GLACIER RESPONSE IN THE EUROPEAN ALPS TO HEINRICH EVENT 1 COOLING: THE GSCHNITZ STADIAL

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The Gschnitz stadial moraines at Trins Austria stabilized no later than 15,400 ± 1100 years ago. Based on the age of the moraine and the cold and dry climate, we suggest that the Gschnitz stadial was the response of Alpine glaciers to cooling of the North Atlantic associated with Heinrich event 1.

The Gschnitz stadial was a period of regionally-extensive glacier advance in the European Alps that lies temporally between the breakdown of the Last Glacial Maximum (LGM) piedmont lobes and the beginning of the Bølling warm interval. Moraines of the Gschnitz stadial are found in medium to small catchments, are steep-walled and blocky, and reflect a snowline lowering of 650-700 m in comparison to the Little Ice Age (LIA) reference snowline. ^{10}Be surface exposure dating of boulders from the moraine at the type locality at Trins (Gschnitz Valley, Austria, 1230 m) (Fig. 1) shows that it stabilized around 15,400 ± 1100 yr ago [1]. The ages were calculated using 5.1 ± 0.3 ^{10}Be atoms (gram SiO_2)$^{-1}$ year^{-1}) as sea level, high latitude production rate (2.6 % production due to muons) [2]. Based on the overall morphological situation and the long reaction time of the glacier we suggest that the climatic downturn lasted about 500 ± 300 yr indicating that the Gschnitz cold period began approximately 15,900 ± 1200 yr ago.

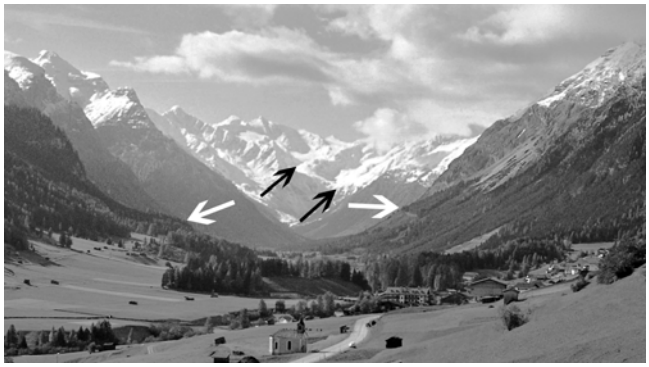

Fig. 1: View of the moraine arc of Trins. The end moraine is represented by the forested ridge crossing the valley in the foreground. The white arrows mark the uppermost position of lateral moraines. The lower black arrow marks position of Egesen Stadial (Younger Dryas) glacier end, the upper black arrow gives the approximate position of the LIA glacier end of Simmingferner (hidden behind bedrock ridge). The highest peaks in the background are between 2900 m and 3200 m (photo: H. Kerschner).

The Gschnitz Valley glacier was characterized by low mass turnover and negative or only slightly positive summer temperatures at the ELA (equilibrium line altitude). This is typical for modern glaciers in the Subarctic. For a glaciologically realistic ice flux scenario, precipitation was two thirds less than today and summer temperatures were lower by ca. 10 K. This is much colder and drier than it was during the Younger Dryas. At that time precipitation in this area was only about 10% less and summer temperatures was only 3.5 - 4 K lower than modern values [3]. During the LIA, summer temperatures were only 0.5 K lower.

Clark and Bartlein [4] and more recently Licciardi et al. [5] compiled evidence from several sites in North America where mountain glaciers readvanced about 16,000 yr ago. Based on ELA differences, the Gschnitz stadial advance in the Alps represented one-half to two-thirds that of LGM glaciers. Gschnitz stadial glaciers were significantly smaller in volume. In contrast, the 16,000 yr ago readvance in western North America was, in many cases, similar in extent to that of the LGM (cf. [6]). In northern Europe, ice sheets readvanced significantly several thousand years after abandoning their most extensive LGM positions, e.g. [7]. The suggestion is that early warming evidenced by glacier contraction right after the peak of the LGM was interrupted by cooling of the North Atlantic caused by the fleets of icebergs released during Heinrich event 1 (H1) (e.g. [7]).

Within the resolution of the dating methods, the Gschnitz stadial is contemporaneous with H1 (17,000-15,000 yr ago), a time during which early deglacial warming was slowed or reversed. A very cold North Atlantic during H1 led to a pause in the delivery of warm moist air masses that today ameliorate the climate of Europe. Thus, the Alps directly record past variations in heat and moisture flux brought by the prevailing westerlies as volume changes in mountain glaciers. Finally, the possibility that H1 was a global phenomenon must not be overlooked, as synchronous glacier advances around 16,000 yr ago have also been recorded at several Southern Hemisphere sites (e.g. [8]).

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