in the future of their industry and I am part of it!

I was also impressed by the students. Each one conducted themselves with professionalism and embraced the purpose of what we were trying to achieve. At one point, while I was out getting some "fresh air", a student approached me and thanked me for organizing the mixer and that it had truly inspired him to get out there and meet people. Mission accomplished!

None of this would have been possible without the support of our gracious sponsors, in order of involvement:
Geotir Inc.
Earth Signal Processing Ltd.
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Terra-Sine Resources Ltd
CSPG Student Outreach
Sigma Exploration Inc.
Apoterra Seismic Processing
Domi Diaz
Ray ?...

And a special thank you to my co-organizer:
Colin Rowell.

★ ★ ★ ★ ★ ★

Temperature versus political...

Continued from Page 47

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REPORT
Coordinated by Helen Isaac

CSEG Scholarship Report

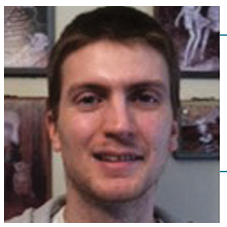
Hassan Odhwani (Divestco Inc.), Matthew Klukas (Talisman), Sarah Cutten (Arc Resources)

The CSEG scholarship committee is a part of the CSEG Foundation and is run by a minimum of 3 volunteers in any given year. The scholarships are funded primarily through generous corporate and individual donations, and through interest generated by memorial trust funds.

Every year, the CSEG scholarship committee distributes scholarships to deserving candidates at Universities across Canada. The criteria for receiving a scholarship are enrollment in a program leading to a career or research in exploration geophysics, academic performance, financial need and extra-curricular activities. Twenty one companies, trust funds and individuals donated a total of $32,000 in 2010 for 16 scholarships. The CSEG presented 20 scholarships in 2009 and 23 in 2008. Our goal is to increase the number of scholarships we distribute each year by increasing the number of industry sponsors. All scholarships have a value of $2,000. Many companies fully sponsor a scholarship with a donation of $2,000 while others partially sponsor scholarships with donations of $1,000 or $500.

The 2010 Scholarship Committee (Hassan Odhwani, Matthew Klukas and Sarah Cutten) is currently soliciting donations for the 2011/2012 academic year. Donation request letters were sent out in March to companies and individuals and are currently following up with a phone campaign. If you are interested in contributing and have not yet been personally contacted by the CSEG Scholarship Committee, we are gratefully accepting donations. *Please contact a member of the committee or mail funds to the CSEG office with cheques payable to the CSEG Foundation. We ask that you clearly indicate that the funds are for a CSEG scholarship.* All donations are tax deductible and a charitable donation receipt will be issued.

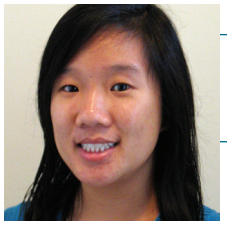
The CSEG scholarship committee would like to thank all of the generous scholarship sponsors for their support in 2009. Your support contributes to the advancement of the field of geophysics, and the education of students pursuing a career in exploration geophysics.



*Sponsored by **Dr. Lines, John and Cindy Townsley,***

and SENSOR GEOPHYSICAL LTD.

Christopher Bird was born and raised in Calgary but graduated from the University of Saskatchewan in 2007 with a B.Sc. honours degree in geophysics. He then worked as a seismic processor in Calgary until 2009. In 2010 he started his Master's Degree program at the University of Calgary with the CREWES project. His research interests include seismic inversion, Q attenuation, and time lapse seismic. He has worked summer terms with EnCana Corporation and Husky Energy in 2007 and 2010, respectively, and in 2011 he will be starting a summer term with ConocoPhillips Canada. Chris would like to express his thanks to the sponsors of his CSEG Scholarship: Dr. Lines, John and Cindy Townsley, and Sensor Geophysical.



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Judith Chan completed her Bachelor of Science in Geophysics at the University of Alberta in 2008. Upon graduation, she worked as a seismic interpreter in an oil and gas company on properties in Northeast BC and West Central Alberta. In 2010 she decided to pursue a M.Sc. degree under the supervision of Dr. Doug Schmitt. Her MSc. project involves processing and interpreting seismic, HRAM and logging data from northern Alberta to gain a structural understanding of the sedimentary basin and basement rocks for geothermal exploration. Upon graduation, she plans to return to work as a seismic interpreter. During her free time she enjoys volunteering, traveling and reading. She is currently a volunteer on the Earth Science for Society Exhibits committee. She would also like to take this opportunity to thank Boyd PetroSearch and the anonymous donor for their generous sponsorship of this CSEG Foundation scholarship.



Sponsored by Canadian Natural

Eric-Martial Takam Takougang got a M.Sc. in Geophysics from the University of Yaounde I in Cameroon, a Post-graduate Diploma in mathematical sciences from AIMS (African Institute for Mathematical Sciences), Cape Town, South Africa, and has been a Ph.D. candidate at the University of Simon Fraser in Burnaby, British Columbia, since September 2007. He is working on the application of waveform tomography to seismic reflection data to obtain high resolution images of the subsurface using both amplitudes and phases of the waveform. He has been working over the last three years on the application of the technique to seismic reflection data from the Queen Charlotte sedimentary basin of western Canada and from the Seattle fault zone. Eric-Martial would like to thank Canadian Natural Resources for their generous sponsorship of the CSEG Foundation Scholarship.

