Time-Exclusive Sediment Transport Mechanisms in the Deepwater Niger Delta

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ABSTRACT

Based on high-resolution 3D seismic data, we document two distinct sediment transport mechanisms operative at mutually exclusive time periods in the Lower Eocene-to-Pleistocene Agbada Formation of the deepwater Niger Delta. Through the application of a continuous wavelet transform, we first reveal the distribution, architecture and organization of sediment transport systems in the study area. We then hypothesize the major factors forcing the development of each sediment transport system and develop conceptual models which highlight the time-exclusive mechanisms and their implications for exploration within the region. A mechanism predates the onset of tectonic deformation of the sedimentary succession and dominated at deeper sections of the Agbada Formation. The principal depositional elements are vertically-stacked channel systems, with both linear and sinuous morphologies which often terminate in fragmented frontal splays. The southeasterly dip of the oceanic crust below and the locations of horst-graben related trenches in the crust were the principal factors influencing the morphologies of the sediment systems and splay locations. Subsequent thrust episodes may serve to trans-locate the sediment systems into the crest of thrust related anticlines which developed latter. The vertical stacking increases sand targeting opportunities and charge potentials are high due to proximity to the overpressured Akata source rock and the occurrence of major thrust faults at depth. A second mechanism post-dates the onset of thrust activity and is ongoing within shallow sections of the Agbada. Here, sediment transport channels are constrained by thrust-induced fold anticlines, to flow along narrow northwest-southeast trending straights between successive seaward verging toe-thrust structures. Cyclic alternations between active thrusting and tectonic quiescence accompanied by sub-aerial erosional episodes, results in repetitive vertical stacks of linear channel systems with extensive levees, and sometimes bypassed splay lobes. Individual systems are bounded by sub-regional erosional unconformities. Vertical stacking of channels improves sand targeting, however recharge potential is low as the systems have largely developed in relatively unfractured piggyback basin areas. Potential exceptions are when channels bridge the crest of thrust ridges or take their course through troughs which resulted from extension induced collapse of anticlinal ridges.