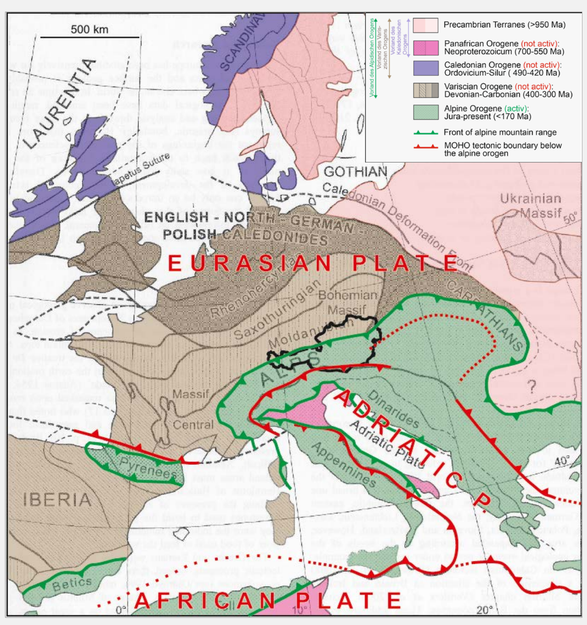
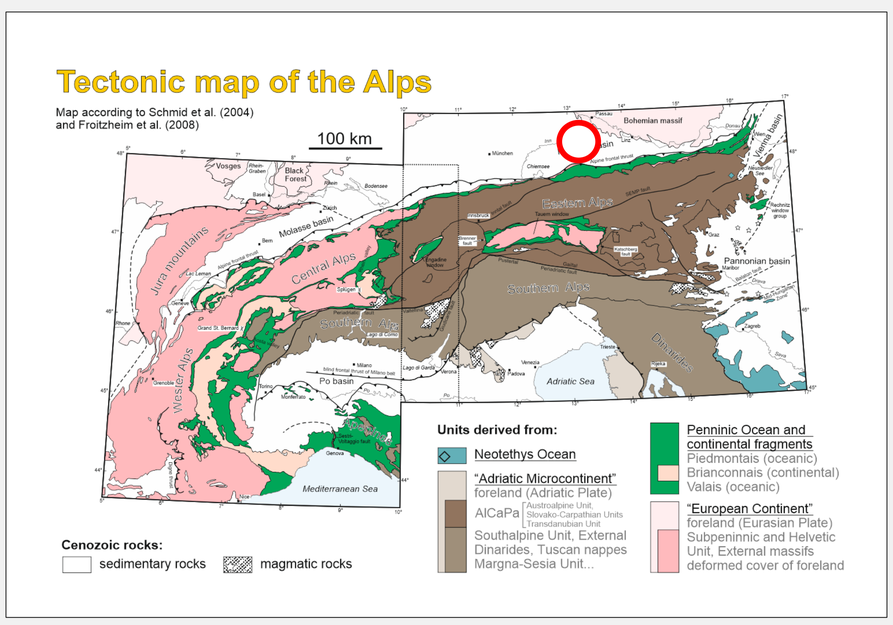
Mineralogical composition of a clayey landslide, Wolfsegg am Hausruck, Upper Austria

Mandana PERESSON, Birgit JOCHUM, David OTTOWITZ, Robert SUPPER
mandana.peresson@geologie.ac.at Neulinggasse 38, 1030 Vienna, Austria
Geological Survey of Austria

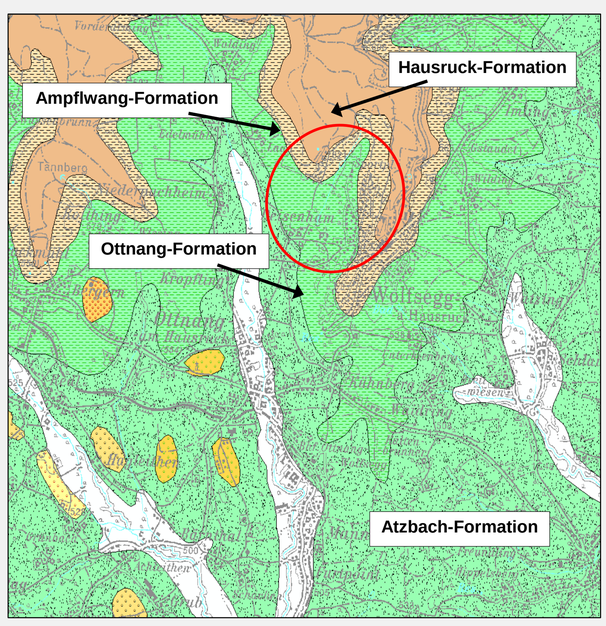
Geographical and geological overview of the project site in Austria (Europe)



Austria is situated in the center of Europe between 46°20' and 49° N parallels (McCann, 2008)



Tectonic map of the Alps (after Schmid, 2004 & Froitzheim, 2008) with site location (red circle)

