Meso- and Macro-Scale Facies and Chemostratigraphic Analysis of Middle Devonian Marcellus Shale in Northern West Virginia, USA

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ABSTRACT

Marcellus Shale Energy and Environmental Laboratory (MSEEL) consists of four produced horizontal wells and two vertical pilot wells. In order to gain a detailed understanding of the Middle Devonian Marcellus Shale and surrounding Upper Devonian shale intervals, we focused on the two vertical pilot wells (MIP-3H and MIP-4H). Understanding the vertical and lateral distribution of the shale lithofacies and changes in chemostratigraphy are critical to understanding the impact of depositional and diagenetic environments on hydrocarbon generation and production. Integrated geological and petrophysical characterization of the Marcellus and adjacent Onondaga through Mahantango units was performed using core and well log data. Macro-scale lithofacies were determined through a combination of core and CT-scan descriptions. Meso-scale shale lithofacies based on mineralogy and total organic content were developed using a combination of triple combo and advanced logging tools and calibrated to core data (XRD and source-rock pyrolysis). Chemostratigraphic analysis utilizes x-ray fluorescence to determine the major and trace-element trends associated within the Devonian Marcellus-Mahantango interval. Devonian Marcellus-Mahantango interval is composed of six shale lithofacies both at the meso- and macro-scale. Petrophysical analysis shows three well developed organic mudstone facies are present in the Marcellus interval. Chemostratigraphic (trace element concentrations) and petrophysical data (spectral gamma derived uranium content) indicate the highly organic mudstone (TOC > 6.5 weight percent) facies in the lowest part of the Marcellus Shale were deposited in a highly anoxic environment compared to overlying units, and the decreased detrital influence indicated by silicon, aluminum, and titanium trends, allowed for better preservation of organic matter.