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The Lateglacial to Holocene transition as recorded by glacier fluctuations

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Examination of glacier associated records may contribute to a better understanding of the ice-continent-ocean-atmosphere interactions, since glacial deposits related to short-term temperature fluctuations, driven by climate change, might be preserved. Surface exposure dating (SED) of such glacial deposits can improve the chronology of climate records. The western Swiss Alps repeatedly hosted mountain glaciers during the Pleistocene, and even during the Last Glacial-Interglacial transition, with abundant stadial and interstadial transitions during the Lateglacial (e.g. Björck et al. 1998).

In this study, the adjacent valleys of Belalp and Great Aletsch (catchment area is generally south facing) in the western Swiss Alps are investigated. The slow responding Great Aletsch valley glacier shows only one confirmed moraine ridge related to the Lateglacial (Egesen stadial) (Kelly et al. 2004). However, the rather fast responding Unnerbäch cirque (recent) glacier at the Belalp (a similarly exposed - and tributary - valley to the Great Aletsch valley), features 6 individual lateral-terminal moraine ridges related to Lateglacial and early Holocene times. In the Belalp valley, 22 erratic boulders from four out of six well-preserved moraines were sampled in order to establish a detailed chronological framework. From the Great Aletsch valley four samples (boulder and ice moulded bedrock) of the lateral moraine were collected for SED.

Our ^{10}Be exposure dates suggest a stabilization of the Great Aletsch moraine related to the Egesen advance in the beginning of the Younger Dryas, assuming that the ages of the oldest erratic boulders on a single moraine ridge are representative for the time of moraine stabilization (Putkonen & Swanson, 2003). According to our investigations on the right-lateral moraine and the dataset (recalculated from Kelly et al. 2004) for the left-lateral moraine, the Egesen stadial is the first preserved re-advance after the last deglaciation. In contrast, the glacier at the Belalp shows multiple advances during the Lateglacial to early Holocene. ^{10}Be exposure age data suggest that the outer moraine ridge can be an advance older than the Egesen stadial and younger than the LGM. This is in concert with other Younger Dryas related glacial landsystems in Switzerland (reviewing the outer moraine ages e.g. Julier Pass, Ivy-Ochs et al. 1996, 2008).

A large number of Lateglacial moraines have been identified and relative correlations on the basis of elevation, equilibrium line altitude (Gross et al. 1977; Maisch, 1987) and morphological characteristics have been established. Nevertheless, it remains important to refine the absolute chronology in order to put further temporal constraints on these relative frameworks. This allows the allocation of such absolutely dated deposits to distinguished cold phases (Preboreal oscillation, Younger Dryas, Aegelsee oscillation) thus underlining their potential significance in the context of regional, as well as global Lateglacial climate conditions. The ^{10}Be exposure ages from an inner moraine ridge are in a good agreement with the recalculated previously published ^{10}Be exposure ages from the Egesen moraines in the Alps. This suggests a synchronicity of the Egesen stadial in the European Alps at the end of the Younger Dryas cold phase.

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