

The Downside of Using GR to Determine TOC Content: An Example from the Marcellus Shale in SE West Virginia

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Two “core holes” (wells drilled to collect geologic and engineering data) were drilled recently in southeast West Virginia by Bluescape Resources Company. The wells, the Rupert #2 in Nicholas County and Rupert #3 in Greenbrier County, were drilled to help characterize the gas potential of the Marcellus Shale in Bluescape’s extensive acreage position in the area; the wells are located 17 miles apart. In total, 15 whole cores were collected from the gray-shale interval adjacent to the Marcellus, the Marcellus itself, and the underlying Onondaga and Huntersville formations. An extensive suite of wireline logs were run in each of these wells.

There are logs available from six legacy wells in the area that were used to help develop the prospect and for picking core points in the Rupert wells; gamma ray (GR) logs are available for several of these wells. However, in examining these legacy logs, we determined that we could not rely on the GR log to determine the actual top of the Marcellus. The resistivity, caliper, and density logs (where available) indicated that the actual top of organic-rich (i.e., prospective) shale was much higher in the stratigraphic column than the GR logs indicated. We decided to core that interval, along with some of the section above it, in both Rupert wells to test this hypothesis.

Geochemical analyses (Rock-Eval/TOC pyrolysis) were performed across the entire shale interval in both Rupert wells. These tests did indeed indicate that TOC values up to 5wt% are present in the shale section above where the top Marcellus is usually picked based on the GR log alone. The character of the openhole GR log does not indicate the presence of high-TOC shale in this upper section of the Marcellus.

The Figure shows logs and core data from the Rupert #2 well. If one draws a typical GR gray shale base line trending along the upper portion of the interval, the upper portion of the Marcellus would appear to be low in TOC; one would be tempted to assert that only the lower 40 ft. of the Marcellus is prospective. However, incorporating the resistivity- and density-log data into the transform makes it much more robust. Adsorption-isotherm analyses confirm a linear relationship between adsorbed-gas content and TOC, so to ignore the upper portion of the Marcellus in this area of the basin is to ignore a huge amount of gas in place.

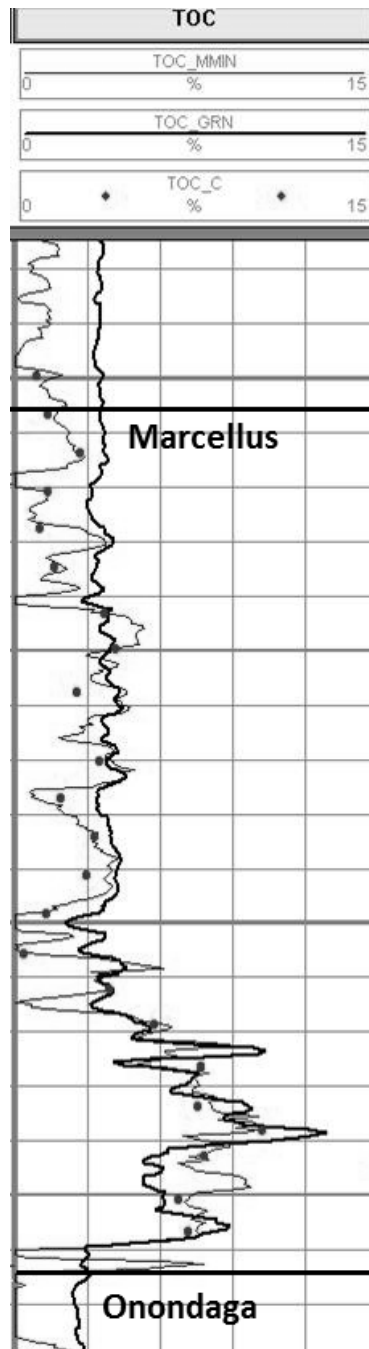


Figure: Data from the Rupert #2 well. Open hole GR log (thicker black line) linearly transformed to depth-shifted core TOC values (dots); in general, there is a poor correlation. The thinner curve represents a more robust TOC transform that incorporates the GR, resistivity, and density data. Minor depth marks are 10ft; TOC values range from 0wt% on the left to 15wt% on the right of the log.