Marine Muddy Depositional Systems - Bedforms to Stratal Architecture and Play Fairways

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Abstract

Recent focus on hydrocarbons hosted in muddy fine grained strata, often referred to as shale gas or shale oil, has increased our understanding of these relatively poorly understood depositional systems. This study will focus on the link between bedforms, depositional processes, and stratal architecture, and their relation to the laterally continuous hydrocarbon accumulations hosted within these strata.

Mudstones are commonly comprised of mudstone aggregates, observable in thin section and SEM. Variable degree of compaction of the mudstone aggregates reflect their different water content at the time of deposition. This together with compositional variations reflect their different origin as intrabasinally derived (flocculates, fecal pellets or rip up clasts from erosion by subaqueous currents of the seafloor), or the mudstone aggregates might have an extrabasinal origin. The mudstone aggregates show evidence of transport by traction currents with them being co-transported with detrital silt and sand sized grains reflecting their hydrodynamically equivalency. In some cases, composition of the mudstones aggregates varies between the parasequence sets, indicating relative sea level induced changes in the geostrophic currents and influx of mudstone aggregates with distinct compositions originated from different parts of the basin.

While mudstone succession commonly have relative uniform thicknesses with gentle tapering geometries, they often have internal clinoform geometries as commonly observed in modern mudstone depositional systems. This clinoform geometry, being inconsistent with deposition from suspension can easily be explained by the recognition of deposition of mudstone by bedload processes. Mudstone clinoforms are, however often not identified in mudstone dominated hydrocarbon reservoirs as correlations are often facies and not chronostratigraphical based. Examples will be shown where cross sections of closely spaced well logs have revealed shoreline detached mudstone dominated clinoforms, which often have complex 3D clinothem geometries. Paleo-relief along the clinothems foresets is supported by redox sensitive trace elements that show increasing oxygenation up along the clinoforms.

Understanding bedforms within mudstone dominated deposits and interpretation of depositional processes and settings will allow a better characterization of reservoir to accumulation scale heterogeneity. This will our understanding of lateral variability in reservoir properties of similar sedimentary facies, leading to improved mapping of productive fairways. Examples from Cretaceous strata of the Western Canada Sedimentary Basin will demonstrate how facies distribution with these clinothems controls the reservoir properties and thereby production sweet spots.