



## **Historic earthflows in the Alps – mechanisms, triggering factors and recurrence times**

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Earthflows (VARNES, 1978) are a common type of mass movement in mountainous regions with clayey or silty subsoil. Different prehistoric, historic and recent events in the Austrian Alps were investigated to study the mechanisms, triggering factors and recurrence times: Plassen earthflow (near Hallstatt, probably Bronze Age), Sandling earthflow (near Altaussee, 1920), Stambach earthflow (near Bad Goisern, 1982) and Sibratsgfall (near Bregenz, 1999).

The geotechnical situation of all these sites is very similar: rigid rock masses are neighboured or underlain by weak rock. Often, the earthflows are part of complex and much bigger mass movements (mainly spreading processes). In regions with lateral spreading processes they are always connected to a rigid rock plate lying on mobile subsoil. In these cases the crown areas of the earthflows are situated in the transition area between the disintegrated edges of the rigid rock mass and the squeezed out mobile subsoil. The activation of the earthflows occurred in all directly observed cases in these crown areas.

Activation and velocity of earthflows with considerable thickness are not directly a function of short term or long term precipitation. In many cases, undrained loading is considered to be the triggering factor. An additional promoting internal factor is the presence of a layer with porewater overpressure (artesian horizon) near the base of the earthflows. In general, the movement of the mass is propagating from uphill

to downhill. After activation only moderate acceleration takes place caused by strain softening. There was no catastrophic acceleration recorded because of the high cohesion of the materials involved in the earthflows. Only in examples when the landslide material was mixed with surficial water from tributary rivulets a decisive acceleration was observed by mudflow development.

Most earthflows are typically multiple events with short active periods (some weeks to months) and very long inactive periods. The recurrence times are supposed to be some hundred up to some thousand years. Radiocarbon dating from woods buried by Stambach earthflow prove at least four active phases since 9700 BP.

VARNES, D. J. (1978): Slope movement types and processes. - In: SCHUSTER, J. & KRIZEK, E. (1978): Landslides, analyses and control. - Transp. Res. Board, Nat. Acad. Sci. Spec. Rep., 176; Washington D. C.