



The late Holocene climatic variations in Russian Altai (Central Asia) on the basis of glaciations radiocarbon chronology

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The Holocene glacier dynamics in Russian Altai have been proposed and debated by many researchers. The debate commonly centers on the age and the number of moraines. By now the glacier history of Russian Altai is reconstructed mainly through relative dating methods. Previous paleogeographical reconstructions based on absolute dating, which is a crucial component of glaciations and climate chronologies, are not well grounded due to the lack of absolute dates. Recent glacier retreats and ice degradation in moraines lead to exhumation of organic material which makes possible the radiocarbon dating. We report 57 radiocarbon dates from dead trees toppled by moraines and at the upper tree limit on trough slopes, peat layers that cover moraines and wood remains from proglacial forefields within six glacial valleys of the North-Chuya Range, SE Altai (Russia). Such numerous set of dates for the vast but unified in neotectonic and climatic conditions area is obtained for the first time in Altai study history. Together with 42 radiocarbon dates obtained by our predecessors they were used for basing the glacier activity in a time period from 7 ky BP to the first half of XIX century.

New data refute traditional conception of the Russian Altai Holocene glaciations as a consecutive retreat of the late Wurm glaciers and argue their complete degradation already by the 7 ky BP. With the exception of Akkem stage (about 4.9 - 4.2 ky BP) further glacier advances had distinctly smaller magnitudes. We present the chronology of three last glaciers activizations (Akkem stage (4.9 - 4.2 ky BP); Historical stage (2.3 - 1.7 ky BP); Aktru stage (Little Ice Age XIII-XIX centuries)) and interstage warming (the Holocene and medieval optimums), that leave persistent imprints on landforms. In addition to radiocarbon data time limits of the Historical stage were specified more correctly using unique dendrochronological and archaeological data from Scythian burials of Pazyryk culture in SE part of Russian Altai.

Repeated forest renovations in modern glaciations area indicates significant retreat or even complete glacier degradation during interstage warming. Abrupt glaciers advances during Akkem stage was caused by coincidence of extrems of temperature lowering and humidity increasing. The Holocene climatic variations in Russian Altai obtained by glaciations chronology were intense, but their amplitude reduces from past to present. The decreases of glacier's length in every following stage in the Holocene also argue to aridity intensification. Moreover the thermal minimum of the middle of XIX century, the greatest in the last millennium, did not influence positively the mass balance of glaciers, which also confirm this conclusion.