Volume 10, No. 2 March 1999

CREWES NEWS

The Consortium for Research in Elastic Wave Exploration Seismology

CREWES Seeks Sponsors' Aid in Renewal of NSERC Grant

CREWES is compiling an application for the renewal of our National Science and Engineering Research Council (NSERC of Canada) Industry Oriented Research (IOR) grant. Our present grant provides nearly 30% of our budget and represents a substantial leveraging of your research dollars. The renewal of our NSERC support will allow us to continue our programme of research for the next five years while maintaining the cost of sponsorship at an economical level. Our new proposal will emphasize the role of advanced seismology in reservoir definition and management. Under the terms of an IOR grant, NSERC will potentially match all sponsors fees provided that sponsors indicate their willingness to support the project for the period of the grant. This indication will not be a legally binding commitment; rather, it would be a statement of intent assuming favorable business conditions.

The directors of CREWES are currently preparing a proposal summary to inform Sponsors of research plans, and letters asking for your support. The time frame for the return of letters of intent is quite small, and we are asking all our Sponsors to respond quickly upon receiving our request for support.

CREWES Welcomes New Sponsor

CREWES is very pleased to announce that Conoco Incorporated has become a Sponsor. We welcome them to the Consortium and look forward to many years of fruitful collaboration with Sponsor Representative, Dr. John Queen.

Welcome Back - CREWES M.Sc. Graduate Begins Ph.D.

Since completing her M.Sc. with CREWES last year, Chanpen Silawongsawat has returned to the University of Calgary to begin her Ph.D. studies. After graduating in July, Chanpen worked on an internship with Geco-Prakla (UK) for 5 months. At Geco-Prakla, she joined the Multicomponent group led by Richard Bale, of the Data Analysis Product Developement (DAPD) department, and was assigned to research the P-S separation of 4-C ocean bottom data. For her Ph.D. under the supervision of Gary Margrave she hopes to continue the research in modeling seismology and ocean bottom seismic she began in her M.Sc. We wish Chanpen the best of luck with her research.

CREWES Students and Staff at Geoscience Conferences in 1999

CREWES staff and students will be presenting papers at all the major Geoscience conferences this year. Besides presentations at the CSEG in May and the SEG in October-November, a couple of CREWES papers are being presented at the European Association of Geoscientists and Engineers (EAGE) conference in Helsinki this June. Dr John Bancroft will be presenting a paper entitled ‘Prestack migration of vertical array data using EOM’. Doctoral student, Rob Ferguson (profiled elsewhere in this issue) will be presenting a paper on ‘Migration of source gather by nonstationary phase shift – TI examples’. If any Sponsors are attending this meeting, John and Rob will be pleased to meet you to discuss the work they and CREWES are doing.

Filtering coherent noise in the radial trace domain

Note: *This is an abstract of a paper that CREWES Senior Researcher, Dave Henley, has submitted to the 1999 SEG at Houston.*

The radial trace transform first became familiar to many geophysicists through the 1980 article in Geophysical Prospecting by M.T. Taner (28, no. 1, pp30-48) describing the attenuation of long-period multiples in that domain. More recently, it was found by researchers at Shell that the radial trace domain is also an effective one in which to attenuate various kinds of coherent noise. We are currently investigating and continuing that work at CREWES, with the ultimate goal of presenting a useful technique to CREWES sponsors for not only noise attenuation, but some wavefield separation applications as well.

The radial trace transform is a simple geometric mapping of a wavefield sampled in co-ordinates of source-receiver offset and two-way travel time into co-ordinates of injection angle (or wavefront apparent velocity), and two-way travel time. Because its constitutive parameters include not only the range of angles or velocities to be spanned, but also the co-ordinates of the transform origin, the transform can be designed to optimally capture linear noises on a shot gather, for example. The key property of the radial transform that enables effective filtering is the fact that noises whose apparent origin and apparent velocity match that of some of the radial traces in the transform have their apparent frequencies dramatically lowered, so that application of a simple bandpass filter designed to span the legitimate spectrum of the reflections on the gather will greatly attenuate the noises. Shown in figure 1 is an example shot gather from the Blackfoot 2D data set (vertical component), with its accompanying coherent noises. Figure 2 shows the results of two passes of radial filtering. Note the strength and continuity of reflections throughout the record, including even those obscured by the formerly strong direct arrivals. Note, as well, the preservation of statics on the shot gather. We are currently using a very fast Matlab function to perform the radial transform, but we aim to build a ProMAX operation in the near future, and to provide more details about the radial trace transform and its properties, including circumstances that might suggest its use rather than the more conventional f-k transform.

