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More robust method of low-frequency model building for seismic impedance inversion

Amit K Ray, Ritesh K Sharma and Satinder Chopra*
Arcis Seismic Solutions, TGS

Summary

Seismic impedance inversion is an important tool to estimate rock and reservoir properties from the seismic data. Seismic data is band-limited in nature and lacks the low-frequency component. As the low-frequency component holds the basic information on geological structure, the lack of low-frequency information degrades the quantitative prediction based on seismic inversion. So, it is essential to build an accurate low-frequency model to have confidence in seismic inversion and in turn on the quantitative predictions made therefrom.

Typically, such a model is built by using well log data, interpreted horizons and sometimes the seismic velocities provided the velocity data is of good quality. There are a variety of interpolation techniques that could be used to construct the low-frequency model from well log data. These include linear interpolation of single well data, inverse-distance, triangulation, kriging, and cokriging methods. If there is considerable lateral variation in the elastic properties across the 3D area, a single-well model does not work very well. Also, inverse distance and triangulation methods usually generate some kind of bull's eye effects on the low-frequency model that creates artifacts on the inversion results, which are not geological.

A novel approach has been devised that uses the multi-attribute regression technique for building the low-frequency impedance model. Multi-attribute regression is a good interpolation technique that uses both well log and seismic data to establish a relationship between various seismic attributes and the available log curves. It is important to include suitable attributes to establish a proper regression relationship. In this paper, we adopt a workflow using multi-attribute regression analysis to predict the low-frequency component for use in seismic impedance inversion.

Furthermore, a collocated cokriging technique has also been used to build low-frequency impedance models for use in impedance inversion. Cokriging is a standard interpolation technique, and it's most common variant in the industry is collocated cokriging that uses seismic data as a secondary variable. It uses the variogram model to distribute the well log properties away from the well location. The variogram model is generally based on some relevant secondary data which can represent the spatial heterogeneity in the study area. Inversion results based on the low-frequency models using both the methods have been compared.