EGU21-489
https://doi.org/10.5194/egusphere-egu21-489
EGU General Assembly 2021

Tectonic control on groundwater flow in a karst polje of southern Italy

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In the last decades, climate changes are affecting the freshwater resources quality and quantity around the globe, reducing their availability. On Earth, glaciers and ice cap occupy 68,7%, but they are not easily usable for human purposes; groundwater stands for 30,1%, while surface waters represent the remaining 1,2%. Therefore, groundwater resource is by far the most important natural tank to be preserved.

In karst, scientists are still working on developing new methods to understand the true groundwater hydrological behavior, due to subsoil anisotropy in both space and time. This requires a deep knowledge about discontinuity systems in the carbonates, and to improve our comprehension of karst processes, as basic elements for modelling.

The possibility to collect data directly from the subsoil, thanks to speleological explorations, is a precious chance for hydrogeology, and in general, for the environmental sciences. In this contribution we take advantage from a variety of speleological data, plus traditional geological surveys, to study groundwater flow in the karst of Apulia. Many karst processes, indeed, affect the Cretaceous limestones belonging to the Apulia carbonate platform, where the deepest cave in the region opens in the Canale di Pirro polje (altitude 300m a.s.l.). This latter is a W-E elongated tectonic-karst valley, representing one of the most significant karst landforms in this sector of Apulia. The cave reaches groundwater at a depth of -260m from the ground surface, whilst additional 60m below the water table have been explored by diving the flooded channels (total depth of the cave 320m).

We deal here with characterization of water flow direction into the fractured and karst aquifer, using a combined approach consisting of analysis of: i) primary and secondary discontinuities, ii) shape, size and orientation of karst conduits, and iii) geometry of the intersections between fractures and karst features.

The discontinuities have been analyzed with classical geological survey at the surface, and a semi-automatic extraction of their statistical properties, using the FracPaQ software. To characterize the water flow into the karst channels, we started from collection of available speleological maps of caves in the study area, in order to assess their main directions of development . From this

analysis, some preliminary links were summarized: on the polje ridges, the prevailing discontinuity systems were well correlated with cave development, and, in turn, with the main regional tectonic directions (respectively, the SW-NE anti-Apennine, and the NW-SE Apennine systems). At the polje bottom, on the other hand, direction of cave segments and discontinuities are about similar, following the Canale di Pirro polje main elongation (W-E).

This first comparison among data from different sources eventually points out that water flows underground following the main structural lineations. These data, together with results of the groundwater flow model, confirm the key role of geo-structural control on karst development, and the possibility of variations at the local scale, as observed at the polje bottom. In karst, the integrated approach of geo-structural discontinuities and karst features and geometry is therefore a fundamental tool to gain insights into the understanding of the main groundwater flow directions.