

## Deep hydraulic tests in a large earth-slide rich in clay

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Different hydraulic tests have been conducted and replicated in a large earth slide characterized by a landslide body that is rich in clay, has a mean thickness of 30 meters, and is located in the Northern Apennines, Italy. All the tests were performed to estimate the hydrogeological properties of the landslide and to design future mitigation measures. To define the geometry of the sliding mass, the stratigraphy in more than 15 boreholes was analyzed. The boreholes were subsequently equipped with inclinometers and open standpipe piezometers. According to the stratigraphy, the landslide body is characterized by the presence of gravel layers in a clay-rich matrix. This study compares the results from the different techniques applied to 2 boreholes, 5 open standpipe piezometers and 1 well. The number of tests performed for each test type were 31 slug tests (ST), 4 falling head tests (FT), 5 low-flow pumping tests (PT), 1 point dilution (PD) test, and 2 aquifer tests (AT). Moreover, the test data was evaluated with different solutions. The ST data was evaluated with the Hvorslev and KGS solutions; the FT data was evaluated with the AGI and Hvorslev solutions; the PT data was evaluated with the Muskat solutions; the AT data was evaluated with the Theis, Cooper-Jacob, Neuman, Moench and Tartakosky-Neuman solutions; and the PD test data was evaluated with the classical solution where Darcy velocity is calculated as a function of the rate of dilution. The results show that hydraulic conductivity (K), storage (S) and specific storage (Ss) vary in the horizontal plane and with the depth (K ranges between  $1.0E-5$  and  $1.0E-8$  m/s; S ranges between  $4.0E-3$  and  $5E-5$ ; and Ss ranges between  $1.0E-3$  and  $3.0E-3$  1/m). The horizontal and vertical variability is correlated with the lithologic heterogeneity highlighted by the borehole stratigraphy. Moreover, all the hydraulic tests conducted on the landslide body give highly consistent results. Comparison of results derived from different methods show that they are comparable with each other and they differ by one order of magnitude only in a few cases.