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The Lateglacial deglaciation history of the high Alpine Gotthard Pass, Switzerland, based on cosmogenic 10Be and in situ 14C

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Rapid downwasting of the large piedmont glaciers in the Alpine foreland marks the onset of the Alpine Lateglacial and the beginning of gradual climate warming after the Last Glacial Maximum (LGM). While the chronology of ice decay and glacier readvance during the Lateglacial is relatively well known for the foreland and the inner Alpine valleys, the timing of the breakdown of the large high Alpine ice cap(s) is less well constrained. To improve the understanding of the effect of climate change on the high Alpine mountain glaciers, we have performed surface exposure dating using cosmogenic 10Be and in situ 14C analysis of bedrock surfaces on the Central Alpine Gotthard Pass, Switzerland. Dating was combined with detailed mapping of glacial erosional features (e.g. crescentic gouges, glacial striae). These give evidence for a gradual glacier downwasting from the maximum LGM ice volume causing a progressive re-organization of the paleoflow pattern and a southward migration of the ice divide. The oldest exposure ages obtained by 10Be ($\sim$16-15 kyr; snow corrected) are interpreted to reflect the decay of the large Gschnitz glacier system which post-dates deglaciation of the foreland by a few thousand years. Thus, continuous ice cover and glacier transfluence over the pass may have persisted throughout the Oldest Dryas, possibly until the onset of the Bølling warming. These data indicate that the timing of glacier recession and climate change in the high Alpine regions cannot easily be correlated with the chronology obtained for the Alpine lowlands.

A younger phase of local glacier re-advance is evident from the erosional features and is consistent with another group of 10Be exposure ages of $\sim$12-13 kyr. These are correlated with the decay of glaciers associated with the Younger Dryas Egesen stadial. The Egesen ice volume remained comparatively small and followed a topographically controlled paleoflow pattern. Dating of a boulder close to pass elevation that was probably deposited during final glacier re-advance gives a minimum age of $\sim$11 kyr for final deglaciation by the beginning of the Holocene. Preliminary in situ 14C data are overall in good agreement with the 10Be ages and confirm continuous exposure throughout the Holocene. In situ 14C provides constraints on the amount of Holocene snow cover and, thus, on the snow correction that should be incorporated in the exposure age calculations.