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Carbonate Digital Outcrop Modeling

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Reservoir characterization, just like the heterogeneity it attempts to describe and model, needs to be three-dimensional in nature. Most recent attempts to provide an understanding of the styles and scales of reservoir heterogeneity have focused on detailed 2D “windows” of well-exposed outcrops to provide important documentation of the scales at which permeability and rock fabrics vary within a stratigraphic framework. High-speed laser-scanning (lidar) and other technology now permit an extension of this capability so that outcrop studies can provide knowledge of the entire “room” rather than just the window. This 3D analog mapping provides a much closer fit to today’s highly 3D subsurface modeling environment and ensures greater relevance of these critical data types. Three outcrop models were constructed using various technologies including lidar, ground penetrating radar (GPR), and real time kinematic global positioning systems (RTK GPS). The first was from Victorio Canyon, west Texas, an Early-Permian icehouse lower slope-basin floor exposure where we display information from facies modeling and seismic forward modeling. The second outcrop is near Pipe Creek, central Texas and highlights Middle-Cretaceous greenhouse to ramp-crest caprinid rudist shoal complexes using outcrop, core, GPR and RTK GPS data as well as mathematical modeling of buildup geometries in 3D. Finally, Dry and Yucca Canyons in southern New Mexico offers Late Pennsylvanian icehouse mixed siliciclastic-carbonate shelf margin buildups and shelf-top strata in three dimensions. The models being constructed with this technology stress the integration of multiple data types to produce examples that compare closely to those of reservoir settings.