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LATE GLACIAL RECORD OF THE QUELCCAYA ICE CAP

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INTRODUCTION

The spatial - temporal patterns of past climate changes are a key means to understand the processes that currently change climate and may impact present habitation of the Andes. Here, we report on fluctuations of Quelccaya Ice Cap (~14°S, 70°W, ~5200-5700 m asl) during late glacial time (~14.5-11,5 ka) and examine possible climate teleconnections between low and high latitude regions.

Quelccaya Ice Cap is the largest topical ice mass and cores from the ice cap yield valuable paleoclimatic data for the last 1500 years (e.g., Thompson et al., 2006). Currently, Quelccaya Ice Cap receives precipitation from the Atlantic Ocean and the Amazon Basin via the Easterlies. However, accumulation records from Quelccaya ice core records also show an El Niño-Southern Oscillation (ENSO) signal (Thompson et al., 1984). Mercer and Palacios (1977), Rodbell and Seltzer (2000), and Goodman et al., (2001) established a chronology of past extents of Quelccaya Ice Cap. Results presented here build in this chronological framework and further document the structure of events during late glacial time. The Huancané II moraines (defined by Mercer and Palacios, 1977) mark the most significant readvance of Quelccaya Ice Cap during late glacial time and represent a nearly continuous, former ice-margin position ~4-5 km from the present-day western ice cap margin.

RESULTS

We present twenty six new radiocarbon ages that afford maximum and minimum age brackets for the Huancané II moraines in two adjacent valleys (Huancané and South Fork valleys). Based on these ages, we suggest that the Huancané II moraines were deposited between 10.5 and 10.4 14C ka. When these ages are converted to calendar ages the summed probabilities of these ages overlap. We suggest an age of 12.4±0.1 cal ka.

Radiocarbon ages of peat and basal lacustrine organic material up valley from the Huancané II moraines in both valleys are 11.6-11.2 cal ka, indicating these moraines were likely deposited during late glacial time, not during the early Holocene. Our work also has identified three smaller moraine sets that lie between the Huancané II moraines and the Huancané I moraines which mark an ice cap advance during the last few hundred years. These intermediate moraines indicate that Quelccaya Ice Cap established equilibrium thrice during the relatively rapid retreat from the Huancané II moraines.

We also applied 10Be dating of boulders atop the Huancané II moraines. We calculate 10Be ages using the global production rate and four different methods for scaling the production rate to the high altitude, low latitude location. The means of eighteen ages determined using the four different scaling methods range from ~8.2-10.2 ka. We suggest that the difference between the ages of the Huancané II moraines determined using radiocarbon and 10Be dating results from uncertainties in the global 10Be production rate and the methods of scaling this production rate. We hope to use these moraines as a.

