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Identification of main flow structures for highly channeled flow in fractured media by solving the inverse problem

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Fractured aquifers are highly heterogeneous media where flows are often highly channeled in a very restricted numbers of fractures. These scarce flow structures must be identified from indirect measurements like hydraulic heads and integrated transmissivities requiring the solution of an inverse problem. The inverse problem in groundwater hydrology has been mostly handled for porous media. It requires classically the regularization of the flow structure based on a certain homogenization of the parameters and a prior knowledge of the permeability structure. In the case of fractured media, the highly channeled flow structure requires on the contrary localization rather than regularization.

To set up the methodology, we work on synthetic 2D fracture networks. We address the inverse problem in which data are the medium heads and parameters are the characteristics of a very limited number of channels (less than 6). The objective is to identify the main flow channels. Even with these few parameters, the inverse problem remains a computationally intensive task. To find the solutions, we work in three directions: the optimization of the simulated annealing method used for the inversion, the optimization of the flow channel patterns and the definition of a hierarchical inversion methodology consisting of iterative refinements of the flow channels.

The flow channels identification directly depends on the quantity of head data. We analyze the influence of this quantity on the relevant channel resolution. We seek for adapting the model complexity to the data quantity. The presented methods are devel-

oped in order to be subsequently applicable to 3D media and natural cases.

keywords: heterogeneous aquifer ; inverse problem ; parameter estimation ; preferential flow path.