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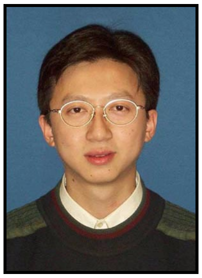
CREWES NEWS

The Consortium for Research in Elastic Wave Exploration Seismology

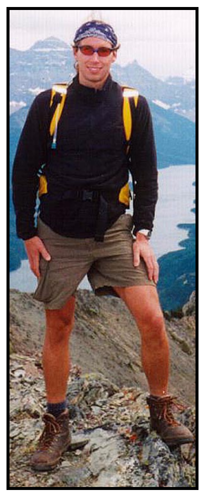
CREWES Welcomes New Students

We are delighted to welcome ten new students to CREWES. We will be introducing them over the next couple of issues of CREWES NEWS.



Kun Liu joined CREWES after graduating from the Institute of Geology and Geophysics, Chinese Academy of Sciences, where he was awarded an M.Sc. degree. The focus of his Honours dissertation there was forward modelling and inversion in anisotropic media. Previously, Kun obtained his Bachelor degree in Geophysics from Yunnan University in China.

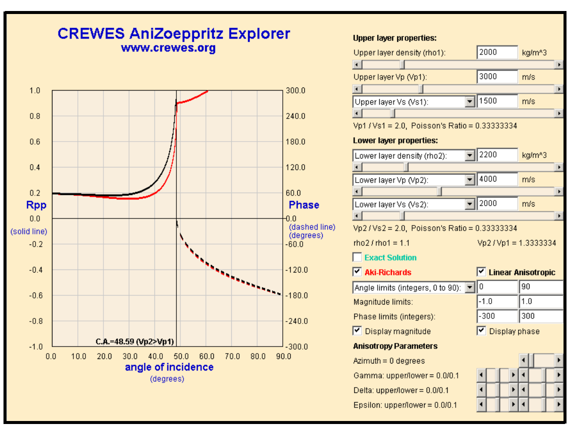
Kun is studying for his second M.Sc with supervisor, John Bancroft, while overcoming the challenges of culture, language, and cold winters. He is interested in migration, residual statics, and converted waves.



Andrew Royle joins us for an M.Sc. while continuing to work at Geo-X Systems. Andrew graduated with B.Sc. Honours in Geophysics from Memorial University of Newfoundland in 1998. He then moved to Calgary to work with PanCanadian. Subsequently, he joined Geo-X Systems in their Seismic Reservoir Analysis group, where he does special project work which includes AVO, inversion, modelling, and seismic attribute analysis.

With his supervisor, Larry Lines, Andrew is studying a three-parameter AVO extraction. In his spare time he likes to mountain bike, hike, squash, run, and work on his house.

New Software: AniZoeppritz Explorer



The CREWES AniZoeppritz Explorer joins the Zoeppritz Explorer and the Reflectivity Explorer as an Interactive Demo at www.crewes.org.

This new utility lends insight into the realm of materials displaying horizontal transverse isotropy (HTI). With it one can explore the behaviour of the linearized P-wave reflection coefficient and compare it with values for an isotropic earth. It features interactively adjustable anisotropy parameters, γ, δ, and ε, as well as the azimuthal angle of incidence.

Questions and comments regarding this or other applets should be directed to Chuck Ursenbach: ursenbach@crewes.org.

In This Issue...

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Nonstationary deconvolution using the Gabor transform

Gary Margrave

Stationary deconvolution is based on the familiar convolutional model for a seismic trace in which each trace is a convolution of a source wavelet with the impulse response of the earth. Neglecting noise, this can be written as a simple product in the Fourier domain, namely, S(f) = W(f)R(f), where S is the spectrum (Fourier transform) of the seismic trace, s(t), W is the spectrum of the wavelet (including possible multiples), w(t), and R is the spectrum of the reflectivity, r(t). The usual approach for extracting W and R from S assumes that W is a smoothly varying function, while R is a random function in the time domain with a white (constant) spectrum. Thus |W(f)| (the bars indicate the amplitude spectrum) can be obtained by smoothing |S(f)|, the phase of W(f) is calculated with a minimum-phase assumption, and R(f) is then estimated as S(f) / W(f).

The stationary seismic trace model assumes that the wavelet is unchanged by passage through the earth; however, a more physically accurate model would recognize that dispersion does occur and multiples accumulate in a nonstationary manner. In the 2001 CREWES Sponsors Meeting, we presented a new non-stationary trace model that includes the effects of attenuation and minimum-phase dispersion. We have analyzed mathematically the behaviour of this model under the Gabor transform, which is a nonstationary extension of the Fourier transform, and developed a new nonstationary deconvolution. Called Gabor Deconvolution, this process was released to sponsors as a ProMAX module and combines the behaviours of stationary deconvolution and inverse Q filtering. (The algorithm determines and removes an apparent Q-like attenuation automatically from the data.)