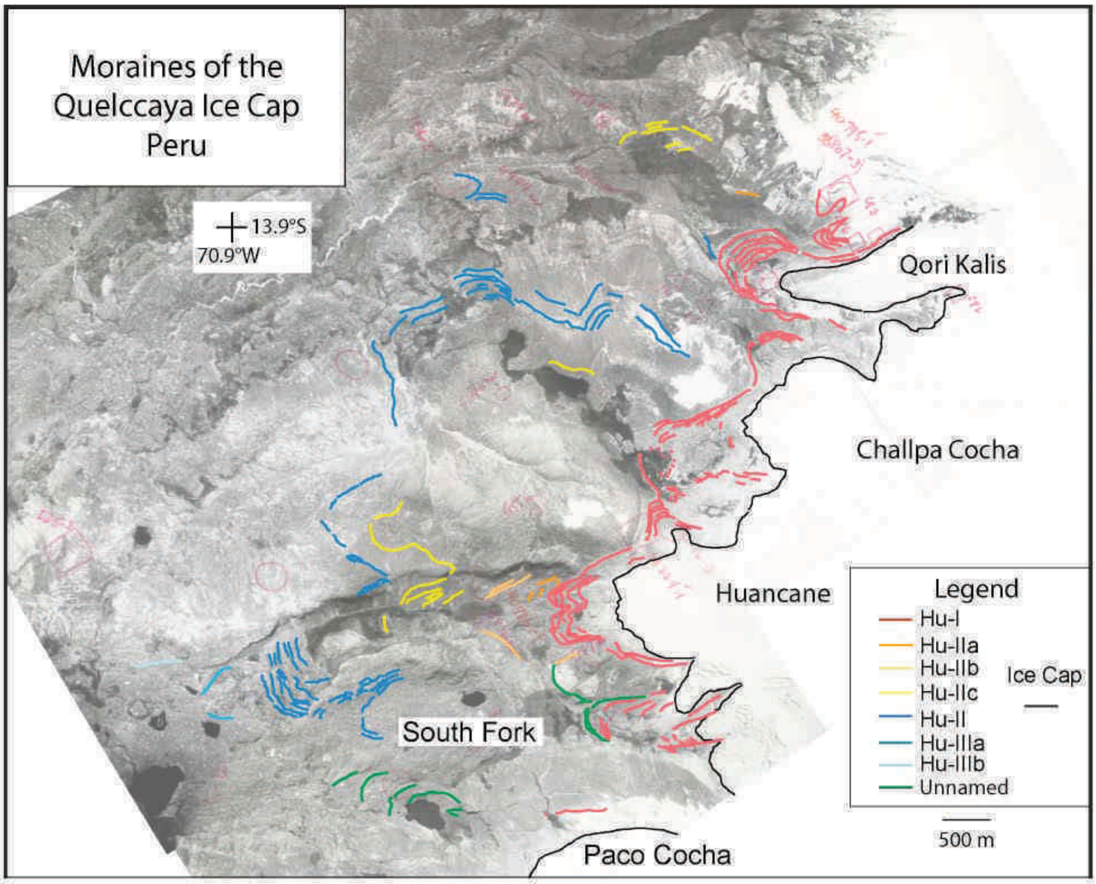

Figure 1. Western margin of the Quelccaya Ice Cap and moraines. Hu-I, Hu-II moraines after Mercer and Palacios (1977), others reported here for the first time.

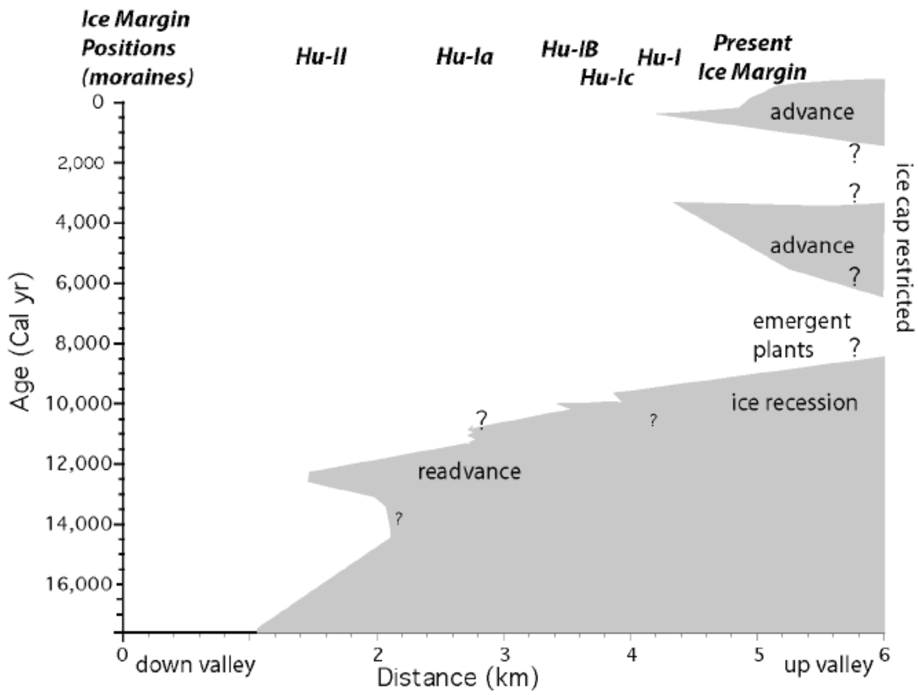

Figure 2. Working time-distance diagram showing extent of the western margin of the Quelccaya Ice Cap.

DISCUSSION

These results suggest that climate changes modulating the QIC during the late glacial are not in phase with well established records from either the Greenland or Antarctic ice cores. The readvance and retreat implies a shift in climatic conditions. This shift lies between the beginning and end of the socalled Younger Dryas cold period as established in the ice core (12.8-11.6 cal ka). Moreover, this event lags the end of the Antarctic Cold reversal (14.5 to 12.8 cal ka) by several hundred years. We note this event also occurs at a time when Lake Titicaca was at a high phase (Baker et al. 2001, Placzek et al.
2006). The simplest interpretation is that the retreat occurred before the drop in lake levels is for warming to occur at 12.4 cal ka. However, as Clement and Peterson (2008) point out changing the heat budget in the topics is an attractive concept but is difficult to explain in global simulations. This suggests our understanding of past climate changes in the Andes may be incomplete.

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