Pores aren't the only gaps: Examining the Gordon Sandstone in the Jacksonburg-Stringtown Field, West Virginia using new Permeability and XRF data

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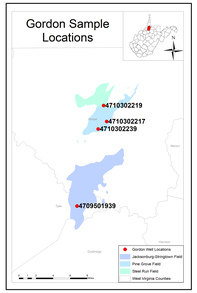
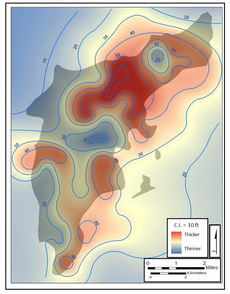
Abstract

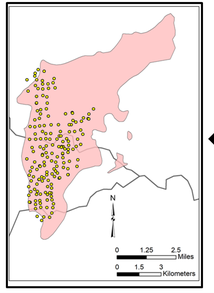
The Midwest Regional Carbon Initiative (MRCI) is evaluating opportunities for utilization of CO_2, including enhanced oil recovery (EOR), in legacy oil fields across the Appalachian and Illinois basins. Although legacy oil fields have previously been characterized under various regional studies, many datasets for the wells have limited availability and are underrepresented in the region. Estimates of permeability, necessary for the construction of CO_2 injection models, are especially underrepresented; publicly-accessible permeability measurements are available for approximately 5% of the fields included in the MRCI oil and gas fields' database. Detailed mineralogical data, which can help to identify subtle lithologic changes and characterize preferential flow pathways, are even more uncommon. To help increase data density in the legacy oil fields of West Virginia, newly acquired continuous cores from the Devonian Gordon sandstone in the Jacksonburg-Stringtown Oil Field are being analyzed using X-ray Fluorescence (XRF) and a permeameter to obtain closely-spaced composition measurements and permeability. Resulting work will improve characterization of heterogeneous reservoirs and allow stakeholders of various backgrounds to evaluate future opportunities in the Jacksonburg-Stringtown Oil Field.



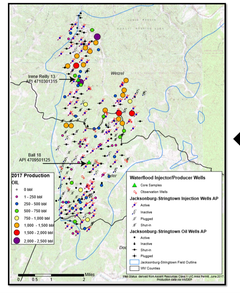
Locations of the sediment cores presented below in Tyler and Wetzel counties.



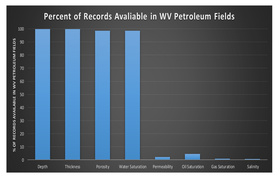
Gross thickness map (10-ft contour) of the Gordon sandstone in the Jackson-burg-Stringtown Field, in Wetzel, Tyler, and Doddridge counties (modified from Moore et al., 2013).



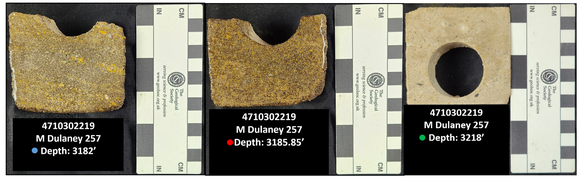
Waterflood wells in the Jacksonburg-Stringtown Field. (Gupta et al., 2020).

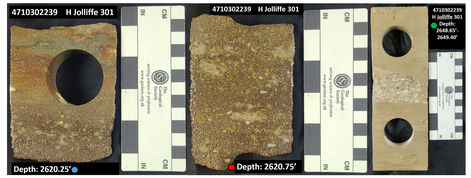


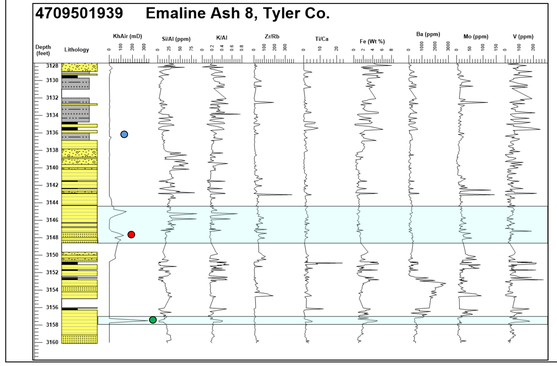
Status of wells associated with waterflood operations in the Jacksonburg-Stringtown Field (Gupta et al., 2020). Highlights the heterogeneity of the field.

