International Conference

Solving the puzzles from Cryosphere

Pushchino, Russia, April 15-18, 2019

Russian Academy of Science
Institute of Physicochemical and Biological Problems in Soil Science RAS
“Okabiolab” Ltd.

International Conference
“Solving the puzzles from Cryosphere”

PROGRAM
ABSTRACTS

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The International conference «Solving the puzzles from cryosphere» organized by: Institute of Physicochemical and Biological Problems in Soil Science RAS and "Okabiolab" Ltd.

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direction of filtration flow (quasi 3D). Proposed model can be used for analyzing more complex situation.

The application of electrical resistivity tomography in the study of the underlake talik

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Study of permafrost underwater permafrost is necessary for estimation of thaw depth and calculation of greenhouse gases emission to the atmosphere. Drilling makes it possible to determine talik depth under a lake, but it is expensive and sometimes quite difficult. The alternatives to drilling are geophysical techniques such as electrical resistivity tomography (ERT) and ground penetrating radar (GPR).

The purpose of the work is to study the appearance of hydrogenic talik in electrical resistivity distribution in underlake medium on the basis of 2-D and 3-D inversion.

We used ERT and GPR on the one of thermokarst lakes on Samoylov Island (Lena River delta). The lake size is 340x90 m, its maximal depth is 5 m. ERT sounding was conducted on 9 parallel profiles with length of 355 m (electrode spacing - 5 m) and distance between profiles of 50 m. Dipole-dipole and Schlumberger arrays were used during the measurements. 2-D and 3-D inverse resistivity models were obtained with Res2Dinv and Res3Dinv software. GPR survey was conducted with 150 MHz antenna. Two GPR profiles were done from the water surface.

It is found that dipole-dipole array measurements yield false low-resistive anomalies on the lower part of the sections (this effect is found only on profiles in the nearby of the lake margin). In the middle part of the lake results of 2-D inversion of Schlumberger array data show that talik depth is about 30-40 m. In contrast 2-D inversion of dipole-dipole array data determine the border between thawed and frozen matter at the depth of 20 m. Joint inversion of dipole-dipole and Schlumberger data yields the most representative result – the border is determined distinctively, beyond that features of permafrost structure in coastal area.

In consequence of 3-D inversion of ERT data it is found that maximal depth of thawing under the lake is 21 m. Horizontal slices of 3-D model show that the main part of melted matter (limited by 400 Ohm·m isoline) is situated under the most deep part of the lake (more than 4 m depth).

Numerical modeling of ERT confirmed the false low-resistive anomalies on the profiles near the lake margin. Beyond that it was clarified that starting geoelectrical model should include an area of elevated temperature in the neighborhood of the talik and complex permafrost structure along the coast.

GPR survey from water surface empowers to determine lake bottom relief with high precision and the border between thawed and frozen matter in the case of its shallow occurrence.

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Features of Automated Soil Moisture Monitoring

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Automated systems are used to monitor soil moisture (W) in geocryological and environmental monitoring programs. We consider the methods used in the most common commercial measurement systems. Such systems convert moisture or potential moisture into electrical signals. This includes measurements of the electrical resistance of a standard porous body in equilibrium with the soil (RM) and the dielectric constant of the soil or the standard porous body placed in it.

To assess the reproducibility and accuracy of measurements while monitoring soil moisture, we compared the values of W measured using the RM technique (Watermark sensors), reflectometry in the time domain (TDR sensors Soil Probe EC20, EC10 and EC05), as well as measuring the real and imaginary components of the dielectric constant (Vitel Moisture Probe), on the one hand, and W values obtained by the thermo-weight technique, on the other hand. The results show that the use of systems with sensors of all three types lead to systematic errors in measured W values.

RM Watermark moisture potential sensors with gauges and loggers were installed at the Pushchino monitoring site in the seasonally freezing gray forest loamy soil. The soil has an average annual temperature of +6°C. The amplitude of the annual temperature variations on the ground surface is 9^{o}. We consider the measurement data at depths 20, 50 and 95 cm, recorded 4 times per hour. The two-year sequence of measurements was accompanied by a quarterly monitoring of soil moisture using the thermo-weighting method. For control measurements, soil samples obtained at the monitoring site in small diameter boreholes were used. The data obtained show that the Watermark sensor, supplied with a factory