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Interactive Comment

Interactive comment on "LGM and Late Glacial glacier advances in the Cordillera Real and Cochabamba (Bolivia) deduced from ^{10}Be surface exposure dating" *by* R. Zech et al.

J. Smith (Referee)

smithj@strose.edu

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Zech et al. used surface exposure dating with cosmogenic ^{10}Be to date a total of 28 boulders on moraines in three valleys in the Bolivian Andes. As calculated using the scaling method of Lifton et al. (2005), the oldest exposure ages fell in the range 22-25 ka. Based on these results, Zech et al. reached two main conclusions: that the glacial advance that deposited the moraines was synchronous with the global last glacial maximum (LGM), and that previous studies of moraines in the Andes may have overestimated the exposure ages because of the manner in which the ages were calculated.

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The paper by Zech et al. makes a valuable contribution to the study of tropical and subtropical Andean paleoclimate. Zech et al. add 28 more numerical ages to the growing body of information about the timing of glacial fluctuations in the Andes. Perhaps more importantly, however, they continue to evaluate the various scaling methods used in calculating exposure ages. They correctly point out that differences between their local LGM (LLGM) and late-glacial moraine ages and the older LLGM and late-glacial ages from other studies in the tropical Andes (e.g., Smith et al., 2005a,b) are the result of differences in the scaling methods used in the calculations and not fundamental differences in the timing of glacial advances.

Specific comments:

1. In the Introduction (section 1), Zech et al. seem to suggest that Schaefer et al. (2006) and Smith et al. (2005a,b) are contradictory regarding termination of the LLGM in the Andes, but that does not appear to be the case. Schaefer et al. (2006) used the late-glacial moraine ages from Smith et al. (2005b) to support their hypothesis that the termination of the LGM was globally synchronous (ca. 17-18 ka). Smith et al. (2005a,b) proposed that the late-glacial moraines marked a stillstand or readvance following retreat from the LLGM ice margins downvalley, and that final deglaciation followed relatively quickly and steadily (in most valleys in the study areas) following deposition of the late-glacial moraines.

2. In section 4.1, the term “recessional terminal moraine” is ambiguous; “recessional end moraine” would be preferable.

3. In section 4.3, regarding the discussion of the effects of neotectonics on exposure ages, it should be noted that surface uplift rates are difficult to quantify. What is the source for the uplift rate of 5 mm/a used in the text? The 5 mm/a value is about 10 times higher than values typically used (e.g., Smith et al., 2005a; Gregory-Wodzicki, 2000).

4. In section 4.4.1, Zech et al. compare their results to those of Smith et al. (2005a,b)

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and Farber et al. (2005). Zech et al. recalculated selected exposure ages from Smith et al. (2005a,b) using the scaling method of Lifton et al. (2005) and obtained younger ages. The recalculated ages were from the Group C moraines in the Antacocha Valley (Peru), which had an age range of 30-25 ka as calculated with Stone (2000) scaling and geomagnetic correction (Smith et al., 2005a). Zech et al. observe that the recalculated ages from Smith et al. are in better agreement with their own results, then leap directly to a tacit conclusion that the recalculated values are correct and that the LLGM in the Central Andes occurred 22-25 ka. A more reasonable conclusion might be that Smith et al. and Zech et al. have dated correlative advances from the LLGM and late-glacial, but that we (the cosmogenic community) have not yet reached the point at which we can assign a definitive age to the advances.

5. In section 4.4.1, Zech et al. seem to dismiss the support for the Stone (2000) scaling method offered by the independent dating of the Breque moraine in Peru, while simultaneously endorsing the Breque site as a potential local calibration site.

6. In section 4.4.2, Zech et al. cite pairs of radiocarbon ages from Argollo (1980) and Servant et al. (1981). As discussed in Smith et al. (2005c), both pairs of ages were presented with incomplete background information when originally published. Because of the high level of uncertainty associated with these radiocarbon ages, one should probably avoid using them as supporting data.

7. In section 4.4.2, the discussion of the MS signal in core NE985PC from Lake Titicaca is somewhat misleading. Zech et al. state that the MS signal "reaches high values only between 25 and 20 ka BP." The graph of MS presented in Seltzer et al. (2002) shows that the MS signal was well above 0 (ca. 25-50 SI units x 10^{-5}) prior to 25 ka; the pre-25-ka signal appears low on the graph because the signal rose to very high levels (ca. 250-300 SI units x 10^{-5}) between 25 and 20 ka. The MS data do not support the contention that glaciers in the Titicaca watershed advanced only between 25 and 20 ka and not before then; on the contrary, the MS data suggest that glacial outwash was delivering sediment to the lake prior to 25 ka and as far back as 31-32 ka (bottom of

core NE985PC).

8. In section 4.4.3, the best estimates of age ranges for the Younger Dryas climate reversal and the Antarctic Cold Reversal should be included.

9. Section 5 should be revised to reflect comments 4-8 above. Specifically, the independent age control for the proposed LLGM 25-22 ka is less supportive than presently stated in the text, and in some cases is actually contradictory.

10. Zech et al. acknowledge that the relatively small dataset presented in the paper limits their ability to reach meaningful paleoclimate interpretations. In light of this limitation, they might consider qualifying their conclusions to a greater extent.

Technical comments: Sent to the authors.

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