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Results of the surface-based geophysical exploration of the Colletorto landslide, Italy

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We report the results of a two-stage geophysical investigation of a vast (about 25 ha) landslide, which occurred in Winter 2005 in the southern periphery of the town of Colletorto (Apennine mountains, Italy). The slide, which badly damaged two important roads, involved mainly a clay-rich portion of a tectonically deformed Miocene age flysch unit that includes marly mudstones, marlstones and limestones. The first stage (Summer 2006) geophysical surveys were of reconnaissance nature and aimed at interpolating and extrapolating the information on groundwater and litho-stratigraphic conditions obtained from a limited number of boreholes. The very low resistivity values (below 30 ohm/m) obtained from the electric tomography, indicated a diffuse presence of water in the unstable slope and pointed out the zones of groundwater concentration. Furthermore, a preliminary three layer model of the subsurface was constructed from seismic refraction profiles executed in few areas of particular interest situated within the landslide limits. The slide body was characterised by the upper and lower layers, with velocities ranging, respectively, from 250 to 750 m/sec, and from 1500 to 1750 m/sec; the velocities in the stable substratum varied from 2000 to 2200 m/sec. Then by integrating the geophysical and borehole data, transversal and longitudinal geological profiles of the slope were prepared to provide a preliminary reconstruction of the main lithological contacts as well as to infer the depth of the landslide. The new boreholes and geophysical surveys executed during the second investigation stage (Summer 2007) of the landslide, provided additional data needed to integrate the information obtained in the first stage and to improve the preliminary subsurface

geological reconstructions. In spite of very dry Winter and Spring seasons in 2007, the detected resistivity values were as low as in 2006, indicating the persistence of shallow groundwater conditions within the unstable slope area. This was further confirmed by the outcomes of piezometer monitoring, which revealed the presence of near surface water table in several parts of the landslide. In addition, the new borehole information generally agreed with the three layers model derived from the seismic surveys, even though the litho-stratigraphic logs of the borings made just outside the flanks of the slide demonstrated that the geometry and depth of the contacts between the relatively stable limestons and more landslide-prone mudstones are somewhat different with respect to the first stage reconstructions. Furthermore, regarding the two deeper seismic-layers, the new seismic refraction surveys revealed lower P- velocities within the landslide (1250-1750 m/s and 2000-2200 m/s) with respect to the stable slope (1950-2000 m/s and 2600-2750 m/s). It is thus suggested that where the surface expression of landslide movements is subtle, the presence of such differences could perhaps be used to identify the approximate limits of areas affected by landslide or superficial slope deformations. In conclusion, the integration of the geophysical and borehole information helped to define better the subsurface lithological contacts and groundwater anomalies that have a direct influence on the slope instability and thus need to be considered in the landslide mitigation efforts.