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Ground-based InSAR monitoring of the Åknes rockslide

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The Åknes rockslide, in the county of Møre og Romsdal in Norway, has been monitored on and off since 1985. Initial monitoring consisted of 3 extensometers installed along the back fracture. These showed that the fracture was opening at an average rate of about 4 cm/year. New mapping and geodetic measurements since 2004 have revealed that there is more than one moving block, and that one part of the slope moves at least 15 cm/year.

An understanding of the 3D kinematics of the rock slope is essential for hazard analysis. In order to correctly model the current sliding and possible future collapse, we need to know how many individual blocks are moving, how fast they are moving and in which direction. Aside from the continuous monitoring of the back fracture, information about movement has come from periodic measurements using GPS and a total station. These provide valuable information, but only at a limited number of points.

In order to better understand the movement pattern at Åknes, the LISA ground-based Synthetic Aperture Radar system (GBINSAR) was installed and operated during the summers of 2005 and 2006. The Synthetic Aperture Radar technique is employed to obtain high-definition microwave images by using antennas of relatively small size. Any pair of these images can be cross-multiplied to produce an interferogram, from which the line-of-sight displacement of targets can be determined with sub-millimetric accuracy. GBINSAR is particularly useful for natural hazard monitoring because it does not require installation of any targets on the observed area. The LISA system can be used to remotely monitor landslides having a spatial extension between one and four squared kilometres, located at a distance ranging from a few metres up to few

kilometres from the system itself.

Rapid atmospheric changes, atmospheric stratification and effects of changing tide levels made the data processing very difficult. Nonetheless, at the end of the 2005 monitoring period, a clear picture of the movement pattern on the upper part of the slope was produced. The maximum line-of-site velocity was about 7 cm/year. For the 2006 monitoring campaign, the system was installed 120 metres above the fjord in order to minimize the effects of changing tides. The displacement map produced is very similar to that from 2005. However, better data and improved processing techniques allowed the generation of several displacement maps throughout the summer and fall. These maps show that the slope movement does not have a constant velocity, and that different parts of the slope move independent of one another. The heavy vegetation on the lower part of the slope prevents us from obtaining a clear understanding of the movement in that area.

Permanent monitoring systems are being installed on the slope. These include eight permanent GPS stations, a Total Station with 28 reflectors, and a real-aperture radar system with 6 trihedral reflectors. Their placement was in part based upon the data provided by the LISA system. These systems were not in operation during the LISA campaigns, but will provide high-precision, 3-dimensional movement information in real-time, even on the lower vegetated part of the slope. The high spatial density of the LISA data, together with the high temporal density of the other systems should provide the complete understanding of slope kinematics necessary for further modelling.