Subsurface Structural Control on Folding and Fracturing at Sheep Mountain Anticline, Wyoming

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Recent field studies at Sheep Mountain Anticline, a Laramide fold on the eastern flank of the Bighorn Basin in Wyoming, constrain the fold kinematics using the fracture pattern mapped across the fold. Modeling studies point to the influence of the elastic stress perturbations induced by slip along the underlying faults on this fracturing. The timing (and master-splay) relationship between the underlying faults has important implications for the mechanism of formation of the mapped fracture sets, but existing interpretations of these faults are in conflict.

We present eleven reprocessed, depth migrated 2D seismic reflection profiles that were acquired in the vicinity of Sheep Mountain Anticline in the early 1980s. Three profiles show the subsurface structure along the trend of the fold axis; eight profiles show the subsurface structure perpendicular to the fold axis. From interpretations of the seismic profiles, we develop a 3D model of the fault geometry beneath Sheep Mountain Anticline. The most probable master-splay fault relationship is determined through geomechanical modeling. A forward model is run for each of the possible fault geometries, and the deformed shapes of representative modeled horizons are compared with horizons interpreted from the 2D seismic profiles. The elastic stress perturbations resulting from slip along the faults in the most probable configuration is then calculated, and compared to the mapped fracture pattern. In this way the influence of underlying faults on the exposed fracturing at Sheep Mountain Anticline is reassessed using geomechanical models with subsurface constraints.