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A step towards temperature-referenced ERT: Laboratory-calibrated ERT of seasonal changes in permafrost rock walls at the Zugspitze (German/Austrian Alps)

M. Krautblatter (1), S. Verleysdonk (1), A. Flores-Orozco (2), and A. Kemna (2)

(1) Dep. of Geography, University of Bonn, Germany (michael.krautblatter@giub.uni-bonn.de / +49 228 739099), (2) Applied Geophysics, University of Bonn, Germany

High-resolution ERT with 127 electrodes and on average 1550 datum points was conducted in a 276 m long gallery along the permafrost-affected north face of the Zugspitze in 2800 m a.s.l. in Februray, May, June, July, August, September and October 2007. Inversion was performed in a 8400 finite element grid with adjusted boundary conditions. To receive quantitatively reliable ERT values, we fitted a smoothness-constrained Occam's inversion to an empirically measured normal-reciprocal error model. Water-saturated dolomised Wetterstein limestone was measured in the laboratory to freeze at 30 ($\pm$3) kohmm at -0.5 ($\pm$0.1) °C, independent of initial or refreezing paths. Resistivity of unfrozen limestones increases by less than 104 ohmm/°C. According to laboratory values, temperature referencing of ERT below -0.5 °C could be described by p [in kohmm] = 19 – 19.3 ($\pm$2.1) * t [in C°] with an R^2 of 0.99. A comparison of the absolute ERT plots and monthly changes is consistent with the temporal changes of air temperature and rock temperature data.

Maximum resistivity changes (30 kohmm $\approx$ lab analogue +1.5°C warming) in depths up to 27 m occur coincidently to maximum measured cleftwater flow in May. Differences in snow coverage seem to dominate the general distribution of permafrost and the timing of thaw in the rock wall transect. Refreezing from the rock wall starts in September is apparent in both, resistivity changes and expansion of the high-resistivity body. Error-controlled inversion and temperature calibration in the laboratory present the first approach towards quantitative temperature-referenced ERT in permafrost rocks.