Influence of Tectonics and Mechanical Stratigraphy on Borehole-Scale Deformation in the Permian Basin (Texas, USA)

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Surface exposures of Permian strata around the margins of the Permian Basin in west Texas reveal a broad spectrum of deformation styles and tectonic settings in a range of lithologic facies. These observations are relevant to predicting natural borehole-scale (below resolution of seismic reflection data) deformation in both the conventional (limestone and sandstone) and the unconventional (fine-grained mudrock) reservoir facies of the Permian Basin. Although outcrop analogs are sometimes discounted by the industry for various reasons, they offer a highly useful scale of observation for understanding what goes on in the vicinity of a wellbore during completion and production. Seismic reflection data do not have the detailed resolution necessary to image these small structures at depth, and log and borehole image data are unable to constrain the vertical and lateral dimensions of and interaction between structures away from the borehole. The Eastern Shelf margin of the Permian Basin has outcrops of relatively undeformed rocks that provide constraints on the likely "background" fracture orientations, spacings, and types (joints and veins) to be found throughout the Permian Basin. At the western edge of the Basin, extensional deformation (normal faults, extensional veins, and joints) associated with the Basin and Range Provinces and Rio Grande rift, and contractional deformation (contractional folds, thrust faults, and tectonic stylolites) associated with the Laramide orogeny are both represented in outcrops. The foothills of the Guadalupe Mountains expose a wide range of rock types that contain deformation features developed by overprinting of these tectonic events. Along

the southwestern margin of the Permian Basin, associated with the Marathon uplift, Permian strata in the Glass Mountains contain deformation features (thrust and strike-slip faults, tectonic stylolites, and veins) produced by both Late Paleozoic (Ouachita) and Late Mesozoic (Laramide) contractional deformations. These exposures reveal structural styles and mechanical stratigraphy that are directly relevant to predicting the distribution and style of small-scale deformation features that are likely to influence the permeability architecture and induced hydraulic fracturing throughout the Permian Basin.