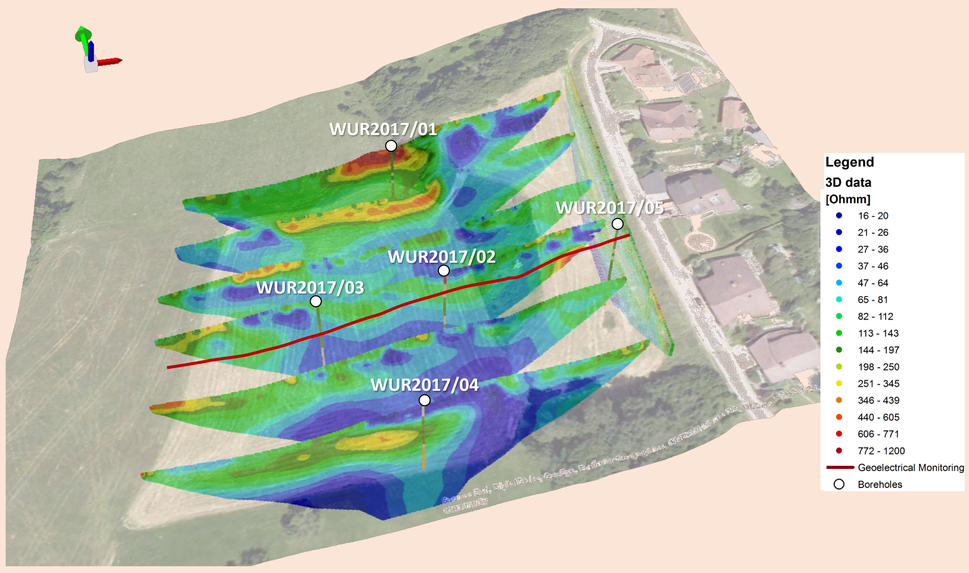


Detail of the geological map of Upper Austria 1:200.000 with site location (red circle)

Introduction

"Hydroslide" is a joint project between France and Austria (funded by the Austrian Science Fund FWF, Project number: I 2619-N29) and monitors hydrological processes in clayey landslides at three different investigation sites. One site is close to the village Wolfsegg am Hausruck located in the western part of the Upper Austrian Molasse Basin. This study covers the qualitative and quantitative determination of clay minerals, grainsize distribution and geotechnical properties aiming for a better understanding and mitigation of landslide processes. The district is historically well known for landslides resulting from the local geologic situation along with former coal mining activities. Recent damages to residential areas in the village Wolfsegg have initiated this investigation.

Beforehand 23 geoelectrical profiles were measured. Five boreholes with up to 30 meters depth were drilled and cored. The boreholes were logged with natural gamma-, electromagnetic- and nuclear magnetic resonance tools and 4 automatic inclinometers for displacement measurements were installed. In total, 31 samples from the cores were probed and analyzed. The wells are characterized by comparable lithological composition comprising three stratigraphic units from top to bottom: "Hausruck-Formation" (Pannonian), fluvial, sandy, fine to coarse grained gravels; "Ampflwang-Formation" (Pannonian), limnic to fluvial coal bearing clays and sands; "Ottnang-Formation" (Lower Ottnangian) shallow marine clay silts. The landslide disturbs the first two formations and exhibits an approximate thickness of 15 meters.



3D-view of the monitoring site with selected inverted geoelectrical depth sections, borehole and monitoring profile locations

Mineralogical composition

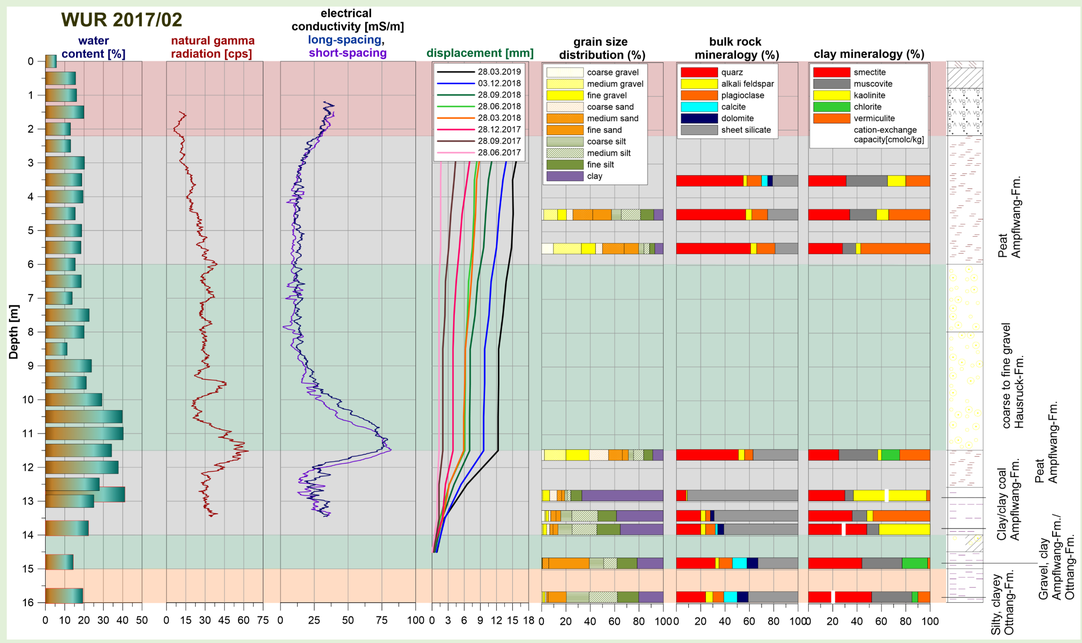
These different stratigraphic units can be clearly distinguished by their carbonate, feldspar, quarz and phyllosilicate *bulk rock mineralogy*. The typical coal bearing "Ampflwang-Formation" is characterized by a distinctive dominance of phyllosilicates, followed by quarz and minor amounts of feldspar (only alkali feldspar). The "Ottnang-Formation" shows due to the high amount of fossils very high amount of carbonate content. There is a slightly backlog of phyllosilicates towards quarz and noticeable amounts of plagioclase and alkali feldspar.