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CSEG Scholarship Report

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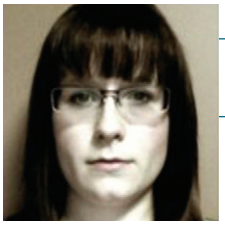

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Cassandra Budd is a fourth year student at the University of Alberta. Her interests lie in the field of environmental and engineering geophysics. Upon graduation she plans to work at EBA Engineering Consultants Ltd., the company where she completed a year-long internship. Her non-academic interests include biking, skiing and travel. She would like to take this opportunity to thank Nexen for sponsoring her CSEG Foundation Scholarship.



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Karol Rohraff is currently a M.Sc. in Geophysics student at the University of Alberta. His thesis topic is related to time series processing of paleoclimatic data with special emphasis on the treatment of unequally sampled data and signal correlation. After graduation Karol would like to pursue a career in industry in the field of seismic data processing and interpretation and become a Professional Geophysicist. He would like to take this opportunity to thank Hampson-Russell Software services for sponsoring the CSEG Foundation Scholarship.



Sponsored by pulse seismic

Frank Ryan is a fourth year earth sciences major at Memorial University of Newfoundland. His concentration and honours thesis is in petroleum geology and wire-line geophysical logging and he is also interested in soft rock stratigraphy. He is the past-president of the undergraduate earth sciences student society (Alexander Murray Geological Club), as well as a Senior Memorial Ambassador. In his spare time he play hockey, guitar and enjoys the outdoors, as well as volunteer in the community. Frank would like to thank Pulse Data Inc. for supporting the CSEG Foundation Scholarship.



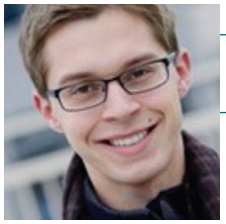
Sponsored by John Peirce and GEDCO

Nadia Kreimer received a Diploma in Geophysics from the National University of La Plata (Argentina) in 2009. She joined the Signal Analysis and Imaging Group at the University of Alberta in September 2009. Nadia is currently enrolled in the Ph.D. program in Geophysics. Her research interests are seismic data regularization and sampling theory. Once she has graduated from her Ph.D. she would like to pursue a career in the oil industry and apply everything that she has learned at the university. Her final goal is to become an expert in the area of signal processing of seismic data. Nadia would like to take this opportunity to thank John Peirce and GEDCO for supporting the CSEG Foundation Scholarship.



Sponsored by PennWest Exploration

Danielle Mountjoy will be graduating from the University of Victoria in April 2011 with an honours B.Sc. in Earth Science. In her last semester she will be presenting her honours thesis and travelling to Hawaii with the University of Victoria geoscience student society to visit the world's most active volcanoes. After graduation, Danielle plans to spend the summer field season working abroad prior to returning to Calgary. When not working, she spends her time hiking, camping and rock climbing. Graduate school is definitely on her horizon but she is looking forward to some real life, hands-on geology before embarking on the next leg of her professional journey.



Sponsored by Divestco

Chris Thompson was born and grew up in Kelowna, British Columbia. During his years in Jr. High and High school, Chris enthusiastically participated in the school band. He developed his love of music and immediately connected with the piano, focusing on an interest in both Jazz and Classical styles of music. Chris enjoys skiing in the Canadian Rockies, playing squash, and practising piano. He also has a growing interest in both travel and the culinary arts. After moving to Calgary at the age of fifteen Chris became interested in geosciences. He attended a job shadow with a professional geophysicist and his passion of earth sciences grew further. It was at this point Chris decided to enroll at the University of Calgary's geosciences department, where he will be completing a five year combined degree program in geophysics and geology. Chris plans on spending a semester at the University of Glasgow in 2012 as a way to experience a different culture and get a feel for geoscience outside of Calgary. Chris is currently in his third year and he is looking forward to a career in the oil and gas industry.



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Ted Popilchak Trust Fund

Aaron Foyer is currently completing his final year of a degree in geophysics along with an honours degree in geology at the University of Calgary. He believes having a strong base in both disciplines gives him a unique vantage point into geophysical problems. His interests lie in further integrating geophysics with geology to help develop a stronger, more unified geoscience. In May of 2011, he'll be graduating, and will immediately enter the oil and gas business as a geophysicist, where he looks forward to a long and prosperous career. His personal interests lie in music and sports. He is an avid collector of vinyl records, many of which are albums by the Beatles or Bob Dylan. He has taught himself to play the guitar, harmonica and piano over the past 8 years. Aaron would like to thank Ted Popilchak Trust Fund for sponsoring the CSEG Foundation Scholarship.

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CSEG Scholarship Report

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Sponsored by Geoterra Seismic Processing Ltd / SIGMA Explorations Inc.

As a Geophysics Ph.D. student at the University of Alberta, **Dunia Blanco** has developed a great interest in the internal structure of the planet, specifically the dynamics and evolution through time of Earth's magnetic field. Her work with Dr. Vadim A. Kravchinsky has leaded her to develop different skills analyzing paleomagnetic and paleointensity data, as well as using specialized experimental instruments. Although her research is directed to more fundamental subjects, she is also interested in the amazing applications of geophysics to industry, especially in electromagnetic, magnetic and gravity exploration methods.



