Hussar converted-wave data processing and analysis

J. Helen Isaac and John C. Bancroft

helen.isaac@ucalgary.ca

ABSTRACT

We processed and inverted converted-wave data acquired during the low-frequency shoot at Hussar, Alberta in September, 2011. The two datasets we selected were generated from dynamite and low-dwell vibroseis sources and were recorded on 3C 10 Hz geophones. The data processing included radial filtering and Gabor deconvolution. The stacked dynamite and vibroseis data both show strong converted-wave reflections. Receiver statics were derived successfully by flattening an horizon picked on a stack of receiver gathers.

Comparison of the stack of vibroseis data obtained through conventional NMO, common conversion point (CCP) stack and post-stack migration and the equivalent offset migration (EOM) stack of the same data show that the EOM method successfully produced a stack of comparable quality. The converted-wave velocity model derived through common scatter point analysis was similar to that obtained through semblance analysis of common conversion point gathers. Thus, EOM shows considerable promise as a method for converted-wave data velocity estimation and migration.

Joint PP-PS model-based inversion was only partially successful. The character ties between the migrated PS data and well data were not easy to make and the registration of the PP and PS data shows that the character match between the two datasets is poor. However, since we clearly have converted-wave data in this area, the dataset will be useful for testing converted-wave processing procedures such as velocity determination, statics estimation and migration, and PP-PS data matching and registration.

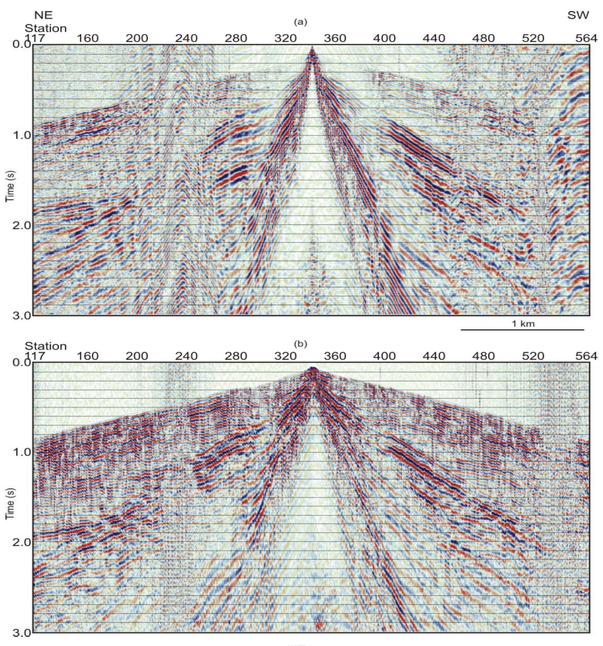

Fig. 1. Typical shot gathers from the two source types taken from the middle of the survey zoomed into the zone of interest within the first 3 seconds of data. There is noise from external sources apparent on both gathers around stations 230 and 530 and P-wave first break energy can be observed. Some converted-wave events show up fairly strongly on both source gathers around 1800 ms on stations 117-160. Elsewhere, any converted-wave energy is masked by the groundroll and noise. There appears to be no great problem with receiver statics, which would manifest themselves on shot gathers as disruptions in the moveout of observed reflections.

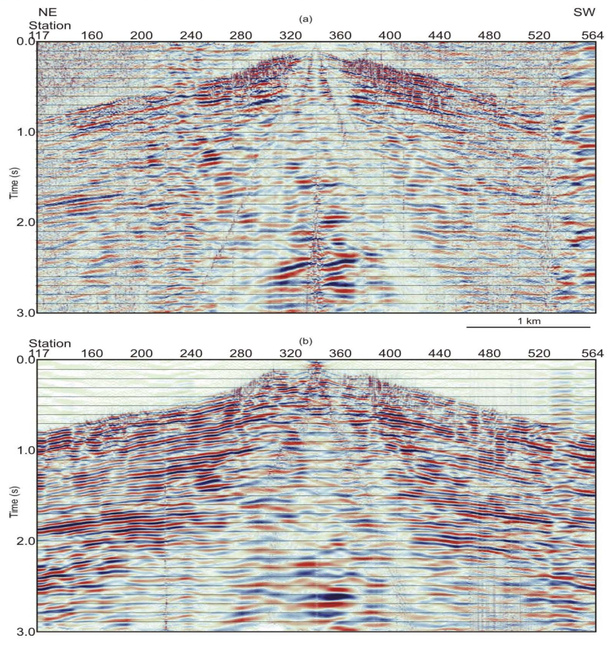

Fig. 2. Shot gathers after application of radial filters, air blast attenuation and surface wave noise attenuation. The radial filters were applied to receiver gathers specifically to attenuate noise trains with velocities significantly lower than the expected converted-wave energy. The velocities we targetted were between 200 m/s and 470 m/s.