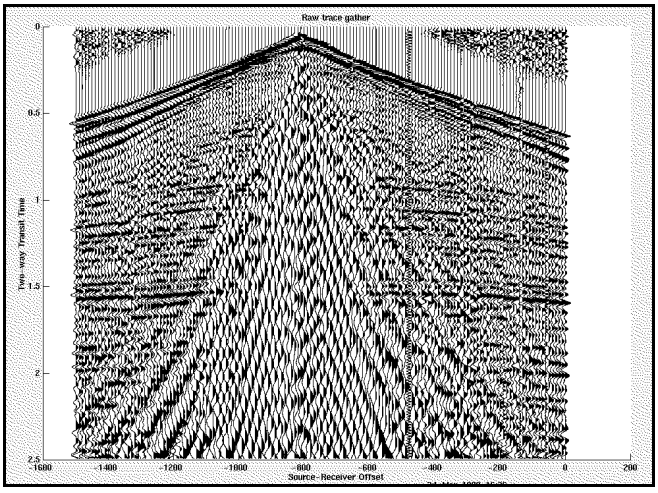


Figure 1: Raw shot gather from the Blackfoot 2D seismic survey (vertical component)

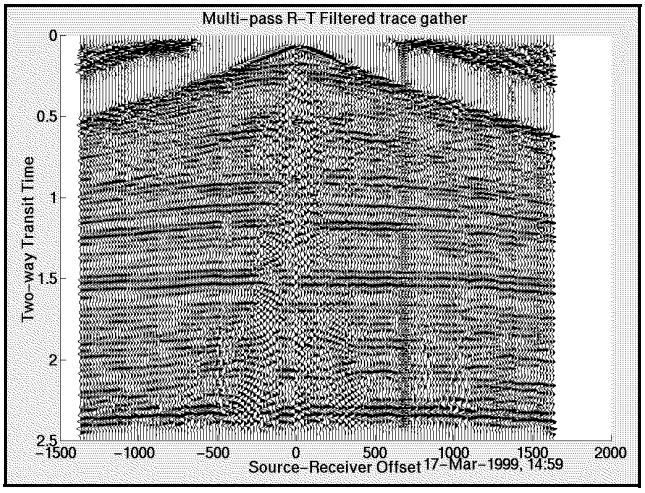
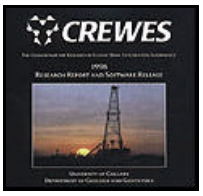


Figure 2: Blackfoot gather after 2 passes of radial trace domain filtering.

Hardbound 1998 CREWES Research Report



A last reminder that hardbound copies of the 1998 CREWES Research Report are still available to Sponsors at a cost of $75.00 (Canadian). Orders can be emailed to crewes@geo.ucalgary.ca or mailed to our address, to arrive by April 9th 1999.

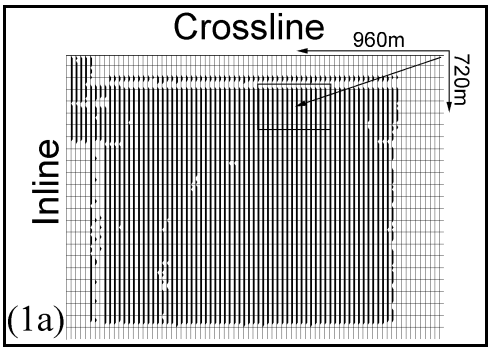
An alternative data gather for imaging wide-azimuth 3-D surveys

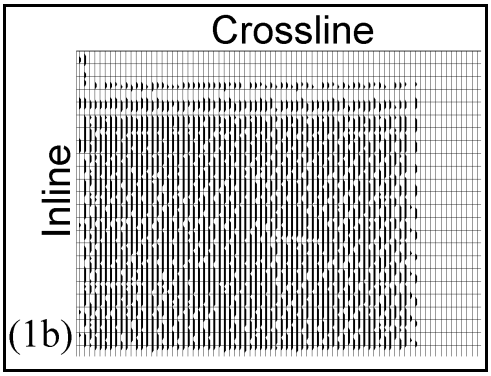
Note: *This is an overview of an abstract that CREWES Visiting Scientist, Peter Cary, has submitted to the 1999 SEG at Houston.*

The impact of sampling and survey design on the quality of a final 3-D image is an important issue. Peter recently began investigating a particular type of 3-D prestack gather, which he has termed a common-offset-vector gather, that is very useful for imaging purposes and is also easy to generate.

Prestack migration on 2-D land data is most often performed on common-offset gathers or shot gathers because these two types of gathers are sampled at or above the spatial Nyquist rate. Common-receiver gathers are not of much use for imaging due to the coarse source interval. Because common-offset gathers extend over most of the survey area, and as there are relatively few of them, common-offset gathers are often preferred over shot gathers for efficiency.