Sponsored by SeisWare Industrial Strength Interpretation

John Mosquera is currently a Master's student at the University of Waterloo. This year he has been fortunate to have been chosen as the recipient of the CSEG Scholarship. He would like to convey his sincere gratitude in your support of his research as well as other students' research. His academic interests lie in the integration of geophysical techniques and hydrogeology. His current research involves the use of ground penetrating radar and its utility in identifying and monitoring contaminant plumes in and above the water table. Through his time at Waterloo, he has been fortunate enough to gain experience with EM, seismic, and resistivity methods. Upon completion of his M.Sc. he hopes to pursue a career with an environmental consulting company, utilizing geophysical tools and his knowledge of hydrogeology to identify and remediate contaminated sites. John would like to say thank you to Zokero Inc. for supporting the CSEG Foundation Scholarship.



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Hassan Khaniani completed his B.Sc. in petroleum exploration engineering at the Petroleum University of Technology (PUT -Iran) in 2003, where he took an interest in connecting petroleum engineering, geology and geophysics in reservoir studies. In May 2006 he completed his Master degree at the University of Calgary, focused on integration of 3D seismic and well data for reservoir characterization. Mr. Khaniani was employed as a processing geophysicist and acquisition QC in TPS and National Iranian Oil Company (NIOC) in Iran for four years. He is currently a full time Ph.D. student within the CREWES project at the University of Calgary; doing research to develop numerical algorithms for enhancing the inversion of velocity from PSDM imaging problems.

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Mathew Baird, Geophysics student at the Memorial University.
No Bio Available.

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Jennifer Fohring, Geophysics student at the University of British Columbia.
No Bio Available.

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Conrad Koziol, Geophysics student at the University of British Columbia.
No Bio Available.

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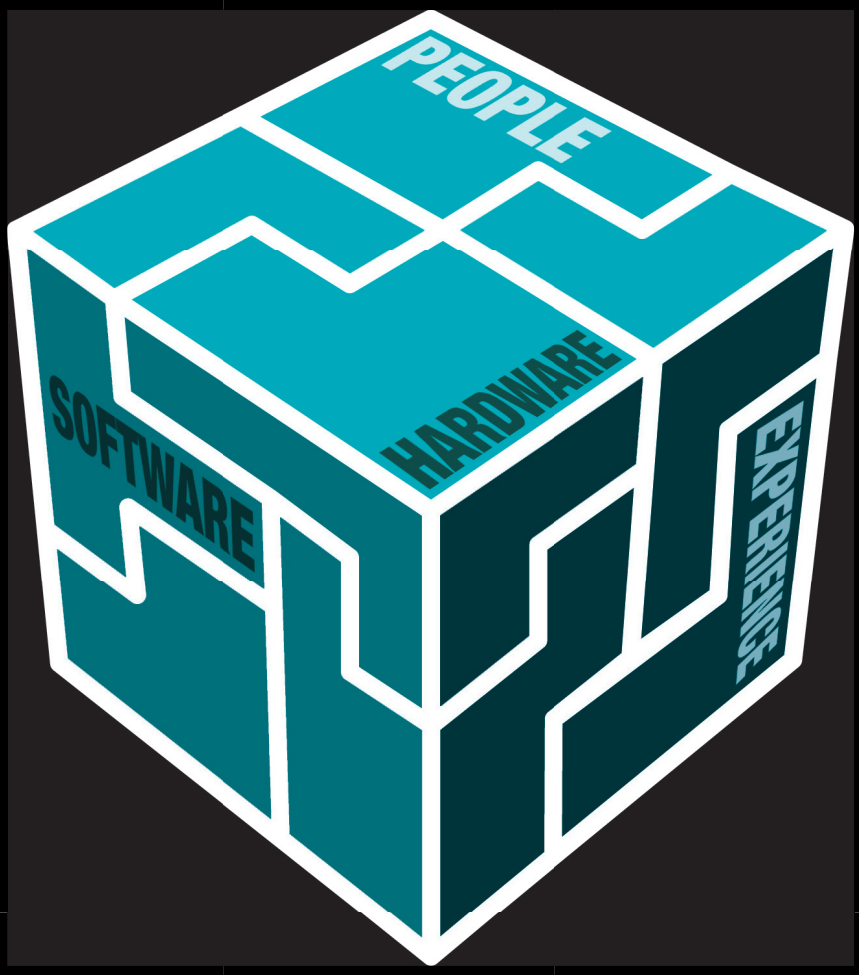

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REPORT

23rd Annual CSPG-CSEG 10km/5km Roadrace and Fun Run

Mike Cardell
Race Director



On your mark! Once again, the CSPG-CSEG will be running its annual Roadrace and Fun Run this September. Building on last year's format, the event promises to be better than ever!

We will be offering both a 10km and a 5km race. We have secured Winning Time to provide chip timing and Events-on-Line will provide easy on-line registration.

The run will take place on Wednesday, September 14, 2011. Start time 6:00pm just north of the Eau Claire YMCA. The route will take you on an out-and-back course along the beautiful Bow River pathway, finishing at the Eau Claire YMCA. Following the race, all racers, volunteers, and guests are invited to gather at the Calgary Curling Club, just north of Princess Island for awards, draw prizes, refreshments, and some friendly camaraderie. So if you are looking for a competitive race or just want to have fun, come join us!

The race is open to all members of the CSPG, CSEG, and CAPL, and the general public, however, space is limited to 200 participants. So register early to avoid disappointment! There will be NO race day registration. For more information or to register, visit our website at www.cseg.ca/events/funrun.cfm. For sponsorship opportunities please contact Mike Cardell at 403-781-1426 or mcardell@arcis.com

To help you, Gord Hobbins of Gord's Running Store has developed a 10km race training guide for novice runners. Try it out and benefit from some expert advice, you may be surprised how easy it can be to gently get yourself in condition for your first race.

