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A Combined Structural Geology and GIS Approach to Rockslides: an Example from Western Norway

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The western coast of Norway presents an ideal area to study active rockslide development due to the recent post-glacial uplift. This study presents the preliminary results of a combined GIS-structural geology approach to the examination of a potentially catastrophic rockslide in the Romsdalen area of western Norway, a mountainous area, despite being well populated, that is particularly vulnerable to rockslides. Svarttinden is a 1600m high mountain lying on a 12-1300m plateau 1km from the southern edge of the Romsdalen Valley. Recent landslide activity from the mountain side under investigation is evinced by the presence of a debris fan, which has been previously dated at c.5000BP. The rockslide removed in the region of 5 millions m3 of rock material. The purpose of this study was to determine the cause of the previous slide and evaluate the likelihood of further rockslides from the same mountainside by applying GIS and structural geology. Preliminary investigations have shown that the mountain is dissected by a north-south trending, steeply-dipping brittle fault. This has acted as a transfer fault, delimiting the western extent of the palaeo-rockslide. The palaeo-rockslide failed along a single, flat-lying (30-35°) down-slop dipping brittle fault. Remnants of a fault breccia up to 20cm are found on this surface. Evidence exists for shearing on this structure and we consider this a major fault plane (MFP), along which the rockslide has occurred. SEM examination of the microstructures present in this fault gouge will be presented. The western half of this mountain, which lies to the east of the major north-south transfer fault, is underlain by the same low-angle fault gouge. The volume of the rock mass above this MFP is approximately 7 millions m3. Several other low-angle structures are present above the MFP, further weakening the rockmass. Up to several metres of down-slope displacement is observed on these structures. High angle tension fractures are abundant in the mountainside above the MFP, detaching down onto it. These structures increase in frequency and displacement downslope. The low-angle fault planes lie sub-parallel to a local, shallowly north-dipping foliation in the gneissic host-rocks and appear to be localized along fold discontinuities within the gneisses. These folds appear to have acted as a significant 'locking mechanism' for movement along the failure planes as evidence is seen for fault tip-zones buttressing against the high angle southern limbs of these folds and reverse high angle fault structures in the fold axial planes, representing local vertical extension as opposed to downslope shearing. Local ramp structures in the MFP led to the increased frequency of high-angle tension fractures. This suggests that the geometry of the MFP is probably a significant factor in changing the degree of fracturing of the potential rockslide rockmass and therefore may have an affect on the continuity of the rockmass prior to failure. To estimate the volume above the MFP a potential sliding

surface was inferred in 3D from field observations and the concept of "sloping local base level" (SLBL). Using a digital terrain model, the SLBL permits to define a surface above which the rocks are assumed erodible (Jaboyedoff 2004). Then the spatial distribution of the shear stress on the sliding plane and the energy of propagation of blocks can be estimated and introduced in a GIS for hazards assessment and zoning.

References: Jaboyedoff, M., Baillifard, F., Couture, R., Locat, J., and Locat, P. 2004: Toward preliminary hazard assessment using DEM topographic analysis and simple mechanic modeling.