Impact of the Initial Model on Acoustic Impedance Inversion

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Interpretation of an acoustic impedance volume requires an understanding of the relative contributions of seismic and well data to the inversion process. In some cases the initial impedance model, which is generated by interpolating and/or extrapolating the well impedances along the seismic event times, can dominate the final impedance inversion, thus overweighting the well information and underweighting the seismic data. In Saudi Arabia, a very strong impedance contrast occurs between the Permian Khuff carbonates and the Pre-Khuff, Unayzah clastics. Vertically smoothing the well impedance across such strong contrasts can create a bias in the initial model which impacts the inverted impedance for the underlying clastic reservoir. In particular, model based inversions which include a constraint requiring that the output impedance result remain within a specified percent of the initial model are susceptible to this problem.

Seismic inversion is not sensitive to slowly varying changes in the initial impedance model which correspond to frequencies outside the seismic bandwidth. This is true not only for vertical variations, but also for lateral variations. For this reason, it is important to compare impedance slices from inversions that were generated using multi-well initial models, to impedance slices that were generated from inversions using either a single well initial model or a constant impedance initial model. Other approaches include subtracting the initial model from the final inversion to highlight the contribution from seismic data, or to use geostatistical methods which allow the user to control the relative contributions of the well information and the seismic to the final inversion results.

Several examples are shown to illustrate problems and solutions related to both vertical and lateral variations in the initial impedance model which are below the seismic bandwidth.