Shale-gas Production and Sequence Stratigraphy: What Makes the Best Part of the Best Plays?

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Stratigraphic analyses of a variety of mudstone-dominated units demonstrate that the best "shale-gas" production is from thermally mature, pelagic-rich strata that can be assigned to the transgressive systems tract and condensed section (TST/CS). They are often referred to as "black shales", although clay minerals can form 20% or less of the rock. A high TOC content (typically marine or mixed) made these strata potential source rocks, and silica and/or carbonate diagenesis produced "brittle" rock that is suitable for hydraulic fracture stimulations. Within these mudstones, thin (< 10 m thick) stratigraphic units can commonly be correlated over several to many 10s of km and show draping to divergent/convergent geometries. Rock properties are therefore unlikely to change significantly over the length of a typical horizontal completion (~ 1 km) in the TST/CS, unless other complications (e.g., fractures) are present. However, changes in thickness, mineralogy, thermal maturity or other stratigraphic/geologic parameters over distances of several km to 10s of km will affect gas generation, storage and production.

The lithologic and stratigraphic characteristics of the TST/CS strata differ considerably from progradational mudstones of the highstand systems tract (HST) and the lowstand systems tract (LST). The latter are characterized by higher clay contents and more detrital silicate/carbonate as silt or coarser grain sizes. The clay content generally makes these shales less brittle than the TST/CS units. These HST/LST mudstones have lower TOC contents than the TST/CS mudstones, and the organic matter is relatively enriched in terrestrial (Type III) constituents. These strata tend to be more heterolithic than the TST/CS mudstones, and may be arranged into submarine failure complexes, prodelta lobes or other stratigraphic features that can show rapid lateral variations in lithology and thickness. These characteristics generally make these HST strata less amenable to development using horizontal wells. In some circumstances gas can be produced from the relatively coarse-grained interbeds, making a type of "hybrid" play that is not a true shale-gas play. Although the descriptions and interpretations presented above have general applicability (i.e. they are the "simple case"), these concepts commonly need to be modified to account for the wide variability in depositional setting, depositional history, and geologic age, represented by gas-productive mudstones.