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Utility of Ground-penetrating Radar in Near-surface, High-resolution Imaging of Lansing-Kansas City (Pennsylvanian) Limestone Reservoir Analogs

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ABSTRACT

High-resolution ground-penetrating radar (GPR) is a subsurface imaging tool that can extend results gained from studies of reservoir-analog outcrops and add detailed information about reservoir analogs that is unavailable from either seismic data or well control alone. Integration of GPR-reflection information and outcrop photomosaics allowed detailed study of subtle changes in lithology and bedding surfaces by comparing lateral and vertical changes in GPR-reflection character with outcrop features. Outcrops are valuable for confirming interpretations of reflections and providing velocity information for the GPR data. Outcrops of two Lansing-Kansas City Group limestone units, the Captain Creek Limestone and the Plattsburg Limestone, were used as test sites to determine the vertical imaging resolution, penetration depth, and reflection character of high-frequency (500 MHz) GPR in interbedded carbonate and shale units, where the carbonate units contained thin interbeds of shale. Features as small as 0.1-0.2 m (0.3-0.7 ft)--including major architectural elements (such as major and minor bounding surfaces) and internal features (such as fractures, internal bedding, and crossbedding)--were successfully imaged and confirmed by outcrop data. Variations in GPR-reflection character between geologic units allowed recognition of argillaceous limestone units in the subsurface. Although shale and soil at the surface generally impeded GPR signal penetration, thin shale layers and shale at bounding surfaces actually enhanced reflectivity and aided in interpretation. Our results indicate that GPR can be successfully used as an aid in outcrop studies to provide quantitative data for use in reservoir modeling.

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