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Unsaturated hydraulic properties of porous sedimentary rocks explained by mercury porosimetry

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The understanding of hydraulic properties is essential in the modeling of flow and solute transport including contaminants through the vadose zone, which consists of the soil as well as of the underlying porous sediments or rocks.
The aim of this work is to study the relationships between unsaturated hydraulic properties of porous rocks and their pore size distribution. For this purpose, two different lithotypes belonging to Calcarenite di Gravina Formation, a Plio-Pleistocene sedimentary rock of marine origin, were investigated. The two lithotypes differ mainly in texture and came from two distinct quarry districts, Canosa di Puglia (C) and Massafra (M) in southern Italy, respectively. This relatively porous rock formation (porosities range between 43% for C and 41% for M) often constitutes a thick layer of vadose zone in several places of Mediterranean basin.
The water retention curves (WRCs) and the unsaturated hydraulic conductivity functions were determined using four different experimental methods that cover the full range from low to high water contents: the WP4 psychrometer test, the Wind's evaporation method, the Stackman's method and the Quasi-steady centrifuge method. Pore size estimation by means of mercury intrusion porosimetry (MIP) was performed. WRCs were compared with the pore size distributions to understand the influence of fabric, in terms of texture and porosity, features of pores and pore size distribution on the hydraulic behavior of rocks.
The preliminary results show that the pore size distributions obtained by MIP do not cover the entire pore size range of the investigated Calcarenite. In fact, some pores in the rock samples of both lithotypes were larger than the maximum size that could be investigated by MIP. This implies that for explaining the unsaturated hydraulic properties over the full moisture range MIP results need to be combined with results obtained by other methods such as image analysis and SEM.