Geologic Characterization in Preparation for the Assessment of Oil and Gas Resources in Upper and Middle Devonian Black Shales of the Northern and Central Appalachian Basin

Michael H. Trippi[1], Catherine B. Enomoto[1], Debra K. Higley[1], William A. Rouse[1], and Frank T. Dulong[1]

[1]U.S. Geological Survey

ABSTRACT

The U.S. Geological Survey (USGS) will assess continuous oil and gas resources in multiple Upper and Middle Devonian black shales of the northern and central Appalachian basin. The black shales that were studied are the Cleveland Shale Member of the Ohio Shale, the Huron Shale Member of the Ohio Shale, the Pipe Creek Shale Member of the Java Formation, the Rhinestreet Shale Member of the West Falls Formation, the Middlesex Shale Member of the Sonyea Formation, and the Geneseo Shale Member of the Genesee Formation (equivalent to the Burket Shale Member of the Harrell Shale). These shales range in age from Givetian to Famennian. They are present in New York, Pennsylvania, Ohio, West Virginia, Kentucky, Virginia, and Tennessee between the Appalachian fold belt to the east and the Cincinnati Arch to the west. The assessment units (AU) for Huron Shale, Middlesex Shale, Pipe Creek Shale and Rhinestreet Shale extend into Lake Erie. These shale members were deposited in marine environments in a foreland basin. Anoxic to dysoxic conditions varied through time. Total organic carbon content of all of the shale members varies from 1 to 13 percent within the assessment area, and contains predominantly Type II marine and Type II/III mixed kerogens. The younger strata contain slightly more Type III terrestrial kerogen and less calcite. The Geneseo Shale carbonate content averages 19 percent with a maximum of 66 percent preserved carbonate content, while the Cleveland Shale has a maximum of 2 percent carbonate content. The Cleveland Shale and Huron Shale maximum thicknesses are 100 ft and 400 ft, respectively. The Rhinestreet and Geneseo Shales exceed 3400 ft and 125 ft, respectively. Within the assessment areas, the shale members are in oil, wet gas and dry gas thermal maturity windows. Natural fractures in all of these shale members facilitate production of oil, natural gas and natural gas liquids (NGL). The Huron, Cleveland, Geneseo-Burket, and Rhinestreet shales are self sourced and have significant historical gas production, with minor oil and/or NGL production in the Huron Shale. After decades of extracting hydrocarbons with vertical wells, operators recently utilized horizontal drilling and multi-stage fracturing to increase production rates.