

## Mechanical stability of Llaima Volcano glaciers

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A sudden and rapid slide of part or a whole glacier is an uncommon phenomenon not unknown in Chile. Such events occurred at Aparejo Glacier in 1980, Maipo basin near Santiago, with the removal of  $7 \times 10^6$  m<sup>3</sup> of ice, about 80% of the glacier volume, and more recently with the slide of a glacier on the southern flank of Tinguiririca volcano (ca. 150 km southeast of Santiago). In the past Rinconada Este rock glacier located 50 km northeast of Santiago experienced a similar catastrophic slide. The risk associated to these events can be very high, as they can release important water volumes and cause fast and extended flows. Five glaciers surrounding the Llaima volcanic cone were analysed to assess the possibility of such slides. Longitudinal profiles in each glacier were established with ice thicknesses measured with radar, and two sliding modes were simulated: the first one including the glacier mass from its bergschrund to the glacier front, and the second scenario from an existing fracture located near the equilibrium line down to the glacier front. For the stability analysis pore pressures were estimated as 22% and 90% (winter and maximum summer conditions respectively), particle acceleration as static and as per Chile's seismic design norm, and bed material as till extending from the glacier front until the mid-accumulation zone. Safety factors below 1.5, which indicate a possible instability condition, resulted in two cases when assuming either saturated or design seismic conditions for the scenario of a fracture located between the accumulation and ablation zones. As catastrophic slides of the Llaima volcano glaciers are not known, it is possible that the assumed till extensions, sensitive parameters for the stability model, are larger than the real ones, probably because recurring volcanic events might have reduced the formation of till at the glaciers' bed.