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First Experiences with wireless Sensor Networks in steep Bedrock Permafrost

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Warming and thawing permafrost in steep alpine bedrock can affect slope stability, lead to natural hazards and complicate the operation of man-made infrastructure. Corresponding heat flux and phase change processes in porous fractured rock are currently poorly understood. To develop theoretical models for temperature simulation as well as for hazard assessment, continuous and reliable measurements of physical parameters in natural and diverse slope areas are required. At present, only limited measurement data exist for selected locations, but no large-scale measurement series are available. This is partly due to the lack of inexpensive, easy to deploy and reliable measurement systems.

The project PERMASENSE aims at developing and demonstrating a flexible, distributed and context sensitive wireless sensor network (WSN) adapted to geophysical sensors. The first sensor generation was developed and deployed in summer and autumn 2006 and measures temperature profiles and resistances in one meter deep boreholes. Currently, the setting-up of the network takes place, which should permit a near real-time survey of the rock condition. The PERMASENSE data chain consists of several wireless nodes to which the sensors are attached, a GPRS gateway node for data uplink as well as a database server in the Internet with a web based front-end for data retrieval and network monitoring. With a measurement intervall of 30 minutes, the low-power network nodes have an expected battery lifetime of at least two years even under cold conditions.

The data gained with this first sensor generation is expected to provide valuable insight into the advective component of the near-surface heat transfer as well as into

freeze-thaw processes. We plan to build a second generation of sensors for summer 2007 that can also measure crack dilatation, moisture/ice content and water pressure in pores or fractures and other geotechnical parameters. An additional challenge on the network side is, to make the timing and measurement rate of some sensors sensitive to the values of others, so that events of special interest can be recorded. Beside its contribution to our understanding of permafrost and rock weathering in steep slopes this context sensitive WSN is also a prototype for future real time monitoring systems for natural hazards.