Guidance/Tips: For novice runners who wish a do-it-yourself program at your leisure.

- Run for short durations between 3 and 5 times per week according to schedule, with your long run days being the key to your training program.
- If your running shoes are giving you some problems, get some which fit and match your gait.
- Guide allows for a gradual increase to a comfortable load; your legs may need some conditioning at first.
- Yes, times are in minutes. The secret is to be regular and not beat yourself up.
- Wear a hat and cool shades. Keep well hydrated. It really helps.
- Gently stretch those calves and quads afterwards.
- Take along a friend and convince them to sign up for CSPG, CSEG and the Roadrace as well.

Many thanks go out to our sponsors and volunteers who make this event possible each year!

We hope to see you there! *R*

Gord's 12 Week Training Guide for Novice Runners

Minutes of running per day:

Week	Mon	Tues	Wed	Thur	Fri	Sat	Sun
June 26–July 2	-	10-15 min	-	10-15 min	-	-	15 minutes
July 3-9	-	10-15 min	-	10-15 min	-	-	20 minutes
July 10-16	-	10-20 min	0-10 min	10-20 min	-	-	25 minutes
July 17-23	-	10-20 min	0-10 min	10-20 min	-	-	30 minutes
July 24-30	-	10-20 min	0-10 min	10-20 min	0-10 min	-	25 minutes
July 31- Aug 6	-	10-20 min	0-10 min	10-20 min	0-10 min	-	35 minutes
Aug7-13	-	15-25 min	0-10 min	15-20 min	0-10 min	-	25 minutes
Aug 14-20	-	15-25 min	0-10 min	15-20 min	0-10 min	-	40 minutes
Aug 21-27	-	15-25 min	0-10 min	15-25 min	0-10 min	-	25 minutes
Aug 28–Sept.3	-	15-25 min	0-10 min	15-25 min	0-10 min	-	45 minutes
Sept 4-10	-	20-30 min	0-10 min	15-25 min	0-10 min	-	25 minutes
Sept 11-14	-	Rest	**10 KM RUN**				

AAPG Imperial Barrel Award Program

Kevin Bianchini

The AAPG Imperial Barrel Award Program (IBA) presents a unique opportunity for teams of students from universities around the world to analyze and present results from a dataset containing real geologic, geophysical, land, economic, and production information. The basin/prospect-style evaluation allows students the chance to use technology on a real dataset, receive feedback from an industry panel, have the opportunity to impress potential employers in the audience, and to win cash awards for their schools. Teams participated in AAPG Regional IBA competitions in March with regional winners earning the right to represent their section or region in the Global IBA competition at the AAPG Annual Convention in Houston, Texas on April 8th and 9th, 2011. This year a total of 97 teams competed worldwide to participate for their respective region or section in the finals, where the 12 regional winners battled for the Imperial Barrel Award. Three teams from Canadian universities competed in Calgary on March 25th, 2011, for the right to represent the Canada Region at the competition in Houston. There were two teams from Alberta and one team from the East Coast. Each team was composed of five geoscience MSc students assisted by a faculty advisor.

The University of Alberta team included students Ryan King, Josh Thomas, Hayley Pothier, Jamie Robbins, Tom Pocklington and faculty advisor Dr. Murray Gingras. The University of Calgary team included students Rachael Rose, Byron Kelly, Maureen Hill, Andrew Nicol, Adam Fraser and their advisor Dr. Per Kent Pedersen. The East Coast was represented by Dalhousie University, whose team included students Ella Goldberg, Bertha Louis, Darragh O'Connor, Christian Rafuse, Archie Rankin and their advisor Dr. Grant Wach.

The volunteer judges for the Calgary competition included Steve Smith representing the CSEG, Stan Lavender representing ConocoPhillips, Doug Stewart representing Husky and Glen McCrimmon representing ESSO.

Sponsors for the Canadian Regional competition included Apache, ConocoPhillips, CSEG Foundation, CSPG, Devon, EnCana, ESSO, Husky Energy, Nexen, Shell Canada, Talisman Energy, Total, AAPG and the AAPG Canada Region.

Those who attended this year's Canadian competition were impressed with the effort put forth by all the Canadian University teams. Each team presented well thought-out, coherent and thorough presentations. In the end, the calibre of the presentations made the final decision difficult and not initially unanimous. Ultimately the team from the University of Calgary won the right to represent Canada as one of the 12 finalists in the Global IBA Finals competition in Houston and their trip expenses were covered by the AAPG.

The Imperial Barrel Award (and $20,000 in scholarship funds) went to The University of Texas at Austin (Gulf Coast Region). Second place (the Selley Cup and $10,000) was awarded to the University of Southhampton (Europe Region). Third place (the Stoneley Medal and $5,000) was awarded to the Sultan Qaboos University (Middle East Region).

Canada has been involved in the AAPG IBA regional competition for the last four years. Last year the University of Calgary team came second in the Global Finals, while in the year before Memorial University placed third. The CSEG-F is proud to sponsor a competition that inspires multi-discipline integration and team work with an emphasis on geoscience.

Are you a Master's student looking to gain experience that will catapult you into the start of a geoscience career? Get a team together and compete next year for the opportunity to go to the next IBA finals in Long Beach, CA, April 22, 2012.

More information about past and future IBA competitions can be found at http://www.aapg.org/iba



Figure 1. AAPG Canadian Regional IBA winners from the University of Calgary (from left to right): Dr. Per Pedersen (Advisor), Andrew Nicol, Rachel Rose, Byron Kelly, Maureen Hill and Adam Fraser.



