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The Role of Structural Geology and Anisotropy in Velocity Model Building for Pre-stack Depth Imaging in Complex Environments

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SUMMARY

Exploration for hydrocarbons in fold and thrust belts can be challenging. Seismic imaging is often hampered by severe topography, outcropping carbonates, acquisition conditions and parameters, near-surface velocity variations, structural complexity and sparse geological control from outcrops or wells. Thus it may be difficult for explorationists to produce
interpretations of subsurface structures in which they have confidence.

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The role of structural geology and anisotropy in velocity model building for pre-stack depth imaging in complex environments

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Exploration for hydrocarbons in fold and thrust belts can be challenging. Seismic imaging is often hampered by severe topography, outcropping carbonates, acquisition conditions and parameters, near-surface velocity variations, structural complexity and sparse geological control from outcrops or wells. Thus it may be difficult for explorationists to produce interpretations of subsurface structures in which they have confidence.

Correct seismic imaging of geological structures in thrust belts requires prestack depth migration due to significant lateral changes in seismic velocities that often occur. A further complexity arises in structural domains where sequences of dipping clastic strata overlie hydrocarbon targets. Structures beneath such sequences will be mispositioned if isotropic velocities are used during processing; anisotropic prestack depth migration (APSDM) is necessary to position these targets correctly. The requirement for success in anisotropic depth imaging is constructing correct models of interval velocities, anisotropy parameters and dip used in the migration. A deterministic approach to model updating through minimizing residual moveout in common-image gathers is used commonly, but discussions between data processors and interpreters are also critical for reducing ambiguity and yielding geologically realistic models that can be structurally balanced. All sources of geophysical and geological data must be integrated to optimize velocity model updating. Determination of anisotropy parameters from offset vertical seismic profiles and field refraction surveys will be demonstrated, and the use of other geophysical data, such as gravity, to provide constraints on the geological models and interpretations will be illustrated.

Interpreters need to understand the limitations of the seismic acquisition and processing methods while data processors must address the credibility of their velocity models in the geological context. Increased collaboration between geology and geophysics is the key to improving success in thrust-belt exploration.