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Deep seated gravitational slope deformation and associated massif fracturing: New insights from physical modelling.

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Deep-Seated Gravitational Slope Deformation (DSGSD) is common in mountain ranges and play a dominant role in geomorphological evolution at various time scales. This deformation is characterised by slow strain rate and seemingly facilitates shallow landsliding which occurs at shorter time scale. Shallow landslides size and location depend on the mountain heterogeneities and in particular fractures, inherited and/or generated in a response to the DSGSD. We investigated DSGSD initiation and evolution to analyse the deformation at depth and its link to superficial deformation such as sagging/sackung in particular. To start with, we considered a homogeneous mountain without any structural heterogeneity. We used a 3-D physical modelling technique based on properly scaled analogue materials, as well as on an original vertical accelerator device. This device enables cyclic loading of the model, and to advance step by step in the deformation process. Internal model deformation was studied by making cross-sections at different experiment stages. This modelling technique allows us to analyse accurately the mountain fracturing during the gravitational failure process. Results showed that the whole mountain is affected by the gravitational destabilization. The model rupture is initiated at the upper part of the mountain, with mountain crest undergoing sagging. Cross-sections showed that superficial ruptures are linked by an almost circular main fracture network. The latter is very deep seated (at about 1.5 km in equivalent depth). Other fractures propagating perpendicularly to the main failure zone were also observed. These secondary fractures reached in some cases the surface, and generated a counterscarp. Our results provide an accurate description of rupture initiation and propagation at depth and its link with geomorphological features.