

Assessment of Spatial Variability in the Marcellus Shale from High Resolution Sedimentology and Stratigraphy, Finger Lakes Region, NY

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The Devonian Marcellus Formation of the Appalachian Basin is an example of the organic rich black shales that are hydrocarbon source rocks. For most of the 20th century, descriptions of black shales, including the Marcellus, emphasized their homogeneity, high organic matter content, and very fine particle size (clay size), and interpreted them to be the result of suspension settling from the water column in the deepest part of the basin. However, recent studies show that these black shales are not homogenous, display a high degree of variability at a small scale, and show evidence of current-induced deposition. In this study we intend to establish the variations in lithofacies within the Marcellus Shale in the Finger Lakes region of New York and use these as criteria with which to understand the environmental conditions under which the Marcellus Shale was deposited. A second component of our study is to recognize key surfaces that may be indicative of basin wide base-level changes that can be tied to the geophysical log signals. We intend to place the rock property variations in a sequence stratigraphic framework. Ultimately, we will estimate the magnitude and variability of those rock properties across the Finger Lakes region, by correlating well logs (wells in the ESOGIS database) within the sequence stratigraphic framework.

By its very nature, study of fine-grained rocks needs careful examination to identify rock properties that range from macroscopic to microscopic scale. For this reason we base our high spatial-resolution analysis of the Marcellus Shale on sedimentological, mineralogical, petrographical and chemical features. Data begin with outcrop observations of the Marcellus Shale in fresh, unweathered surfaces of an active rock quarry (Seneca Stone Co.) in Seneca County. Laboratory analyses of the fresh rock include petrographic thin sections, Total Organic Carbon (TOC), X-Ray Diffraction, Scanning Electron Microscopy and microprobe.

Results to date emphasize the variability within the lower member of Marcellus Formation, the Union Springs member. Based on the preliminary sedimentology and geochemistry data, the Union Springs Member shows great variability within an approximately 3-meter interval. We observe three lithofacies that differ in terms of sedimentology and geochemistry; 1. Lower “silty shale” lithofacies, 2. Middle “finely laminated shale” lithofacies, 3. Upper “calcitic concretionary shale” lithofacies. The first one, silty shale, is dominated by mm-cm scale intercalations of silt-sized and clay-sized grains, with hints of erosion at the bases of silt lamina; it is very low in organic matter. The second lithofacies, finely laminated shale, has more homogeneous clay-sized particles and is darker grey; it has the highest organic matter content. The third lithofacies, shale with calcite concretions, although also laminated, contains abundant

large calcite concretions that range from 5 cm to 30 cm in diameter. This unit is also rich in organic matter, except in the concretionary levels. All these variations in the Union Springs Member suggest that the depositional conditions at the time of Marcellus deposition were not steady, and that varying depositional mechanisms played roles in creating the physical and chemical properties of this formation.