Geophysical Research Abstracts
Vol. 14, EGU2012-11949, 2012
EGU General Assembly 2012

Simulate speleogenesis processes with an approach based on fracturing and hydrogeological processes: effect of various hydraulic boundary conditions

A. Lafare (1,2), H. Jourde (2), V. Leonardi (2), S. Pistre (2), and N. Dörfliger (3)

(3) brgm, Water department, Orléans, France (n.dorfliger@brgm.fr), (1) 1Laboratoire Hydrosciences, Maison des Sciences de l'Eau – Case MSE – Place Eugène Bataillon, 34095 Montpellier Cedex 5, France, lafare@msem.univ-montp2.fr, (2) Antoine Lafare

Several numerical modeling approaches attempted to simulate the processes of karst conduit genesis. These existing methods are mainly based on the physical and chemical laws driving the carbonate dissolution processes (taking account of calcite saturation of the water and the partial pressure of carbon dioxide). As a consequence, these works bring a well-documented knowledge on the kinetics of the carbonate dissolution processes in karst systems. Nevertheless, these models are mainly applied on simplified initial void networks, which do not match the fracturing and geological reality. Considering that the initial geometry of the void network (fractures, bedding planes) would have an influence on the final pattern of the speleological network, taking account of it could improve the understanding of speleogenesis.

In the aim to take into account the geometry of the initial void network (fracture networks of several orders), a numerical model is developed, which involves a pseudo-statistic fracturing generator (REZO$_3$D, Jourde 1999, Josnin et al. 2002, Jourde et al. 2002) coupled to a finite element groundwater simulator (GROUNDWATER, F. Cornaton, CHYN, University of Neuchâtel). The principle of the modeling of the genesis of the karst drainage system is based on an analogical empirical polynomial equation considering the pore velocity and the mean age of the water as main parameters. The computation is carried out on the basis of a time step, whose duration depends on the simulated scenario (from 100 to 5000 years). The mean age of the water is used in order to simulate the decrease of the chemical dissolving potential of the water within the aquifer, in contact with the carbonate rock.

The first simulator -REZO$_3$D- allows producing three-dimensional discrete fracture networks constituted by plane fractures, whose spatial distribution respects mechanical and statistical laws. These networks are then processed in order to write finite element meshes which constitute the bases of groundwater flow and transport simulations. The polynomial parameters of the equation are calibrated with former speleogenesis studies (Dreybrodt 1996, Dreybrodt et al. 2005, Palmer 1991).

The presented study involves two orthogonal families of fractures embedded in a carbonate matrix, in a mono-stratum setting. For each simulation, several settings of boundary conditions are tested, in terms of recharge (diffuse or concentrated, hydraulic head or flux limited) and discharge (spatial position, punctual or diffuse). The results are interpreted in terms of head fields, mean groundwater age distributions and total flow rates as a function of time. The aim is to assess the influence of the hydraulic boundary conditions on the finally obtained morphologies of the karstic networks, and on the velocity of the evolution of the drainage system. Results are discussed and perspectives are given on the application of such model to real case studies.