Stratigraphic Megasequences of the San Joaquin Basin: Origins, Characteristics, and Petroleum Occurrence

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San Joaquin basin fill consists of stratigraphic megasequences (2nd order sequences) controlled by major tectonic phases in the evolution of the California continental margin. The tectonic controls that set the stratigraphic architecture also determine petroleum system characteristics of the basin. Seven megasequences, named after major lithostratigraphic units, can be recognized and related to distinct tectonic episodes of basin or margin development. These are generally bounded by basin-wide unconformities and consist of 3rd order sequences typically arranged in a transgressive/regressive stacking pattern reflecting basin initiation or rejuvenation followed by filling. The oldest of the megasequences, the Jurassic-Lower Cretaceous Gravelly Flat, is recorded only in limited outcrops of the Diablo Range, but the widespread overlying Upper Cretaceous Panoche megasequence represents forearc basin sedimentation synchronous with voluminous Sierran magmatism. The megasequence reflects a general balance between rapid subsidence and sediment supply, the latter driven by rapid arc unroofing. Gas-prone terrigenous organic matter and low-reservoir-quality, arc-derived sand were introduced into the basin from the arc by turbidity currents.

The Upper Cretaceous-Lower Eocene Moreno/Lodo megasequence, ca. 68-50 Ma, reflects sedimentation in a shoaling forearc during flat slab subduction of the Laramide orogeny. The initial confined deep-water setting fostered local source-rock deposition, which was superseded by stacked cycles of shallow marine to coastal plain reservoir sand and shale derived from the deeply denuded, inactive arc. This cycle ended with major basin reorganization and initiation of the Middle-Upper Eocene Kreyenhagen megasequence at about 50 Ma associated with uplift in the Diablo Range. Renewed subsidence resulted in bathyal, biogenous sourcerock sedimentation in a much restricted, deep-marine forearc. The overlying Oligocene-Lower Miocene Vedder/Temblor megasequence spans the middle Tertiary, ca. 35-18 Ma, a time when magmatism resumed in the arc. Stacked sandshale cycles form favorable reservoir-seal architecture. The Miocene Olcese/Monterey megasequence, ca. 18-8 Ma, developed during migration of the Mendocino triple junction past the basin. In the southernmost basin, block-faulting and volcanism dominated early; farther north, sandy units of the Olcese formed a series of backstepping sequences. Subsidence culminated in deposition of the deepwater biogenous Monterey Formation source-rock interval. Stacking of low-stand fans within the basinal mudstones set the stage for the premier petroleum system of the basin. The youngest megasequence, the Upper Miocene-Recent Etchegoin/Tulare, developed as transpressional foreland basin fill after ca. 8 Ma in response to a change in relative motion between the Pacific and North American plates. This megasequence hosts basin margin accumulations of heavy oil, as well as promotes maturation of source rocks in underlying Eocene-Miocene megasequences.