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Geophysical investigations at the Aaknes rock-slope failure

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Unstable rock masses at the Åknes site in North-Western Norway, was first studied in the middle of the eighties. The first evaluation estimated a total volume of a few million cubic metres. Long term extensometer measurements demonstrated annually movements in the order of 2-3 cm. A new evaluation of existing data in 2003 presented several scenarios indicating that the total volume could be much larger. Based on this, a geophysical test survey was performed in 2004. As a model for the area, we expected that the demonstrated rock movements could cause fracturing of the bedrock, and due to the steepness of the hillside (about 30 degrees), parts of this could be drained. The challenge for the test survey was to evaluate which geophysical method could give information on the distribution and depth of the unstable rock masses.

The test survey included refraction seismic, 2D resistivity and ground penetrating radar (GPR) profiling. All methods gave valuable information on the distribution of fractured bedrock. Based on the first experience, new field campaigns were planned in 2005 and 2006. All together, we now have made 10 profiles of resistivity data (total of 10 km), 5 profiles of GPR data (4 km) and 3 refraction seismic profiles (1 km).

The resistivity data indicate that we on the top have high resistive talus above highly fractured drained bedrock with a thickness of several tens of metres. Underneath, we find possible fractures water saturated bedrock. This package seems to undulate down the hillside with a total thickness of 10 to 60 metres. Unfortunately, it was not possible to achieve reliable resistivity data to greater depths. The 3 refraction seismic profiles confirm this model, and at the same time give indications of fractured bedrock down

to about 100 metres. The ground penetrating radar data give information on possible fractures in the upper 20 metres of the subsurface.

Partly based on the geophysical data, all together 6 boreholes are drilled. Borehole logging with resistivity, full waveform sonic, natural gamma, temperature and water conductivity have confirmed the results from surface geophysics. Flowmeter measurements in combination with water quality measurements (temperature, electric conductivity, Eh, Ph, dissolved oxygen and nitrate), have revealed a good understanding of the groundwater conditions on the steep slope.

Based on the geophysical data, the probably total volume of fractured rock masses is in the order of 30-40 million m^3, but a larger volume can not be excluded. The geophysical model from the Åknes site is used to construct a structural geological model of the area. Data from instrumentation in borehole will in the coming year will be a good test for the geophysical interpretations.