Characterization of lateral petrophysical heterogeneity within Paleozoic dolomite reservoir facies using outcrop analogs

Colette B. Hirstius
University of Colorad, Department of Geological Sciences
Boulder, Colorado
cbhirstius@yahoo.com

Different scales of lateral petrophysical variability are observed within rock fabric facies of dolomitized shallow-water carbonates. To properly characterize and model the spatial variability of petrophysical properties effecting fluid flow and storage within dolomites, an accurate quantitative description of small-scale lateral variability within the different dolomite rock fabrics is essential. Outcrop analogs of subsurface dolomite formations are used to provide the critical information to address the issue of lateral variability within dolomites not available from typical subsurface data. Porosity and permeability measurements were acquired for 1250 samples from Mississippian-age dolomite units (Madison Formation) exposed at Sheep Mountain, Wyoming.

Four lateral transects, 14 to 165 meters, and twelve vertical transects, averaging 5 meters, were obtained within dolomitized lower and upper shoreface facies. Variography on the lateral traverses show three distinct scales of lateral petrophysical variability, including a significant hole-effect. Short-range lateral variability is reflected by short correlation distances of 2 to 5.5 meters and can be modeled using a spherical model. The nugget effect is generally high and accounts for approximately 50% of the variance. A distinct cyclicity is present on the lateral experimental variograms with periodicities of 16 to 50 meters. The periodicities can be modeled using hole-effect variograms. Petrographic analyses, including point-counting pore type, show distinct lateral changes in percentage of intercrystalline to moldic porosity.

Stochastic 2-D cross-sectional models explore the effects of these heterogeneities on fluid flow. Streamline simulations using different petrophysical models demonstrate the relative effect of the different scales of variability on flow behavior.