Figure 2. AAPG Canadian Regional IBA Volunteer Judges (from left to right): Doug Stewart (Husky), Stan Lavender (ConocoPhillips), Glen McCrimmon (ESSO) Steve Smith (CSEG/Bonavista).



Column Contributor
Carmen Swalwell

Swalwell Resource Consulting
Professional Placements

Phone: 403-560-8431
email: carmen_swalwell@yahoo.com

The convention is over and summer is on its way. As you know, the RECORDER does not publish in July or August. But you can still send me announcements for the September issue.

I had the pleasure of sharing my experiences with the Junior Geophysicists Forum with our sister society the CSPG (Canadian Society for Petroleum Geologists). They held a very successful under 35 networking event last year. I had the pleasure of meeting one of the organizers Ayaz Gulamhussein. We also worked together on the under 35 event at the convention. Ayaz was gracious enough to share information on the charity he is involved with, Kids Up Front Foundation. Thank you Ayaz.

If you have a new job, have been promoted, retired, or want to share your contact information, you can contact me at carmen.swalwell@shaw.ca or 403-560-8431.

ON THE MOVE…

Arcis is pleased to welcome **Jan-Willem Vrolijk** from Delft University of Technology (TU Delft) in the Netherlands. Jan-Willem has joined Arcis for a three month summer internship exploring the use of novel interbed multiple elimination tools on some of Arcis' proprietary data sets in the Montney area. Welcome, Jan-Willem, we hope you enjoy our beautiful city!

Oil Sands Imaging is pleased to announce the addition of **Kevin Lee** to its growing team. Kevin joined us full time in April 2011 and will be developing Interactive Geophysical Applications for the company. He brings 25 plus years of diverse experience in interpretation, processing and geophysical software development. He tuned his programming skills while working for several major seismic processing companies, including CGGVeritas, Geco-Prakla (WesternGeco), and Seis-Pro. Kevin can be contacted at: kevin@oilsandsimaging.com

Pavlo Cholach is pleased to announce his new career opportunity with **TAQA North Ltd.** Pavlo can be reached at 403-724-5073 or by e-mail: pavlo.cholach@taqa.ca

Earth Signal Processing Ltd. is pleased to announce that **Sandy Lucas** has joined the ESP team in the capacity of Sales and Marketing. Sandy's wealth of experience and earned respect over 15 years in the oil and gas industry will compliment the efforts and continued success at Earth Signal. Sandy can be reached at 403-264-8722 (main), 403-968-3968 (cell) or by email at sandy@earthsignal.com

GIVING BACK…

Many members of our community give tirelessly to worthwhile charities. In this portion of the column, readers have a chance to share information about the charity that is close to their heart. Raise awareness for your charity and events supporting it! I am particularly pleased to share the following story with you this month because I was fortunate to attend a fundraising event for Providence Children Centres. It was a fantastic event with many people from our industry in attendance. CS

Submitted by Ayaz Gulamhussein, a Geologist with NuVista Energy Ltd.

"I think it was the most awesome thing I have ever done!"

Do you remember attending your first hockey game, concert, or performance? Do you recall your excitement the first time you were inside of the Saddledome, Max Bell Theatre or McMahon Stadium? For many of us, these experiences nourished our imaginations and inspired our creative spirit! For thousands of kids and families in Calgary, these experiences would not be possible without the work of the **Kids Up Front Foundation.**

As President of the Board of Directors of Kids Up Front Foundation, I am proud to be a part of this local charity that provides life-enhancing experiences for children and youth right here in Calgary who would never get the opportunity otherwise.

It's amazing to hear the impact on the kids. One young person wrote, ***"For once I was the cool kid instead of the poor kid. Everyone wanted to be me for a change."*** The opportunity to attend a hockey game at the Saddledome, a rock concert, or live theatre can make a huge difference in a child's life. For an evening they feel special, can build healthier relationships, and they don't have to worry about their situation – they can have fun and just be a kid!

As a Board member, I am committed to help raise awareness and funds for Kids Up Front's programs so that we can give more kids in our community the chance to attend fun and educational events.

And I'm hoping you will get involved. Last year, Kids Up Front distributed over **30,750 tickets** worth **$1,152,900!** Program costs to distribute the tickets to the kids are approximately $200,000 a year, and this funding is raised entirely from contributions from individuals, companies and foundations.

Please consider supporting Kids Up Front and give kids experiences and memories they will never forget! It's easy to donate. You can go online to www.kidsupfrontcalgary.com to donate tickets or financial gifts.

Your support will provide an experience which may be the key that opens the door to a world of possibilities for a child right here in our community. Research has proven that children in challenging situations can develop and flourish simply from exposure to positive experiences. There is not another program in operation today like the Kids Up Front Foundation. Our charitable partners focus on providing food, shelter and clothing. ***We provide nourishment of the spirit!***



Last year, a youth living in a group home wanted desperately to attend a concert and made his wish known to Kids Up Front. When a ticket experience was given to him, he responded by screaming at the top of his lungs! His words of thanks describe the profound impact this experience had:

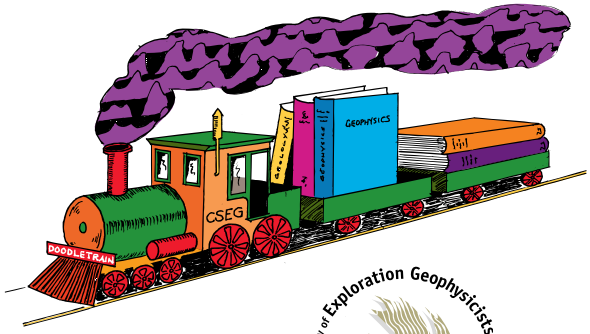
Continued on Page 58

All Aboard!

for the 10th running of

The CSEG Continuing Education DoodleTrain

October 31 – November 4, 2011
Calgary, Alberta



Canadian Society of Exploration Geophysicists
CSEG
Since 1949

The Canadian Society of Exploration Geophysicists invites you to attend our 10th annual Continuing Education Week.

