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Timing of glaciations in south and west Tibet determined by cosmogenic ^{10}Be dating

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The Himalayan Mountains contain the highest concentration of glaciers outside of the Polar regions and glaciers in many parts of the region have undergone significant retreat in the last century. They are sensitive climatic markers and are either advancing or withdrawing with the temperature and/or precipitation variations. Looking at their fluctuations on the long-term (in our case, several ka, up to about 300 ka) allows some assumptions regarding past climatic changes during the Late Quaternary. In particular, the reconstruction and dating of the former extent of glaciers in these areas is essential for paleoclimatic modeling that are used to predict future climate change.

The relative importance of glaciations varies throughout the region and the Quaternary glaciations may have been asynchronous between different regions of Tibet and the Himalaya. Some studies indicate that, although glaciations throughout these regions were broadly synchronous, they were out of phase with fluctuations of the Northern Hemisphere ice sheets. The Himalayan regions contain impressive successions of moraines that record multiple glaciations and a detailed reconstruction of their chronology is required to understand the relationships between the glacial, climatic and hydrologic systems. Timing of glaciations in Tibet is hard to determine because of the vastness of the region and few glacial successions have been numerically dated. Where studies have been undertaken, controversy exists over the extent and timing of former glaciations in the Himalaya and Tibet, more specifically, concerning the importance of the LGM relatively to previous advances.

Here we present surface exposure dating (cosmogenic ^{10}Be) of glacial moraines at 8 sites in south and west Tibet, mostly along the Southern Karakorum Fault (KF), between Bangong Lake and the Kailas. Multiple samples (10 in average) were collected from each moraine to ensure reproducibility of the measurement and to test for post-abandonment evolution of the moraines. The number of ages obtained (88 samples), distributed over a region of about 480 km x 720 km, allow to discuss climate changes at the regional scale from the glacial advances and retreats deduced at each site.

The distribution of ages shows that the advances occurred during the coldest epochs of the last and penultimate glacial cycles, when the climate is the coldest, MIS-2 (LGM, $\sim$ 20 ka), late MIS-3 ($\sim$ 40 ka), and MIS-6 ($\sim$ 135 ka). Glaciers rarely advance when the climate is the warmest. We observe that about 70% of our ages are younger than 50 ka with LGM and MIS-3 peaks. The view that LGM advance is not prominent in the Western Himalayas and Karakorum, and in Tibet in general, may only reflect insufficient sampling. The several climatic records available, global: Specmap, Vostock, Marine Oxygen Isotope, or local: Guliya and Dunde ice caps, show the same tendency at the same time for all the data. We observe that while the relative amplitudes of the signals revealed by the different proxies vary, the dates seem to correlate. They also correspond well with our dated peaks of glaciations in southern and western Tibet.