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Ambiguity and Sensitivity of Rock Properties under Different Reservoir Conditions

One of the goals of seismic prospecting has been to determine petrophysical properties of the reservoir (such as lithology, porosity and pore fluid type) using remote measurements, yet little has been done to analyze the ambiguity and sensitivity of the seismic measurements to the petrophysical properties of interest. A likely reason for this is that AVO attributes, commonly used to reduce the risk in qualitatively determining petrophysical properties, cannot be easily related to physical properties of rocks given that the attributes' amplitudes give information about changes across interfaces with no significant information about the intervals above and below these interfaces. Furthermore, common practice has been to estimate two term AVO which results in two attributes related to changes of three physical properties of rocks (P- and S-wave velocity and density) across interfaces. Unambiguous estimation of the three properties (Vp, Vs and r) or their reflectivities is not possible with only two attributes.

The same rock properties used to analyze sensitivity and ambiguity through well log reconstruction can be obtained from seismic data by post-stack inversion of AVO attributes.

P- and S-wave velocities and density determine reflection amplitude as a function of offset, and their estimation (or attributes related to them) from seismic data is important given that reservoir properties in clastic reservoirs are related to these rock properties through effective media relations.The reconstruction of P- and S-wave velocity and densisty logs for different reservoir conditions through the effective media relationships allows for the ambiguity and sensitivity analysis of rock properties to different reservoir conditions. The same rock properties used to analyze sensitivity and ambiguity through well log reconstruction can be obtained from seismic data by post-stack inversion of AVO attributes. The resultant seismic data is a measure of rock properties of subsurface formations (not changes across interfaces) and can be related directly to well log data.

In this presentation examples of ambiguity and sensitivity analyses of rock properties are presented at both well log and seismic resolution and for the case of two and three term AVO analyses followed by post-stack inversion. ■

Biographical Sketch

Alvaro Chaveste received a BS degree in Geophysical engineering from Montana College of Mineral Science and Technology (Montana Tech) in 1982. In 1984 he joined Geophysical Services Incorporated in Mexico where he acted as assistant party manager of a vibroseis™ crew, area geophysicist and system manager for the first interactive interpretation system in Mexico. In 1989, when Halliburton acquired GSI, Alvaro moved to Halliburton Geophysical Services in Houston where he processed 2D and 3D seismic data. While at Halliburton, he was technically responsible for the SRS (Seismic Reference Services) group, which did borehole geophysics (VSP's synthetics, etc). In 1994, Western Geophysical acquired Halliburton where Alvaro became a group leader for the 3D processing group. During 1994 he accepted a position with The Andrew Group, where his responsibilities included the preparation and teaching of processing courses in Mexico and South America, consulting, and later Manager of Mexico's and Houston's processing centers. In 1999, after Core Laboratories acquired The Andrews Group, Alvaro was asked to be Manager of the Advanced Reservoir Geophysics Group. During his tenure at Core Laboratories, Alvaro implemented the methodology to reduce risk in the estimation of petrophysical properties through estimation of rock properties (LMR), as well as pore pressure prediction.