ACQUISITION

1 3D Seismic Data Acquisition: An Update on Modern Technologies and Usage Methodologies - New
Malcolm Lansley — October 31 - November 1

2 Planning Land 3D Seismic Surveys
Andreas Cordsen — November 2 - 3

PROCESSING

3 ABC's of Seismic Data Regularization - New
Mauricio Sacchi — November 2

INTERPRETATION

4 3D Seismic Attributes for Prospect Identification and Reservoir Characterization
Kurt Marfurt / Satinder Chopra — November 3 - 4

5 Seismic Geomorphology
Henry Posamentier — November 3 - 4

6 Structural Interpretation and Analysis of Fractured Reservoirs
Paul MacKay — November 1 - 2

ROCK PROPERTIES

7 Rock Physics for Geophysical Reservoir Characterization and Recovery Monitoring
Gary Mavko — October 31 - November 1

8 Geophysical Characterization of Heavy Oil Reservoirs
Satinder Chopra — October 31 - November 1

9 Geophysical Petrophysics - New
Winston Karel — October 31 - November 1

BASIC CONCEPTS

10 Seismic Data Basics - Level 1
John Fernando — October 31 - November 1

11 Exploration: From Geology to the Seismic Section
Bob Parker — November 2 - 4

DEVELOPMENT GEOPHYSICS

12 Multicomponent Seismic Exploration in Western Canada
Richard A. Bale / Robert Kendall — November 2

13 Naturally Fractured Reservoirs
Roberto Aguilera — November 3 - 4

14 Hydraulic Fracturing and Microseismic
Shawn Maxwell / Mike Jones — November 3 - 4

15 Geostatics for Reservoir Characterization
Clayton Deutsch — October 31 - November 1

16 Fractured and Shale Reservoirs: From Geologic Concepts to Reservoir Models
Ahmed Ouenes / John Lorenz — November 3 - 4

PROFESSIONAL SKILLS

17 Value of Information Workshop
Kent Burkholder — October 31 - November 1

18 Leadership and Coaching: Active Mentoring
Gary Waldron — November 2 - 3

19 Powerful Presentations - New
Val Carter — November 2

REGISTRATION OPENS MAY 9, 2011 – COURSES SUBJECT TO CHANGE WITHOUT NOTICE • LIMITED CLASS SIZES, SO BOOK EARLY

Early Bird Registration deadline is September 15, 2011. Registration closes October 11, 2011.

For course details and registration information call (403) 262-0015 or visit our website at:

www.cseg.ca

Keep your ear to the rail for the Wednesday Night Social Event, November 2, 2011.

CANADIAN SOCIETY OF EXPLORATION GEOPHYSICISTS



Column Contributor
Kristy Manchul
Target Data Ltd.
Phone: 403-585-5204
email: kristy@target-data.com

Happy June! Is it summer yet? I wonder (by the time this magazine reaches your desk) if the Canucks will have actually won the Stanley Cup and if Winnipeg is getting an NHL team back… hmmmm… can you tell I've become addicted to hockey pools? Whatever. It's June. It's time for swatting mosquitoes whilst playing golf, or ultimate frisbee or soccer…

*Quick congratulations go out to the winners of the GeoConvention's Challenge Bowl: **Chris Bird** and **Peter Gagliardi** from the University of Calgary. Nice work!*

If you have any company or industry news, please send me an email to kristy@target-data.com or call at (403) 585-5204.

ARE YOU A PAST DOODLESPEIL CHAIRMAN?

If so, the 2012 Doodlespeil Committee is looking for you! If you are a past Doodlespeil Chairman, or know of any, will you please contact us, through email or phone ASAP. The Committee is looking at doing some extra things with a special anniversary year coming up, and we would value your input.

Some upcoming changes are: redoing the official Doodlespeil website and modernizing the Doodlespeil Guy. Also, with all the construction on the new curling rink in Banff completed, the Doodlespeil will be moving back to Banff for 2012 and we are very excited about this return.

Both **Victor Irwin** (current chairman) and myself **John Bertsch** (past chairman) would be extremely happy to hear from our Past Doodlespeil Chairmen and certainly if anyone has a partially composed list from the past we would welcome this information as well. Contact **Victor Irwin** at Victor.Irwin@divestco.com or **John Bertsch** at john@earth-signal.com or 1.403.875.8990.

SIGMA NAME THE SECTION CONTEST & BUSINESS CARD DRAW

Sigma Explorations Inc., **Canadian Stratagraphic Services (2000) Ltd.**, and **Apoterra Seismic Processing Ltd.** would like to thank all of our friends and colleagues who stopped by our New Booth at the Joint Annual Convention. We would like to also thank those people who volunteered during the convention and made it a success! We are looking forward to seeing everyone next year!

We would like to congratulate the following winners of our Name the Section contest and business card draws.

