



## Analysis of the karst drainage system of Cà Freghé Cave (Upper Graveglia Valley karstic area, Ligurian Apennine)

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The upper Graveglia Valley - which is located in the Ligurian Apennine - is well known for its universally recognized geological, geomorphological and mining resources. From a geodiversity perspective the valley is also characterized by karstic phenomena, such as dolines, swallow holes, caves and karstic springs. The upper Graveglia Valley is specifically identified as one of the 39 Ligurian karstic areas.

Karstic landforms develop in the "micritic" limestone (Calcare a Calpionelle auct.), one among the sedimentary covers connected to the ophiolitic sequence of oceanic floor.

The Calcare a Calpionelle auct. formation is made up of white and light grey limestone bedding varying in thickness. The limestone is very fine-grained and compact. The limestone bedding surfaces are separated by thin layers of marly clay or clayey shales.

In the Upper Graveglia Valley these limestones outcrop between cherts and shales with limestones, although the sequence is frequently reversed.

Besides several karstic landforms, both shallow and underground, in the Upper Graveglia Valley a great amount of karstic springs are reported; scientific studies were carried out on some of these springs since the 19th century and are currently used by local waterworks.

Recent researches on karst hydrogeology have allowed to obtain preliminary data on water flows, temperatures and electroconductivity of three major karstic springs: Boregu, Tana della Madonna and Molinello.

This work develops this type of research and regards the Cà Freghé karst aquifer analysis, the most important cave of the Upper Graveglia Valley that has already been studied for over forty years now.

The cave is located at 475 m a.s.l., on the orographic right of the Orti stream, which is characterized by several karst landforms. Between the upper springs at 770 m a.s.l. and the confluence with the Molinello stream, a spring at 725 m, a swallow-hole at 580 m and another at 540 m, a spring at 495 m and another at 490 m, some pools at 435 m and finally one more spring at 425 m can be observed.

Since February 2010 an automatic instrument for monitoring hourly water flow, temperature and electroconductivity has been installed in the cave; this is the first continuous analysing system that has been set up on a Ligurian karst area.

Water samples have been analysed by laboratory tests on a seasonal base. Calcium, magnesium, sodium, potassium and manganese cations, as well as chlorine, sulfates, bicarbonates, nitrates anions have been found. The water mainly results to be of the calcium bicarbonate type.

The karst aquifer data have been correlated with rainfall data recorded at the Reppia weather station, which is located at 546 m a.s.l., in a favourable position for the study area.

The comparison between rainfalls and water flows show a conduit or tube flows drainage system; precipitation peaks of 10-20 mm cause significant water flow changes over an hour.

During the monitoring time the electroconductivity ranged between 130 and 210 microS/cm, with an average of 180 microS/cm, while the water temperature varied between 10,5° and 12 °C, with an average of 11,7 °C. Electroconductivity and temperature show a similar trend, whereas the water flow trend is the opposite, highlighting an external input that causes quick dilution phenomena.

Karst groundwater flow always shows high values, even in dry summer months: this feature suggests an important role of condensation phenomena that supply water to the limestone rock mass.

The water hydrogeological balance shows that the average karst underground waterflow comes from the water seepage in the limestone outcrops along the Orti stream, between 425 and 800 m a.s.l.

The narrow limestone outcrop and the quick drainage into the rock masses suggest that the karst aquifer is extremely vulnerable.