Reservoir Quality Trends and Paleogeography in an Ancient Deepwater Environment: The Carneros Turbidite Systems, San Joaquin Basin, California

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ABSTRACT

The Carneros sandstone member of the Temblor Formation is a petroleum reservoir in California that has been the focus of increased exploration and production activities in recent years. The Carneros sandstone was originally deposited in the early Miocene as a group of turbidite systems located along the structurally complex western and southwestern margins of the San Joaquin Basin, which was in a stage of extensional/transtensional tectonics and volcanism at that time. Regional petrologic studies, petrographic analyses from outcrop and core samples, and new subsurface mapping efforts confirm the presence of multiple, discrete Carneros depositional systems with differing reservoir-quality properties due in part to different provenance areas. This study will focus on two of these systems, the Westside system and the Belridge system.

Syndepositional normal faulting adjacent to the San Andreas Fault along the western margin of the basin is interpreted to have created local accommodation into which the Westside system was deposited. This localized accommodation was the main control on development of a channel fairway in the Westside system. The fairway contains the greatest thicknesses of Carneros sandstone in the basin; the thickness trends suggest abrupt changes in paleotopography. Several prolific Carneros-productive oil fields are located along this fairway, and the Westside system sandstones generally exhibit favorable reservoir quality. Subsurface map trends and paleocurrent data from outcrop suggest that the general sediment transport direction for the Westside system was from northwest to the southeast, toward the deepest part of the basin.

The Belridge system was deposited east of the Westside system, closer to the synclinal axis of the greater basin. The two systems, and possibly their source terranes, were separated by a seafloor high that was located near the current McDonald Anticline and Antelope Hills oil fields. From subsurface map patterns, it is interpreted that the general sediment transport direction for the Belridge system was from northwest to southeast, and the Belridge system source terrane might have been located farther to the

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north than the Westside source terrane. Petrographic analyses show that the Belridge system contains a distinctive petrofacies marked by >50% volcanic rock fragments and zoned feldspar grains. The volcanic detritus appears to be first-cycle reworked, suggesting that these rock fragments were derived from contemporaneous or recently deposited lower Miocene volcanics. As a result of the presence of this volcanic petrofacies and other factors, the Carneros sandstone in the Belridge system tends to exhibit poorer reservoir quality than the Westside system.

This example of contemporaneous turbidite systems deposited in a tectonically active, topographically complex basin has exploration implications for other deepwater depositional systems/reservoirs deposited in structurally segmented basins. This study has particular relevance to syn-rift reservoirs deposited during phases of localized volcanism.