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Modeling approaches for fluid flow and pollutant propagation in a fractured and karst limestone

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Fractured aquifers can exhibit complex hydrodynamic flow patterns due to some degree of heterogeneity and anisotropy of the medium. In the presence of karst phenomenon, moreover, dissolution-generated cavities and conduits with highly variable geometry may give rise to strongly varying velocity fields.
Karst aquifers generally prove to be even highly vulnerable to groundwater contamination; significant deviations from Darcian flow for relatively high Reynolds numbers can create turbulent flow conditions that permit rapid transport of pollutants for even long distances. Therefore a critical emerging issue for those aquifers is the validity of the Darcian-type "local cubic law" which is represented by a linear relationship between flow rate and pressure gradient to accurately describe flow patterns.
In this context a detailed reconstruction of the reservoir heterogeneity features is fundamental in order to simulate subterranean draining conditions as close as possible to the real ones.
In the present paper the above methodology has been applied to the ex Gasometer area, located in the city centre of Bari (South of Italy), characterized by a fractured and Karst limestone aquifer heavily contaminated by hydrocarbons. Distinct schematizations of the hydrogeological system based on different reconstructions of the level of fracturation, of the distribution of karstic cavities and terra rossa lenses have supported flow and transport simulations in the mentioned area.
All the carried out realizations show that that the aquifer hydrodynamics depends primarily on heterogeneity and karst network architecture that provides a fast preferential pathway: the contaminants propagate rapidly and get out of the site in direction of the sea.