

Extracting Information from Seismic Amplitudes:

Promise and Reality

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Over the last 30 years, the quality and usefulness of information derived from both prestack and poststack seismic amplitudes has led to increases in exploration success rates as well as to more effective use of amplitudes to predict reservoir properties away from well control. However the temporal and spatial resolution and the signal to noise ratio of various attributes even for relatively shallow target depths is often inadequate to address subsurface issues of interest. An ongoing challenge to geophysicists is that of acquiring, processing and analyzing 2D, 3D and 4D surface seismic amplitudes so as to improve resolution and further quantify geologic properties of interest including subsurface porosity, lithology and fluid types.

Seismic acquisition technologies continue to advance with increases in land and marine channel counts, longer offsets, wide azimuths, higher fidelity sources and receivers, more ancillary field measurements and model driven survey designs. Seismic processing industry has advanced with model driven noise suppression, signal distortion corrections, tomographic velocity modeling, wave equation prestack depth imaging and amplitude recovery technologies. Seismic analysis techniques continue to evolve with model-driven, Bayesian based statistical analyses of seismic attributes including the estimation of amplitude attribute uncertainties.

However, in the midst of these seismic technology advances, very little has been done to adequately compensate for the effects of wave propagation from recording surface to subsurface targets of interest. In fact processing models are typically devoid of the earth property detail required to compensate for scattering, illumination and attenuation effects. Analysis of various amplitude attributes taken from walkaway VSP's and modeling studies strongly indicate that the vertical and angle dependent transmission effects of an overburden on land or marine seismic data imposes a dominant imprint on reflected amplitudes. In many cases this imprint completely obscures subsurface amplitude variations that might otherwise be useful in determining subsurface properties of interest.

Modeling studies have led to a deeper understanding and quantification of the magnitude of earth transmission effects and noise on seismic data. Finite difference models of transmitted and reflected pulses in a layered earth make clear that weak earth lenses and wide angle scattering can have first order effects on the relative phase, time and scale of angle dependent reflections which can lead to very large errors in inverted amplitude attributes. Even when compensated in a "true amplitude" seismic processing sequence, it is unclear the degree to which these effects eventually introduce uncertainty into inversion results.

Post-imaging, pre-inversion amplitude processing sequences that apply time, offset and frequency dependent residual event alignment, scale and phase corrections to CRP gather data can improve inverted amplitude attribute quality. Such software relies on statistical information drawn from well log and borehole data to **constrain** processed amplitude behavior to conform to that expected of bandlimited earth reflectivity.