A Numerical Stratigraphic Model for Mixed Fluvial-Eolian Successions: Implications for Reservoir Prediction

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Mixed fluvial-eolian successions are widespread in the stratigraphic record and form several important hydrocarbon reservoirs. In modern examples of these systems, the water table or its capillary fringe is in contact with the accumulation surface and moisture influences sedimentation. A progressive rise in the relative water table is the fundamental mechanism by which dune, interdune and associated fluvial deposits accumulate, the angle of dune climb being determined by the ratio between the rate of relative water table rise and the rate of downwind migration of the bedforms. Accumulations of these 'wet' eolian systems tend to be characterized by units of climbing dune strata separated by units of damp interdune and associated fluvial deposits. For simple geometric configurations, where the size of the dune and interdune units, the rate of bedform migration and the rate of aggradation all remain constant over space and time, the resulting accumulation has a simple architecture characterized by sets of uniform thickness inclined at a constant angle. However, the dynamic nature of most eolian dune systems means that such simple configurations are unlikely in nature. The complexity inherent in these systems is here accounted for by a numerical model in which key controlling parameters such as dune and interdune size, migration rate and aggradation rate are allowed to vary systematically both spatially (e.g. from a dune-field center to its margin) and temporally (e.g. in response to changes in sediment availability). The range of synthetic stratigraphic architectures generated by the model can be used to account for all the best-known examples of eolian dune and interdune stratigraphic configurations documented from the global stratigraphic record. Modeling results have been used to erect a scheme for the classification of dune system type whereby the many elaborate stratal architectures known to exist in nature can be effectively accounted for by only four parameters that are allowed to vary over space and time. This modeling technique represents an effective way to populate reservoir models, to test their sensitivity to various stratal configurations and to predict resulting effects on sand body connectivity, flow rates and pathways. The work has implications for modeling the flow of hydrocarbons, water, CO_2 and contaminants within important reservoirs such as the Permian White Rim Sandstone (USA) and parts of Triassic Sherwood Sandstone Group (UK).