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Geomorphological and geophysical investigation of a complex rock glacier system - Morenas Coloradas valley (Cordon del Plata, Mendoza, Argentina)

Jan-Christoph Otto (1), Joachim Götz (1), Markus Keuschnig (1), Ingo Hartmeyer (1), Dario Trombotto (2), and Lothar Schrott (1)

(1) University of Salzburg, Department of Geography and Geology, Salzburg, Austria (jan-christoph.otto@sbg.ac.at), (2) Instituto Argentino de Nivologia, Glaciología y Ciencias Ambientales (IANIGLA), Mendoza, Argentina

In the semi-arid high Andes of Argentina and Chile, rock glaciers are more frequent and often larger than glaciers. Aridity and high solar radiation hamper the development of large glaciers, favour permafrost conditions and the generation of rock glaciers. One of the few rock glaciers that have been studied in more detail since more than 20 years is located in the Cordon del Plata range about 60 km west of Mendoza, Argentina. The Morenas Coloradas rock glacier in the Rio Vallecitos catchment can be described as a multilobe, multiunit, multiroot and multipart rock glacier. It is a complex, transitional landform composed of a high altitude glaciated zone, which transforms into a debris covered glacier with thermokarst phenomena followed by various active rock glacier lobes and subsequently, inactive and relict lobes in the lower sections. Its total length is about 5 km.

Complex transitional landforms between debris covered glaciers and rock glaciers are frequently observed in semi-arid mountain environments with high sediment production in periglacial areas like the Andes of Argentina but can be found also in other similar mountain ranges like for example Pamir, or Karakorum. However, the evolution and internal characteristics of such landforms are often unknown. Glacial and periglacial landforms of this size represent important water stores that play an essential role in water management and agriculture in the foreland of the Andes of Mendoza.

In February 2008 subsurface conditions were investigated at three different altitudes using geophysical methods (ground penetrating radar, electric resistivity tomography). Complemented by digital geomorphological mapping we analyse the complex rock glacier ensemble, to gain insight into landform evolution, sediment flow structures and internal characteristics (permafrost occurrence, active layer depths, ice content, possible ice origin).

Geophysical surveying at Morenas Coloradas clearly indicates the existence of frozen ground at at least two different altitudes. However, ice characteristics revealed by resistivity values and radar wave velocities vary significantly between the sites indicating changing ice contents and ice origin that indicate differences in landform evolution. Active layer thickness detected at two sites corresponds to ongoing borehole temperature measurements that help to interpret the geophysical modelling results.

The valley of Morenas Coloradas presents a unique location to investigate the transition of debris-covered glacier ice to permafrost conditions in close proximity and contributes to the ongoing debate on rock glacier origin. The study reveals that the chosen combination of ERT and GPR is a best practice complement delivering detailed information on ice characteristics (ERT) and location of frozen ground and active layer depths (GPR). However, more geophysical data is required to fully understand the evolution of the nested landform composition and its future reaction to climate change.