HARTENERGY HOUSTON SEPT. 23, 2013
E&P DAILY NEWS
2013 SEG Annual Meeting
OFFICIAL SHOW DAILY PUBLISHER OF THE SEG INTERNATIONAL EXPOSITION AND 83RD ANNUAL MEETING

Increasing the Bandwidth of Marine Seismic Data

A unique broadband solution addresses both the ghost and earth filtering effects.

Contributed by TGS

Broadband seismic data is data that is rich in both low and high frequencies. High frequencies increase temporal resolution, and low frequencies reduce the side lobes of the wavelet. Bandwidth, a measure of broadband data, is defined as the difference between the upper and lower frequencies in a continuous set of frequencies. It is often defined in octaves: two frequencies are one octave apart if they have a ratio of two. A standard goal in broadband processing is to achieve six octaves of bandwidth. However, two factors limit significantly the bandwidth of seismic data: interference between the source pulse and reflections from the water surface – "ghosts" – and the "earth filter," which attenuates high frequencies in the wavefield as it travels through the subsurface.

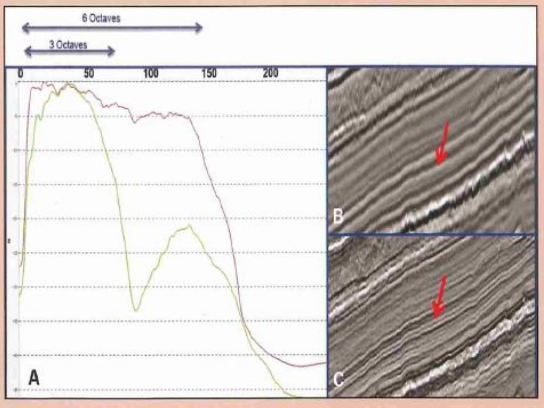

Figure 1: Two-D data from West Africa shows the increase of bandwidth from three to six octaves after application of Clari-Fi: A) Amplitude spectra: green=no de-ghosting; brown=tau-p domain de-ghosting; B) 2-D Kirchhoff prestack time migration (PSTM) without de-ghosting; C) 2-D Kirchhoff PSTM, with tau-p domain de-ghosting. Note: neither dataset has been corrected to zero-phase.
(Image courtesy of TGS)

It is possible to identify two classes of broadband solutions: those that make use of specialized recording equipment to eliminate the receiver ghost and/or source ghost (for example, by recording the pressure and velocity components of the wavefield using a dual-sensor cable) and those that utilize conventional streamers and solve the ghost effect computing an inverse operator to deconvolve the ghosts from the data.

Furthermore, by employing variable-depth streamers, energy lost at or near the notch frequency of one receiver can be compensated for by others of a different depth, making the deconvolution process easier.

See BANDWIDTH continued on page 20 >>

>> BANDWIDTH continued from page 16

De-ghosting solution

Developed by TGS, Clari-Fi is a broadband solution that addresses both the ghost effect and earth filtering effects. TGS's de-ghosting solution acknowledges the fact that in marine acquisition ghosting is a function of propagation angle. Therefore, de-ghosting can be appropriately performed in the τ-px-py domain. After transformation, all seismic events along a single slowness trace share a common ray parameter, which means that the time delay between the main signal and its ghost remains invariant along the τ axis. The attenuation solution shown here makes use of a constant Q correction, which represents a reasonable balance between the recovery of high frequencies and the minimization of noise. Although the results shown are for horizontal streamers, Clari-Fi has recently been extended to cover the case of linearly slanting cables. Figure 1A shows amplitude spectra before and after the technique, where the removal of the source and receiver notches at low and high frequencies are clearly evident.

Broadband data represent a step-change in marine seismic data acquisition and processing. Structures that were hitherto too small to be resolved by conventional data can now be identified and mapped in detail. By systematically dealing with the ghost effect and the results of effective Q, TGS' Clari-Fi technique provides a way to recover a broadband signal in both the shallow and deep sections. ■