

## **Applicability of Micro-FTIR in Detecting Shale Heterogeneity**

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### **ABSTRACT**

Samples of Late Devonian/Early Mississippian New Albany Shale from the Illinois Basin, having maturities ranging from early-mature to post-mature (vitrinite reflectance 0.55 to 1.41%) and variable organic matter content (TOC 4.3 to 15.8%), were analyzed with micro-FTIR spectroscopy, ImageJ processing software, and scanning electron microscopic x-ray spectroscopy to explore the distribution, connectivity, and chemical composition of organic matter, clay minerals, carbonates, and quartz, and to further test the applicability of micro-FTIR mapping to study shale heterogeneity. Each sample was analyzed in planes parallel and perpendicular to the bedding in order to investigate anisotropy in component distribution, with a possible implication for better understanding anisotropy in porosity and permeability in organic matter-rich shales. Our results show that for low maturity samples organic matter is better connected in the plane parallel to the bedding than in the plane perpendicular to the bedding. Organic matter connectivity decreases with increasing maturity, as a result of kerogen transformation, but increases again in the post mature stage. Clay minerals are very well connected in both planes, whereas carbonates are not abundant and dominantly isolated in most samples, independent of maturity. This study demonstrates that micro-FTIR mapping is a valuable tool to study shale heterogeneity on a micrometer to millimeter scale, and becomes even more powerful in combination with SEM technique that extends observations to a nanometer scale. However, in order to obtain meaningful and comparable results, micro-FTIR mapping requires very careful standardization, precise selection of peak heights/areas, and mapping conditions (such as aperture size, scan numbers, resolution, etc.) well suited for the analyzed samples.