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Experimental techniques for the hydrogeological prospecting of groundwater flow systems in torbiditic units

L. Piccinini, **V. Vincenzi**

Earth's Sciences Department, University of Ferrara, Italy

(pcr@unife.it / vncvnt@unife.it / Fax: +39 0532 206468 / Phone: +39 0532 293718)

In the northern Appenninic chain (Italy) torbiditic units mainly outcrop. They are typically constituted by alternating layers of arenites and pelites, that are locally very jointed due to the intense tectonic activity related to the Appenninic chain's formation.

Due to their lithology these rocks have been considered so far aquitards, but the boring of high speed railway tunnels between Bologna and Firenze has demonstrated the local "aquifer-type" behaviour of the Marnoso-Arenacea formation, a typical torbiditic unit of Lower-Middle Miocene. At the same time the tunnels have locally induced a high impact on both groundwater and surface water flow systems (Bencini A. et al., 2004), as pointed out by the *in-opera* hydrogeological monitoring on 5 watersheds. So, it has been considered the opportunity to study the groundwater flow system of a complex fractured aquifer in a transitory state.

The presented paper deals with the experimental techniques comproved up to now on a test site in the Veccione creek's watershed, crossed and impacted by the Firenzuola tunnel, that's interested by significant water inflows. Firstly, the river flow's continuous monitoring on two sections of the Veccione creek (one upstream and the other downstream from the crossing with the tunnel) has permitted to verify a discharge's decrease. Then, with an hydrogeochemical approach it makes possible to identify the hydrochemical facies involved and to assume an hydraulic connection between creek and tunnel. The major ions' analysis has put in evidence that tunnel's waters are a mixture between shallow "geochemically young" water and deep "mature" waters.

The isotopic analysis (δ^{18}O and δ^{2}H vs VSMOW ‰) have comproved this conceptual model, where tunnel waters stand on the isotopic mixing line that joins the shallow isotopically enriched waters and the deep depleted ones. A first qualitative tracing test with a fluorescent dye (uranine), even though sparely used in fractured aquifer, has proved this transitory flow system induced by tunnel's drilling and the consequent depletion of water resources. Finally, estimating the baseflow and comparing it with the one of a natural flow system of another test site (Gargini & Piccinini, 2004), it's possible to quantify the water resources' depletion.

The integrated use of these approaches is a basic tool for the definition of a reliable hydrogeological conceptual model. This methodology could be improved by the carrying out of quantitative tracing tests, tritium water dating and chemical hydrograph separation through electrical conductivity's continuous monitoring.

References

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