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Comparison of applied Geophysical Methods for detecting high alpine ground ice

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The detection of ground ice in the higher regions of the Alps is an important aim of alpine studies. Geophysical research in this field is important for alpine risk, infrastructure and climate change studies. Because of the complexity of detecting ground ice, the database of permafrost maps is currently not very well evaluated for wide areas of the Alps.

The research for this project was conducted at Lazaun rockglacier (Schnalstal, Italy) and Rofenberg (Ötztal, Austria). This area was chosen because of good network of BTS (Base Temperature of Snowcover) measurements and terrain changes from ALS (Airbourne Laser Scanning) data which could possibly indicate permafrost degradation.

Georadar, geoelectric and seismic methods were used to detect permafrost, with each geophysical method being applied on all profile lines. This parallel application enabled us to compare and cross-validate the results of the three techniques. After the analyses of the single datasets, a tomography including all results was created.

At Rofenberg, three profiles were measured at a height of about 3200 meters. Two of them were parallel and one was crossing them both. Each profile had a length of about 100 m. The spacing of the electrodes was 2 meters for geoelectrical measurements using Schlumberger and Wenner geometries. The geophone spacing for seismic measurements was about 4 meters and a shot spacing of 4 meters was applied. For georadar measurements 50 MHz, 100 MHz and 200 MHz antennas were used and CMP measurements with the 200 MHz antenna were accomplished as well.

A further profile line was investigated at the Lazaun rockglacier at an elevation of about 2800 meters. This profile was more difficult to measure because of rugged and impassable terrain.

First analyses at Rofenberg show good results for two of the profiles. Permafrost is assumed at a depth between 2 meters and 8 meters and similar ground structures can be spotted for every method. At Lazaun, the interpretation is much more difficult due to a low signal to noise ratio. Data from two boreholes in direct neighborhood considerably facilitate the interpretation. The combined data show both the difficulties and the high potential of multi-method geophysical permafrost surveys in high-alpine terrain.