Stratigraphic Architecture of Turbidite and Mass-Transport Deposits in the Outcropping Bone Spring Formation, Delaware Basin, Texas

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ABSTRACT

The dynamics of sediment delivery and partitioning of mixed carbonate-siliciclastic sediment routing systems are poorly understood, but impact the spatial and temporal distribution of reservoir-forming elements. The Bone Spring Formation of the Delaware Basin in west Texas is a prolific mixed carbonate and clastic turbidite reservoir, with stacked pay zones and relatively low operation costs. The Bone Spring Fm. consists of shelf-to-basin sandy turbidites and carbonate mass-transport deposits and turbidites that were sourced from the north and northeastern shelf margins during Leonardian time (~275 Ma). Much research has focused on the distal (subsurface) deposits of the Bone Spring Fm., but there has been little research on the staging area (i.e., the proximal part of the system) that outcrops in the Guadalupe Mountains National Park. Our research aims to describe the stratigraphic architecture of the proximal Bone Spring Fm. in order to delineate the staging area and the dynamics of carbonate and siliciclastic sediment delivery to the basin. Using photogrammetric 3D outcrop models and measured stratigraphic sections, we identify and quantify large-scale architectural elements, including slope orientations taken from mass-wasting scars and deformed bedding. We also delineate the mixing of carbonate and sandy turbidites and carbonate mass-wasting deposits within the proximal Bone Spring Fm., which are likely a primary control on the stacking patterns and sediment partitioning in the distal portion of the reservoir. Using this data, we suggest that variations in mechanical properties, porosity and permeability values, and lateral variability of the distal reservoirs can be traced back to the proximal architecture of the Bone Spring Fm. Additionally, understanding the architecture of the Bone Spring staging area has implications for deposition of the overlying units that have hydrocarbon prospectivity such as the Victorio Peak, Cutoff, and Brushy Canyon formations. Our results help to define the staging area and the morphometric parameters of the Bone Spring Fm. to improve prediction for future development in the Delaware Basin. Our work will also help to constrain sediment delivery and partitioning in other mixed carbonate-siliciclastic sediment routing systems, which form active exploration targets around the world.

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