Correspondence

Reply to comments by Kovanen and Begét on “Early Holocene glacier advance, southern Coast Mountains, British Columbia, Canada”

Kovanen and Begét question an advance of alpine glaciers in the southern Coast Mountains of British Columbia during the 8200-yr cold event (Menounos et al., 2004). We welcome the opportunity to clarify the points we made about evidence for glacier fluctuations at Mount Baker reported by Thomas et al. (2000) and to counter arguments that Kovanen and Begét make to discount the evidence for the 8200-yr cold event in the southern Coast Mountains.

The statement in our paper pertaining to the chronology of Thomas et al. (2000) was made in the context of an apparent lack of evidence at Mount Baker for a glacier advance at 8200 cal yr BP. We proposed possible explanations for this apparent lack of evidence. Kovanen and Begét (2005) counter our explanations by: (a) summarizing what they consider to be unique hypsometry and mass-balance gradients of glaciers at Mount Baker; and (b) describing sequences of terrestrial deposits on the flanks of the volcano that suggest an advance of glaciers corresponding to the 8200-yr cold event. They suggest that glaciers on Mount Baker have steep mass-balance gradients, but they do not explain why steeper mass-balance gradients might change the relative magnitude of probable early Holocene and Little Ice Age glacier fluctuations or the preservation of early Holocene glacier deposits. Hypsometric differences between mountains do not account for the relative extents of early Holocene and Little Ice Age glaciers being greatly different from mountain to mountain. In any case, their argument is tangential to whether the 8200-yr cold event caused glaciers at Mount Baker to advance.

Kovanen and Begét’s major criticism of our work relates to the uncertainty in our age estimates and to multiple sources of clastic units in proglacial lake sediments. They suggest that our radiocarbon dating does not allow us to correlate clastic intervals in three lake basins (two in the southern Coast Mountains and one in the Canadian Rockies) to the 8200-yr cold event. Our argument, however, rests on multiple lines of indirect evidence for glacier fluctuations: overlapping age ranges for five detrital wood samples collected in two separate glacier forefields, and clastic intervals in downvalley lake sediment records. The terrestrial evidence, together with the lake sediment records and overlapping age ranges of the two data sets, is a strong indication of a glacier advance coinciding with the 8200-yr cold event. The pooled radiocarbon age (7640 ± 25 14C yr BP) of the five detrital wood samples presented in Menounos et al. (2004) has a 95% calendar age range of 8450–8380 cal yr BP. This range differs from the range quoted in our paper (8630–8020 cal yr BP) because the latter is based on maximum and minimum ages of each wood sample. Both age ranges are consistent with the best age estimates of the 8200-yr cold event recorded in the annually resolved Greenland ice cores (8400–8000 cal yr BP; Alley et al., 1997; Alley and Ágústsdóttir, 2005) and in a speleothem from Ireland (8490–8170 cal yr BP; Baldini et al., 2002).

Kovanen and Begét do not acknowledge half of our data set, namely the terrestrial record of glacier fluctuations. The use of both dated detrital wood in glacier forefields and downvalley lacustrine deposits to infer a glacier advance is one of the key contributions of our paper. We commented on the danger of using either of these types of evidence alone to infer glacier fluctuations, given that each can arise from non-glacial processes.

Kovanen and Begét are inconsistent in their interpretation of lake sediment records. They comment on the poor temporal resolution afforded by lake sediments to constrain glacier fluctuations, yet they cite the lake sediment evidence presented by Heine (1998) to support their claim for a glacier advance in the Cascades prior to the 8200-yr cold event. Many of the radiocarbon ages presented by Heine (1998) are from bulk sediments, and such ages typically are unreliable (MacDonald et al., 1987; Reasoner and Jodry, 2000).

Kovanen and Begét incorrectly recalculate sedimentation rates for the clastic interval reported in our paper by using the AMS radiocarbon age above Mazama tephra in the Lower Joffre Lake sediment core as the minimum-limiting age of the clastic event. This error artificially extends the uncertainty Kovanen and Begét place on the age of the clastic event by ca 70 yr. In addition, they quote a minimum-limiting age for the clastic event that is ca 160 younger than the minimum-limiting age ascribed to Mazama tephra (Hallett et al., 1997).
Kovanen and Begét also argue that an interpretation made by Davis and Osborn (1987) is incorrect. The argument relates to a deposit on Glacier Peak, Washington, referred to as the White Chuck Moraine by Begét (1981). The relevance of this argument to Menounos et al. (2004) is not clear because we present neither empirical data nor statements that support or deny the origin of the deposit. Because Kovanen and Begét raise the issue, however, we reiterate the key points made by Davis and Osborn (1987): (a) they could not find Kovanen and Begét’s lateral moraine during a visit to Glacier Peak; (b) the “ground moraine” that yielded Begét’s (1981) dated charcoal could be colluvium; (c) the dated charcoal could be considerably younger than the ridges even if those ridges are moraines; and (d) it is unlikely that early Holocene ice from the small cirque upslope from the cinder cone flowed up and over the inner (west) rim of the cone, crossed its floor, and then rode up onto the outer (east) rim. More likely, early Holocene ice, if present, was diverted around the north side of the cone, consistent with the behavior of Little Ice Age glaciers there.

A general, and still unresolved, problem relating to the interpretations of Begét (1981) at Glacier Peak and Heine (1998) at Mt. Rainier is the implied magnitude of ELA depressions during their reconstructed early Holocene advances, relative to Little Ice Age values (~550 m in the case of Mt. Rainier), at a time when solar insolation values were close to maximum Holocene values. Their evidence for early Holocene glaciers that were more extensive than glaciers during the Little Ice Age stands in marked contrast to evidence elsewhere in the Pacific Northwest (e.g., Kaufman et al., 2004).

In closing, based on our reading of Thomas et al. (2000), the possibilities presented by us for the lack of evidence of the 8200-yr cold event at Mount Baker are well founded. Kovanen and Begét suggest that moraines at Mount Baker and Glacier Peak might correlate with the 8200-yr cold event, yet they seem to disagree that such correlations can be made in the southern Coast Mountains where there is, arguably, better age control and more than one type of supporting evidence. More importantly, they criticize us by isolating complementary records of glacier fluctuations that were not meant to be discussed out of context. When these lines of evidence are considered together, however, they provide strong support for a minor advance of alpine glaciers in the southern Coast Mountains during the 8200-yr cold event.

References


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