

# The role of hydrogeotechnical mapping on the sustainable management of urban groundwater

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Urban aquifers are vitally important but very fragile. Groundwater conditions are of primary significance in the construction and maintenance of subsurface engineering structures. This study presents the results of the structural geology and hydrogeotechnical studies of granitic rock masses. Moreover, hydrogeological methods were used to assess the suitability for use of groundwater from spring galleries in Porto city (NW Portugal, Iberian Peninsula). The underground area was studied using various tools, such as, subsurface geological-hydrogeotechnical mapping, structural geology and geomechanical techniques. Scanline sampling technique of discontinuities has been used for the characterization of the granitic rock mass. Groundwater samples were also collected for hydrogeological studies.

The geological units that outcrop in the surroundings of Paranhos spring galleries include alluvia, saprolite and medium to fine grained granitic rocks. The granitic bedrock is weathered to different grades, altering randomly from fresh-rock mass to residual soil. Nevertheless, the surrounding area of Paranhos spring galleries is dominated by  $W_{1-2}$  to  $W_3$  granite. The granitic rock-mass is crossed, preferentially, by discontinuities with NE-SW and NW-SE orientations and a medium uniaxial compressive strength ( $S_3$ ). The granite permeability is generally low to moderate, though with minor values than alluvia. The hydrogeochemical typology of the groundwater reveals anthropogenic influence, ascribed to the sulphate and nitrate concentrations.

In this kind of urban environment, densely populated, there are few rock massif outcrops, so the access to these underground galleries is extremely useful for gathering *in situ* geotechnical, geomechanical and hydrogeological data. In addition, integrating these geo-databases into a dynamic GIS to define different scenarios and approaches has culminated in the hydrogeotechnical zoning for the surrounding area of Paranhos. Multidisciplinary approaches offers the best starting point for reliable geo-engineering studies and for the characterization of groundwater resources in urban areas. The use of this kind of methodologies has proven highly valuable in increasing our knowledge of the Porto city urban groundwater systems.