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Combining Deterministic structures and stochastic heterogeneity for transport modeling

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Contaminant transport in highly heterogeneous aquifers is extremely challenging and subject of current scientific debate. Tracer plumes often show non-symmetric but highly skewed plume shapes. Predicting such transport behavior using the classical advection-dispersion-equation (ADE) in combination with a stochastic description of aquifer properties requires a dense measurement network. This is in contrast to the available information for most aquifers.

A new conceptual aquifer structure model is presented which combines large-scale deterministic information and the stochastic approach for incorporating sub-scale heterogeneity. The conceptual model is designed to allow for a goal-oriented, site specific transport analysis making use of as few data as possible. Thereby the basic idea is to reproduce highly skewed tracer plumes in heterogeneous media by incorporating deterministic contrasts and effects of connectivity instead of using unimodal heterogeneous models with high variances.

The conceptual model consists of deterministic blocks of mean hydraulic conductivity which might be measured by pumping tests indicating values differing in orders of magnitudes. A sub-scale heterogeneity is introduced within every block. This heterogeneity can be modeled as bimodal or log-normal distributed. The impact of input parameters, structure and conductivity contrasts is investigated in a systematic manor. Furthermore, some first successful implementation of the model was achieved for the well known MADE site.