Demonstration and Validation of the Fracture Rock Passive Flux Meter

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Complex hydrogeologic conditions such as fractured and karst bedrock settings pose substantial economic and technical challenges both to the characterization and remediation of DNAPL source zones. The objective of this project is to demonstrate and validate the fractured rock passive flux meter (FRPFM) as new technology for measuring the magnitudes and directions of cumulative water and contaminant fluxes in fractured rock aquifers. The sensor consists of an inflatable core that compresses a reactive fabric against the wall of a borehole and to any water-filled fractures intersected by a borehole. The reactive fabric is designed to intercept and retain target groundwater contaminants (e.g. TCE, DCE, VC); in addition, the fabric releases non-toxic tracers, some of which visibly indicate active fracture location, aperture, orientation, and direction of fracture flow along a borehole, while others quantify cumulative groundwater discharge within the fractures.

Demonstration and validation studies are in progress comparing multiple competing technologies (including fractured rock passive flux meters, hydrophysical logging, scanning colloidal borescope, and borehole dilution tests). The technologies are being evaluated based upon their ability to: identify flowing fractures, determine flow direction, and quantify both water and contaminant mass flux in flowing fractures. Recently completed laboratory studies test the capabilities of each technology in two separate flow simulators: a planar single fracture simulator (performed multiple tests for varying duration; fracture aperture = 0.5 mm; specific discharge range 25 – 2500 cm/day) and a large-scale three-dimensional aquifer box with layered high contrast flow zones (physical flow domain 2 m length, 0.5 m width, and 1 m height; alternating layers of low permeability sand separated by high permeability gravel; specific discharge range 25 to 4000 cm/day (per layer)). Demonstration objectives include assessing the performance of competing technologies under controlled conditions and developing a standard operating procedure for using these technologies to accurately characterize both flow and contaminant flux in fractured rock systems. Field demonstration tests have recently started at a site in Guelph, Ontario and will be performed at the Former Naval Air Warfare Center (NAWC), West Trenton, NJ.