^{36}Cl dating of Holocene moraines in the semi-arid Andes of central Chile: the case of the Maipo and Juncal river basins (33ºS)

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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 20th/21st 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 multifarious, patrimonial 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 study cryospheric changes and the long-term evolution of glaciers. Distinct moraine ridges at three glacier sites in watersheds around Santiago (the Chilean capital) are the focus of our research: Juncal Norte, Loma Larga and Nieves Negras glaciers (33ºS). At all three glaciers, we distinguished at least three moraine systems of a Holocene/Late glacial putative age. These prominent moraine belts show that glaciers were at least 5 km longer than at present. Figures 1 and 2 give an overview of the Loma Larga study site. The prevailing rocks are made up from silicates. We use ^{36}Cl cosmogenic nuclides to date boulders resting on top of moraine ridges and thereby reconstruct the regional glacial history. We complement our ^{36}Cl data with ^{14}C ages that suggest that glaciers advanced before ~2500 and then before ~850 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 active flowing ice to dead ice covered by debris. In parallel, paraglacial processes affect the morphology of the moraines.

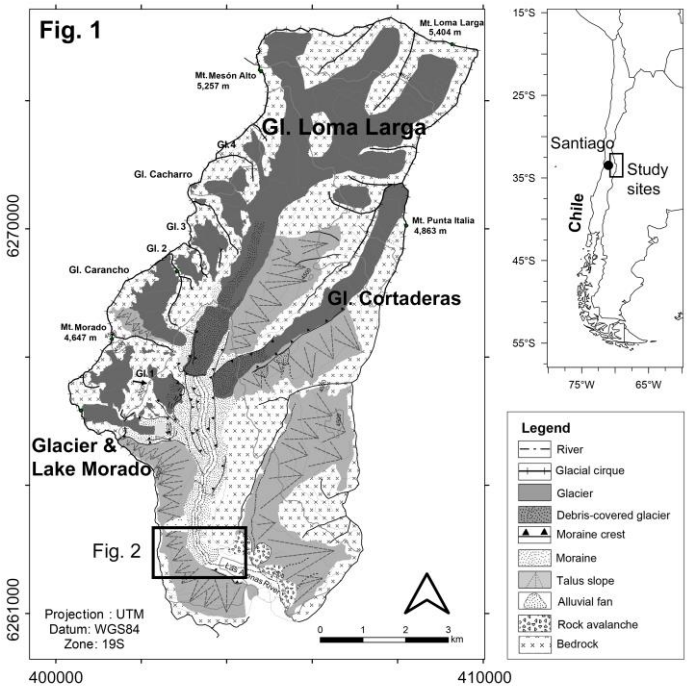

Figure 1*: Geomorphological map of the Loma Larga Glacier. The map shows the main topographic context and details of the glacier system within the Cajón de las Arenas Valley. The moraine landforms illustrate the reconstructed perimeter of past glaciers with the main Loma Larga Glacier receiving ice from multiple tributary sources, most of them in a deep retreating phase at present.*

Figure 2*: (see inset in Figure 1) Aerial photograph showing the outer frontal moraine complex preserved at Loma Larga Glacier.*

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