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Multi-method dating of ancient permafrost of the Batagay megaslump, East Siberia

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Dating of ancient permafrost is essential for understanding permafrost stability and interpreting past climate and environmental conditions over Pleistocene timescales but faces substantial challenges to geochronology.

Here, we date permafrost from the world's largest retrogressive thaw slump at Batagay in the Yana Upland, East Siberia (67.58 °N, 134.77 °E). The slump headwall exposes four generations of ice and sand-ice (composite) wedges that formed synchronously with permafrost aggradation. The stratigraphy differentiates into a Lower Ice Complex (IC) overlain by a Lower Sand Unit, an Upper IC and an Upper Sand Unit. Two woody beds below and above the Lower Sand Unit represent the remains of two episodes of taiga forest development prior to the Holocene forest. Thus, the ancient permafrost at Batagay potentially provides one of the longest terrestrial records of Pleistocene environments in western Beringia.

We apply four dating methods to the permafrost deposits to disentangle the chronology of the Batagay permafrost archive – optically-stimulated luminescence (OSL) dating of quartz and post-infrared-stimulated luminescence (pIR-IRSL) dating of feldspar as well as accelerator mass spectrometry-based Cl-36/Cl dating of wedge ice and radiocarbon dating of organic material.

The age information obtained so far indicates that the Batagay permafrost sequence is discontinuous and that the Lower IC developed well before MIS 7, the overlying Lower Sand Unit formed during MIS 6, and the Upper IC and the Upper Sand Unit formed both during MIS 3-2.

Additional sampling for all dating approaches presented here took place in spring 2019, and is part of ongoing research to enhance the geochronology of the exceptional palaeoenvironmental

archive of the Batagay megaslump.