The mechanism of the Gschliefgraben earthflow (Austria)

by: Poisel, R., Preh, A., Hofmann, R. (Vienna University of Technology)

A rock slide on top of the clayey – silty - sandy – pebbly masses in the Gschliefgraben valley (Upper Austria province, Lake Traunsee) which occurred in 2006, together with the humid autumn of 2007, triggered a mudslide comprising a volume up to 4 Mio m³ and moving with a maximum displacement velocity of 5 m/day during the winter of 2007-2008. The possible damage was estimated up to 60 Mio € due to the possible destruction of houses and of a road to a settlement with intense tourism.

Observations showed that
- the movement front ran ahead in the creek bed; therefore it was assumed that water played an important role,
- movement fronts were formed by normal faults where clayey – silty - sandy – pebbly masses were thrust over downslope lying areas (Figure 1),
- inclinometer measurements revealed that a less permeable layer was sliding on a thin, more permeable layer.

Figure 1. Movement front

Coupled flow and mechanical models showed that the soaking of water into the ground from top downwards, as well as the consequences of the material thrust over the downward lying, less soaked areas, created a cyclic process (Figure 1, phases 1 and 2) without any indication of a sudden failure of the complete less permeable, sliding layer (Comegna, Picarelli, Urciuoli, 2007). These investigations confirmed that earthflows in most cases are sliding of mud (Hutchinson & Bhandari, 1971) and that the phenomena of "undrained loading" described by Hutchinson & Bhandari (1971) contributed to the evolution of shear zones, forming thrust faults.

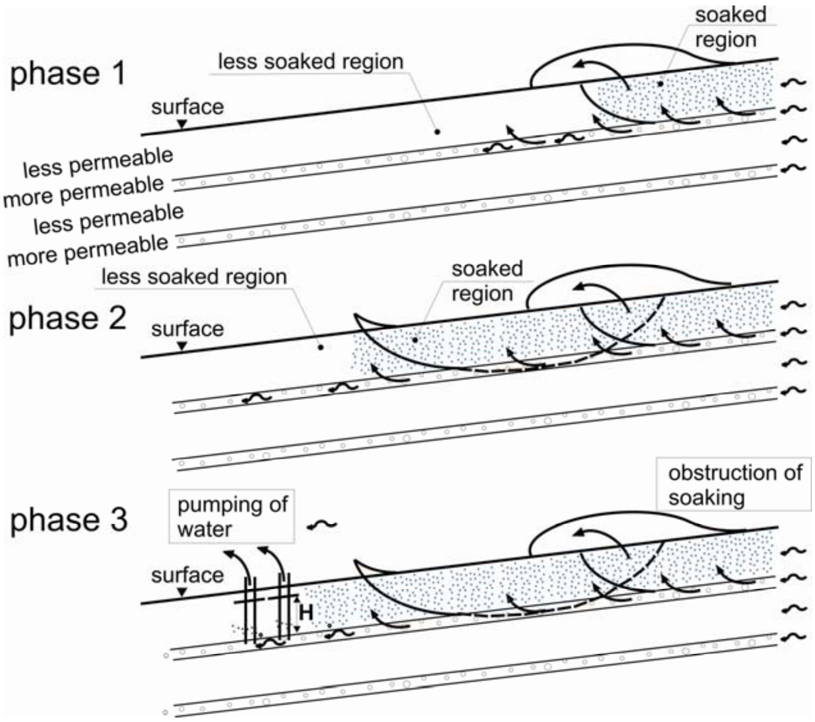

Figure 2. Process model derived from observations in nature and numerical models
(from: Poisel et al. 2012)

The structure of the lateral edges of the mudslide (Figure 3) was an additional indication that earthflows are sliding of a layer of mud on the stable ground or on previous layers of mud. The loss of frictional resistance on the border between the mud layer and the ground or previous layers of mud produced Riedel-shears at the lateral edges.

Figure 3. Riedel-shears at the lateral edges of the mudslide

According to the process model, slowing down or stopping Gschliefgraben mudslide could be achieved by preventing water from soaking into the mud upslope and by pumping water out of the more permeable layer (Figure 1, phase 3).

During the last few centuries, mudslides in the Gschliefgraben had already pushed farms into the lake, as reported by chronicles. Thus the inhabitants of 46 houses had to be evacuated for safety reasons. They could return to their homes after displacement velocities had decreased.

It was decided

- to prevent soaking of water into the uppermost, less permeable layer by transversal drainages upslope,
- to lower the pore water pressures by longitudinal trenches filled with blocky material,
- to pump water out of the more permeable layer by well drillings upslope of the houses in order to create a stable block below the houses and
- to remove material thrust over the stable blocks in order to avoid damage to the houses.

These mitigation measures, costing 11.5 Mio €, led to a deceleration of the process to displacement velocities of some cm/year up to now. The houses and the road were not damaged.