In the Gabor domain, the nonstationary trace model predicts that $V_g s(f,t) = W(f)\ \alpha_Q(f,t)\ V_g r(f,t)$. Here $V_g s(f,t)$ denotes the Gabor trans-form of s, which is a decomposition of s(t) onto the frequency-

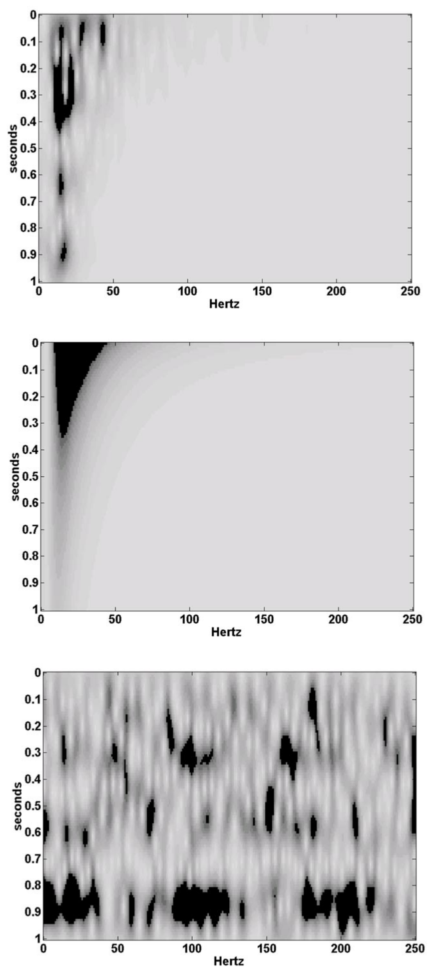


FIG. 1. The first panel shows the Gabor transform of a seismic trace. The second shows a smoothed version of the first panel. This estimated the wavelet times the attenuation function. The third shows the Gabor transform of the reflectivity. According to the nonstationary convolutional model, the first panel is the product of the second and third.

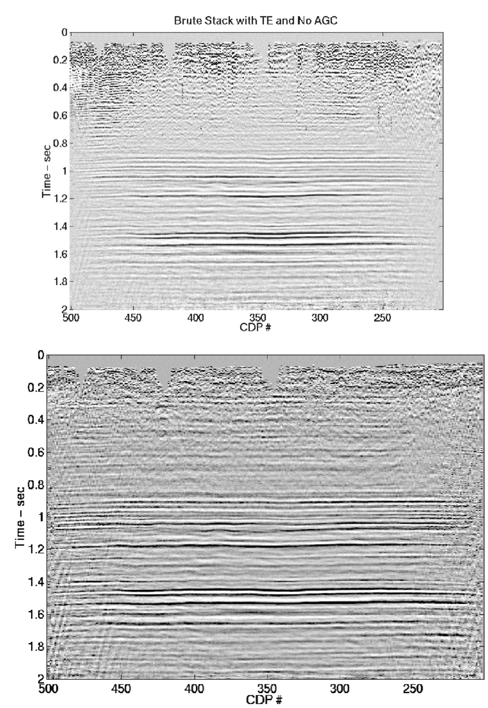


FIG. 2. CMP stacks for a Blackfoot dataset. Nonstationary deconvolution is used in the first panel, and stationary deconvolution is used in the second.

time plane. The function W is the Fourier spectrum of the source signature, α_Q is the constant-Q attenuation function, and $V_g r(f,t)$ is the Gabor transform of the reflectivity. The estimation of reflectivity from $V_g s(f,t)$ requires an estimate of W(f) $\alpha_Q(f,t)$. Assuming that r is random and therefore that $V_g r(f,t)$ is nearly constant, one way to estimate W(f) $\alpha_Q(f,t)$ is by smoothing the absolute value of $V_g s(f,t)$ and then computing a phase using the minimum phase assumption. This is how our ProMAX module proceeds.

Figure 1 illustrates the quantities $V_g s(f,t)$, W(f) $\alpha_Q(f,t)$, and $V_g r(f,t)$, which play key roles in this non-stationary deconvolution method.

Figure 2 compares results of nonstationary (Gabor) and stationary (Wiener) deconvolution methods applied to a Blackfoot dataset. They give similar results within the Wiener design gate, but elsewhere the Gabor method is superior.

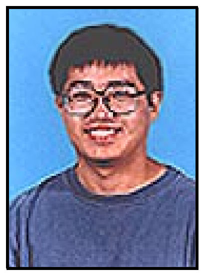
A complete description of this work given in a series of articles in the 2001 CREWES Research Report (Margrave and Lamoureux; Henley and Margrave; Iliescu and Margrave; Grossman, Margrave, Lamoureux, and Aggarwala). This is available to sponsors at www.crewes.org, along with a PowerPoint slide show from the sponsors' meeting.

Congratulations

CREWES congratulates **Yanpeng Mi**, who successfully defended his Ph.D. in December. His thesis concerned "Prestack Depth Imaging and Velocity Analysis for P-P and P-S Data with Nonstationary Integral Extrapolators". Yanpeng is now working for Shell, here in Calgary. We wish Yanpeng every success in his future career.

Congratulations are also due to M.Sc. student, **Shauna Oppert**, and Ph.D. student, **John Zhang**, who both received scholarships from the CSEG this year.

We wish Shauna and John all the best in continuing their studies.



Yanpeng Mi

Shauna Oppert

Jianlin (John) Zhang

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