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Climate of the Past Discussions

Interactive comment on "Exposure dating of Late Glacial and pre-LGM moraines in the Cordonde Doña Rosa, Northern/Central Chile (∼31° S)" *by* R. Zech et al.

Anonymous Referee #2

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General comments:

Zech et al. present new cosmogenic ^{10}Be surface exposure ages obtained from boulders on a suite of moraines in two valleys in the Cordon de Doña Rosa (approx. 31°S) in the Chilean Andes. This project builds on earlier work by the authors in the Encierro Valley (approx. 29°S), where they found evidence for a prominent glacial advance that they dated to approx. 14 thousand years before present (approx. 14 ka), as well as several stratigraphically younger moraines and a possible earlier advance. The authors are among the few workers using surface exposure dating to develop glacial chronologies in this climatically important section of the Andes. Zech et al. explain that both of

their recent study areas lie in or near the so-called “Arid Diagonal”, the transition zone in which the dominant form of precipitation delivery in the Andes shifts from summer easterlies in the tropics to winter westerlies in the higher latitudes.

For the present study, Zech et al. sampled a total of 22 boulders at three locations in the main valley of the Rio Los Molles and on six moraines in a tributary valley. The authors used the scaling method of Desilets and Zreda (2003) to calculate surface exposure ages for the boulders, acknowledging in the text that other scaling methods exist. The resulting 10Be exposure ages ranged from approx. 34 ka to 11.6 ka, with two older outliers (approx. 98 ka and 43 ka). The authors compared the surface exposure ages to the expected sequence of moraine ages based on stratigraphic setting (i.e., younger moraines upvalley of older moraines) and concluded that evidence for a late-glacial advance (approx. 15-11 ka) and for an older advance (approx. 35-29 ka) predating the global last glacial maximum (LGM, approx. 21 ka) was strong, but that dating of the stratigraphically oldest moraines was inconclusive. Zech et al. did not identify any moraines as being of LGM age.

Zech et al. conclude that the late-glacial advances probably reflect an increase in precipitation, perhaps as a result of moisture transport from the east by an intensified and southward-shifted Bolivian High. The authors do not discount the possibility of a northward shift of the westerlies during the global LGM, but note that they found no moraines of LGM age in either study area.

Zech et al. include a discussion of scaling methods and a comparison of the ages of two samples calculated using different scaling methods. The authors note that one of the methods (Stone, 2000) produces substantially different results than the others (specifically, older ages), including the method of Desilets and Zreda (2003). Readers should bear in mind that the paleoclimatic interpretation of the moraine sequence hinges on the chronology, which in turn is highly influenced by the scaling method used to calculate the ages. The interpretation would likely differ if the exposure ages were calculated using the Stone scaling system (for example, by using the CRONUS online

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calculators: http://hess.ess.washington.edu/math/). Zech et al. should be applauded for acknowledging that the cosmogenic community is still working toward a consensus on the best scaling methods to use in calculating surface exposure ages and that existing chronologies will likely be revised as the consensus emerges.

Zech et al. are using a relatively new dating technique to develop a numerical glacial chronology for a critical region that bridges the tropics and higher latitudes of South America. The final paper will be a valuable contribution to the small but growing body of paleoclimate research in the Andes.

Specific comments:

A brief statement about boulder lithologies would be enlightening, particularly for readers from the cosmogenic-dating community.

If ice actually flowed from west to east up the main valley (Rio Los Molles Valley), the exposure ages from DR8, DR9, and DR10 would make sense. This seems unlikely, as glaciers typically do not flow uphill, especially when it means gaining 500 m in altitude, but is there any possibility of this, or of some other unorthodox flow pattern?

The meaning of “re-calculated total reference production rate” in Section 4.2 (Systematic uncertainties - absolute glacial chronology) is not immediately apparent.

It would be interesting to see what happens to the sample ages if a geomagnetic correction is applied to the two sample ages calculated with the Stone scaling system (Section 4.2).

The last paragraph of Section 4.3.2 (Northward shift of the westerlies during the LGM and/or the pre-LGM?) should be expanded and clarified.

Technical corrections:

Returned directly to the authors.

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