Is the Skutshorn rockslide held back from failure by its foot and could it be eaten up by rock falls prior to a failure event?

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The unstable rock slope Skutshorn is a slow-moving rockslide with a volume of at least 7 million m^3. It is situated above lake Vangsmjøse in Innlandet county, Norway. The lithology of the rockslide is characterised by arkose and quartzite of the Valdres sparagmite nappe. The rockslide is positioned at the lower limit of this nappe. In the lower part of the mountain are these competent rocks underlain by more ductile phyllite rocks of the Vangs nappe. The back scarp is well developed along subvertical joint sets with very high persistence. This back scarp limits the slide to the top but also to much less defined rocks to the NW. The SW lateral flank is free as it is truncated by a tributary valley to the main valley that hosts lake Vangsmjøse. The upper sliding surface coincides with the schistosity that is in this part of the slope less folded and acts as a planar sliding surface or it can act in combination with several joint sets as one of the surfaces of a wedge slide. The foliation is folded towards the front of the slide body where average dip angles of the foliation are on average steeper than in the upper part of the rockslide. The foliation is vertical at the foot of the slide body. Here the basal sliding surface is interpreted to be the thrust separating the Valdres sparagmite nappe from the Vangs nappe, however outcrops of a daylighting structure or the thrust fold do not exist on that slope section that is covered in scree.

We have dGNSS data of installed measurement bolts (installed in 2018 and 2020 and last measured in 2022), satellite based InSAR for the past 8 years and GB-InSAR deformation data (collected in 2019 and 2020) for this slope. While the dGNSS data, and satellite based InSAR data are from the upper rockslide body that are accessible by helicopter or are in line of sight from the satellite do the GB-InSAR data better cover the frontal part. The deformation rates vary between 1 and 4 cm/yr and data mimic the structural conditions; in the upper parts of the rockslide, the movement vector is parallel to the dip of the foliation plane, while in the folded lower parts, the movement vector is steeper, corresponding to the dip of the foliation. The velocities are in general highest in the upper parts, decreasing down slope. In areas where the sliding surface in the upper part of the rockslide is exposed by rock fall do the GB InSAR data suggest that indeed no deformation takes place below that surface.

The underlying phyllites along lake Vangsmjøse also show deformation. This is slower than in the rockslide body and more diffusive, however also more difficult to measure as the foot is covered by extensive scree deposits. It is possible that this deformation is part of the upper rockslide, however electric resistivity tomography analysis in the lower part did not reveal any sliding surface within the phyllite. This is supported by the lack of geomorphological features showing deformation below the lake level on the newly collected bathymetric. Thus, we favour the interpretation that the deformation in the phyllite is local and detached from the main rockslide body.

The scree deposit at the foot of the instability is morphologically connected to a pronounced niche within the slide body at its SE flank exposing the basal slide surface parallel to schistosity. Today, most rock falls source from that niche; it stretches up in the slide body towards the upper part with the highest deformation rates. Be-10 surface exposure ages from multiple boulders from the scree vary strongly laterally and in time, suggesting that the scree was build up by continuous rock fall activity over a long time span rather than as one sudden failure from the niche. Rock fall activity is thus battling against rock strength in the foot of the instability to “eat up” the unstable rock slope.

The unstable rock slope has a high likelihood of failure following the Norwegian hazard and risk classification (Hermanns et al. 2012) and the population exposed to a displacement wave in lake

Vangsmjøse caused by a failure is following the used hazard and risk high. Skutshorn is thus since 2022 under continuous surveillance by the Norwegian Water and Energy Directorate.

Hermanns, R.L., T. Oppikofer, E. Anda, L. Blikra, M. Böhme, H. Bunkholt, G. Crosta, H. Dahle, G. Devoli, L. Fischer, M. Jaboyedoff, S. Loew, S. Sætre & F. X. Yugsi Molina, 2012, Recommended hazard and risk classification system for large unstable rock slopes in Norway. NGU rapport 2012.029: 53.