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Influence of preexisting fractures on rockslide initiation an evolution: a 2-D physical modeling approach based on the Randa 1991 events.

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Fractures are known to play a dominant role on massive destabilization. This is the case of the well documented 1991 Randa rockslides. Indeed, seven distinct families of joints have been identified on the Grossgufer cliff [Ischi and al., 1991; Noverraz and Bonnard, 1992; Sartori et al., 2003]. In spite of the large number of field data and numerical models carried out on this area, the number and continuity/persistence of fractures affecting the massive at depth are not well constraint. In order to determine if such parameters are of first importance on rockslide initiation and evolution, we performed 2-D physical scaled models of the natural case of Randa. 2-D models were based on a West – East cross section proposed by Schindler & al., [1993] and modified by Eberhardt & al [2004]. Along this West – East cross section two families of fractures are present [Schindler and al., 1993]. The first one appears as a series of nine sub vertical fractures and the second one as three sub horizontal fractures.

We present the result of four sets of experiments. In the first one we considered a homogeneous model without any fracture. In this case the non-elastic deformation is localized along a circular master fault. The mobilized volume above this master fault slides without major internal fracturing. In a second set we imposed the nine vertical fractures and three horizontal fractures of the same length. Once again, sliding occurred in a deep seated landslide way with a master fault delimitating the moving mass at depth. The latter was localized as in the first set of experiment. The main difference between the two configurations was the intense fracturing of the mobilized mass. In a third set of experiment we have prolonged the fractures corresponding in the nature to the ones that have delimitated the two 1991 rockslides. In this case destabilization was completely different. Instead of a deep landslide as previously observed, we obtained two successive rockslides corresponding to what occurred in the 1991 Randa sequence in terms of positions and volumes. In the last set of experiment we removed from the previous configuration the fractures that seem to not have played any role during the destabilization. In this last case most of the fractures have been removed. Only the fractures previously prolonged have been kept. In this last set of experiment we obtained a result very close to what was observed in the first one (e.g. homogeneous model) with a deep seated destabilization.

Our 2-D experimental results allowed identifying some of the first order parameters guiding the destabilization of a mountain. The first one is the number of fractures. Indeed, in order to generate a rockslide that look like the 1991 Randa events, it has been necessary to take into account all fractures affecting the cliff according a West – East cross section. Fractures weaken the massive and facilitate gravitational movement but also induce significant perturbation on the stresses state of the massive. This implies that non-elastic deformation will be localized on some fractures. The second important parameter is the fracture persistence. Indeed, in order to reproduce the 1991 Randa rockslides sequence we had to increase the persistence of some well chosen fractures. Our results showed that the geometry of the fractures at depth have a great influence on the gravitational deformation of a hillside. It is thus of first importance to determine not only the fracture networks affecting a massive but also their persistence at depth.