The winners are as follows:

Business Card Draw

Garmin Running Watch
– John Behr of Terra Energy

Name the Section

First Place: 42" flat screen TV
– Doug Campbell of Devon Canada
Second Place: LG Blu Ray DVD player
– Vladan Simin of CNRL
Third Place (drawn from all entries)**:** BBC Series LIFE videos
– Andy Iverson of Apache

WiSE GOLF TOURNAMENT

Save the date! The Women in Seismic annual golf tournament to raise funds for breast and ovarian cancer research will be held on **Monday, September 12th, 2011** at **Fox Hollow** in Calgary. This is a great opportunity for peer networking whilst supporting a great cause! Online registration will begin shortly.

If you are interested in hole or prize sponsorship, please contact**: Danielle Harrison** at Danielle.harrison@divestco.com

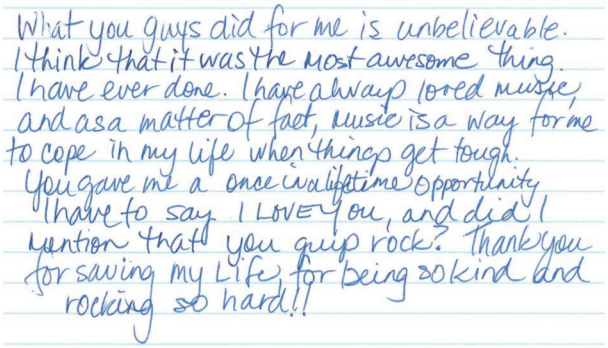
LIGHT UP THE WORLD SILENT AUCTION

I wanted to take a moment to thank all of the people and companies involved with the **Light Up The World** silent auction at the GeoConvention this May. Thanks to your generosity, over $13,000 was raised for this great cause.

In particular, I would like to thank my committee members for all of their efforts: **Jeff Gautreau** (RPS Boyd), **Naomi Storey** (Edge), **Dani MacLeod** (GeoTir), **Val Topinisky** (GeoTir), **Laurie Ross** (Divestco), **Kristy Manchul** (Target), **Vic Urban** (Target), **Sean Callaghan** (Surveyza), **Carmen Swalwell** (Swalwell Resource Consulting), **Judi MacDonald** (MacDonald Cole) and **Tara Collins** (LUTW).

See you at GeoConvention 2012!
Craig Van Dongan (GeoTir)HR

★ ★ ★ ★ ★ ★



TTI…

Continued from Page 56

Not only was the experience an immediate positive influence, but this young man has continued to work diligently to improve his situation and recently graduated high school. The positive experience in his life was one factor that helped him achieve his success and open future opportunities.

There are so many ways we can make a difference in the lives of the kids that Kids Up Front supports. As one recipient recently stated, "I feel good inside my heart. Thank you."

For more information please visit www.kidsupfrontcalgary.com

CSEG ADVERTISING RATE SCHEDULE

RECORDER

Size	Corporate Member Rate	Non-Corporate Rate
outside back cover	$ 1500.00	$ 1650.00
inside back cover	$ 1320.00	$ 1450.00
full page	$ 1170.00	$ 1290.00
2/3 page	$ 960.00	$ 1060.00
double 3/4 or 1/2 page horizontal	$ 750.00	$ 825.00
1/3 page	$ 660.00	$ 725.00
1/6 page	$ 450.00	$ 500.00
double page spread	$ 2340.00	$ 2570.00
double 1/2 page spread	$ 1500.00	$ 1650.00

Special Requests:

Placement of each AD in the issue is assigned at time of the final layout. Preferences for positioning of an AD, while not guaranteed, will be honoured within production limitations. Advance booking is recommended for preferred positioning of ADs and for frequency booking discounts.

Frequency Discounts:

10% discount for 5-9 insertions
20% discount for 10 or more insertions

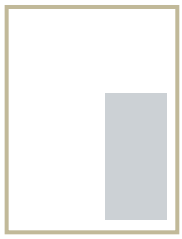
Pubset Material:

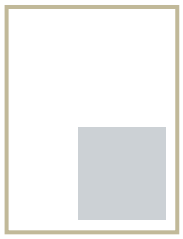
A fee will be charged any required production changes to supplied ADs. Please contact the CSEG Office for details.

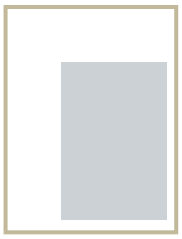
Inserts:

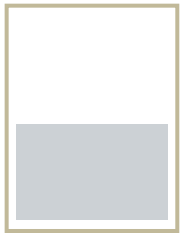
Material must be supplied to the CSEG office, one week before distribution date. Per item charge 50¢ per copy.

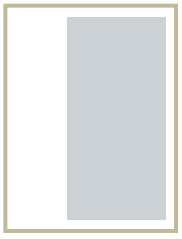
Advertising Units:

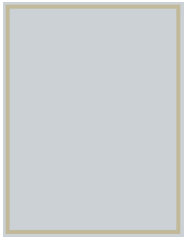

1/6 page vertical

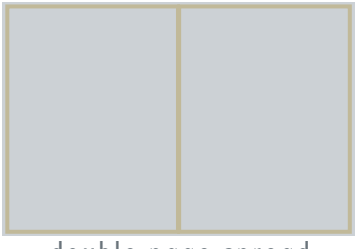

1/3 page square


double 3/4 column


1/2 page horizontal


2/3 page


full page


double page spread


double 1/2 page spread

Terms:

1. 30 days net (no cash discount)
2. Invoice dated on day of distribution
3. GST 5% additional
4. Rates subject to change without notice
5. No agency discounts
6. Interest at 2% per month will be charged on all overdue accounts
7. Cancellation deadline is 30 days prior to issue date

