Geophysical Research Abstracts
Vol. 12, EGU2010-13121, 2010
EGU General Assembly 2010

Changes in the type and pattern of fissures observed on active clay-rich landslides.

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Structures observed on active clay-rich landslides exhibiting a viscous-plastic behavior are similar to certain structures observed on a larger scale in the deformation of rocks. These structures (fissures, scarps, ridges, bulges, grabens) are proxies for analyzing the kinematics and rheology of the landslide, and may control its hydrological behavior by differentiating preferential water pathways, surface saturated areas or impermeable frontiers.
The objective of this work is to present a methodology combining analysis of very-high resolution multi-temporal images and careful field geomorphological mapping at the Super-Sauze landslide (Southern French Alps). Three detailed structure and fissure maps are produced for the period 2007 – 2009 at the 1:500 scale.
First, the different type of fissures generated by the movement of the slide (strike-slip fissures, concentrating fissures in traction, transverse compression ridges and thrust fissures, bulges) are described and explained from a mechanical point of view. The superficial cracking caused by swelling and shrinkage of the clays are not part of the analysis.
Second, the fissure pattern (abundance of fissures, direction of fissures, synthetic or anthitetic distribution of fissures) is portrayed from the main scarp to the toe of the landslide and associated to the topography of the bedrock. All observed open fissures occur at the boundary of in-situ stable crests covered by the landslide material.
Third, the spatial and temporal changes of the fissure pattern are identified by comparing the three maps of July 2007, October 2008 and July 2009.
The analysis reveals differential movement within the sliding mass with stretching and compressive zones, different spatially-explicit rheological behavior (brittle, ductile) and possible hydrological behavior (high vs. low permeability zones). A conceptual model linking the forces, the time and the rheology (soil strength) involved to produce these structures (fissure development) is proposed.
These maps are important inputs for advanced modeling of hydrological processes observed on landslides. Krzeminska et al. (2010, this session) propose an approach to simulate the spatial and dynamic feedback between changes in hydrologic properties and differential movements. Such detailed spatial and temporal information on fissure types and patterns is a pre-requisite for a spatio-temporal hydrological modeling in terms of input maps and validation of the modeled stability and displacement patterns. The advantage of the presented observation technique relies on its objectivity and reproducibility at the field scale.