Approximation-Free AVO Attributes

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Abstract

The existing formulation of seismic trace (impedance) inversion at nonzero angles of incidence rely on a number approximations and simlifications, such as the various forms of approximate Zoeppritz equations, assumprtions of a constant background velocity ratio, $V_P/V_S=2$, or of a heuristic functional velocity-density relation, such as $\rho=\rho(V_S)$. We show that by taking a different approach to the inversion problem, such approximations become unnecessary. Although the new attributes become ray-path functionals rather than combinations of local elastic parameters, the inversion and presentation are still performed in the forms fully suitable for conventional interpretation.

In an example, an impedance inversion procedure by time- (depth-) variant spectral eqialization of the seismic and well log data is formulated for several AVO attribuites. The inversion is accurate within the entire incidence angle range, stable, tolerant to noise, and allows efficient implementation. The inversion leads to "synthetic logs" that can be utilized in the interpretation in the usual manner. Additionally, true-amplitude seismic processing is not required for the inversion, and true reflection amplitudes can even be reconstructed from its results. The method is illustrated on 1D synthetic examples and real data, and allows a straightforward extension into 3D. This inversion is used to generate the exact (Zoeppritz) Elastic Impedance and a generalized fluid factor, both of which are accurate for all ranges of ray parameters, reflection angles, and are free from any approximations. Thus, by removing much of the potential inaccuracies involved in AVO analysis, this inversion should leads to improved and reliable lithological interpretations.