Geophysical Research Abstracts
Vol. 21, EGU2019-10451, 2019
EGU General Assembly 2019

The Use of Constant Head Tests for Determining Fracture Transmissivities in Sparsely Fractured Rock

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Flow and transport in bedrock settings is typically governed by the presence of fractures, which allow for the rapid migration of contaminants through convoluted pathways. The successful application of numerical models based on discrete fracture formulations in the prediction of transport relies on accurate estimates of fracture transmissivity. A commonly used method for the measurement of fracture transmissivity is constant head testing using straddle-packer systems. These tests, however, measure a bulk transmissivity for the entire section tested, which is often >2m in length due to the difficulty and cost associated with smaller measurement scales. As a single 2m section will often include several fractures, it is frequently unclear how the bulk transmissivity relates to that of individual fractures. As a further complication, it has been recognized that only a small percentage of fractures are likely to govern transport. Thus, evenly dividing up the measured transmissivity in an interval among the observed fractures is likely not appropriate. The primary goal of this study is to determine how constant head tests at a 2m scale can be used to create a discrete fracture network (DFN) that accurately describes flow and transport. To do this, core logs and transmissivity measurements from constant head tests at 0.1 and 0.5m intervals, which were conducted in a Silurian-aged dolostone in Southern Ontario, Canada, were first used to generate a DFN most likely to be representative of the natural setting. Using this, transport of a conservative tracer was simulated to a distance of 50m. The results indicate that transport at this site is controlled by less than 20% of the observed fractures. These predictions are then compared to predictions from DFNs produced using 2m constant head tests and various methods of determining individual fracture transmissivities from a bulk value. Based on the comparison we seek to establish a method for proportioning larger scale test results to obtain a representative DFN at a site.