Central Asia Paleoglaciation Project: Assessing the robustness of cosmogenic nuclide dating in reconstructing regional patterns of glaciation

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Abstract

Cosmogenic nuclide exposure dating has emerged as a powerful tool in reconstructing the timing and impacts of past glacier fluctuations, a key element for understanding interactions between the cryosphere and changing climate. Exposure ages from glacial deposits such as moraines typically provide constraints on the minimum ages of glacier advance to this limit. As an international team, we have reconstructed glacial histories of several regions across Central Asia, including parts of the eastern Tibetan Plateau and along the Tian Shan and Altai Mountains. Results to date show significant variations in the timing and extent of glaciation; during the global last glacial maximum (marine oxygen isotope stage, MIS, 2), the southeast Tibetan Plateau, the Tian Shan, and Altai Mountains had extensive valley and ice cap glaciation, in contrast to areas in central and northeast Tibetan Plateau that had very limited valley glacier expansion.

However, some important questions remain: how reliable are exposure ages from moraines and how well can the chronological control be used to tell whether glaciers advanced only locally or across a wider region? To quantify the robustness of the dating control, we compiled, recalculated, and statistically evaluated available exposure ages from the Tian Shan (25 locations). We find that correlating glacial

stages along this mountain range remains a difficult task due to the large observed scatter in surface exposure data for individual moraines. Our analysis shows that we can only clearly define/correlate glacial stages during MIS 2 (15-28 ka) and, based on our statistical criteria, only one site has a robust dating control indicating moraine deposition during MIS 3 (29-57 ka). Correlation between glacial stages prior to MIS 2 is less reliable because of the low resolution of the dating control. At present this record only allows for a climate inference for MIS 2 that, in the absence of glacier and climate modeling results, appears to indicate regional patterns of pronounced aridity.