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Internal Structure of a Lithalsa in the Akkol Valley, Russian Altai Mountains

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Perennial frost mounds are present near the edges of ponds located on the terrace between the mountain flank and a valley-bottom lake in the Akkol valley of the Russian Altai Mountains. These mounds are 10?50m in diameter and 3?6m in height. We describe one mound, identified as a lithalsa, which had been eroded so as to expose almost the entire vertical cross-section and reveal its internal structure. The frozen core consisted mainly of soil segments suspended in reticulate ice lenses with a mean thickness of 11?48mm and a maximum thickness of about 160mm. The shapes of the soil segments matched their neighbours. Other features included soil segments suspended in the ice veins shaped like En echelon gash veins, and the presence of a radial structure of ice-rich and sediment-rich frozen bands. These features in the core all suggest a differential stress field during and after heaving of the mound due to ice segregation, acting as a more important factor than the thermal gradient, including its direction and water supply. Based on observations of the cross-section and isotopic analysis of the ice in the permafrost core, this lithalsa appears to have developed by syngenetic differential ice segregation, even after uniform thermal and hydrologic conditions, since these were followed by epigenetic creep deformation of the cryostructure, probably with a redistribution of ice due to non-coaxial shear. Given the complexity of the cryostructures in this lithalsa, the reconstruction of its development using cores samples from boreholes would have been very difficult, particularly since the dip angles of segregated ice lenses and soil segments suspended in the ice networks have changed. Laboratory experiments and numerical simulations, supported by field observations such as those in this paper, are needed to generate further insight into the growth processes of lithalsas.

Keywords: lithalsa, frost heave, frost mound, Altai, segregated ice, internal structure