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Numerical investigation of the triggering mechanisms of the Piz Dora sackung system (Val Mustair, Switzerland)

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Deep-Seated Gravitational Slope Deformations (DSGSD) are widespread phenomena in alpine environments, where they affect entire high-relief valley flanks involving huge rock volumes. Slope scale inherited structures related to ductile and brittle tectonic deformation can control the onset and development of DSGSD and the localization of strain in deep gravitational shear zones. Slope unloading, rock mass damage and hydrological perturbations related to deglaciation are considered important triggers of these phenomena in formerly glaciated areas. Furthermore, earthquake shaking and the long-term effects of seismicity in active tectonic areas might provide an additional triggering component. Nevertheless, the role played by these different processes and their interplay is not obvious, especially in geological context less typically favourable to DSGSD and in low-magnitude seismicity settings as the axial European Alps.

We analysed the Piz Dora sackung system (Val Mustair, Switzerland), which affects conglomerates, meta-conglomerates and phyllites of the Austroalpine S-Charl nappe, involved in a slope-scale, WNW trending closed anticline fold. The area is actively uplifting, seismically active (maximum Mw>5) and experienced extensive glaciation during the LGM. The slope is affected by sharp gravitational morphostructures associated to the deep-seated sliding of 1.85 km3 of rock along a basal shear zone up to 300 m deep (Agliardi et al., 2014; Barbarano et al., 2015).

We investigated the controlling role of inherited tectonic features and the relative influence of different candidate triggering processes (post-glacial debuttressing, related changes in slope hydrology, seismicity) through a series of 2D Distinct Element (DEM) numerical models set up using the code UDEC (ItascaTM). Based on field structural and geomechanical data, we discretized the slope into an ensemble of discontinuum domains, accounting for the slope-scale folded structure and characterised by unique combinations of rock mass properties and persistent brittle structural patterns related to folding or regional stress fields. We analysed the processes leading to DSGSD onset and evolution by testing combinations of: a) rock mass constitutive models; b) in situ stress fields; c) hydro-mechanical coupling; d) dynamic loadings. DEM results, validated using field evidence and discussed against the results of continuum-based Finite-Element models (Agliardi et al., 2014; Barbarano et al., 2015), suggest that DSGSD failure mechanisms are constrained by fold-related brittle structures, and stress and hydrologic conditioning of deglaciation were key triggers modulated by active tectonic processes.

References:

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