

## **SUBSURFACE APPLICATIONS OF SCALING MODELS: EXPERIENCES AND CHALLENGES**

Scott Painter  
Center for Nuclear Waste Regulatory Analyses, Southwest Research Institute,  
spainter@swri.edu

Spatial heterogeneity has a profound effect on a number of subsurface processes with important economic and social implications. For example, petroleum exploration and extraction, certain types of mining activities, and groundwater utilization and protection are all influenced in a fundamental way by subsurface heterogeneity. Contemporary approaches to modeling these activities rely in part on stochastic methods to incorporate the effects of unobserved heterogeneities. Unfortunately, spatial variations in subsurface properties are complex, and often do not conform to classical stochastic models based on Gaussian random fields with short correlation range. A number of studies have shown fractal scaling models - and related models with long-range spatial dependence - to be more realistic models for many subsurface formations. Most of these studies were concerned with model validation only; relatively few large-scale applications using fractal scaling models have been attempted. This talk summarizes experience with scaling models in subsurface applications, with emphasis on the general requirements and challenges for successful industrial applications. A successful integrated study of a large Alaskan petroleum reservoir will form the basis for the discussion, but other examples involving petroleum engineering and geological disposal of high-level nuclear waste will also be discussed. Issues arising in applications include the following: difficulty in modeling permeability extremes that control subsurface flow and transport, need for multivariate models and simulation algorithms, need to honor available measurements in simulations, challenges in merging fractal simulations with reservoir performance and seismic data, and constraints on algorithms imposed by non-uniform simulation grids.