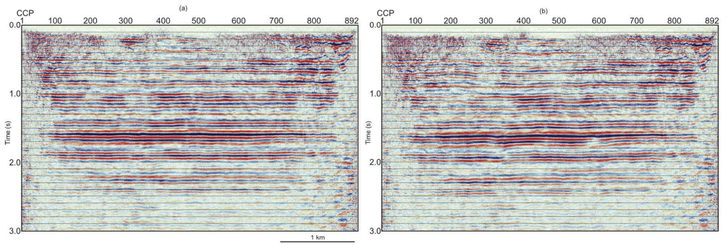

Fig. 3. CCP stacks with the first pass of receiver statics calculated by subtracting from the picks of a horizon near 1600 ms the flattened (a) and smoothed (b) versions of those picks.

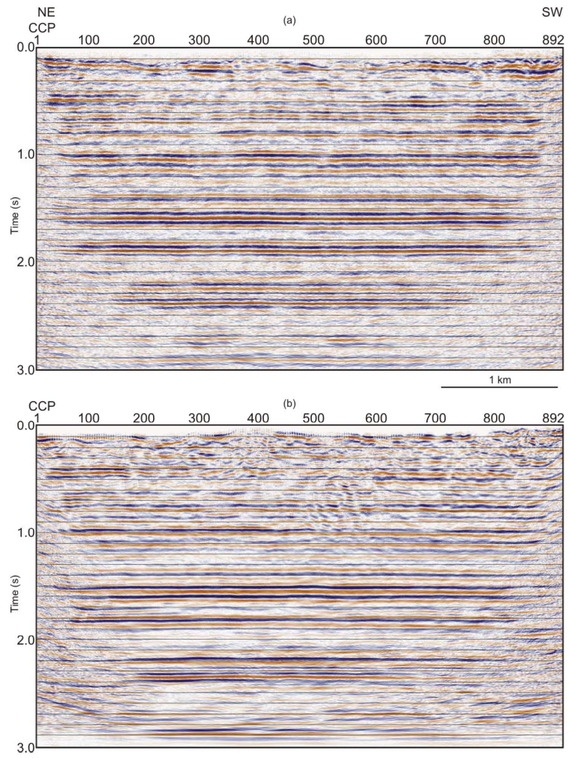

Fig. 4. Poststack migrated CCP stacks of the (a) vibroseis and (b) dynamite PS data.

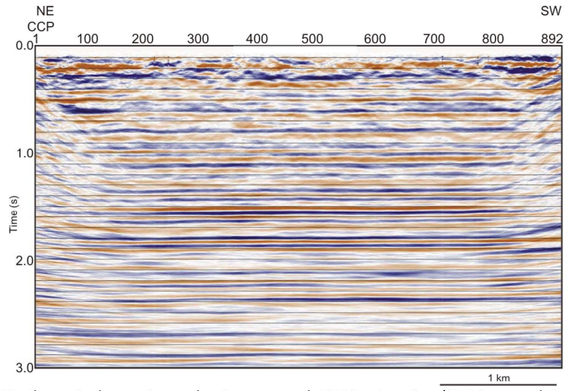

Fig 5: PS vibroseis data migrated using prestack EOM migration (Guirigay and Bancroft).

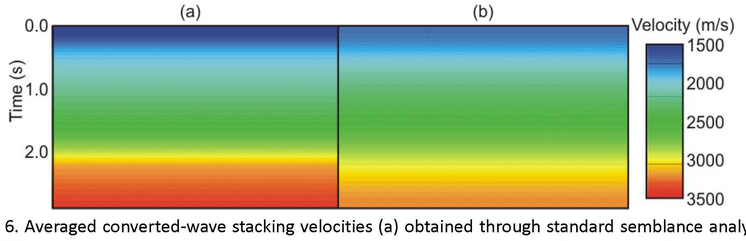

Fig. 6. Averaged converted-wave stacking velocities (a) obtained through standard semblance analysis of CCP supergathers and (b) the single migration velocity (Guirigay and Bancroft), derived through analysis of data binned into common scatter points (CSP). The two velocity functions are quite similar, suggesting that the CSP method of analysis is useful for converted-wave velocity analysis.

