Geophysical Research Abstracts,
Vol. 10, EGU2008-A-03843, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-03843
EGU General Assembly 2008

Integration of 3D geological and numerical models to investigate fractured geological media

D. Blessent and R. Therrien

Laval University, Québec, Canada

(daniela.blessent.1@ulaval.ca)

A new approach has been developed for hydrogeological modeling in fractured geological media by combining the geological modeling platform GOCAD (Mira Geoscience) and the HydroGeoSphere numerical model (Therrien et al. 2005). The combination of geological and hydrogeological models facilitates and improves fractured media representation and simulation of groundwater flow and mass transport, especially for complex fracture geometries.

As fracture surfaces are built in the geological modeling platform, available spatial field data (hydraulic test responses, borehole core samples observations and geophysical interpretations) can be easily incorporated and used to more realistically represent fractures. For example, borehole intervals with hydrogeological properties different from the average borehole proprieties can be designed as belonging to a fracture structure. These intervals represent fixed points within the rock volume to be modeled. Thus, these points are correlated and are used to define the shape to fractures, which are assumed to have a quasi-planar structure in the 3D space. Within the geological modeling platform, the fracture network is visualized and edited. The 3D computational mesh required by the numerical model is then created with the LaGriT mesh generation software (Los Alamos National Laboratory).

Complex fracture networks contain irregular and intersecting fractures. Their representation with a discretely-fractured conceptual model is a challenging task because each fracture has to be discretized and its intersection with other fractures needs to be represented with a conforming spatial mesh. As a result, nodes and segments belonging to the two intersecting fractures have to match at the intersection line. Fractures are discretized here with 2D triangular finite elements and the rock matrix, which can contribute to flow and transport, is represented with tetrahedra. Thus, a topological relation is required between 2D and 3D finite elements representing, respectively, fractures and porous matrix. The topological relation proposed here is that the faces of tetrahedra lying on fractures coincide with triangles belonging to the 2D fracture surfaces. This guarantees the commonality of nodes between tetrahedral faces and triangles ensuring the continuity of hydraulic head and concentration at the fracture matrix interface.

Illustrative examples show the capabilities of the proposed approach and are used to verify it. These examples prove that the HydroGeoSphere enhanced version is well designed to simulate groundwater flow and solute transport in discrete fractured media with the approach presented here. The approach is validated by comparisons with analytical solutions and with numerical results computed using other type of meshes. This new approach offers several advantages: easy local refinement around fractures, possibility to handle complex fracture network geometries and straightforward method to identify faces of tetrahedra that coincide with fracture elements.