Quantitative Facies Characterization of Mississippian Limestone Outcrop Using Ground-Based Hyperspectral and LiDAR Imaging in Jane, Missouri

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Abstract

Ground-based hyperspectral imaging is useful for geological mapping because of its high spectral and spatial resolutions at a millimeter to centimeter scale. This study used hyperspectral and Terrestrial Laser Scanner (TLS) data collected in close range to a roadcut near Jane, Missouri that contains a sub-vertical outcrop of Lower Mississippian limestone. The outcrop is comprised of Compton, Northview, and Pierson formations, which were evaluated for facies heterogeneity. The sequence near Jane, Missouri was deposited in shelf margin with high-frequency sea-level fluctuations. These fluctuations introduced lithological and geometrical heterogeneity to the facies, and debris flows brought in carbonate mounds that are referred to as outrunner blocks. These are important to accurately interpret because of their equivocal depositional origin, which is highly debated in the previous literature. This study combined hyperspectral data with TLS for an integrated spatial analysis of geometrical and compositional variations in facies by accurate point cloud-registered mineralogical mapping. Several carbonate facies were mapped based on spectral signatures of calcite, silt, and clay particles. Pure limestone outrunner blocks were distinguished from surrounding mud-prone limestone facies with various proportions of silt and clay (total of ~60%). A lithostratigraphic framework was built by tracing the classified facies from combined hyperspectral and TLS imagery. The framework shows rapid changes in lithology and the presence of shale baffles that vary the character of the Compton

through Pierson interval and contribute to heterogeneity in this outcrop. The data suggests lower energy depositional environment and supports the hypothesis of transported outrunner blocks in a distally steepened ramp system. The information presented in this study could help explain reservoir heterogeneity in equivalent carbonate fields.