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Project Title: Relationship between Rome Trough Reactivation and the Distal Stratigraphy and Reservoir Quality of the Devonian Marcellus and Burkett Formations of the Appalachian Basin

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The purpose of this study is to examine variations of the Marcellus and Burkett (also called the “Geneseo”) Formations’ shale stratigraphy, sequence/systems tract character, thicknesses, mineralogy, and organic matter content within and just outside of the reactivated, basement-rooted Rome Trough, and use these variations to gain insight into the Rome Trough tectonic history and shale provenance during the Middle to Late Devonian. With the support of ACS PRF, we are comparing mineralogy and organic content variations of the Devonian Marcellus and Burkett/Geneseo Formations in ESGP2 core from the Allegheny County, PA, portion of the Rome Trough. In addition to the core work, we are also mapping sequence stratigraphic and thickness variations from subsurface data collected throughout the Rome Trough in West Virginia and Pennsylvania and comparing these results to outcrops east of the study area. This study integrates XRD, carbon isotopes, mineralogy, TOC, sequence stratigraphy, and thickness maps.

During the report period, the Marcellus and Burkett/Geneseo Formation intervals from the ESGP2 core (stored at the Pennsylvania Geological Survey) were described and sampled, and well logs for the core were obtained. A total of 24 samples were collected from the two formations where facies appeared to visibly change (Figure 1). These 24 samples were split for XRD analysis by the Pennsylvania Geological Survey and TOC content and ^{13}C analysis by Global Aquatic Research. Thin sections for each sample were prepared by Spectrum Petrographics and are currently being analyzed under both petrographic and scanning electron microscopes (Figure 2). The lithologic variations between the Marcellus and Burkett/Geneseo Formations suggest that, though these two shales initially appear to be similar in hand sample and outcrops, the depositional and diagenetic processes resulting in the two shales were quite different. The repetition of the Marcellus lithofacies, the disseminated and biogenic nature of the quartz, and lack of detrital quartz and plagioclase suggest that eustatic sea-level variations and/or a cyclic subsidence history primarily affected organic facies deposition during the Middle Devonian. Abundant detrital quartz and the presence of plagioclase in the Burkett Formation indicate that this portion of the Appalachian basin had a more proximal position to sediment source during the Late Devonian. ^{13}C values for both shales are similar and indicate that the organic matter has a significant terrestrial component. These results suggest that: 1) Acadian Orogeny deformational loading migrated southwestward between the Middle to Late Devonian, and/or 2) Upper Devonian shale provenance has significant cratonic input.

Approximately 400 well logs supplied by the Pennsylvania Department of Environmental Protection, the West Virginia Geologic Survey, and the New York State Museum from within and around the study area were imported into well log analysis software. Preliminary interpretations were made, with an initial focus on the Burkett/Geneseo Formation within the Rome Trough. A Burkett/Geneseo Formation isopach was generated for a portion of the study area, which highlights localized depocenters. Additional well logs are currently being imported into the well log analysis software, and more detailed thickness stratigraphic interpretations are being made.

During summer 2019, we visited six Devonian shale outcrops east of the Rome Trough study area in Pennsylvania, West Virginia, and Virginia. A total of 27 samples were collected, which are currently being prepared as thin sections. These samples will be compared to samples collected from the ESGP2 core

After receiving approval from ACS, we spent more money in the undergraduate student stipend line of the budget than anticipated, as one summer undergraduate research assistant did not require payment for the budgeted on-campus housing fee. This money was then reallocated to the student stipend line in the budget. We spent less in the supplies line than anticipated, as the Pennsylvania Geological Survey performed XRD analysis for no cost, and we completed field work faster and at a lower cost than anticipated this summer. This leaves a balance of \$3,628.15, which we plan to carry over and spend during the next grant period.

This ACS PRF support has allowed Dr. Tamulonis to begin new research focusing on shale stratigraphy and to initiate collaborations with geologists from the petroleum industry, the Pennsylvania Geologic Survey, and the West Virginia Geological Survey. Student researchers are learning about unconventional petroleum geology and gaining valuable field, laboratory, software, and conference experience. To date, two students presented this work at

regional geology conferences, and we are planning to continue to present this work at several more conferences in 2020. A manuscript on the ESGP2 core results is in preparation for submittal to *Environmental Geoscience*.

