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Complex study of permafrost mounds in Sentsa river (Russian Federation) valley by geophysical methods

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Permafrost covers a considerable area of the Northern Hemisphere and over 65 percent of the territory of Russia and is possible place for the formation of specific permafrost landforms such as lithalsas – mineral-rich permafrost mounds with ice lenses. The understanding of lithalsa geomorphology is important for the Arctic and mountain regions, which contain technical-engineering constructions for several reasons. Firstly, such landforms represent potential hazard while ice melting. Secondly, lithalsa are geomorphological indicators of past and present conditions of the formation of permafrost mounds. Such landforms also can indicate recent climatic or environmental influences.

The study is considering the results of the examination of genesis and configuration of lithalsas in Sentsa river valley (East Sayan Mountains, Russia). The climatic conditions of the region are appropriate for their formation and existing the annual average air temperature varies from -4 ° C -6 ° C, and the average July air temperature varies from +9 ° C to +11.5 ° C.

A complex study of two lithalsas (80 and 30 meters in diameter) was carried out in summer 2017 on a surface of 150x350m. We performed electric survey in a modification of profile vertical electrical sounding (VES). The total amount of electric measurements consists of 28 points with a step of 15 m. Obtained data was interpreted considering the geological data from two boreholes (20 and 15 m depth), that allowed us to create geoelectric sections for each of the lithalsa mounds. Additionally to define the geomorphological structure of the upper part of the section the kappametry examination of a vertical profile of 10 soil pits (1.5 m depth) was performed. Total amount of measurements of the magnetic susceptibility (χ) is more than 500. The results of kappametry examination were also used for the dividing the soil profile into horizons.

Obtained geoelectric sections for two lithalsas allowed us to build a 3D model of mounds and define the contours of ice lenses. The lenses are defined by isometric zones of high electrical resistivity from 18 000 to 30 000 Ohm meters on a background of loamy sediments with low resistivity around 80-300 Ohm meters.

Due to the complex geophysical research it was established, that ice lenses are at the depth of 4 meters and are 10 meters thick. The largest of the studied lithalsas occurred to have two separate perennial ice-cores. This can be the sign of the formation of two separate lithalsas and subsequent fusion due to the close position. Russian science foundation (grant №. 14-27-00083) and Russian Foundation for Basic Research (grant №. 16-05-00115) supported the research.