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10Be dating of the end of low-altitude rock glacier activity in the Alps - evidence for cold conditions during the early Preboreal.

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Large relict rock glacier complexes are conspicious features in the Alps. Their occurence can roughly be subdivided into a "lower rock glacier belt", which reaches down to about 1900 m a.s.l., an "intermediate rock glacier belt" with rock glacier snouts at around present-day timberline (approx. 2200 m a.s.l) in the central Alps and an "upper rock glacier belt" at similar altitudes as presently active rock glaciers.
All these rock glaciers indicate the former presence of discontinuous permafrost at their respective altitudes and are good indicators for the mean annual air temperature during their active period.
The end of rock glacier activity at a given altitude marks also the end of the existence of permafrost conditions. Experience from the Alps shows that it may take about a century until the surface of a rock glacier is stabilized, Hence, if it is possible to date the surface of a relict rock glacier with 10Be, we get a close date for the end of permafrost activity at the altitude of the rock glacier. From the difference between the altitude of the relict rock glacier and presently active rock glaciers, the rise of mean annual air temperature can be calculated.
Relict rock glaciers at present-day timberline at Julierpass (Swiss Alps) and at Larstigtal (Austrian Alps) gave ages in the order of 10.5 ka BP for surface stabilization. Both rock glaciers, which belong to the "intermediate rock glacier belt", developed from lateral moraines and scree slopes. They started to move into former glacier beds after ice recession from the Younger Dryas "Egesen" advance.
Their age indicates that climatic conditions favouring permafrost existence about 300 - 400 m below 20th century permafrost occurence prevailed during most of the Preboreal. Taken together with the Kartell glacier advance (10.8 ka) they show that rapid climatic warming at the Younger Dryas / Holocene boundary was followed by more unstable climatic conditions and and somewhat slower warming until full Holocene climatic conditions were reached by ca. 10.5 ka or perhaps a little earlier. Mean annual air temperatures should have been about 2.5 K lower than during the 20th century.
Since then, there has been no time window long enough to allow the formation of large rock glaciers at low altitudes.

Ivy-Ochs, S., H. Kerschner, M. Maisch, M. Christl, P.W. Kubik, Christian Schluechter: Latest Pleistocene and Holocene glacier variations in the European Alps. Quaternary Science Reviews 28 (2009), 2137-2149.