**Upscaling & Complexity in Modeling Hierarchical Subsurface Reservoirs**

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**Abstract:**

Geologic modeling and fluid flow simulation are routine tools used to evaluate a variety of fluid flow and transport processes in the subsurface. However, significant uncertainty exists in building and simulating subsurface models. First, natural porous rocks are heterogeneous at multiple scales. But, due to data scarcity and computation limit, models are often constructed without representing smaller scale variability. Second, subsurface heterogeneity is often organized within a hierarchy. Given the type and availability of site characterization data, multiple geologic models can be built at different complexities, while higher cost can be incurred by greater complexity in these models. Thus, given a suite of prediction objectives, what kind of model should be built, and at what complexity? This talk will summarize research projects we’ve carried out to address the above questions. Novel permeability upscaling methods are developed so that simple models can capture bulk flow and transport behaviors arising out of the underlying (unresolved) heterogeneity. To evaluate model complexity, increasingly detailed hierarchical models are developed and are compared within the full parameter space using computationally efficient statistical techniques. This talk will summarize the insights gained and if time allows, ongoing research will be discussed as well.