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Combining solid- and voxel modelling in one 3D modelling framework at a landslide site

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Since landslides are complex phenomena involving multitude of factors, it appears of vital importance to make all relevant data available in a 3D framework. Thus a major challenge in the geological, geodetic and geophysical study of landslides is that we can observe mainly what is exposed at or near the surface. To use that knowledge efficiently, a georeferenced and three-dimensional representation of all data in one modelling framework was realised for the landslide Gradenbach.

The Gradenbach landslide (Carinthia, Austria) has an extension of about 2 km^2 with a difference in altitude of about 2000m, the head scarp shows a length of about 300 m and it is affected by a large-scale gravitational deformation. Following its reactivation in 1965/1996, the Gradenbach slope has been subject to intense geological/geomorphological mapping, geotechnical tests, geophysical investigations and exhaustive surveying campaigns, turning this landslide into a unique testbed.

A comprehensive 3D solid modeling framework has been established to incorporate typical geological/geotechnical/surveying data. The combination of boundary representations (B-Rep) and voxel modeling ensures the unambiguous representation, analysis and modelling of arbitrarily shaped 3D objects and their internal parameter variation. CAD-based B-rep modelling was used for representing relief and strata of the landslide region. Because geological objects are naturally difficult to access and thus are in relation to the project area sparsely available, processing of geological mapping data plays a decisive role in representing subsurface conditions. To make geological mapping data available in the 3D framework, scripts were developed to automate 3D representation of schistosities, discontinuities, slickensides, faults and folds from a database. After developing 3D shape of geologic features on specific layers they can be viewed, identified and selected individually or based on spatial queries.

B-Rep aggregates the total solid model from self-contained, complexly shaped solid objects and has its strengths in the quasi-natural presentation and in a straightforward manual editing of objects. In contrast voxel modelling as the 3D analogue to 2D raster cells is based on tessellating the whole model volume. Respectively, voxel modelling excels in representing continuous spatial data and in analytical flexibility. For swapping between solid construction and analysis realms, we implemented an interface allowing a conversion of solid CAD objects to voxel inheriting-Rep object properties (like e.g. physical properties of strata). Therefore usage of voxels for describing spatial variation inside a volume element can also help to limit the number of volume elements. This makes such a 3D framework an ideal tool for object based 3D analysis and modelling of landslides, providing an interpreter with analysis of complexly shaped 3D objects.