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Abstract

The accurate characterization and remediation of contaminated subsurface environments requires the detailed knowledge of subsurface structures and flow paths. Enormous resources are invested in scoping and characterizing sites using core sampling, 3-D geophysical surveys, well tests, etc. Unfortunately, much of the information acquired is lost to compromises and simplifications made in constructing numerical grids for the simulators used to predict flow and transport from the contaminated area to the accessible environment. In rocks and soils, the bulk geophysical and transport properties of the matrix and of fracture systems are determined by the juxtaposition of geometric features at many length scales.

In the interest of computational efficiency, recognized heterogeneities are simplified, averaged out, or entirely ignored in spite of recent studies that recognize that: (1) Structural and lithologic heterogeneities exist on all scales in rocks. (2) Small heterogeneities influence, and can control the physical and chemical properties of rocks. In this work we propose a physically based approach for the description and treatment of heterogeneities, that highlights the use of laboratory equipment designed to measure the effect on physical properties of fine scale heterogeneities observed in rocks and soils. We then discuss the development of an integration methodology that uses these measurements to develop and upscale flow and transport models.

Predictive simulations are 'calibrated' to the measured heterogeneity data, and subsequently upscaled in a way that is consistent with the transport physics and the efficient use of environmental geophysics. This methodology provides a more accurate interpretation and representation of the subsurface for both environmental engineering and remediation.

We show through examples, (i) the important influence of even subtle heterogeneity in the interpreting of geophysical data, and (ii) how physically based upscaling can lead to a different and more accurate description of a heterogeneous system, when compared to a more traditional upscaling approach that combines averaging and the application of core-based models. This may be of particular significance in bio-remediation studies where the link between microorganism activity and mesoscale flow through geologic structures, resides in the integration of multiscale processes.

Contact NER for more information.