A Simple Way to Improve AVO Approximations

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Abstract

Some twenty years ago it was suggested that the average angle, $\theta = (\theta_1 + \theta_2)/2$, in the Aki-Richards approximation could itself be approximated by the angle of incidence, θ_1. Numerical computations however suggest that approximating θ by θ_1 can actually *increase* the accuracy of the theory at low angles (although the original θ formulation is still superior near the critical angle). A theoretical study rigorously validates this observation for converted-wave reflections, while in the case of P-wave reflections it reveals varying behavior based on two different regimes of earth parameters. In the regime more typical of exploration seismology earth models, the observation again holds that the θ_1 formulation is more accurate than the θ formulation. In the other regime, the opposite conclusion holds.

The theoretical study also suggests a means by which the strengths of both the θ and θ_1 formulations may be combined into one theory. This new theory is given, and is accurate over a wider range of pre-critical angles than the θ_1 formulation. It is therefore promising for use with pre-critical AVO studies. An analogous approach can also be applied to various methods derived from the Aki-Richards approximation, such as the Fatti and Smith-Gidlow approximations.