AAPG Annual Convention
Salt Lake City, Utah
May 11-14, 2003

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3-D Modeling of Deepwater Carbonate Outcrops Using Laser Technology (Lidar)

Outcrop studies have made major contributions to the understanding of high-resolution stratigraphy of reservoirs by providing realistic images of stratigraphic architecture and petrophysical variability. To date, construction of 3-D models from outcrops has been limited by outcrop character and the ability to capture scaled images of the outcrop that can be interpreted in 3-D space in a manner similar to 2-D or 3-D seismic data. New laser imaging technology developed for the architectural/civil engineering profession now presents the opportunity for construction of high-resolution 3-D models with a high degree of spatial integrity.

An example of 3-D outcrop modeling using lidar technology is taken from Permian slope and basin-floor carbonates that are analogs for submarine channel complexes from the eastern shelf of the Midland Basin. An intricate arrangement of distal toe-of-slope slump complexes and channelized and unconfined debris flows composes the nonreservoir. Slumps and debris flows are mud-dominated, tight fabrics that compartmentalize the reservoir intervals. Debris-filled channels have remarkable aspect ratios of 1:1 or 2:1 with near-vertical walls forming lateral flow barriers. Reservoir intervals are point-fed basin-floor fans and line-fed slope apron turbidites that are grain-dominated packstone and grainstone fabrics having good reservoir properties.

The resultant model preserves the spectacular spatial resolution of the outcrop to 10-cm point spacing with subcentimeter accuracy while allowing gridding and upscaling to occur as would be practiced on standard subsurface models. The ability to make direct comparisons of reservoirs and analog data within a common environment greatly increases the impact of the outcrop information.

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