Oswald, Patrick[1]; Sanders, Diethard[2]; Mair, Gregor[1,2]; Wacker, Patricia[2]; Moernaut, Jasper[2]; Strasser, Michael[2]; Geitner, Clemens[2]; Scholger, Robert[3]; Poscher, Gerhard[1]

New perspectives on volume and emplacement dynamics of the Köfels rockslide deposits by combined geophysical–geological studies

[1]geo.zt gmbh (Austria);
[2]Institute of Geology, University of Innsbruck (Austria);
[3]Chair of Applied Geophysics, University of Leoben (Austria);
patrick.oswald@geo-zt.at

The Köfels rockslide (Eastern Alps, Austria) represents one of the largest prehistoric rockslides in the Alps and has been extensively investigated for its surface geology, geomorphology, event age, and detachment- and deposit volumes. However, the interaction of the rockslide mass with the pre-existing topography and valley-fill substrate, as well as the emplacement mechanisms, remain unclear.

This study presents new geophysical data and documentation of temporary outcrops in the upstream valleys of the rockslide to elucidate the dynamics of the rockslide emplacement. New reflection seismic data image the subsurface of the Längenfeld basin, revealing rockslide deposits several kilometers south (upstream) of the main rockslide area. This indicates that after halting at the opposite valley side near Niederthai, the rockslide mass collapsed and divided into two branches. The downstream branch traveled at least 1.9 km, as evidenced by a surface outcrop, while the upstream branch extended 2.3 km upstream. The rockslide dammed the Ötz river, causing subsequent burial of the rockslide deposits under an up to 238 m thick, generally coarsening-upward deltaic backwater sedimentary sequence. Seismic data reveal no postglacial sediments between the rockslide and bedrock beneath the central rockslide, indicating extensive scraping of the pre-rockslide valley infill. The upstream branch's basal shear surface displays a south-verging ramp-flat geometry with at least three ramps accompanied by low-angle thrusts. Thrusting and buckling of the rockslide topography resulted in the formation of toma-hills, with normal fault sets forming depressions between the hills. These observations indicate that the internal collapse dynamics of the rockslide mass are governed by a combination of thrusting (buckling) and normal faulting, with the rockslide mass thinning progressively with distance.

Electric resistivity tomography and ground-penetration radar investigations of the Niederthai plain (~450 m above the present-day valley floor) reveal no sign of lake sedimentation typically expected from a rockslide-dammed backwater lake. Instead, observations in a temporary construction pit show that the uppermost succession of the plain is composed of an overall graded but largely homogeneous silt-sized sedimentary deposit with abundant dykes and large flame structures filled with coarser-grained sands and rounded pebbles of upper Ötz valley provenance. Geophysical data reveal superposition and lateral thrusting geometries of subsurface intervals with high resistivity overlying/overthrusting moderate resistivity packages in the deeper subsurface. These findings indicate significant mobilization, bulldozing, and fluidization of the pre-event fluvial sediment in the Ötz valley floor.

Three-dimensional mapping of all available data estimates the minimum rockslide depositional volume at 5.8 km^3, at least 1.5 times larger than the estimated detachment volume (3.1-4.0 km^3). This discrepancy cannot solely be explained by the tendency of the rockslide mass to gain volume during progressive destabilization but highlights the significant erosion and incorporation of pre-rockslide water-saturated sediments into the moving mass, which in turn likely further influenced the rockslide's mass propagation and depositional behavior. Thus, our findings enhance the understanding of the Köfels rockslide's emplacement mechanisms and highlight the interaction between the rockslide and the pre-existing valley infill.

Session: *Pangeo workshop: Earth Surface Dynamics*
Keywords: *Köfels, rockslide, sediment dynamics, volume estimation, geophysics*