Geophysical Research Abstracts
Vol. 15, EGU2013-12954-1, 2013
EGU General Assembly 2013

The value of inclined coreholes for characterizing the geometry of 3-D fracture networks in bedrock aquifers

Jonathan Munn (1) and Beth Parker (2)

(1) G360 - Centre for Applied Groundwater Research, University of Guelph, Guelph, Canada (jmunn@uoguelph.ca), (2) G360 - Centre for Applied Groundwater Research, University of Guelph, Guelph, Canada (jmunn@uoguelph.ca)

In bedrock aquifers where matrix permeability is low, the nature and distribution of the fracture network has a strong impact on the transport and fate of contaminants. Accurate fracture characterization is therefore essential to fully understand the flow system and to predict contaminant migration. Powerful DFN models exist, yet the limitation is often on obtaining field data of sufficient quality to use as input parameters. One major contributing factor is the common practice of using only vertical coreholes to characterize bedrock aquifers. This can lead to datasets that are significantly biased toward fractures perpendicular to the corehole and are therefore not well suited for three-dimensional (3-D) fracture geometry characterization. This bias is particularly pronounced in flat-lying sedimentary strata where fracture networks are typically comprised of flat-lying bedding parallel fractures and vertical, or near vertical joints.

An examination of such bias was conducted at a contaminated site in Guelph, Ontario, Canada, in a Silurian dolostone aquifer. Three inclined coreholes plunging 60 degrees with varying azimuths were drilled between 2010 and 2012 to supplement existing data from eleven vertical coreholes from previous investigations. Depth discrete datasets were collected in the coreholes including lithological and fracture logs from rock core, downhole geophysical surveys (e.g, acoustic televiewer, formation conductivity, temperature, natural gamma), and hydraulic testing including the first use of flexible liner profiling in inclined coreholes. These datasets were integrated to provide estimates of fracture frequency, orientation and aperture distributions and to estimate values of bulk effective fracture porosity. Orientation analysis revealed three dominant fracture sets on site that vary in intensity through mechanical layers. These sets consist of a horizontal, bedding-plane set with an average spacing of 0.3m, and two high-angle sets, NE-SW and WNW-ESE striking, with average spacings of 1.5m and 2.1m, respectively. When data from only the vertical coreholes are used for the analysis, only two fracture sets are identifiable: a bedding plane set and a high-angle E-W set, confirming the necessity of inclined coreholes for complete fracture orientation analysis. Hydraulic fracture apertures were estimated using the cubic law and range from 15 to 407 μm with a geometric mean of 125 μm.

The fracture network properties will ultimately be used as input parameters for static and dynamic discrete fracture network models to assess current and future risks to nearby municipal supply wells. The study shows that inclined coreholes of varying orientation can help minimize sampling bias, and thereby provide a more representative sample of the fracture network.