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Geological modeling and infiltration pattern of a karstic system based upon crossed geophysical methods and image-guided inversion

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Karstic aquifers represent an important part of the water resources worldwide. Though they have been widely studied on many aspects, their geological and hydrogeological modeling is still complex. Geophysical methods can provide useful subsurface information for the characterization and mapping of karstic systems, especially when not accessible by speleology. The site investigated in this study is a sinkhole-spring system, with small diameter conduits that run within a chalk aquifer (Norville, in Upper Normandy, France).

This site was investigated using several geophysical methods: electrical tomography, self-potential, mise-à-la-masse methods, and electromagnetic method (EM34). Coupling those results with boreholes data, a 3D geological model of the hydrogeological basin was established, including tectonic features as well as infiltration structures (sinkhole, covered dolines). The direction of the karstic conduits near the main sinkhole could be established, and the major fault was shown to be a hydraulic barrier. Also the average concentration of dolines on the basin could be estimated, as well as their depth. At last, several hypotheses could be made concerning the location of the main conduit network between the sinkhole and the spring, using previous hydrodynamic study of the site along with geophysical data.

In order to validate the 3D geological model, an image-guided inversion of the apparent resistivity data was used. With this approach it is possible to use geological cross sections to constrain the inversion of apparent resistivity data, preserving both discontinuities and coherences in the inversion of the resistivity data. This method was used on the major fault, enabling to choose one geological interpretation over another (fault block structure near the fault, rather than important folding). The constrained inversion was also applied on covered dolines, to validate the interpretation of their shape and depth.

Key words: Magnetic and electrical methods, karstic system modeling; image-guided inversion