

Three-Component Amplitude Versus Offset Analysis

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Abstract

Three-component (3-C) amplitude versus offset (AVO) inversion is the AVO analysis of the three major energies in the seismic data, P-waves, S-waves and converted waves. For each type of energy the reflection coefficients at the boundary are a function of the contrast across the boundary in velocity, density and Poisson's ratio, and of the angle of incidence of the incoming wave. 3-C AVO analysis exploits these relationships to analyse the AVO changes in the P, S, and converted waves.

3-C AVO analysis is generally done on P, S, and converted wave data collected from a single source on 3-C geophones. Since most seismic sources generate both P and S-waves, it follows that most 3-C seismic data may be used in 3-C AVO inversion.

Processing of the P-wave, S-wave and converted wave gathers is nearly the same as for single-component P-wave gathers. In split-spread shooting, the P-wave and S-wave energy on the radial component is one polarity on the forward shot and the opposite polarity on the back shot. Therefore to use both sides of the shot, the back shot must be rotated 180 degrees before it can be stacked with the forward shot. The amplitude of the returning energy is a function of all three components, not just the vertical or radial, so all three components must be stacked for P-waves, then for S-waves, and finally for converted waves.

After the gathers are processed, reflectors are picked and the amplitudes are corrected for free-surface effects, spherical divergence and the shot and geophone array geometries. Next the P and S-wave interval velocities are calculated from the P and S-wave moveouts. Then the amplitude response of the P and S-wave reflections are analysed to give Poisson's ratio. The two solutions are then compared and adjusted until they match each other and the data.

Three-component AVO inversion not only yields information about the lithologies and pore-fluids at a specific location; it also provides the interpreter with good correlations between the P-waves and the S-waves, and between the P and converted waves, thus greatly expanding the value of 3-C seismic data.