[PS]Approaches to Modeling Stratigraphic Heterogeneity in Mixed Fluvial and Aeolian Hydrocarbon Reservoirs*

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Abstract

Dynamic relationships between coevally active fluvial and aeolian systems give rise to a range of styles of sedimentary interaction that are documented from both modern arid-climate systems and analogous ancient preserved outcrop and subsurface successions. Mixed fluvial and aeolian successions are known to form several major reservoirs for hydrocarbons, including the Permian Unayzah Formation of Saudi Arabia, the Permian Rotliegend Group of the North Sea, and the Jurassic Norphlet Sandstone of the Gulf of Mexico and typically give rise to stratigraphic heterogeneity at a number of scales. Quantitative stratigraphic prediction of the three-dimensional form of heterogeneities arising from fluvial and aeolian interaction is notoriously difficult: (i) the preserved products of system interactions observed in one-dimensional core and well-log data typically do not yield information regarding the likely lateral extent of sand bodies; (ii) stratigraphic heterogeneities typically occur on a scale below seismic resolution and cannot be imaged using such techniques. A database recording the temporal and spatial scales over which aeolian and fluvial events operate and interact in a range of present-day and ancient desert-margin settings has been collated using high-resolution satellite imagery, aerial photography and field observation. Together, these data have been used to develop a series of dynamic facies models to predict the arrangement of architectural elements that define gross-scale system architecture. Case-study examples have enabled the construction of a series of depositional models to account for the diversity of styles of fluvial and aeolian system interactions. Several styles of aeolian-fluvial interaction have been documented and the preserved deposits can now be predicted through quantitative geological models that account for spatial and temporal changes in system dominance. For example, the preserved architectural elements of fluvially flooded interdunes tend to expand laterally as successive flood deposits develop in front of advancing aeolian dunes. In non-climbing aeolian systems, such behavior favors the development of sheet-like bypass surpersurfaces. In aeolian systems that climb at low angles and for which fluvial incursions are episodic, thin and laterally impersistent fluvial elements tend to accumulate. The scale and connectivity of fluvial flood deposits tends to diminish with increasing distance toward the aeolian dune-field center.