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Complex patterns of glacier advances during the Lateglacial in the Chagan-Uzun Valley, Russian Altai

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Over the last decades, numerous paleoglacial reconstructions have been carried out in Central Asian mountain ranges because glaciers in this region are sensitive to climate change, and thus their associated glacial deposits can be used as proxies for paleoclimate inference. However, non-climatic factors can complicate the relationship between glacier fluctuation and climate change. Careful investigations of the geomorphological and sedimentological context are therefore required to understand the mechanisms behind glacier retreat and expansion.
In this study we present the first detailed paleoglacial reconstruction of the Chagan Uzun valley, located in the Russian Altai. This reconstruction is based on detailed geomorphological mapping, sedimentological logging, in situ cosmogenic 10Be and 26Al surface exposure dating of glacially transported boulders, and Optically Stimulated Luminescence (OSL) dating.
The Chagan Uzun valley includes extensive lobate moraine belts (>100 km2) deposited in the intramontane Chuja basin, reflecting a series of pronounced former glacial advances. Observation of “hillside-scale” folding and extensive faulting of pre-existing soft sediments within the outer moraine belts, together with the geomorphology, indicate that these moraine belts were formed during glacier-surge like events. In contrast, the inner (up-valley) glacial landforms of the Chagan Uzun valley indicate that they were deposited by retreat of temperate valley glaciers and do not include features indicative of surging. Cosmogenic ages associated with the outermost, innermost and intermediary stages, all indicate deposition times clustered around 19.5 ka, although the 10Be ages of the outermost margin are likely slightly underestimated due to brief episode of glacial lake water coverage. Such close deposition timings are consistent with periods of fast or surge advances, followed by active glacier retreat. OSL dating yields significantly older ages of thick lacustrine accumulation along the Chagan Uzun River, which confirms the presence of lacustrine sediments in the Chagan Uzun glacier foreland before the glacier advances. Such sediments could have acted as a soft bed over which fast or unstable glacier flow occurred.
This is the first study reporting surge-like behaviour of former glaciers in the Altai mountain range, supported by detailed geomorphological and sedimentological evidences. Such findings are crucial for paleoclimate inference, as the surge-related features cannot be attributed to a glacier system in equilibrium with the contemporary climate, and cannot be interpreted with traditional ELA reconstructions. This study also highlights the complexity of establishing robust paleoglacial chronologies in highly dynamic environments, with interactions between glacial events and the formation and drainage of lakes.