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Vertical electric sounding of selected Arctic and Antarctic soils: advances in express field investigation of the Cryosols

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Physical properties of the soils of the cold environments are underestimated. Soil and permafrost border and active layer thickness are the key classification indicators for the polar soils. That is why electrophysical research has been conducted with aim to determine the soil-permafrost layer heterogeneity and the depth of the uppermost permafrost layer on examples of selected plots in Antarctic region and Russian Arctic.
The electric resistivity (ER) was measured directly in the soil profiles using the vertical electrical sounding (VERS) method, which provides data on the changes in the electrical resistivity throughout the profile from the soil surface without digging pits or drilling. This method allows dividing the soil layer vertically into genetic layers, which are different on main key properties and characteristics Different soil layers have different ER values, that is why the sharp changes in ER values in soil profile can be interpreted as results of transition of one horizon to another. In our study, the resistivity measurements were performed using four-electrode (AB + MN) arrays of the AMNB configuration with use of the Schlumberger geometry. A Landmapper ERM-03 instrument (Landviser, USA) was used for the VES measurements in this study. Electrodes were situated on the soil surface, distance between M and N was fixes, while distance from A to B were changed during the sounding. Vertical Electrical Resistivity Soundings (VERS) using Schlumberger array were carried out at stations, situated on the different plots of terrestrial ecosystems of Arctic and Antarctic. The resistance readings at every VERS point were automatically displayed on the digital readout screen and then written down on the field note book. The soils had been ‘sounded’ thoroughly and found to vary between 5 cm and 3–5 m in A-B distances.
It was shown that use of VES methodology in soil survey is quite useful for identification of the permafrost depth without digging of soil pit. This method allow identify soil heterogeneity, because the ER values are strongly affected by soil properties and intensively changes on the border of different geochemical regimes, i.e. on the border of active layer and permafrost. VES data obtained show that the upper border of the permafrost layer coincides with that border, which were identified in field on the base of soil profile morphology. The VERS method also can used for identification of Gleyic, Histic and Podzolic layers. It has been also shown that permafrost layer is less homogenous in upper part of permafrost, than in lower one. It is caused by number of cracks, channels and other paths of dissolved organic matter and iron containing compounds migration. VES methodology is useful for preliminary soil survey in the regions with permafrost affected soil cover. It is also can be applied for detalization of soil-permafrost layer stratification in field soil pits.