Identifying Lithosomes of the Marcellus Shale: A Provenance Approach

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ABSTRACT

Controls on mudrock deposition can produce localized and time-transgressive lithosomes that vary in terms of rheologic properties and organic richness. Currently, there are few reliable techniques for delineating or predicting the extent of mudrock lithosomes across a play. One approach to this problem is mudstone provenance, which can be used to predict the direction and timing of detrital dilution in an organic mudstone depocenter. Integrated mineralogic, geochemical, and petrographic analysis of Marcellus Shale and Mahantango Formation mudrock samples recovered from 2 well-bore cores in Monongalia Co., West Virginia (MSEEL MIP-3H and WV-6), reveal contributions of northern- and eastern-derived clastic detrital influx. Major and trace element geochemistry indicates a felsic, upper continental crust sediment source, with mineralogy reflecting an increased influx of extrabasinal phases with time. In particular, the upper part of the Marcellus Shale reflects influx of chlorite that is not observed in the lower part, which is attributed to increasing contribution from exhumed metasedimentary rocks in the Acadian fold-belt. However, Sm-Nd isotopic analysis reveals δNd values that increase upsection from -9.85 to -11.65 and depleted mantle model ages (TDM) that decrease from ~1.85 Ga to ~1.65 Ga. Overall, TDM ages decrease upsection as δNd values decrease. These results require contribution of extrabasinal detrital sediments from erosion of both the Superior Craton to the north and the adjacent Acadian fold-thrust belt to the east, with increasing contribution from Acadian sources with time. In contrast, previous work by other researchers in western and central New York documents younger TDM of the Marcellus Shale (1504-1689 Ma) and lower ÎµNd values (approx. -5) that reflects greater contribution of Acadian-derived sediment compared to Superior craton-derived sediment in this part of the basin. These different provenance results support distinctive lithosomes for the Marcellus Shale in NY compared to WV. In order to explain the greater input from the Superior Craton in WV compared to NY, either the Catskill delta system mainly transported detrital clays from the Superior craton and influx of Acadian-derived material only locally overprinted this signature in NY, or the Marcellus Shale developed in a time-transgressive manner longitudinally across the Acadian basin and variation in provenance reflects a secular change in the source-to-sink system.