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The Batagay megaslump in east Siberia as an archive of climate–permafrost interactions during the Middle and Late Pleistocene

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The Batagay megaslump (67.58 °N, 134.77 °E) is the largest known retrogressive thaw slump on Earth, and located in the Yana River Uplands near the town of Batagay in east Siberia. The slump headwall is about 55 m high and exposes ancient permafrost deposits that provide a discontinuous record of the Middle and Late Pleistocene that dates back to at least 650 ka.

In this contribution, we compile cryostratigraphic observations and dating results for the permafrost exposed in the Batagay megaslump. Both provide evidence for several periods of permafrost formation and degradation. Permafrost formation and stability during Marine Isotope Stage (MIS) 16 or earlier (lower ice complex), MIS 7–6 or earlier (lower sand unit), MIS 4–2 (upper ice complex), and MIS 3–2 (upper sand unit) are reflected by the presence of deposits hosting syngenetic ice wedges and composite (i.e., ice–sand) wedges. In contrast, permafrost thaw and erosion are indicated by sharp, erosional discordances above reddish and organic-rich layers and by the accumulation of woody (forest) remains in erosional downcuts below and above the lower sand unit, and above the upper ice complex. Permafrost thaw and erosion likely took place during one or several periods between MIS 16 and MIS 7–6 as well as during MIS 5 and the late Pleistocene–Holocene transition.

To gain seasonal-scale climate signals, we analyzed the stable isotope composition of ground ice (ice and composite wedges and pore ice) from all four main stratigraphic units reflecting permafrost aggradation exposed in the Batagay megaslump. Ice and composite wedges contain winter climate signals. Their distinctly depleted $\delta^{18}O$ values reflect the extreme continentality of the region with large seasonal temperature differences. Pore ice is mostly characterized by less depleted $\delta^{18}O$ values and rather reflects summer to annual climate signals subject to post-depositional isotopic fractionation.

To draw large-scale conclusions on climate–permafrost interactions we compare our data to independent climate and permafrost reconstructions from terrestrial (cave deposits, lake sediment cores, and permafrost deposits) and marine sediment cores across the Arctic.