3D HYDROGEOLOGICAL MODELLING SUPPORTING STUDIES ON THE SOURCES OF MANGANESE, SULPHATE AND TRICHLOROMETHANE IN GROUNDWATER AT PORTOSCUSO (SARDINIA, ITALY)

Cristina BUTTAU [1], Gianfranco MULAS [2], Giorgio GHIGLIERI [1], Carla ARDAU [1], Rosa CIDU [1], Franco FRAU [1], Andrea PORCHEDDU [1], Salvatore VACCA [1], Stefania DA PELO [1]

[1] Department of Chemical and Geological Sciences, University of Cagliari, Via Trentino 51-09127 Cagliari, Italy, sdapelo@unica.it
[2] Comune di Portoscuso, Settore lavori pubblici, Via Marco Polo 1-09010 Portoscuso, Italy, g.mulas@comune.portoscuso.ci.it

The municipal area of Portoscuso (South-Western Sardinia, Italy) has been affected by considerable negative environmental impact, such that the whole territory was declared as a contaminated site of national interest by the Italian Government (D.M. March 12, 2003). Groundwater pollution is a crucial environmental issue in this area, where a volcanic ignimbrite succession up to 500 m thick outcrops, locally covered by sand deposits of variable thickness. Groundwater upgradient to the industrial district showed concentration exceeding threshold levels only for Mn, SO_4 and trichloromethane (Vecchio et al., 2010). In order to verify the origin of such elements, a multidisciplinary approach has been applied. A 3D hydrogeological model has been built, and studies on the geochemical features and stable isotope ratios ($\delta^{34}S$; $\delta^{18}O_{SO4}$; $\delta^{2}H$ and $\delta^{18}O_{H2O}$) in groundwater, together with further insights on mineralogy of Mn mineralizations and the sources of trichloromethane, are now ongoing.
The interpretation of geochemical data required the reconstruction of the geometry of the aquifers and the determination of their hydrodynamic parameters. Therefore, this work presents the methodology employed in the hydrogeological investigation and characterization of the volcanic and sandy aquifers.
The preliminary hydrogeological conceptual model derived from the analysis of geognostic boreholes and monitoring piezometers from previous studies (Vecchio et al., 2010).
Given the considerable extension of the study area, a multiscale approach was used to refine the 3D hydrogeological conceptual model and to understand the relationships between the hydrogeological parameters and the properties of discontinuities in the fissured volcanic aquifer. The fracture network was characterized using both digital photogrammetry and field measurements. Fracture network data was employed for the generation of an intersection fracture density map that was further interpreted through overlapping the piezometric maps. Furthermore, fracture frequency and their aperture were used to determine the hydraulic conductivity of fissured aquifer. Obtained data were compared with hydraulic conductivity data derived from the Lugeon test.
The 3D hydrogeological model allows the reconstruction of the geometry of aquifers. The volcanic aquifer showed variable permeability from low to medium (10^{-4} to 10^{-6} m/s), depending on vertical and lateral extension of the deposits and the structural framework.

The permeability decreases with depth. The sandy aquifer showed a thickness of less than 15 m and a medium permeability (10^{-6} m/s). The relationship between the groundwater flow directions and the fracture network could not be clearly inferred from the piezometric contour line from the fracture density map. However, in this 2D preliminary elaboration, sub horizontal fracture family that may be condition the groundwater flow has not been represented. Further investigations are ongoing aimed to consider all the families fractures in 3D environment.

References

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