

Effects of Diagenesis in the Mineralogy and the Total Organic Carbon Content of the Marcellus Formation in Core Samples from Northern Pennsylvania and an Outcrop Sample from Central New York



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ABSTRACT

Profitable hydrocarbons production in the Marcellus shale gas play has been possible because of three main factors: the Marcellus formation's excellent source rock qualities, technological advancements in hydraulic fracturing stimulation and directional drilling, and a steady increase in price and demand of hydrocarbons.

This project examines the mineralogy and organic carbon content of the Marcellus shale in Northern Pennsylvania. Three core samples at different depths were obtained from the Pennsylvania Geological Survey core library and an outcrop from central New York was obtained from the University of Pennsylvania. They were analyzed using x-ray diffraction at the University of Pennsylvania and Rock-Eval pyrolysis conducted by a private source rock analysis laboratory in Texas.

The study describes how the mineralogy and the total organic carbon content of the Marcellus Shale were affected by burial diagenesis. The mineralogy observed by the x-ray diffraction analysis was consistent with the literature of the Marcellus shale, consisting primarily of quartz, carbonate minerals and clays. The organic material identified through Rock-Eval pyrolysis in the four samples was kerogen type II. The core samples showed thermal maturity and all of them were classified as potential dry gas source rock.

BACKGROUND

- The Marcellus formation is a geological unit that is comprised mainly of marine organic rich shale deposited during the middle Devonian in a subtropical environment (Figure 1).
- It is found in most of the Appalachian Basin (Figure 2), and it covers an area of about 191,000 mi²
- It is composed mainly of fine-grained material including clays and organic compounds. It is organic-rich, with an average gross total organic carbon (TOC) of 6.5%. The average porosity is 10%.



Figure 1. Appalachian Basin during the Middle Devonian - 385GA. (Modified from Blakey, 2011)



Figure 2. Extent of the Marcellus Shale (Soeder, D.J., and Kappel, W.M., 2009)

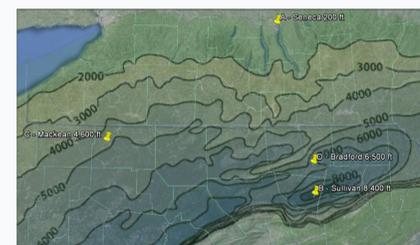


Figure 3. Location of the Marcellus Shale Samples

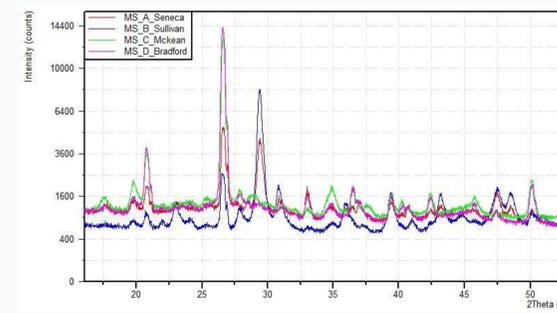


Figure 4. XRD Intensity Curve Comparison

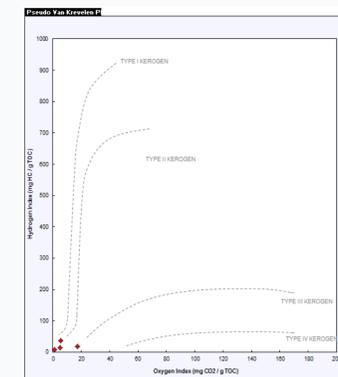


Figure 5. Pseudo van Krevelen plot

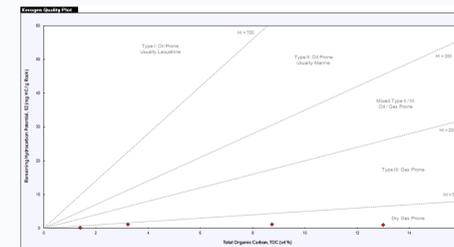


Figure 6. Kerogen quality plot

METHODS

- Core Samples at different depths were obtained from the Pennsylvania Geological Survey Core library and an outcrop sample from the University of Pennsylvania Collection (Figure 3).
- X-Ray Diffraction was used to analyze the bulk minerals of the samples for their characterization (Figure 4).
- Rock-Eval Pyrolysis was used to identify the type of kerogen found in the rock and the maturity of the organics (Figure 5 and Figure 6).

ANALYSIS AND CONCLUSIONS

- No pyrite was present in the cores, which is probably caused by the geothermal, and more importantly, the pressure gradient that the mineral was potentially subjected at depth as well as the depositional history of the sediments.
- A higher percentage of quartzite is predominant in samples C and D which is probably related to the higher calcite in A and B.
- The Pseudo van Krevelen plot confirms the origin of the kerogen type II, and it is concordant with the literature review.
- It's evident, from the kerogen quality plot, that the organic compounds underwent a full diagenetic process - the four samples were identified as being dry gas prone - .

WORKS CITED

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