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Deformation modelling of the Valoria earth slide - earth flow and reconstruction of past evolution phases in its head area.

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A Finite Element deformation model has been developed for the head area of the Valoria earth slide- earth flow (upper Secchia River basin, northern Apennines, Italy). The prehistoric landslide with evidence of reactivation phases dating back to as far as 7800-7580 cal yr BP affects weak rock masses of Cretaceous to Miocene age and extends over an area of about 2 km2 and resumed activity in 2001, 2005 and 2007. The recent sequence of reactivation events has repeatedly damaged roads and has endangered houses located in areas of potential landslide enlargement. The evolution of the landslide from 2001 on was mapped, investigated and monitored with various systems including GPS, Lidar, seismic refraction, borehole coring, inclinometers, extensometers and piezometers.

On this basis, two different 2D geometry models were set up along a representative section through the head area in order to account for different plausible interpretations of the field and monitoring data. The first model is simplified and more robust. The second one is more complex and detailed, but implies a higher number of assumptions. Numerical modelling was performed on the basis of both geometries in the framework of continuum mechanics, comprising a constitutive approach that is based on a rheological model. The different entities of the landslide were discretized as soft ho-

mogeneous blocks, showing only little internal deformations and moving along thin, soft and highly plastic shear zones which exhibit a pronounced time dependency in their material behaviour. Thus, the sliding bodies themselves are considered only in the form of the load they impose onto the creeping shear zones. Finite-Element calculations performed by means of a well-established commercial code, using the Soft Soil Creep Model as constitutive model for the shear zone material, were able to reproduce qualitatively the distribution of displacements and stresses at different stages of the slope evolution. Thereby the consequent topographic variations could be explained: pre-reactivation phase 1973–2001 (obtained by existing 1:5000 topographic maps), post-reactivation phase 2001 and pre-reactivation phase 2005 (obtained using a 1:2000 topographic map of 2003) and post-reactivation phase 2005 (obtained from Lidar data of 2007). As the actual spatial distribution of the material properties along the shear zones is unknown, each of them was divided into homogeneous sub-zones characterised by a specific set of material parameters (smeared approach), considering the engineering geological setting.

The model proved to be able to simulate the past and the ongoing deformation of the head zone of the Valoria landslide, and suggested that the evolution of this area is determined not only by groundwater condition, that is the main triggering factor, but also by the progressive reduction of friction and cohesion along the shear zones, linked to the recent and ongoing sliding processes.