Sequence Stratigraphic Control on Lateral Placement in the Marcellus Shale, Appalachian Basin

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Placement of a lateral in the Marcellus shale necessitates consideration of two properties of the reservoir: location of the hydrocarbon within the reservoir, and pre- and post stimulation deliverability of the formation. Core calibrated petrophysical analysis of Marcellus logs is conducted to determine total organic carbon (TOC) content, gas-filled porosity, clay volume, and both free and adsorbed gas-in-place volumes. The distribution of in-place hydrocarbons is controlled by the sequence stratigraphic framework of the Marcellus, which comprises two third-order transgressive-regressive cycles. Within a particular T-R cycle, the shale becomes progressively more organic and quartz rich through the transgressive systems tract and progressively diluted by clay through the overlying regressive systems tract. Organic richness throughout much of the Marcellus basin appears to have been controlled principally by a combination of bottom water conditions conducive to preservation of organic macerals and dilution by clastic detritus. Given that the Marcellus accumulated rapidly (~1.5my), condensed intervals are dominated by TOC that is largely undegraded. Deposits of the Union Springs Member illustrate the best reservoir development. The significance of TOC to Marcellus gas production is evinced in that it not only is the site of adsorbed gas, but it also seems to be a major site for porosity development within the Marcellus shale. Further, the combination of TOC and thermal maturity result in high density of natural fractures that are largely confined to the most organic-rich black shale intervals enhancing system permeability. Inferred condensed intervals are defined by minimal clay and especially abundant quartz, principally diagenetic. These siliceous horizons serve as higher modulus, brittle rock necessary for the initiation of hydraulic fracture stimulation. Further, minimal clay within the condensed intervals may be expected to diminish the degree of propant embedment.