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Using cave data for improving the reliability of karst groundwater flow models

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Rock masses are typically anisotropic and heterogeneous, due to presence of sin-sedimentary discontinuities as bedding planes and of post-depositional features such as joints and faults. When compared to soil mechanics, therefore, a greater complexity of the simulation models for rock masses derives, which is further increased when dealing with carbonate rock masses. Beside the aforementioned types of discontinuities, other features are produced by karst processes; these latter are able to create highly complex networks of voids and conduits, with passages of variable size, which may reach dimensions enterable by man. These features definitely represent the larger discontinuity families within carbonate rock masses, in terms of size, frequency, and pervasiveness, and significantly control the flow of water.

The peculiar characteristics of karst require dedicated approaches to take into the due account the presence of its typical landforms (voids, conduit/caves of variable size, swallow holes, etc.), and their variable functionality as well. Ignoring karst features in the analysis and characterization of carbonate rock masses, any approach followed, or model implemented, will inevitably result in too great uncertainties (if not errors), and in incorrect information to the engineers.

What stated above is true also as regards the study of water flow in fractured carbonate rock masses, that cannot be initiated without considering the stratigraphic and structural discontinuity families. To implement flow models scholars typically start from traditional structural-geological surveys, characterization of rock masses through the classical geomechanical approaches, and elaboration of outcrop pictures elaborated by means of image process softwares. The statistical outcomes are then used as parameters in mathematical models, where also the hydrogeological boundary conditions need to be defined.

A significant step forward in this approach is the use of data directly collected underground, through surveys within the cave systems. The data so collected can be used with a two-fold goal: first, to add a view from the inside of the karst underground landscapes to what is generally observed only at the surface; second, to validate the models, when these are initially implemented only with surface data.

Plan maps of explored cave systems may be useful to determine in first approximation the main direction of development of the karst processes. Reliable maps of caves are nowadays available, that can be used to extract the main direction of karstification, as well as the average size of the

explored karst conduits and passages. All these informations are precious underground-truth data that are definitely worth to be included in hydrogeological models aimed at improving them and their reliability as well.