Strategy of the Fracture Network Characterization for Groundwater Modeling

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The characterization strategy of fracture networks are classified into a deterministic or statistical characterization according to the type of required information. A deterministic characterization is most efficient for a sparsely fractured system, while the statistics are sufficient for densely fractured rock. In this study, the ensemble mean and variability of the effective connectivity is systematically analyzed with various density values for different network structures of a power law size distribution. The results of high resolution Monte Carlo analyses show that statistical characteristics can be a necessary information to determine the transport properties of a fracture system when fracture density is greater than a percolation threshold. When the percolation probability (Π) approaches unity with increasing fracture density, the effective connectivity of the network can be safely estimated using statistics only (sufficient condition). It is inferred from conditional simulations that deterministic information for main pathways can reduce the uncertainty in estimation of system properties when the network becomes denser. Overall results imply that most pathways need to be identified when $\Pi < 0.5$ statistics are sufficient when $\Pi \to 1$ and statistics are necessary and the identification of main pathways can significantly reduce the uncertainty in estimation of transport properties when $0.5 < \Pi << 1$. It is suggested that the proper estimation of the percolation probability of a fracture network is a prerequisite for an appropriate conceptualization and further characterization.