Geophysical Research Abstracts
Vol. 17, EGU2015-1159, 2015
EGU General Assembly 2015

The mechanical implications of deep fluids in the rupture process of giant landslides

Frédéric Cappa (1), Yves Guglielmi (2), Sophie Viseur (2), and Stéphane Garambois (3)

(1) University of Nice Sophia-Antipolis, Géoazur (CNRS/UNS/IRD/OCA), Earth Sciences, Sophia-Antipolis, France (cappa@geoazur.unice.fr), (2) University of Aix-Marseille, CEREGE (CNRS/PYTHEAS), Marseille, France, (3) University of Grenoble Alpes, ISTERRE (CNRS/IRD/OSUG), Grenoble, France

Fluids are known to be a triggering and driving factor for landslides. Hydromechanical coupling has been proposed as possible explanation for landslide dynamics, including both slow, aseismic slip, as well as fast, seismic rupture. The widely accepted understanding is that rainfall, snowmelt and the seasonality of the groundwater recharge increases fluid pressures, which in turn reduces effective stress, and thus alters the strength of rocks and rupture surfaces, promoting sliding. So far, most interpretations focused on the effects of rainfall infiltration into landslides, and did not investigate in detail the role of groundwater table variations below the landslides on the rupture processes. However, such considerations are important, since observations of well-documented giant landslides showed that the moving volume extends hundreds of meters above the slope aquifer. Furthermore, although motions correlate well with seasonal infiltrations, no significant pore pressure increase has ever been measured within the landslide body, particularly in high-permeability rocky landslides. Indeed, motions occur in the near surface of the unsaturated slope, which is in general highly permeable (which allows high infiltration rates), perched, highly discontinuous, size-limited, and experiences low magnitude pore pressure build-up that is not high enough to significantly vary the effective stresses in the slope. Triggering of local instabilities by such perched low-pressurized zones may be possible only at the critical stress level of the rock, but do not explain the slow increase in the permanent background seasonal accelerations and decelerations that affect the entire landslide. Thus, clarifying the role of fluids, especially the effects of groundwater table variations within the deep aquifer on the unsaturated slope slow rupture is important for improved understanding of weak forcing mechanisms on landslides and risk assessment.

The study of strain partitioning in two giant rocky landslides in France (La Clapière and Séchilienne, estimated volume of about 60 million cubic meters) provides a unique insight into the sensitivity of landslide motions to the changes in deep fluid pressures and surface frictional properties. Here we show with hydromechanical modeling that a significant part of the observed landslide motions and associated seismicity may be caused by poroelastic strain below the landslide, induced by groundwater table variations. In the unstable volume near the surface, calculated strain and rupture may be controlled by stress transfer and friction weakening above the phreatic zone and reproduce well high-motion zone characteristics measured by geodesy and seismology. The key model parameters are friction weakening and the position of groundwater level, which is sufficiently constrained by field data and seismic imaging to support the physical validity of the model. These results are of importance for the understanding of surface strain evolution under weak forcing and they demonstrated that the seasonal variation of deep fluids below the landslide is a major increasing factor of instability.