

Younger Dryas glaciation and climate in the central Swiss Alps – first results.

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The Younger Dryas was the last return to severe cold conditions prior to early Holocene warming and is recorded in several lateglacial proxy records in Europe and elsewhere on Earth. Although isolated studies on Younger Dryas glacier extent exist in some areas of the Swiss and Eastern Alps, attempts to synthesise the gathered data have not been undertaken yet. In addition, studies conducted so far largely concentrate on mapping and dating Younger Dryas moraines, by surface exposure dating (SED) or radiocarbon dating of associated organic deposits. We here present an approach that combines glacier reconstruction with palaeoclimatic parameters using examples from formerly glaciated valleys in the Ticino. The approach is centred on the notion that once a glacier surface has been reconstructed by geomorphological means, its equilibrium-line altitude (ELA) can be calculated. Potential problems such as unknown former ablation and accumulation gradients across the glacier can be alleviated through the use of data from modern glaciers in Switzerland, for which such data are available. If independent summer temperature estimates exist, e.g. from chironomids, pollen or coleoptera, annual precipitation at the ELA can be reconstructed using empirical relationships such as that of Ohmura et al. (1992). Therefore, glaciers act as a direct tool for reconstructing palaeo-precipitation (cf. Kerschner et al., 2000). They are thus invaluable for the understanding of past climate variability and, in terms of providing palaeo-tie points, as constraints on numerical models that seek to predict future climate change (e.g. Benn and Lukas, 2006). In addition, the distribution of glaciers across a larger area, such as the Swiss Alps, would also indicate the predominant wind direction at the time of formation since wind is an important (re-) distributor of precipitation.

Geomorphological mapping shows that Younger Dryas glacial landsystems in the Ticino, which had hitherto not been reported in the literature, are characterised by 3-6 large moraine ridges that are several 100 m long, up to 200 m wide and 10-100 m high. All moraines are sharp-crested with steep proximal and distal slopes around 40°. Evidence of solifluction in or on these moraines has not been found indicating that permafrost did not reach their altitudes following moraine formation. In all cases, the distal slope is much shorter than the proximal one, indicating significant overdeepening of the glaciated basin prior to, and presumably also during, moraine formation. Frequent bifurcations of crestlines and moraine complexes suggest that the glacier margins oscillated in response to climate change. However, the relatively small number of Younger Dryas moraines compared to other areas (e.g. Scotland; Benn and Lukas, 2006) appear to indicate long frontal response times of the glaciers. It is thus difficult to decipher whether the moraines were formed during sustained period of stability, e.g. by ice-marginal dumping (e.g. Zielinski and van Loon, 2000), or actually record frequent

oscillations that reached roughly the same location over a longer time period leading to the formation of larger moraines by pushing and dumping of frozen-on slabs of basal sediment (e.g. Matthews et al., 1995). Although early sedimentological observations appear to favour the first mechanism, more detailed investigations are necessary before a glaciodynamic model of moraine formation can be developed (cf. Lukas, 2005).

Early ELA calculations indicate that ELA depressions are systematically lower compared to the neoglacial ('Little Ice Age') maximum, but exhibit significant differences even in neighbouring valleys. The implications of these data, together with our sampling approach for SED, will be discussed in detail.

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