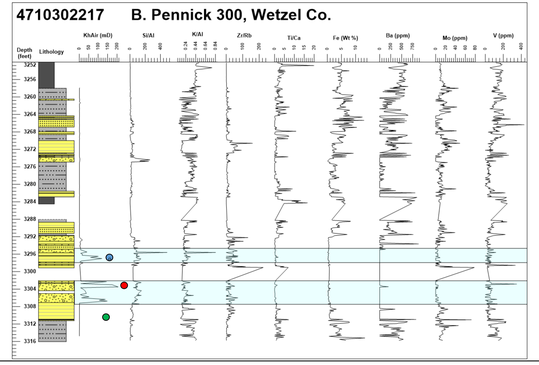


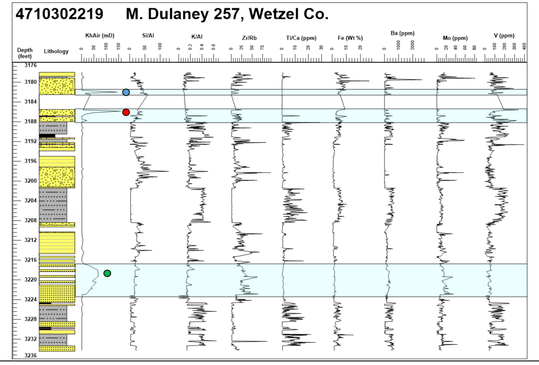
The percent of data available for WV oil fields. Out of the approximately 5% of the fields included in the MRCSP oil and gas fields' database 2% of that data is from WV alone. Adapted from Lewis et al., 2019

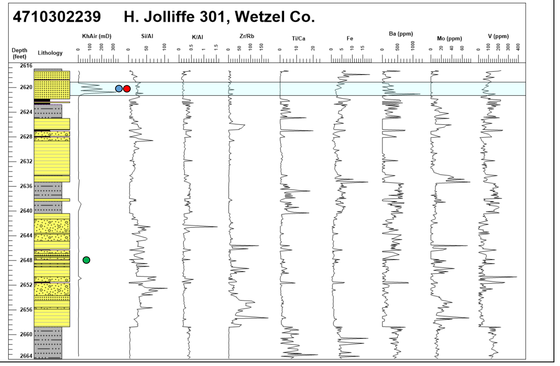












Discussion

To increase data density in the legacy oil fields of West Virginia, 4 cores from the Devonian Gordon sandstone were analyzed using a XRF to create high resolution elemental profiles, a permeameter to get localized permeability measurements, and detailed stratigraphic columns made to expand lithological descriptions. XRF can be used in defining stratigraphic/depositional sequences. The usefulness of elemental proxies that have a range in specific settings, like degrees of bioturbation and grain size (Al, Ti, Mo, V, Si/Al), can help define depositional dynamics related to redox conditions all the way to sediment sources. Elemental profiles for Fe, Ba, Mo, and V are presented for trace element fluctuations. Proxies used were Si/Al, K/Al, Zr/Rb, and Ti/Ca for detrital influxes and grain size characterization.

The Jacksonburg-Stringtown Field was first discovered in 1895 and has already had 2 phases of production. Secondary recovery pilot waterfloods began in early 1980's while full scale waterfloods began in 1990 and is ongoing. With the Jacksonburg-Stringtown Field being rated high for depth, pressure, size, and matrix porosity it is a favorable EOR target for tertiary recovery. This data will improve the characterization of heterogeneous reservoirs and allow stakeholders to evaluate future opportunities for tertiary recovery.

Lithology Legend

- Conglomeratic Sandstone
- Featureless Sandstone
- Hetrolithic Bioturbated
- Laminated Sandstone
- Missing
- Shale
- High Permeability (> 50 mD)

Methods

Permeameter

Permeability measurements were taken by author using a CoreLab™ PPP_250 Portable Probe minipermeameter. The experimental permeability was determined by the unsteady state method of Honarpour and Mahmood (1988) where pressure decay was measured as a function of time to compute Kgas.

Injected gas used was air at ambient temperatures and initial pressures of 28-35 psi. Measurements include observations of core (fossils, fractures, matrix), depths, and horizontal permeability values. The process involved spacing measurements to every half foot, averaging 3 measurements at each spot, and recording observations and measurements into an Excel spreadsheet.

XRF

Semiquantitative X-ray fluorescence (XRF) spectroscopy was used to determine bulk elemental concentrations. Measurements were taken by author every tenth of a foot or at lithological changes using a Bruker TRACER 5i pXRF spectrometer equipped with a SDD graphene window detector and Rh X-ray tube. Measurements were analyzed at 90/180 second phase intervals with air under an 8mm spot window.

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