Geophysical Research Abstracts, Vol. 5, 03449, 2003

INCIPIENT WEATHERING AND CRUSHING AS A POTENTIALLY IMPORTANT MECHANICAL EFFECT FOR LANDSLIDE BEHAVIORS

M. Jaboyedoff (1,2), E. Bardou (4), F. Baillifard (1,3)

(1) CREALP (Research Center on Alpine Environment), (2) Quanterra, Lausanne, (3) Institute of Geology and Paleontology, University of Lausanne, (4) div. Natural Hazard - WSL (Federal Research Institute on Forest, Snow and Landscape).

Many natural contexts indicate that mechanical behaviors of landslides can be controlled by small amounts of fine-grained materials. Examples can be found for rock instabilities and debris flows.
Water pressure is traditionally used either as an explanation of the increasing displacement velocities, or as a triggering factor for rock instabilities. But many observations indicate that these hypotheses are not valid, for rock mass is often completely dismantled and the concomitant high permeability makes an increase in hydrostatic pressure assumed by these hypotheses not possible.
As has been shown in many cases, the movements of rock instabilities increase during and immediately after the beginning of the precipitation, highlighting the effect of water. This observation can be explained only with the change of cohesion or/and angle of friction with hydration. This is supported by two different arguments:
- The reaction time of the movement to precipitation is often rapid, indicating that the permeability is sufficient for transporting water quickly out of the system, and sufficient to moisten part of the sliding surface.
- The movements can continue after precipitation.
The weathering observed in alpine environments is not sufficient to explain changes in the characteristics of rocks material. However, small amounts of fine-grained material, or of weathered mineral such as clays, can be a source of these changes under wet conditions. These transformations are usually not taken into account during rock and soil mechanics tests.
The occurrence of montmorillonite in Randa gneiss underlines the effect of crushing

and weathering on alpine rocks (Girod and Thélin, 1998). Such fine-grained material gives particular mechanical characteristics to rock material. For example, a pressure equivalent to more than 20km of rock pile at surface temperature is necessary to expel the bounded H2O in the montmoriollonite interlayer. Thus, the water adsorbed at the surface of fine-grained material - newly formed or not - must have a significant effect on local strength within joint gauges. This will lead to small displacements favoring rock mass destabilization.

Such an hypothesis is confirmed by the high density (2,200kg/m3) of alpine debris flows that contain small amounts of swelling clays, and indicates that water may be weekly bound to surface of fine-grained materials. Furthermore, the particular rheological behavior of debris flows underline the fact that fine-grained material and clay fractions have an important effect on the whole flow behavior (e.g. creation of high density "liquid" in which rock blocks can float). In general, the impact of incipient weathering processes appears very important in regard to factors triggering catastrophic landslides.

Reference

Girod, F. and Thélin, P., 1998. Weathering of granitic rocks in the Alps: preliminary results from orthogneiss associated with the Randa rockfall (Matter-Valley, Valais, Switzerland). Schweiz. Mineral. Petrogr. Mitt., 78: 179-184.