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REVISITING FRACTURES IN THE MONTEREY FORMATION

The Monterey Formation is intensively fractured, due in large part to its mechanical properties and its proximity to an active plate boundary. As an important hydrocarbon producer characterized by low primary porosity and permeability, much attention has focused on the abundant fractures that transform the Monterey into an economic hydrocarbon reservoir. Outcrop field observations reveal that mechanical stratigraphy plays a major role in controlling fracture distribution. Lithologies such as cherts, porcellanites and dolostones are highly fractured, whereas impure porcellanites, mudstones and shales are considerably less fractured, and in some cases unfractured. Mesoscale fractures in the Monterey Formation group into two main categories: single layer fractures and throughgoing fractures that span multiple beds. Many throughgoing fractures are tar-filled breccia zones, and are considered to be the backbone of the fracture-flow system in the subsurface.

Many predictive models for fracture distribution are based on the old paradigm that fold-related fractures develop in response to bending forces, and thus should be aligned parallel to fold axes. However, the most pervasive fracture set in the Monterey Formation of coastal California trends perpendicular to fold axes, a conclusion supported by both outcrop and subsurface data. An alternative concept is that brittle deformation in the Monterey Formation represents along-strike extension in response to tectonic shortening. This explains the angular relationship between the dominant fracture set and fold geometry, as well as the occurrence of fractures across entire structures. Another new concept applicable to fractures in the Monterey Formation is the evolution of fracture populations through time. Detailed structural analyses reveal that throughgoing fractures are genetically related to the bed-confined fractures. The larger, hydrologically significant fracture zones develop through the coalescence and linkage of numerous smaller fractures. Thus, throughgoing fractures represent advanced stages offracture development, and are likely connected to a network of abundant small fractures.