Kinematic Analysis using Profile and Time-Slice Animations of 3-D Seismic Volumes: Examples from the Rocky Mountain Foreland Province

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Kinematic analysis of geologic structures capable of entrapping hydrocarbons has traditionally been` constrained by an incomplete subsurface database. Now that high-quality 3D data volumes have become available for study and interpretation, complete images of the geometry of subsurface structures are available. By creating animations with continuous profiling moving through a 3D data volume in a selected direction, a vivid mental image of the structure is created. For example, in the case of ubiquitous basement-involved thrust-generated folds of the foreland province, a profile movie using profiles oriented orthogonally to the strike of the causal thrust and advancing from the tip of the thrust to the area of maximum displacement and maximum fold amplitude, a self-similar image of the kinematic development of the structure is created. Also, time-slice animation of 3D volumes can contribute to better interpretations of the kinematic development of subsurface geologic structures. For example, bottom-up movies can image the nucleation and upward propagation of fold-generating basement thrust zones, and top-down movies can bring to light the evolution of circular rim structures and the downward narrowing of rootless impact structures.

Movies of structural oil fields in the Rocky Mountain foreland province include the giant Salt Creek structure on the Casper Arch, a Laramide basement-involved thrust-generated fold, the nearby Sussex oil field, a fault-parallel, basculating, pop-up structure at the Paleozoic level produced by left-lateral shearing along a reactivated wrench zone, and the Red Wing Creek field in the Williston Basin; a 9-km-diameter, impact structure buried beneath Jurassic strata and supporting a 2800-foot oil column within the Mississippian chaos of the central peak.