Sequence Stratigraphic Characterization of the Permian in the Delaware Basin: An Improved Model for Predicting Facies Trends

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Abstract

Industry has historically approached unconventional reservoirs, such as those in the Permian, as “statistical” plays that lack the spatially predictable reservoir characteristics which are typical of conventional reservoirs. Detailed characterization of the Permian reservoirs in the Delaware Basin, however, indicates they are not statistical plays. The geology is predictable and can be characterized using the same stratigraphic concepts, tools and workflows utilized to characterize conventional reservoirs. The first step in characterization of these unconventional reservoirs is construction of a robust sequence stratigraphic framework in order to understand facies trends. The application of sequence stratigraphic methods works particularly well in the Permian of the Delaware Basin as distinct cyclic packages are observed of carbonate- and silica-rich rocks. These changes are interpreted to be linked to changes in relative sea level and a reciprocal sedimentation sequence stratigraphic model has classically been applied to the Permian. This model predicts that at relative lowstands in sea level, the shelf would be exposed, and siliciclastic deposition would dominate. When relative sea level was high, the shelf would be flooded, and the carbonate factory would have been active and dominate deposition. This basic model appears to work well at the 3rd order sequence set scale but is not for the finer scale 5th order systems tracts comprising the 4th order sequences. What is observed in the succession is that where the 3rd order sequence sets are siliciclastic dominated then the 5th order lowstand and highstand system tracts are siliciclastic dominated. This pattern is again repeated in the calciclastic dominated

sequence sets where the 5th order lowstand and highstand system tracts are primarily carbonate facies. In mixed siliciclastic/calciclastic sequence sets, siliciclastic dominate the lowstands and calciclastic dominate the highstand system tracts. The suggests the classic reciprocal sedimentation sequence stratigraphic model is too simple to explain the temporal variance in systems tracts observed in the Delaware Basin. Applying this new model to explain the relationships between the composition of the 3rd order sequence sets and the associated 5th order systems tracts greatly improves the understanding geologic trends both at the regional and local scales and is important to predicting well performance.

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