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New Insight on Deepwater Deposition in the Permian Basin, West Texas and Southeast New Mexico

Buddy Price

Geologist, Devon Energy

ABSTRACT

Permian Basin of west Texas and southeast New Mexico houses significant mixed carbonate and siliciclastic slope and basinal environments representing multiple unconventional reservoirs. These systems typically are described as accumulations driven by gravitational flows moving downdip into the basin or by suspension fallout of sediment. Bottom current influence and controls on deposition have long been hypothesized in the basin but only recently have been interpreted. This talk aims to present subsurface log, core, seismic, and outcrop examples of bottom current deposits and their overlooked impact on the broader Permian Basin. Detailed regional subsurface mapping by Price et al. (2022) characterized anomalous deposits along the western slopes of the Delaware Basin in Leonardian-age carbonate dominated units, reaching over 600 meters thick. Interpretations suggest these represent drift complexes comprised primarily of carbonate muds accumulated from bottom current deposition. Locations of interpreted drifts coincide with significant bathymetric irregularities resulting from structural uplift, underlying carbonate accumulations, and turning of the margin and slope profiles, which may influence slope-parallel currents and promote deposition. Regional thickness maps show significant thinning to the east of the drifts, possibly indicating sweeping of sediments from east to west and plastering along the western slopes of the northern Delaware Basin by counter-clockwise bottom currents. These anomalous geometries subsequently influence gravitationally-driven sediment routing into the basin. Image logs through one of the interpreted drifts noted by Price et al. (2022) highlight variations in deposition and grading. The high-resolution resistivity image displays abundant repeated bigradationally graded accumulations ranging from 0.1-0.5m thick as well as normally graded, sharp based packages. Comparison of image log trends with analogous core indicates the normally graded beds likely represent high-resistivity mud-dominated carbonate turbidites fining upward to lower resistivity siliciclastic muds. Bigradationally graded packages typically reference an upward coarsening and increase in carbonate mud and bioturbation followed by an upward fining with a decrease in bioturbation and enrichment in siliciclastic mud. These features cannot be adequately described by gravity flow deposition. These more reasonably represent contourites deposited by waxing and waning of bottom current strength.Seismic interpretations also highlight anomalous deposition along the slopes and seafloor of the Permian Basin. 2-D and 3-D seismic illustrates progradation of sediment bodies across the seafloor well below the shelf edge, development of straight crested channels ornamenting deepwater sediment bodies, some of which are 90 degrees to one another, and abrupt truncation of sediment packages irrespective of structural influence. These observations are best explained by accretion, distribution, and erosion of sediments by bottom currents. These ongoing studies highlight the more pervasive and complex nature of bottom current influence in the Permian Basin. While large-scale drifts provide insight into broader scale bottom-current circulation, the presence of winnowing currents likely imparts underappreciated controls on reservoir

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BIOGRAPHY:

Buddy Price is a geologist currently working for Devon Energy. He received his undergraduate degree in geology at Western Kentucky University, Masters at Oklahoma State University, and his PhD from the University of Texas at Austin. His research focuses Paleozoic mixed carbonate-siliciclastic systems with emphasis on Mississippian through Permian stratigraphy in both outcrop and subsurface. At Devon Energy works on the integrated subsurface team leading and assisting with technical projects across the company's assets.