Methodical advances in borehole temperature measurement – Insights from the MOREXPERT project, Kitzsteinhorn (3.203 m), Austria

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Temperature data from shallow and/or deep boreholes is pivotal to the success of many permafrost-related investigations. Among others, borehole temperature data is utilized for the study of active layer dynamics, the calculation of permafrost thickness, the recognition of long-term climate trends, or the validation of geophysical measurements. Despite heavy reliance on borehole temperature data there only exists a surprisingly low number of scientific contributions addressing the technical details and methodical challenges that come along with the instrumentation of boreholes in permafrost-affected ground. Within this methodological contribution two technical developments from the research project MOREXPERT ("Developing a Monitoring Expert System for Hazardous Rock Walls") are presented.

Firstly, an improved system for temperature measurement in deep boreholes (>10m) is introduced. The measurement system, which has been developed by the Austrian company Geodata, consists of an impermeable polyethylene casing that prevents water and air entry into the borehole. The polyethylene casing is furnished with brass rings which are located in the designated depths of the temperature sensors. Brass was selected as it is non-corrosive and possesses a high thermal conductivity. The temperature sensors which are inserted into the casing automatically establish mechanical contact to the brass rings. The annulus (i.e. the space between casing and bedrock) is then filled up with concrete from bottom to top. As opposed to numerous other techniques the newly introduced system enables significantly improved thermal coupling between the temperature sensors and the surrounding rock and is therefore able to deliver highly representative temperature data. In order to demonstrate the functionality of the newly developed system we present, for the first time, temperature data from four boreholes (20-30m deep) that have been drilled into permafrost-affected rock at the Kitzsteinhorn (3.203 m), Austria.

Secondly, a low-cost and easy-to-apply strategy for temperature measurement in hand-drilled, shallow boreholes is introduced. The presented measurement strategy is based on the deployment of specifically adapted iButton® sensors. iButtons® are computer chips enclosed in a 16mm thick stainless steel can. In contrast to conventionally used temperature loggers, iButtons® are inexpensive and easy to replace in case of damage. For this reason a large number of measurement sites can be equipped for the measurement of near-surface rock temperatures and thermal offsets. A special workflow for the installation of iButtons® in depths of 10 and 80 cm is presented within this contribution. All iButtons® were attached to polyethylene rods and placed in previously drilled holes. The presented results, which cover different elevations and slope aspects of the Kitzsteinhorn summit pyramid, show the great potential of the introduced measurement strategy.