Modeling effective fractures in a well-characterized intact core

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An intact core (1.5 m long, 0.45 m diameter) was collected from a fractured sedimentary rock on the Oak Ridge Reservation. A series of tracer experiments were conducted in the core, then the core was characterized on a detailed scale to evaluate fracture and matrix characteristics. Specifically, over 4000 measurements of fracture spacing were made in cross sections at 0.5 cm intervals along the length of the column. The average spacing was between 0.5. Aperture and matrix porosity were also measured for a smaller number of points. The average aperture was 0.02 cm. The matrix porosity averaged about 0.40.

The average measured parameters were used in a 1D fracture flow and transport model (CRAFLUSH) to try to reproduce the observed tracer breakthrough. The average parameters produced a modeled breakthrough that was smoother and broader than observed. Model parameters calibrated to the tracer breakthrough are a fracture spacing of 1.5 cm, an aperture of 0.16 cm, and a matrix porosity of 0.25. These results suggest that the effective fractures in the column are more widely spaced and have a larger aperture. A 2D fracture flow and transport code is being used to model a more complete set of fractures with variable aperture to show how aperture variation can create a small subset of effective fractures.

Detailed characterization of heterogeneity must be accompanied by a measure of which features are hydrologically important. The modeling of the tracer experiments provided the comparison in this study. The modeled fracture spacing suggests that one third of the fractures are hydrologically connected. In other words, a smaller number of large fractures controls the transport rather than the whole population of fractures.

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