Analysis of Geological Controls on the Geometry of Incised-Valley Fills and Implications for Facies and Sequence Stratigraphic Models

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ABSTRACT

Incised-valley fills are important reservoir targets in many hydrocarbon provinces. However, existing models that account for the characteristics of incised valleys and their infills are largely conceptual or experimental, and based on limited data. Therefore, such models do not necessarily represent the full variety of valley types known from nature, nor the variety in facies arrangements of their infills. Moreover, little is known about controls on valley morphologies and whether resultant valley characteristics (geometry, facies architecture of infill) can be used to interpret formative processes. Here, a relational database – The Shallow-Marine Architecture Knowledge Store (SMAKS) – is used to investigate controls on incised-valley characteristics. The method utilises quantitative data extracted from the published literature and relating to over 200 classified valley fills. Lithofacies and architectural-element data are coded in a standardized format into SMAKS, which stores hard and soft data on the sedimentary architecture of ancient shallow-marine and paralic clastic successions, and on the geomorphological organization of corresponding modern environments. SMAKS includes data on classified ancient incised-valley fills from different physiographic and climatic settings worldwide. The database has been used to identify differences in the preserved architecture of incised-valley fills for different settings, with a particular focus on late-Quaternary examples, to gain an improved understanding of geological controls. Key results are as follows: (i) valley size and shape are governed by both upstream controls, such as river discharge, and downstream controls, including coastal-plain and shelf physiography, shelf width, shelf-break depth, substrate lithology, climate, and rate and magnitude of sea-level change; (ii) valley width, depth and cross-sectional area show correlation with the size of the associated drainage basin at lowstand; (iii) valley dimensions (width and depth of incision) change in a predictable manner basinward from coastal-plain to shelf-break. A statistical analysis has been performed to assess the significance of different geological controls on incised-valley morphometry: the results challenge currently accepted paradigms embedded within sequence stratigraphic models regarding the relative importance of upstream and downstream controls. Results have significant implications for hydrocarbon reservoir prediction and characterization.