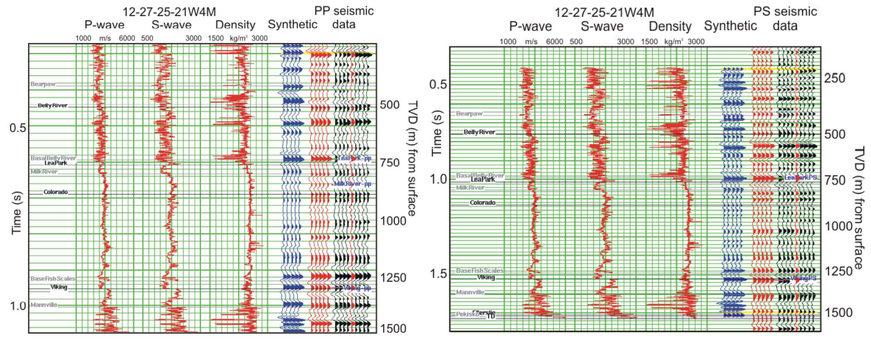

Fig. 7. Ties between well 12-27-25-21W4M and the PP and PS seismic data. The correlations are based primarily upon character matches between the field and synthetic data of the Lea Park and Viking reflections.

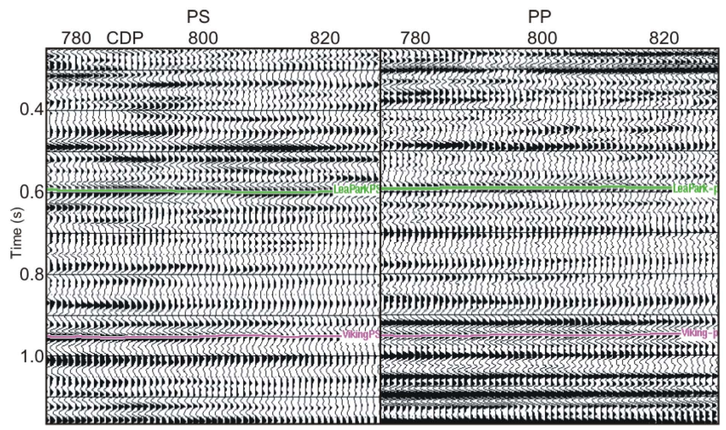

Fig. 8. Registered PS and PP data with the correlated horizons. The PS data have been scaled to PP time.

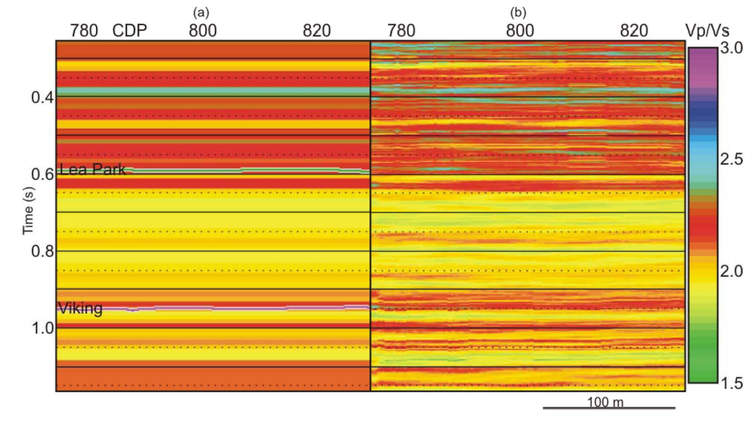

Fig. 9. (a) Initial Vp/Vs model derived from the well 12-27-25-21W4M and the registered PS and PP sections (Figure 8), and (b) the inverted Vp/Vs.

DISCUSSION

Converted-wave data were recorded successfully at Hussar. We processed data with both dynamite and vibroseis sources. The EOM method successfully produced a stack of vibroseis data comparable in quality to that obtained through conventional NMO, CCP stack and post-stack migration. The converted-wave migration velocity was comparable to the stacking velocity derived through semblance analysis. Thus, we believe that converted-wave EOM shows considerable promise as a method for converted-wave data velocity estimation and migration.

Joint PP-PS inversion was only partially successful. The character ties between the migrated PS data and well data were not easy to make and the registration of the PP and PS data shows that the character match between the two datasets is poor. Further work could be done to process the datasets so that the character match is better.

ACKNOWLEDGEMENTS

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