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Comparison of alternative electrode types for improvement of electrode-ground coupling in highly-resistive environment. Experience from the time lapse geoelectrical station for high-latitude permafrost monitoring, Ilulissat, West Greenland

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The contribution is concerning the experiments carried out in the spring 2013, having as purpose the improvement of grounding of the electrodes placed in fine-grained permafrost after we discovered that standard electrode types are surprisingly performing not well enough during the winter time (comparing to other, geologically less favorable sites in Greenland), when the ground resistance is extremely high.

The field experience revealed unexpected facts (unexpected based on previous experience) about problems with reliable ERT measurements that can be encountered in highly resistive environments (such as permafrost sites). We carried out a series of field test (and we still have ongoing laboratory test) in order to design the best electrode type for the challenging, highly resistive environments when reliable operation is required due to the remoteness of the sites.

Comparison of performance of different electrode types in extremely high ground resistivity conditions – case of automated high-latitude permafrost monitoring station (Ilulissat, West Greenland)

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The extremely high contact resistances pose challenges to automated permafrost monitoring in remote areas, particularly in winter period. The electrode design is one of the important factors helping to maintain data quality when no electrode contact adjustment is possible prior to every single measurement sequence.
We have established a permanent high-latitude permafrost monitoring site in Ilulissat (West Greenland) in August 2012. Since then, the automated station has been collecting 1625 data points per day. The electrodes used on the profile were 10cm long steel rods inserted in the clayey material ca 10-20 cm below the ground surface. This electrode type was previously proved suitable at another permanent, though not automated station in Sisimiut (West Greenland) where the geology is even less favorable for good ground coupling then in Ilulissat. However, during the winter 2012/2013, major problems with the electrode contact resistances caused large gaps in the time lapse data series from the Ilulissat site.
Following series of field and laboratory experiments aimed to identify the optimal electrode type for the given setting, as well as to quantify the benefit of using a given electrode type. 3 compared electrode types include: 10 cm long steel rods, 10x5 cm steel plates and 10x10 cm metal mesh electrodes. In field conditions, both metal plates and mesh electrodes performed better then the originally used steel rods. The mesh electrodes reduced the contact resistance by as much as 61% (in average by 54%, measured 3 days after installation) and the plate electrodes reduced the contact resistance by 48% in average comparing to the steel rods with smaller surface area. The field results were confirmed in the laboratory, where different soil types and for different electrode types were used and contact resistance was measured at different temperature steps.