Stratigraphic Evolution and Reservoir Quality in a Neogene Accretionary Forearc Setting: Eel River Basin of Coastal Northwestern California

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Studies of modern and ancient subduction zones and accretionary forearc settings can shed light into regional tectonic histories, as well as evaluate petroleum reservoir potential within these settings. Published models of trench-slope (accretionary forearc) basin evolution describe a thick (>2 km) succession of coarsening-upward sedimentary fill deposited on top of an accretionary basement. The southern Eel River basin in the vicinity of coastal northwestern California is an excellent example of an ancient trench-slope basin. Its outcrops and subsurface data provide a wonderful opportunity to validate/update the aforementioned models, as well as document the petroleum reservoir potential within a Neogene accretionary forearc basin.

The Eel River basin developed near the base of an inner trench slope (inboard of the Cascadia subduction zone) in the early Miocene. The tectonic development and infilling of the Eel River basin are recorded in its stratigraphy. Earliest basin deposits, the lower-middle bathyal Bear River beds, are comprised of isolated hemi-pelagic siliceous mudstones and calcareously-cemented sandstones. These beds are areally confined and are quite rare in basin margin outcrops; this observation reflects a structurally confined or terraced depositional environment on the lower trench slope. After deposition of the Bear River beds, there was an apparent basin reconfiguration. This allowed for subsequent, more areally extensive Wildcat Group deposition which “healed” older structural ridges. As in other California basins, this late Miocene-Pleistocene sedimentary succession is thick and mostly conformable. The Wildcat Group records generally shoaling basin conditions, from bathyal debris-flow deposits and turbidites to fluvial deposits. These deposits represent an upward-thickening trend.

XRD analyses performed on Wildcat Group turbidite sandstones (from conventional core and outcrop) reveal a relatively high clay mineral content (19-28%). SEM analyses reveal extensive bioturbation, and demonstrate that clays are authigenic as well as detrital in origin. Detrital clays were largely entrained into turbidity currents on the muddy slope. Reservoir quality is especially diminished by the presence of authigenic clay minerals, which formed due to alteration of constituent plagioclase feldspars and diagenetic processes. Horizontal permeability values range from <1 md in silty turbidites up to 36 md in thickest turbidite sands.