

How well do we really know the timing and extent of glaciers during the Last Glacial Maximum in the Alps?

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The Last Glacial Maximum (LGM) in the Alps saw much of the mountains inundated by ice. Several main accumulation areas comprising local ice caps and plateau icefields fit into a picture of transection glaciers flowing into huge valley glaciers. In the north the valley glaciers covered long distances (hundreds of kilometers) to reach the forelands where they spread out in fan-shaped piedmont lobes tens of kilometers across, e.g. the Rhine glacier. In the south travel distances to the mountain front were often shorter, the pathway steeper. Nevertheless, not all glaciers even reached beyond the front, as the temperatures were notably warmer in the south. For example at Orta the glacier snout remained within the mountains. Where glaciers reached the forelands they stopped abruptly and the moraine amphitheatres were constructed, e.g. at Ivrea and Rivoli-Avigliana. Sets of stacked moraines built-up as glacier advance was directly confined by the older moraines.

We may temporally and spatially identify the culmination of the last glacial cycle by pinpointing the outermost moraines that date to the LGM (generally about 26-24 ka). On the other hand, the timing of abandonment of foreland positions is given by ages of the innermost, often lake-bounding, moraines (about 19-18 ka). Between the two, glacier fluctuations left the stadial moraines. In the Linth-Rhine system three stadials have been recognized: Killwangen, Schlieren and Zurich. Nevertheless, already in the Swiss sector correlation of the LGM stadials among the several foreland lobes is not unambiguous.

Across the Alps, not only north to south but also west to east, how do the timing and extent of glaciers during the LGM vary? Recent glacier modelling by Seguinot et al. (2017) informs and suggests the possibility of differences in timing for reaching of the maximum extent and for the number of oscillations of individual lobes during the LGM. At present few sites in the Alps have detailed enough geomorphological constraints with well-dated ice-marginal positions for in depth discussion of outermost, innermost and in between moraines. Where locations of the LGM farthest extent are conflicting depending on author, we are trying to establish the precise location of the most extensive LGM position by directly dating moraine boulders with cosmogenic ^{10}Be . Here we present ^{10}Be data from the Orta and Rivoli-Avigliana amphitheatres. A key comparison is with the Tagliamento amphitheatre to the east, where dating testifies to a two-phase maximum (Monegato et al. 2007). Furthermore, comparison is made to sites north of the Alps including previously unpublished data.

Monegato G. et al. 2007. Evidence of a two-fold glacial advance during the last glacial maximum in the Tagliamento end moraine system (eastern Alps). *Quaternary Research* 68: 284-302.

Seguinot J. et al. 2017. Modelling last glacial cycle ice dynamics in the Alps. EGU2017-8982