



## **GIS hydrogeological mapping, scale 1:10000, of the Apuan Alps (Tuscany, Italy) karst and fissured groundwater systems.**

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In the Apuan Alps region, carbonatic formations are spread over an area of about 370 km<sup>2</sup>, which makes it the most important carbonate hydrogeological complex of Tuscany (Italy). Due to the complex structural geological setting, (one of the best examples of direct superposition of high-crustal tectonic units over an intensely deformed metamorphic complex; Carmignani et al., 2001) several hydrogeological systems may be defined. Groundwater resources are hosted in the water-bearing formations of the Tuscan metamorphic complex (mainly defined by marbles, dolomitic marbles, and dolomites) and of the Tuscan nappe (constituted by massive, and cherty limestone). The former show a karst and fissured permeability, while the latter a predominant fissured permeability.

In recent years descriptive studies led to a qualitative knowledge of the hydrodynamic regional model of the area (Piccini et al., 1999). However, the lack of a detailed structural geological setting prevented the analysis and the development of a conceptual model for each hydrogeological system. Thus, the main objective of the project was to develop and represent a digital geographic archive, scale 1:10000, of all the known and accessible hydrogeological data and relating features, which would enable a detailed description of each hydrogeological structure and following quantitative studies.

From various regional and local authorities hydrodynamical and hydrodispersive data were collected, validated, georeferenced and then implemented in a dedicated digital geographic database (appropriately developed by means of ESRI® geodatabase; ESRI, 2005). Solid geology data, separated by superficial deposits, were implemented according to the activities of both the Geological Map project of the Regione Toscana

and CARG project (Servizio Geologico d'Italia-APAT) in order to facilitate the geo-structural analysis. Based on field observations, the analysis of drainage network density and the distribution and density of surface karst cavities, geological formations were classified and ranked in term of hydrogeological complexes and of inferred yield. Data regarding hydrological and hydrogeological features (such as hydrographic network, springs, wells, etc.), karst morphology features (cave development, dolines, swallow holes, etc.), investigations (tracer test data, monitoring stations, etc.) and anthropogenic features (quarries, water supply facilities, etc.), and their attributes were gathered and stored in the geodatabase. When possible hydrogeological watersheds were delineated, where possible, based on previous isotopic studies or tracer test experiments.

All the implemented features permit the editing of “dynamic” hydrogeological maps, scale 1:10000, which constitute the basis to perform detailed quantitative studies of each single hydrogeological system and its relationship with adjacent ones. The produced hydrogeological maps also allow for outlining areas where further investigations are required, either to define or to confirm assumptions on the proposed conceptual models.

## **References**

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