Hydrocarbon seals: a seismic perspective

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Summary
Seals are one of the most poorly studied elements of a petroleum system. Geologic and geophysical analyses tend to emphasize the determination and evaluation of reservoir and hydrocarbons, respectively, without specific regard to the presence of a sealing facies.

Geophysical evaluation of a shale seal is somewhat analogous to evaluation of sandstone reservoirs – while depositional criteria may suggest reservoir quality, this property may vary significantly due to other factors. For shale sealing facies, the competence of the seal is controlled by many factors, such as bulk composition, specific clay types, lithification, and presence of micro– or macro–scale fracturing due to post–deposition structuring. As with reservoir facies, it is critical to understand the petrophysical character and any variations within the shale seal, so that this information can be rigorously calibrated to the seismic signal.

A simple investigation of shale seal competence is an evaluation of variations in compressional seismic velocity (V_p). This evaluation is useful if seal competence is associated with significant lateral pressure variations or overpressure. Comparison of V_p with shear velocity (V_s) may identify the presence of overpressured section.

Other seismic techniques that may aid in top seal evaluation include well calibrated seismic inversion, seismic anisotropy and azimuthal AVO.

Fault seals are typically identified by significant lateral variations in seismic attributes across the fault plane. Calibrated direct hydrocarbon indicators conforming to the fault plane readily identifies fault seal presence.

As with most seismic techniques, the degree of prediction accuracy is directly proportional to the amount and proximity of calibration data. Thus in rank exploration there may still remain significant uncertainty in the seal competence prediction.