Geophysical Research Abstracts
Vol. 18, EGU2016-11172-2, 2016
EGU General Assembly 2016

A cellular automaton model adapted to sandboxes to simulate the transport of solutes

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The increasingly use of groundwater sources for human consumption and the growth of the levels of these hydric sources contamination make imperative to reach a deeper understanding how the contaminants are transported by the water, in particular through a heterogeneous porous medium.

Accordingly, the present research aims to design a model, which simulates the transport of solutes through a heterogeneous porous medium, using cellular automata. Cellular automata (CA) are a class of spatially (pixels) and temporally discrete mathematical systems characterized by local interaction (neighborhoods). The pixel size and the CA neighborhood were determined in order to reproduce accurately the solute behavior (Ilachinski, 2001).

For the design and corresponding validation of the CA model were developed different conservative tracer tests using a sandbox packed heterogeneously with a coarse sand (size # 20 grain diameter 0,85 to 0,6 mm) and clay. We use Uranine and a saline solution with NaCl as a tracer which were measured taking snapshots each 20 seconds. A calibration curve (pixel intensity Vs Concentration) was used to obtain concentration maps.

The sandbox was constructed of acrylic (caliber 0,8 cms) with 70 x 45 x 4 cms of dimensions. The “sandbox” had a grid of 35 transversal holes with a diameter of 4 mm each and an uniform separation from one to another of 10 cms.

To validate the CA-model it was used a metric consisting in rating the number of correctly predicted pixels over the total per image throughout the entire test run. The CA-model shows that calibrations of pixels and neighborhoods allow reaching results over the 60 % of correctly predictions usually. This makes possible to think that the application of the CA- model could be useful in further researches regarding the transport of contaminants in hydrogeology.