Tectonic History and Evolution of the Faulting at Elk Hills Oil Field: A Mechanical Study

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We present a method by which subsurface data are integrated with mechanical modeling to suggest a geologically and physically consistent fault evolution model for the Elk Hills oil field, California. A three-dimensional volume of seismic reflection data is interpreted for field-scale faults as well as stratigraphic time horizons. The fault interpretations are built into a three-dimensional fault network. The stratigraphic interpretations are used to identify growth wedges, unconformities, variations in isochron maps, and discontinuities in sand bodies, all of which are synthesized to develop a sequential fault growth history. This structural and stratigraphic information is then incorporated into a fourdimensional fault model. These mechanical models are run in Poly3D, an elastic boundary value code that uses the governing equations of continuum mechanics to solve for the stresses, strains, and displacements that are induced at designated observation points by slip on a set of angular dislocations that approximate faults. We use Poly3D in a forward modeling manner, comparing the deformed shapes of representative modeled horizons with horizons interpreted within the seismic data. Differing remote strains applied to the models represent the boundary conditions for various tectonic scenarios for Elk Hills. Variations in fault geometry, fault timing, and remote loading are tested, and the combination(s) that produce modeled horizons that closely replicate the seismically interpreted horizons are selected as possible fault evolution models.