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Shallow subsurface temperature and moisture monitoring at rock walls during freeze thaw cycles in the Northern Calcareous Alps, Austria

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The process of frost weathering as well as the contribution of further weathering processes (e.g. hydration, thermal fatigue) is poorly understood. For this purpose, different measuring systems were set up in two study areas (Dachstein massif – permafrost area (2700m asl, 47° 28′ 32″ N, 13° 36′ 23″ E) and Gesäuse mountains – non permafrost area (900m asl, 47° 35′ 19″ N, 14° 39′ 32″ E) located in Styria, Austria within the framework of the research project ROCKING ALPS (FWF-P2444).
A key to understand frost weathering is to observe the rock temperature with several high resolution temperature sensors from the rock surface down to -20cm depth. The temperatures are measured hourly at north and south exposed rock walls since 2012 in the headwalls of the Dachstein glacier at the Koppenkarstein (built up of limestone) in about 2600m asl. Since 2013 the same measurement setup is installed in the lower Johnsbachtal (Gesäuse mountains, prevailing rock type is dolomite) in about 800m asl. To know the temperature is crucial to understand internal heat flow and transport and latent heat effects during freezing and thawing caused by night frost (lasting some hours), cold fronts (lasting some days) or winter frost of several weeks or months. At these study points we also have installed small-scale 2D-geoelectric survey lines, supplemented by moisture sensors. Moisture is determined by means of resistivity measurements which are difficult to calibrate, but provide good time series. Additional novel moisture sensors were developed which use the heat capacity of the surrounding rock as a proxy of water content. These sensors give point readings from a defined depth and are independent from soluble salt contents. First results from the Dachstein show that short term latent heat effects during the phase change have crucial influence on the moisture content. The moisture distribution and movements during temperature changes inside the rock are discussed upon the two main frost weathering theories – (A) volume expansion of moisture during the phase change and (B) the ice segregation.