Reimagining Bedrock Conceptual Models with Simplifying Assumptions, Spreadsheets, and Visualization Tools: An Approachable Method for Qualitative Evaluation of Fate and Transport

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Background/Objectives. Frequently overwhelming in complexity, fractured bedrock systems present a unique challenge: How to evaluate the data in such a way as to allow for understanding, without the data output becoming so abstract and generalized that it loses much of its contextual meaning. Since groundwater transport is predominately controlled by secondary porosity (fractures) in bedrock systems it is critical to successful characterization and subsequent remediation efforts that the overall flow regime be understood simultaneously in both a general and specific capacity. Since high resolution surficial and down-hole assessment technologies now allow us an unparalleled accounting of fractures in the subsurface, site-wide assessment can often identify hundreds to tens of thousands of individual, potentially water bearing fractures. Through the use of graphic tools, simplifying assumptions, spreadsheets, and modern visualization a conceptual model for fractured bedrock subsurface flow can be developed which enables successful identification of controlling fracture pathways and establishes a means to evaluate those pathways for delineation and remedial purposes.

Approach/Activities. This approach has been utilized at two sites, where dissolved phase chlorinated solvents were present in bedrock, to generate advanced conceptual models of flow and to develop a qualitative and visual framework from which decisions can be made relating to characterization and remedial needs. Specifically, the approach involves sorting fracture data based upon water bearing potential, then grouping the fracture orientation data graphically to determine a predominant and secondary orientation as well as open area, concentrations of constituents of concern, and flow data for each group. In this way, a set of hundreds of fractures can be grouped into tens. Following the initial grouping a color coded cross-sectional spreadsheet is developed which graphically and numerically depicts the individual characteristics of each fracture group. As the dataset is compiled, in cross-section, patterns begin to emerge allowing for the qualitative assessment of features controlling fate and transport, through comparative analysis of like-traits between fracture groups. This allows for another level of visual simplification whereby controlling fracture groups are selected from the cross-sectional data set. Those intervals selected as controlling features are then graphically input into 3-D modeling software to allow for three dimensional projection of those controlling features.

Results/Lessons Learned. By utilizing these methods a seemingly large and relatively inaccessible fractured rock dataset can be evaluated to determine controlling features which are then used for graphical projections. This process, maintains the integrity of the underlying data while simplifying the depiction of complex datasets. A model developed in this way allows for comprehensible discussion with stakeholders, regardless of technical acumen, enabling cost effective decision making for advancing projects while maintaining data integrity.