What subsets of 3-D datasets can be correctly imaged with prestack migration? For narrow-azimuth (marine) surveys, common-offset gathers and shot gathers can be used. For wide-azimuth 3-D's the answer is not so obvious. In recent years, Gijs Vermeer and others have drawn attention to the usefulness of cross-spreads because traces in this 3-D subset have small spatial sample rates in both the inline and crossline directions. Unfortunately cross-spreads do not extend over much of the survey area, and there are lots of them in each 3-D survey: in these respects 3-D cross-spreads are like 2-D shot gathers. Is there a 3-D gather that offers the same advantages as 2-D common-offset gathers? Yes: but not an ordinary 3-D common-offset gather, because traces within each common-offset gather must also have the same azimuth in order for 3-D migration to map them into a continuous image. To emphasize the requirement that offset must be treated as a vector, it is better to call this type of gather a common-offset-vector gather.





A 1-fold common-offset-vector gather is easily generated by using Cartesian coordinates (inline and crossline offset) instead of polar coordinates (offset and azimuth). A couple of years ago, Gary Hampson at Texaco noted that stacking diagrams for 3-D orthogonal geometries can be formed by plotting the inline offset and inline CDP independently of the crossline offset and crossline CDP. Therefore, if we need the 3-D volume to have a trace at every CDP, we bin the offsets in the inline and crossline directions as we do with 2-D data to form common-offset sections with a trace at each CDP.

For example, if the ratio of source line spacing to receiver station interval is 4, and the ratio of receiver line spacing to source station interval is 5, then binning 8 inline offsets together in the receiver line direction and binning 10 crossline offsets together in the shot line direction will yield 1-fold coverage in each CDP bin. Traces within each common-offset-vector gather share the same binned inline offset and binned crossline offset, and when they are sorted or stacked by CDP, the volume spans most of the survey area. The concept is illustrated in Figure 1(a) and 1(b) with the common-conversion-point binning of the radial component of the Blackfoot 3-C 3-D data.

Figure 1(a): The area of coverage of a common-offset-vector volume binned by midpoint. The inline offset is $960 \pm 240m$ *and the crossline offset is* $720 \pm 180m$ *, as indicated by the arrow (the offset vector) and the rectangle (the offset bin). Figure 1(b): The area of coverage at 600ms after P-S CCP binning.*

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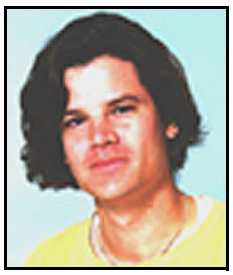
Students at CREWES - Rob Ferguson



The focus of this month's profile is Rob Ferguson, a long-time CREWES student, who is currently completing his Ph.D.

Rob graduated with a B.Sc. in Geophysics from University of British Columbia. He joined CREWES in September 1994 as an M.Sc. student. During his M.Sc. work Rob developed a stacking process for converted wave seismic resulting in traces suitable for 1D inversion. For his Ph.D., under the supervision of Gary Margrave, Rob is developing a prestack depth migration for P- and S-waves in anisotropic media which is based on the Fourier domain expression of nonstationary wavefield extrapolators. The nonstationary extrapolator used can be shown to be more stable than similar methods.

Outside the CREWES lab, Rob gained 4 years experience as a seismic data processor with Haliburton Geoservices and Integra Geosciences. He has also worked on a number of projects related to exploration seismology during three summer jobs. At AMOCO Canada (1995) he processed and migrated offset VSPs and compared the results with similarly processed synthetic VSPs to illustrate the viability of imaging complex structures with a limited number of offsets. With Chevron Canada (1996), Rob compared S-wave VSPs to synthetics computed from S-wave sonic logs. The S-sonics were estimated from P-sonics using a large number of empirical relationships. The comparison illustrated the amplitude difference between porous oil filled carbonates and non-porous carbonates. At Chevron Petroleum Technology Company last year, Rob developed a prestack migration for isotropic media as part of his Ph.D. research in depth imaging.

Rob has written and co-authored a number of refereed papers, and has presented several papers at the SEG (Denver, Dallas, Houston, and New Orleans), CSEG (three meetings in Calgary) and EAGE (Glasgow, Amsterdam,and Geneva). In 1996, Rob was awarded best student paper by the CSEG. He will be attending this years EAGE meeting in Helsinki, presenting a paper titled 'Migration of source gather by nonstationary phase shift – TI examples'.

Apart from Geophysics, Rob enjoys producing noise from a non-seismic source as a drummer with a rock band.

Student Graduations

Congratulations to CREWES student, Dan Cieslewicz, who graduated with an M.Sc. in January. After taking a well-deserved break to travel, Dan will be working in Calgary for PanCanadian. We wish him the best of luck in developing his career.

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