The *clay mineralogical composition* is also significantly different. The clayey sediments in the coal bearing "Ampflwang-Formation" show a predominance of kaolinite, vermiculite and expandable mixed-layers. The "Ottnang-Formation" is dominated by smectite and partly vermiculite without traces of kaolinite.

Grain size distribution of the sediments is in line with the mineralogical composition.

The *natural water content* of the samples was determined after DIN 18196. The very fine grained and coal bearing "Ampflwang-Formation" features the highest water content compared to the "Ottnang-Formation".

Also the highest amount of *cation-exchange-capacity* (CEC) can be found in the clayey sediments of "Ampflwang-Formation". Especially for Ca^{2+} cations the values are increasing extremly in the coal bearing parts of the boreholes.



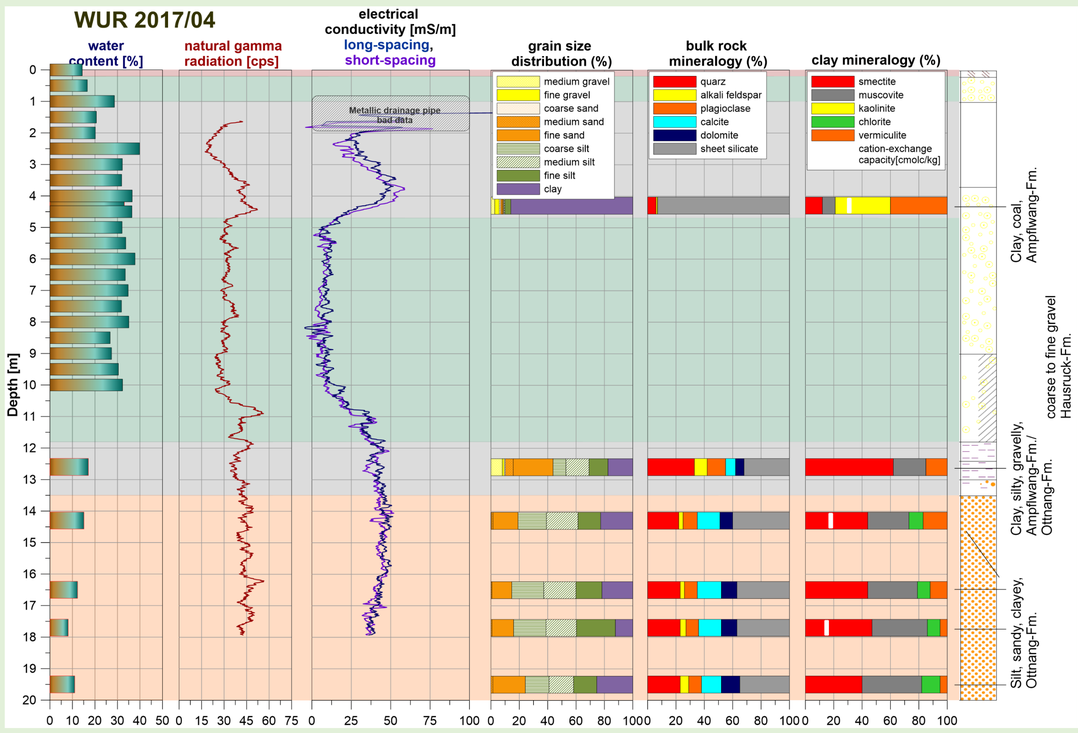


Photo-documentation of borehole 4 (WUR 2017/04): Alternation of coal bearing "Ampflwang-Formation" and coarse grained, gravel dominated "Hausruck-Formation" until the depth of 12 m beneath surface. From 12 m to final depth the borehole consist of "Ottnang-Formation" which is mainly characterized by sandy siltstones.

Results

The highest amount of cation exchange capacity (CEC) and natural water content was detected within the coal bearing formation. The clay mineralogy is notably influenced by weathering alterations evidenced by the presence of expandable mixed-layer clay minerals and vermiculite. Due to the mineralogical composition and the high CEC, an abundant occurrence of slip surfaces within the coal bearing "Ampflwang-Formation" (at 4 -15 m depth below surface) is inferred. Following heavy precipitation incidents, the coal bearing "Ampflwang-Formation" acts like a lubricant triggering repeated landslide events.