Attenuation of Ground Roll Using Wavelet Transform

N. B. R. Prasad
ONGC, Chennai

Summary

Although generally very powerful, ground roll and multiple attenuation techniques can often leave remnants in seismic data. For example, ground roll can be hard to model and fully remove using standard methods. Similarly, multiple remnants are often present after multiple attenuation when multiples are generated by relatively complex geology, such as rugose water bottoms or salt, and as such do not conform to the assumptions of most multiple attenuation algorithms. These remnants can cause problems in later processing, for example through the generation of migration noise and contamination of AVO analysis etc. and therefore often need to be further attenuated in the processing sequence. As these remnants are often localized and may have high amplitudes compared to the underlying data, they can be relatively easy to identify and can be targeted in a different number of domains. The application of a wavelet transform (wavelet decomposition) on pre-stack data can be used to separate signal from coherent noise in both frequency and time. The noise can then be removed from the data by a variety of noise attenuation methods in the wavelet domain.

Methodology

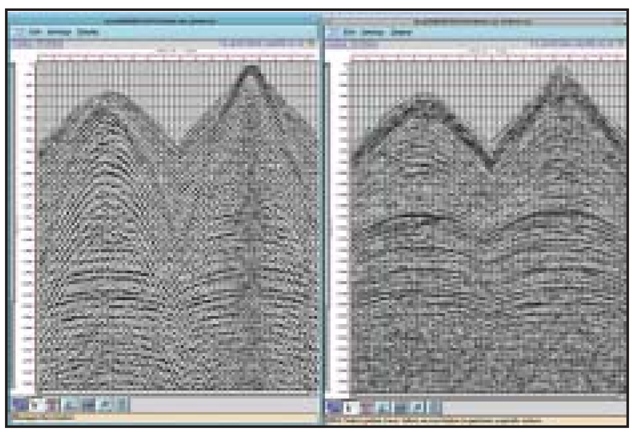
The separation of signal from noise is a challenging problem.

It has been recognized that the data can be transformed into alternative domains, such as the tau-p, f-k and f-x domains, where the noise is separated from the signal groups and can thus be attenuated without corrupting the integrity of the signal. The data is then inverse-transformed back to the original domain for further processing. An ideal transform should successfully attenuate the noise component with no distortion of signal and leave no footprint behind. The **Wavelet Transform (WT)** was introduced first by J.Morlet (1982) for analysis of seismic signals as an alternative to the Fourier Transform (FT). The WT is a reversible transform. The main differences between the FT and WT are: Fourier transform is a natural tool for stationary signal analysis, while the wavelet transform represents signals in time and frequency simultaneously. The FT provides good frequency resolution at the expense of providing no temporal resolution. The WT has variable resolution: higher frequencies are better resolved in time, while low frequencies are better resolved in frequency.

The Wavelet Transform is a unique multi-dimensional tool. Seismic data is successively split into different subbands by applying low-pass and high-pass filters along frequency and space axes. Each iteration of the filtering decomposes the seismic data into four frequency-space quadrants: high F and high K values, low F and high K values, high F and low K values, and finally, low F and low K values. It is this last quadrant that is input into the next filtering iteration. This exercise demonstrates that some of these quadrants are home to well isolated seismic noises. These subbands are simply muted. Since the filters are designed to be perfectly reversible, full reconstruction of the signal is possible by inverse transform.

Real data example

An endeavor has been made to attenuate the ground roll using Wavelet Transform over 3D seismic data acquired in Krishna-Godavari basin, India and the results are discussed.



3D shot gather before(left) and anfter(right) wavelet transform application.