Static correction issues for PS-wave surface seismic surveys

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Summary

Several issues related to the calculation and application of surface-consistent static corrections are addressed in this presentation. These include the calculation of both long-period and short-period detector static corrections, the incorporation of near-surface anisotropy and the integration of residual statics corrections with the CCP binning process. Each issue must be addressed during the processing sequence to properly position the prestack data for subsequent time or depth imaging. It is particularly important to resolve these static corrections prior to any prestack imaging that will destroy the surface-consistency of the data.

Long-period Static Corrections

Long-period shear-wave detector statics can be significant, but are often difficult to estimate given the highly variable Vp/Vs values at the near surface. Conventional P-wave refraction statics methods are not generally useful due to the lack of easily picked, refracted shear-wave arrivals. One method available involves the use of P-wave common-detector stacks to estimate the geologic time structure and correct the PS-wave data to match. To do this, the P-wave data must be stretched to simulate PS-wave time using an interpreted, regional Vp/Vs field. Common events can then be manually correlated in order to derive the time shifts associated with near-surface delays. Cross-correlation methods may also be used to automatically calculate PS-wave detector statics and speed up the process. Figure 1 illustrates this procedure showing the common-detector stacks for the P-wave data and the PS-wave data before and after static corrections.

A new method is also presented for computing long-period static corrections that identifies and inverts the various modes found in the source-generated surfaces waves (i.e. ground roll) to estimate the near surface S-wave velocity model. This method has been shown to provide good estimates of the long-period S-wave static corrections in the shallow water OBC situation using surface-waves in the marine environment know as Scholte waves.

Near-surface Anisotropy

An additional complication to the estimation of the near-surface S-wave velocity model is the phenomenon of S-wave birefringence. In the presence of HTI anisotropy, S-waves polarize in the principle earth orientations and split into two orthogonally oriented waves that travel at different velocities (S1 and S2). If this birefringence occurs in the near surface, different static corrections may be required depending on the horizontal component recorded. A method is presented to first identify this differential near-surface response and then correct for it. This is a critical step in any survey in which azimuthal anisotropy analysis is to be performed to determine fractured reservoir properties.

CCP Binning and Statics

Once the long-period corrections are computed, conventional residual statics method have been show to be very effective. Proper spatial positioning of the reflection point, however, is critical in computing accurate residual statics. CCP binning methods that preserve surface-consistency must be iterated with residual statics computation and velocity analysis to improve convergence to a stable solution.

Conclusions

While the estimation and correction of S-wave statics is a challenging task, several methods have been developed and successfully utilized to provide accurately positioned PS-wave data for subsequent time or depth imaging. These methods include the use of the P-wave data as a time reference for manual or automatic cross-correlation analyses as well as new developments using valuable information contained in the source-generated surface waves often recorded. Azimuthal anisotropy also must be considered when estimating near surface S-wave statics, especially in surveys designed for birefringence analysis, to avoid near-surface effects contaminating the reservoir level. Iterating proper CCP binning with the static and velocity analysis is also critical do converge on the proper time structure.

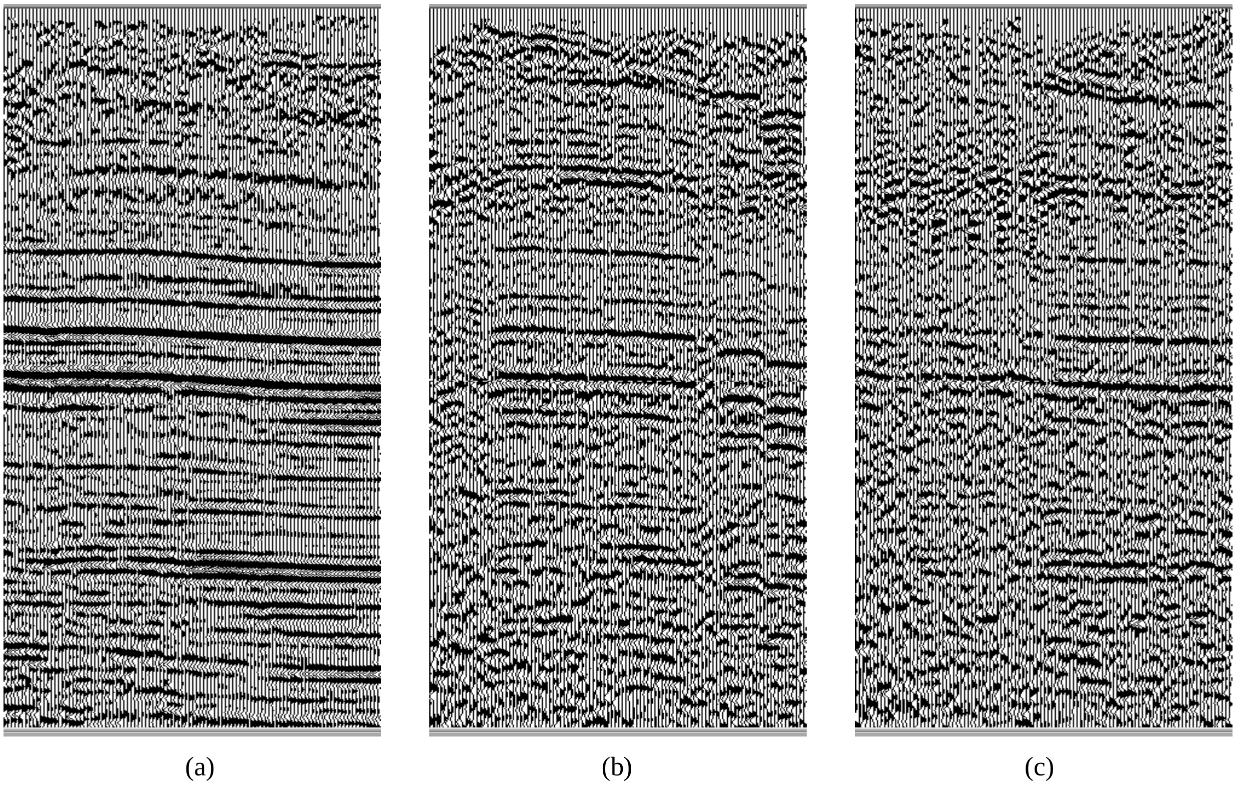

Figure 1 – Common-detector stacks for a single detector line extracted from the Buffalo Valley 3-D/3-C survey. (a) Shows P-wave data stretched to PS-wave time, (b) shows PS-wave data with P-wave source statics applied and preliminary residual statics and (c) shows the same PS-wave data after automatic cross-correlation analysis using the P-wave data in (a) for structural control.