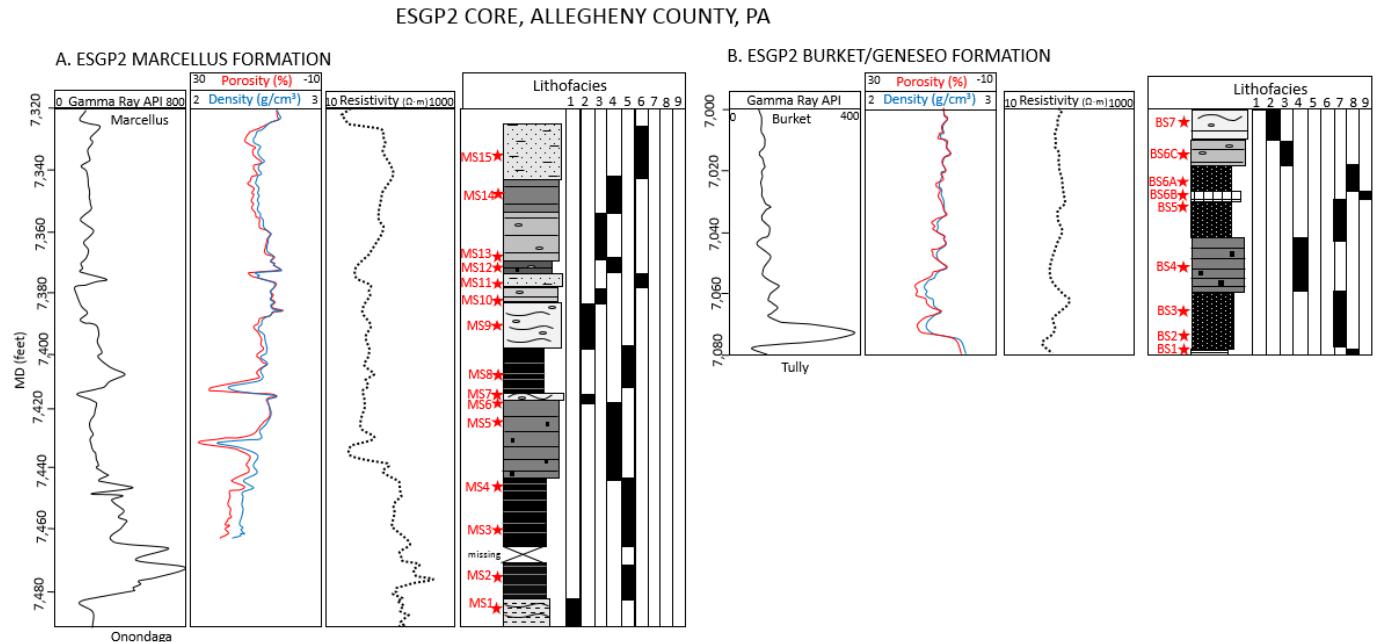


Figure 1. A) Marcellus Formation and B) Burket/Geneseeo Formation well logs, lithofacies, and mineralogy from the ESGP2 core from Allegheny County, Pennsylvania. Red stars indicate sample location.

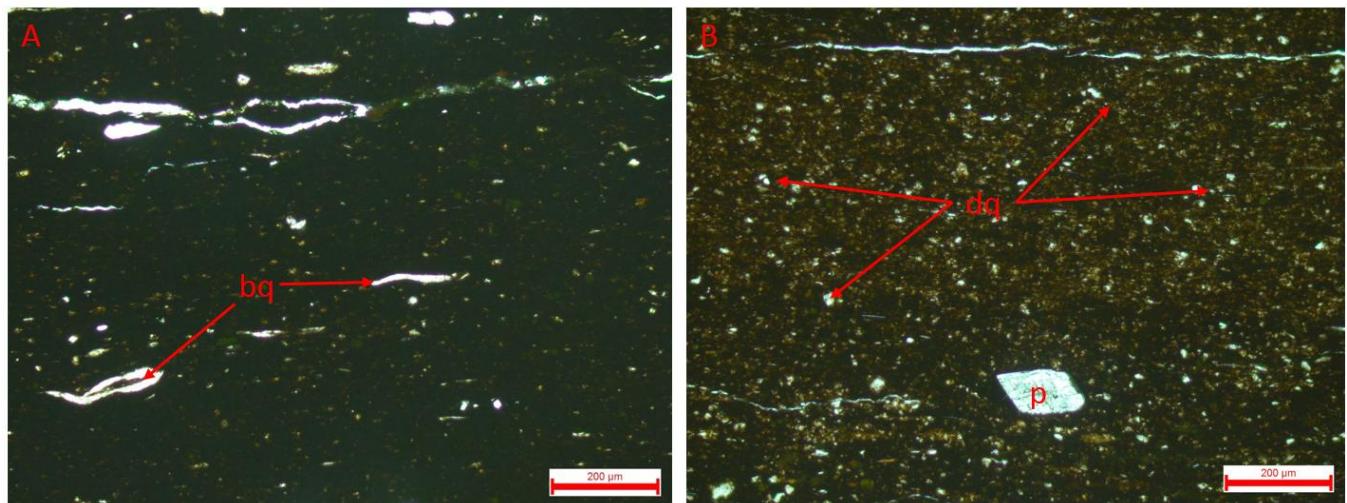


Figure 2. Thin sections for the ESGP2 core from the A) Marcellus Formation organic facies, and B) Burket/Geneseeo Formation organic facies. bq=biogenic quartz, p=plagioclase, dq=detrital quartz.