

Determining the Sequence Architecture of Incised Valley-Fills in the Lower Pennsylvanian Morrow Formation through Multi-Well Borehole Image Analyses, Anadarko Basin, Oklahoma, U.S.A

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The Morrow Formation of northwestern Oklahoma contains paleo-valleys that were incised during falling sea-level and filled during lowstands and subsequent transgressions. The sandstones within these incised valley-fills form challenging gas reservoirs, due to a high degree of stratigraphic compartmentalization. This study involves characterization of the Morrow sequence architecture using high-resolution resistivity borehole images to determine sedimentary facies distributions and to define sequence boundaries, and thus delineate the stratigraphically-controlled heterogeneities in reservoir properties.

Variations from fluvial to estuarine and marine systems are observed within these incised valley-fills. Sandstones lack diagnostic signatures on conventional wireline logs but exhibit a variety of sedimentary structures resolved by the image logs which permit differentiation between fluvial, estuarine and marine systems. Paleo-current directions interpreted from the borehole images proved critical in identifying and determining the orientation of fluvial sand-bodies constrained within the paleo-valleys. The sequence framework is based on the recognition of boundaries representing distinct landward and basinward shifts in facies. Sea-level driven superimposition of contrasting depositional systems resulted in variable preservation of channel deposits, causing reservoir compartmentalization.

Integration of production results with the sedimentologic and sequence architecture analyses provide a clearer understanding of the key depositional (lithologic and architectural) controls on reservoir heterogeneity. Reservoir properties are closely tied to lithofacies and depositional environments. Each Morrow sandstone facies assemblage (or architectural element) exhibits a unique set of reservoir properties. Elements exhibiting favorable reservoir properties include fluvial to estuarine channel to upper shoreface, whereas elements exhibiting marginal to poor reservoir properties include interfluvial to middle shoreface deposits.