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ABSTRACT

Timothy R. Carr*, Taylor McClain*, Guochang Wang*

A TALE OF TWO SHALE UNITS – PETROPHYSICAL ANALYSIS AND SEQUENCE STRATIGRAPHY OF THE MARCELLUS SHALE AND UTICA SHALE IN THE APPALACHIAN BASIN, USA

Paleozoic organic-rich mudrock ("shale") units were deposited on the eastern margin of the United States of America from the initial Cambrian rifting to the assembly of Pangaea after the Devonian. Two of these organic-rich shale units the Ordovician Point Pleasant-Utica and Devonian Marcellus Shale of the northern Appalachian basin are some of the most active shale gas and liquids plays in the world, and a significant component in the United States energy market. Unconventional hydrocarbon plays are often referred to as statistical plays due to their high degree of heterogeneity, and present challenges for characterization and exploitation. Productivity depends upon an inter-related set of reservoir, completion and production characteristics. A key control on success is regional geology and sequence stratigraphy, in particular the geographic and stratigraphic distribution of organic matter, silica, and carbonate. The distribution of these key elements has been modeled at the basin and local scales. A 3-D mudrock lithofacies model is constructed using sequence stratigraphy to constrain mineral composition, rock properties and organic content. Core analysis and log data were used to calibrate the model from core scale to well scale and finally to regional scale. Geostatistical approaches were used to develop a quantitative relationship between conventional logs and lithofacies, and to model the distribution of mudrock lithofacies in three-dimensions. Controlled primarily by dilution, organic matter productivity, and organic matter accumulation distribution of organic-rich mudrock lithofacies was dominantly affected by water depth and distance to shoreline. The controls on mudrock reservoir quality are subtle and heterogeneity present in Utica and Marcellus results in regional and local well production variations. The proposed 3-D lithofacies modeling approach aids in recognizing geologic and engineering targets, designing horizontal well trajectories, targeting fracture stimulation strategies and understanding shale depositional environments and processes. The proposed approach can be extended to other organic-rich shale reservoirs.

* Department of Geology and Geography, West Virginia University, Morgantown, West Virginia, USA