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Comparison of different methods for dating glacial features in Central Asia

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Reconstruction of spatio-temporal changes in paleoenvironmental conditions is crucial to the development and testing of climate change models. Mountain glaciers, which are especially sensitive to climate change, constitute a particularly advantageous proxy, as they are abundant and widely distributed, and moraines and other landforms resulting from their former extent can provide location-specific information about paleoclimatic conditions. Extracting paleoclimatic information from paleoglaciological data involves establishing reliable local glacial chronologies that can then be correlated at regional and hemispheric scales. Hence, the successful application of this method requires robust dating of glacial landforms.

Beyond traditional radiocarbon dating (14C), the main modern dating methods used for establishing a chronological framework of past glaciations in mountain environments are optically stimulated luminescence (OSL), terrestrial cosmogenic nuclide (TCN), and sometimes electron spin resonance (ESR) techniques. Each method is based on specific physical phenomena and properties of the geological material used, which limit the situations in which they can be used. Organic material necessary for 14C dating is often absent in glacial landforms. For the OSL and ESR techniques, a major source of uncertainty is the assumed effectiveness of the signal resetting processes during sediment transport and for the TCN technique, nuclide inheritance and complex exposure history of samples can be problematic. In addition, the “age” obtained by analysis of different materials from different parts of a glaciated landscape may represent different stages of a period of glacial advance and retreat.

To enhance our understanding of the appropriateness and robustness of the OSL, TCN and ESR dating techniques for constraining the timing of glacial advance and retreat, we are comparing these three methods at a series of key locations in Central Asia (as part of the multinational Central Asian Paleoglaciology Project). Four sites were identified that have abundant glacial landforms potentially suitable for applying the three dating methods: Bogeda Peak area (Tian Shan, China), Chagan Uzun valley (Altai, Russia), Nurgan valley (Altai, Mongolia) and Kanas valley (Altai, China). For each site, TCN, OSL and ESR sampling have been complemented by detailed geomorphological observations.
Initial OSL analyses provide some insights into luminescence properties of the samples and efficiency of signal resetting processes in high mountain glacial environments and yield tentative ages. TCN and ESR analyses are in progress.

The OSL results are novel in that there are almost no previous studies addressing high alpine glacial envi-

ronments, and the forthcoming ESR and TCN results will provide another novel dataset against which to evaluate the merits of each dating technique.