

Induced polarization as a new tool to monitor the degradation of permafrost

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Spectral Induced Polarization is a geophysical method studying the ability of porous rocks to store reversibly electrical charges under the influence of a primary electrical field. In this presentation we discuss the influence of permafrost on induced polarization and how induced polarization can be used as an efficient tool to monitor the degradation of permafrost. First we establish the theory which is combined to a freezing model establishing the relationship between the liquid water content and temperature during freezing and thaw and accounting for the segregation of salt in the liquid water phase. We show that the model unifies electrical conductivity and induced polarization of rocks. Then the model was validated using a large dataset of laboratory experiments in well-controlled conditions in the temperature range +20°C to -16°C with 15 samples including soils, crystalline rocks, sandstones, and graphitic schists. Finally, we applied this model to at two test sites in the Alps and one field experiment in which permafrost was created using a geothermal heat exchanger. The model shows its ability not only to detect permafrost and to estimate its temperature and liquid water content but also to monitor its degradation thanks to a new generation of time-lapse algorithms.