Digital Guidelines:

The RECORDER uses a Macintosh platform. Printing is offset lithography; CMYK; Saddle stitched; Screen – 175 lines per inch. **All digital files provided by advertiser must be high resolution: 300dpi, and formatted as a CMYK PDF.**

Page Size:

Trim size	8.375” x 10.875”

Advertising Unit Sizes:

full page *(with bleeds)*	8.625” x 11.125”
full page *(no bleeds)*	8.375” x 10.875”
double page spread *(with bleeds)*	17” x 11.125”
double 1/2 page spread *(includes bleeds off each side and bottom)*	5.5” x 17”
2/3 page *(no bleeds)*	4.875” x 9.875”
1/2 page horizontal *(no bleeds)*	7.375” x 5”
double 3/4 column *(no bleeds)*	5” x 7.375”
1/3 page square *(no bleeds)*	4.875” x 4.875”
1/6 page vertical *(no bleeds)*	2.25” x 4.875”

Keep all critical or illustrative material minimum .5” from final trim, including spread. Publisher reserves right to crop .125” from either side of all bleed ads to compensate for left or right hand page.

Email for files under 15mg:

printman@nucleus.com

FTP Site for uploads of larger files:

Host: ftp.cseg.ca
User ID: recorder
Password: !r3cord3r

Issue Date	Ad Deadline
September	July 15
October	August 15
November	September 15
December	October 15
January	November 15
February	December 15
March	January 15
April	February 15
May	March 15
June	April 15

For rates or further information contact Jim Racette at the CSEG Office: Telephone (403) 262-0015 or jimra@shaw.ca

ADVERTISERS' LIST

Company	Page	Website
Absolute Imaging Inc.	17	www.absoluteimaging.ca
APEGGA	21	www.apegga.org
ARCIS	IBC	www.arcis.com
CGGVeritas	30 / OBC	www.cggveritas.com
CSEG DoodleTrain	57	www.cseg.ca
Earth Signal Processing Ltd.	53	www.earthsignal.com
Edge Technologies Inc.	15	www.edge-tech.ca
Geokinetics Inc.	49	www.geokinetics.com
GeoLogic Systems Ltd.	2	www.geoscout.com
Key Seismic	5	www.keyseismic.com
Oilsands Imaging	27	www.oilsandsimaging.com
Petrel Robertson	31	www.petrelrob.com
SeisWare	19	www.seisware.com
SEG 2011	33	www.seg.org
Sensor Geophysical Ltd.	25	www.sensorgeo.com
Tetrale Technologies Inc.	11	www.tetrale.com; www.tesseral-geo.com
Western Geco	IFC	www.westerngeco.com/idi
Xworks Geoservices Inc.	29	www.xworksgeo.com

What's Coming in Future Issues of the RECORDER...

Theme	*Coordinators*	*Issue*	*Paper Deadline*
Microseismic: Processing	Rob Ferguson	*Sep-11*	15-Jul-11
Microseismic: Case Studies	Kurt Wikel / Eric Anderson	*Oct-11*	15-Aug-11
Rock Physics/Geomechanical Modeling	Kurt Wikel / Eric Andersen	*Nov-11*	15-Sep-11
Exploring Unconventional Reservoirs	David Close / David Cho / Kurt Wikel	*Dec-11*	15-Oct-11
Future of Geophysics in the Canadian Oil Patch	Oliver Kuhn	*Jan-12*	15-Nov-11
Reservoir Geomodeling	Cheran Mangat / David Close	*Feb-12*	15-Dec-11
Inversion and Optimization	David Cho / Rob Ferguson	*Mar-12*	15-Jan-12
Geostatistical Inversion	Cheran Mangat	*Apr-12*	15-Feb-12
Time Lapse/Multicomponent	Kurt Wikel / Mohammed Al Ibrahim	*May-12*	15-Mar-12
Advances in Processing Techniques	Jason Noble / Carson Yarham	*Jun-12*	15-Apr-12

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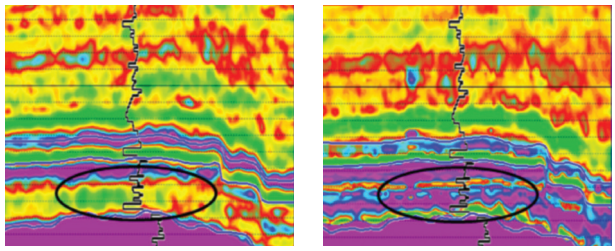
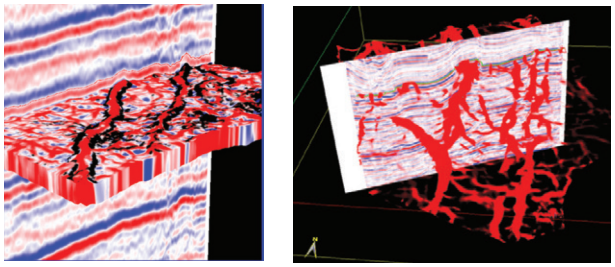
View more Reservoir Solution examples at **www.arcis.com**

Left: P-impedance obtained from model-based, poststack inversion.
Right: P-impedance obtained from Probabilistic Neural Network Analysis.



Notice the detailed and accurate correlation of the impedance values with the impedance log curves as seen on the neural network estimated impedance.

Left: Strat-cube from the most positive curvature attribute co-rendered with coherence seen here in a 3D chair view.
Right: Strat-slice from k_1 curvature shows fault/fracture skeleton with transparency.



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