

# **Multi-scale Laboratory Experimentation for Process Understanding and Upscaling for Field Problem Solution**

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## **ABSTRACT:**

Along with all of the significant theoretical and computational advances made in the last several decades, laboratory experiments designed to observe phenomena for better insight, accurate data generation, and hypothesis development are critically important to make scientific and engineering advances to address some of the emerging problems in hydrology and the environment. Porous media science issues that are central to these problems and the role laboratory experimentation can play will be addressed. Improved understanding of fundamental flow, transport, reactive, and biological processes that occur at the pore-scale and their manifestation at different modeling and observational scales will continue to advance the subsurface science. Challenges come from the need to integrate porous media with biogeochemical and atmospheric systems, requiring observing and quantifying complex phenomena across interfaces at different scales of interest (e.g., fluid/fluid in pores to land/atmospheric in the field). How carefully designed and theory driven experiments can play a central role in providing answers to critical scientific questions and how they will help to fill knowledge gaps will be presented. Focusing on the subsurface, the need to keep observing through controlled laboratory experimentation in various test scales and how the resulting insights will complement modeling and field investigations are highlighted.