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

James W. Castle[1], Fred J. Molz[1], Cynthia L. Dinwiddie[2], Silong Lu[3], Ronald W. Falta[1], Scott E. Brame[1]
(1) Clemson University, Clemson, SC (2) Southwest Research Institute, San Antonio, TX (3) Geotrans, Inc, Roswell, NM

Application of the Fractal/Facies Concept to Predicting Sedimentologically Controlled Permeability Variation for Reservoir Modeling

Using a newly designed drillhole minipermeameter, outcrop permeability data were collected from two facies within the Upper Cretaceous Straight Cliffs Formation near Escalante, Utah. Approximately 500 permeability measurements were made in triplicate at a 15-cm sample spacing in lower shoreface bioturbated sandstone and upper shoreface cross-bedded sandstone. These data demonstrate facies-dependent variations in permeability and scale, which are caused by lithologic characteristics related to the depositional processes. Permeability of the cross-bedded sandstone varies greatly over the scale of a few cm. In contrast, permeability of the bioturbated sandstone shows relatively little variability because of homogenization by burrowing.

Incorporating sedimentological observations from our outcrop study, analytical property distribution methods using fractals were conditioned to the permeability data for characterizing heterogeneity. This analysis shows that the permeability data display the property of "scaling" in fractal theory, and that Gaussian stochastic fractal structure is present within each facies. The results support an approach for representing natural heterogeneity that is called the fractal/facies concept. This concept, combined with 3-D geological models of the stratigraphic architecture, has been applied to understanding the petrophysical structure of the Temblor Formation at West Coalinga oil field, California. The resulting heterogeneity models are being used to numerically simulate oil recovery in the field by steam injection.

The significance of the fractal/facies concept is that it is a Gaussian-based theory that recognizes the fundamental importance of facies concepts in modeling natural heterogeneity. This approach offers an alternative to using variograms for generating realizations of subsurface properties.