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Reconstruction of cryospheric changes in the semi-arid Andes of central Chile (33° S): an integrative approach using geomorphological mapping and surface exposure dating

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1. Abstract

The central Andes of Chile, a glaciated semi-arid mountainous area with elevations over 6000 m asl., are a climatically very sensitive zone, embracing a key location for uncovering the ENSO-like climate conditions during the (Late) Holocene. However, the evolution of local ice bodies since the last deglaciation (i.e., last ~12,000 years), and their feedback with climate is fairly unknown. Understanding ice variability in the semi-arid Andes of Chile during the pre-instrumental time can provide the urgent climate background before the $20^{th}/21^{st}$ century global warming, and is needed to assess local atmosphere-cryosphere linkages. Glacial landform preservation is excellent and provides an opportunity to reconstruct Holocene ice/climate fluctuations. This varied, natural heritage and geological archive in the Chilean Andes is nowadays not only threatened by climatic change but also economic activities (e.g., mining).

By applying an integrative geomorphologic and chronologic approach, we are able to study cryospheric changes and the long-term evolution of glaciers at three sites in watersheds around Santiago: Juncal Norte, Loma Larga and Nieves Negras glaciers (33º S). At all three sites, distinct moraine ridges are preserved. We distinguished at least three moraine systems of possible Holocene age. These prominent moraine belts show that glaciers were at least 5 km longer than at present. To determine the age of the Andesite boulders and hence, the moraine ridges upon which they rest, we use surface exposure dating with cosmogenic nuclides. These boulders are composed mainly of silicates and a small amount of quartz and therefore we will use ^{36}Cl nuclides to determine the age when the boulders were deposited by the glacier. Cosmogenic nuclides (^{10}Be, ^{26}Al and ^{36}Cl) are produced in rock due to cosmic ray induced reactions. We will complement our ^{36}Cl data with ^{14}C ages that suggest that the glaciers advanced at least twice, earlier than 2500 and earlier than 1000 years before present.

This is the first time moraines are directly dated using ^{36}Cl in central Chile and therefore we assess the potential of this terrestrial cosmogenic nuclide for future glacial geomorphologic applications in the area. We present first results, including a detailed geomorphological mapping and analysis of the landform dynamics. Deglaciation from these ice marginal positions was gradual and complex in response to the detrital cover on the glaciers. Differences in ice thickness of the main glaciers in the respective valleys amount to about 100 m. Due to the partial, extensive debris coverage, the glaciers diminished in thickness without significant retreat of the glacier front. Another geomorphological feature identified is the separation of ice facies, from ice dynamically flowing with an active ice front, to dead ice covered by debris. In parallel, paraglacial processes affect the morphology of the moraines.

2. References

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