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Solute transport in fractured media - from the laboratory to the groundwater protection zones

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In fractured formations the fluids show channel flow and this makes these media particularly vulnerable to contamination. In order to understand this phenomenon the usual practice is to use numerical modelling. These models simulate transport in two phases: first the solution of a flow problem and then the solution of the transport problem. The output of the first problem is the mean velocity of the flow. These values become the input for the second problem. This approach might result in wrong estimates because the distribution of real velocities (in the channels) can induce flow paths quite distinct from those simulated.

Bearing mind the laboratory evaluation of the limitations of the numerical models, we created an artificial fracture in a block of granite. This fracture was then connected to the upper face of the block by means of several vertical holes. The transport of the solutes was tested with tracer tests. These were meant: (i) to analyse the mechanisms of transport and dispersion of contaminants in fractured media, and (ii) to verify the importance of the direction of flow in the dispersion of contaminants in fractured media.

The results indicated that: (i) it is possible to detect differences in the morphology of the fracture by using non-neutrally buoyant solutes (sodium chloride, for instance); (ii) it is better to estimate the circulation volume of water by using models that neglect dispersion in comparison to advection.

The indications from this work are being applied in a project to define improved strategies for the delineation of groundwater protection zones in fractured media aquifers, and to structure a model for the evaluation of risk in fractured massifs.