Ground Based Hyperspectral Imaging and Geochemical Analysis of the Woodford Shale Oklahoma

Ekenem Adigwe
University of Houston

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Abstract

In this study, we used ground-based hyperspectral remote sensing to image the Upper, Middle and Lower Members of the Woodford Shale in the Arkoma and Ardmore Basins of Oklahoma. In order to distinguish between the three different members, we imaged outcrops and drill core samples for their clay, kerogen and carbonate contents. We applied the spectral angle mapper and support vector machine classification methods on hyperspectral data to generate mineral maps of the Woodford Shale within the Poe well and in outcrop. We calibrated the hyperspectral data with total organic carbon data. Our hyperspectral imagery analyses confirm the previously reported mineralogical composition of the Woodford Shale: It is mostly composed of the clay mineral illite, with smaller concentrations of dolomite, very little calcite and jarosite, an alteration product of pyrite. Kerogen was detected in areas that coincided with high total organic carbon concentrations. Hyperspectral image analysis also enabled us to differentiate between the relatively clay-poor Upper and Middle Members and the clay-rich Lower Woodford Member. This makes both the Upper Woodford and Middle Woodford intervals good candidates for hydraulic fracturing. The Lower Woodford interval, however, would be the least likely candidate for hydraulic fracturing due to its ductile nature. Compared to the traditional methods of analysis (e.g., x-ray diffraction), hyperspectral imaging offers a non-invasive and faster method for determining mineralogical and kerogen content in hydrocarbon-bearing rocks, thus reducing turnaround time in hydrocarbon exploration and exploitation.