



The slab-on-slab model as a key model to hazard assessment related to large slope instabilities

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Three large scale rock slope movements took place in the same alpine environment at the end of the Würm glaciation (around 7 to 9,000 years B.P.). The La Madeleine rock avalanche mobilized 0.1km³ of calcschist rocks in the Arc river valley (France). The Flims rock slide deposits consist in 12km³ of limestone brecciated rocks in the Anterior Rhine River valley (Switzerland). The Köfels rock slide mass is composed of 3km³ of gneissic rocks in the Oetz valley (Austria).

These large rock slope movements collapse by sliding along schistosity surfaces (La Madeleine), bedding planes (Flims) or foliation surfaces (Köfels). The La Madeleine rock mass reveal flowing structures preserved in the fragmented granular deposits. The Flims rock mass is supposed to have evolved into a multi-slabs sliding process with a final top and lateral fragmented flow. The Köfels rock movement is typically a complex rockslide with a basal layer and a top blocky level.

The La Madeleine, Flims and Köfels rock movements can be compared as three stages of transformation of a rock mass, from a block to a granular material. Consequently, as rock material evolved during transport, the sliding motion cannot be preserved and progressively change into a rock avalanche. A disintegration model is associated to transport processes. Shearing affects the rock mass sliding on specific surfaces; dilatancy induces general inflation of the rock material, at the origin of the grain flowing motion.

Transformation of the rock mass, and so of transport processes, is particularly affected by conditions of confining pressure, and by structural and mechanical properties of the

mobilized material. The Köfels rock slide is an example of hardness rocks; fragmentation was not enough intense to produce flowing motion. On the opposite, sliding collapse of the La Madeleine calcschist rocks is characterized by production of fine grains at the origin of the fragmented flow. The Flims rock mass is the case of the intermediate level of fragmentation, as a rock slide that stopped before complete evolution into a rock avalanche.

The slab-on-slab model experience to mobility of large rock masses with favourably inclined surfaces to sliding collapse and evolution into flowing motion depending on rock material properties and geomorphologic characteristics. This model can help to define more precisely deposits areas of potential scenarios of failure. Examples are known in France with the Sechilienne and La Clapière slopes.