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A 3D geological and geomechanical model of the 1963 Vajont landslide

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The Vajont rockslide has been the object of several studies because of its catastrophic consequences and particular evolution. Several qualitative or quantitative models have been presented in the last 50 years, but a complete explanation of all relevant geological and mechanical processes remains elusive. In order to better understand the mechanics and dynamics of the 1963 event, we have reconstructed the first 3D geological model of the rockslide, which allowed us to accurately investigate the rockslide structure and kinematics. The input data for the model consisted in: pre- and post-rockslide geological maps, pre- and post-rockslide orthophotos, pre- and post-rockslide digital elevation models, structural data, boreholes, and geophysical data (2D and 3D seismics and resistivity). All these data have been integrated in a 3D geological model implemented in Gocad®, using the implicit surface modelling method. Results of the 3D geological model include the depth and geometry of the sliding surface, the volume of the two lobes of the rockslide accumulation, kinematics of the rockslide in terms of the vector field of finite displacement, and high quality meshes useful for mechanical and hydrogeological simulations. The latter can include information about the stratigraphy and internal structure of the rock masses and allow tracing the displacement of different material points in the rockslide from the pre-1963-failure to the post-rockslide state. As a general geological conclusion, we may say that the 3D model allowed us to recognize very effectively a sliding surface, whose non-planar geometry is affected by the interference pattern of two regional-scale fold systems. The rockslide is partitioned into two distinct and internally continuous rock masses with a distinct kinematics, which were characterised by a very limited internal deformation during the slide. The continuity of these two large blocks points to a very localized deformation, occurring along a thin, continuous and weak cataclastic horizon. The chosen modelling strategy, based on both traditional "explicit" and implicit techniques, was found to be very effective for reconstructing complex folded and faulted geological structures, and could be applied also to other geological environments.

Finally 3D FEM analyses using the code MidasGTS have been performed adopting the 3D geological model. A c-phi reduction procedure was employed along the pre-defined failure surface until the onset of the landslide occurred. The initiation of the rock mass movements is properly described by considering the evolution of plastic shear strain in the failure surface. The stress, strain and displacement fields of the rock mass were analysed in detail and compared with the monitored data.