Towards a better understanding of the role of glacier retreat and permafrost degradation in triggering secondary lahars

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As everywhere in the Andes, tropical glaciers have been rapidly retreating since several decades. The glaciers of Cotopaxi volcano, Ecuador, have been reduced in area by about 50\% since 1976 (Cáceres, 2017). The Cotopaxi is mostly famous for its capacity to produce massive lahars during volcanic eruptions, but comparably smaller, secondary lahars generated in post-eruptive periods by heavy rainfall occur more frequently on the volcano’s flanks. However, since a few years, secondary lahars that originate in proglacial areas without any clear trigger mechanism are recorded at Cotopaxi. This raises the question of whether there exists a process-based link between the occurrence of secondary lahars and the retreat of cold-based glaciers with accompanied permafrost degradation in the former subglacial frozen pyroclastic material over the following years and decades.

Here, we present the data obtained from laboratory-calibrated Electrical Resistivity Tomography (ERT) and Seismic Refraction Tomography (SRT) conducted near the glacier margin between 5000 and 5300 m asl, which provide a better understanding of frozen/unfrozen conditions and the structure of the subsurface. In addition, data loggers have been recording surface air temperatures close to the glacier since May 2018. Our measurements show that permafrost cannot develop under current thermal conditions, but high electrical resistivities at depths of 10-20 m correspond to calibrated rock temperatures below 0 °C. The detected frozen lenses may act as detachment planes of periglacial secondary lahars in pyroclastic material recently exposed by glacier retreat.