Shale Tectonics and Sedimentation of the Offshore Niger Delta

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We present a new regional analysis of the structure and stratigraphy of the offshore Niger Delta from interpretation of the new NigeriaSpan regional 2D seismic survey, acquired and processed by GX Technology. These data have optimal characteristics (long-offset, long-recording time, prestack-depth migrated) that provide advanced imaging of the previously enigmatic mobile shale structures, as well as the better understood fault-related folds. On the shelf we recognize the soling out of syndepositional, listric normal faults along a unambiguous detachment surface at over 11 km subsea. This detachment sits near the base of the Tertiary. This fundamental detachment in the contractional toe of the delta shallows to about 7 km subsea rather uniformly in the upper Eocene to lower Oligocene section. The inner slope is both translating and accommodating shortening from updip extension, and exhibits a ductile and complex shale response. In the past, these mobile shale structures have been poorly imaged by seismic data and have sometimes been referred to as 'diapiric' structures. Based on improved NigeriaSpan imaging we interpret these as primarily contractional, asymmetric, sometimes thrusted, detachment folds with mobile, Eocene-Early Oligocene prodelta and marine shale chaotically deformed in the cores of these structures. Growth commenced in the late Oligocene, and continues to the present day on many of these structures. These long-lived structural highs often show later thrusting, with substantial cutand-fill geometries and several unconformities on their crests. In places, adjacent basins sometimes show evacuation of the prodelta and marine shale out of the synclines forming welds on the underlying lower Tertiary strata. This structural and stratigraphic style is in stark contrast to the deepwater contractional toe of the delta which is primarily a brittle foldand-thrust belt of imbricate fault-bend, fault-propagation folds, and shear fault-bend folds. The Eocene-Early Oligocene prodelta and marine shale is locally mobilized here into symmetric, shale-cored detachment folds. Growth strata on these fault-related folds, constrains timing from late Miocene to the present day, but individual structures do not generally show long-lived activity. Instead, thrusting in the more brittle toe tends to be a relatively systematic break-forward sequence.