THE IMPORTANCE OF PERIGLACIAL INVESTIGATIONS – NEEDS FOR A SOUTH AMERICAN PERIGLACIAL MONITORING NETWORK

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The periglacial environment has been of significant political importance in South America recently. The debate is so heated because different parties involved mean likely different things when they talk about the periglacial environment and there are several factoids passed around that prevent a proper scientific discussion from being formed. By definition, the term "periglacial" means "*The conditions, processes and landforms associated with cold, nonglacial environments*". The NSIDC Glossary (NSIDC, 2010; van Everdingen, R., 1998) further notes: "The term was originally used to describe the climatic and geomorphic conditions of areas peripheral to Pleistocene ice sheets and glaciers. Modern usage refers, however, to a wider range of cold climatic conditions regardless of their proximity to a glacier, either in space or time. Many, but not all, periglacial environments possess permafrost; all are dominated by frost action processes". The periglacial environment therefore does not include glaciated areas, i.e. areas with surface snow and ice, but ground ice, which may be present in the permafrost is included. This is an important aspect to understand, because ground ice in permafrost, in contrast to glacier ice, does not contribute to the annual runoff, hence the water level in the rivers (e.g. French, 2007). By definition, ground in permafrost is frozen (below zero degree centigrade) for at least two consecutive summers, which means that the water stays frozen within these grounds. However, in a geological time scale the ground ice stored in the permafrost can be a significant water source. It is therefore important to understand the differences between the glacial and the periglacial environment and select investigation methods that are appropriate for a particular environment.

Site investigations in a periglacial environment are required for any sort of development in the area. Initially, environmental assessment studies are required and later, data are required for engineering designs or hazard assessments (Arenson et al., 2009, Bommer et al., 2010). When challenged with such an investigation most importantly the local conditions have to be assessed using site visits and air photo interpretations (Fig 1). Current periglacial conditions are often affected and controlled by the past environmental conditions, e.g. climate, or glaciations. These effects may be very local and therefore it is not exceptional that the periglacial conditions change dramatically within close proximities. After a proper evaluation and mapping (e.g. after Trombotto 2003) of the ground surface conditions using site visits and remote sensing data, the subsurface conditions need to be inspected using geophysical methods, boreholes or test pits. In particular the ground ice content can only be assessed using such methods (Fig 2). Monitoring forms the next crucial element in such a study. Because permafrost is defined using time and temperature, measuring latter over a long enough time period is the only way to non-ambiguously proof the existence of permafrost. In contrast to glaciers, where the mass balance is often needed, ground temperatures (Fig 3 and 4) and potential ground deformations are more important in understanding the periglacial environment. Further, several data points are required to draw conclusions from these records, hence starting with a monitoring program early in a project is key.

Understanding the differences between the glacial and the periglacial environment is an important step in any project development at high altitudes. Only proper monitoring programs and qualified terrain analysis provide the tools necessary for such an assessment. Because of its importance it is encouraged to form and install a South American periglacial monitoring network, which would help clarifying some factoids and create a scientific, rather than emotional debate about the periglacial environment and its role in the future.

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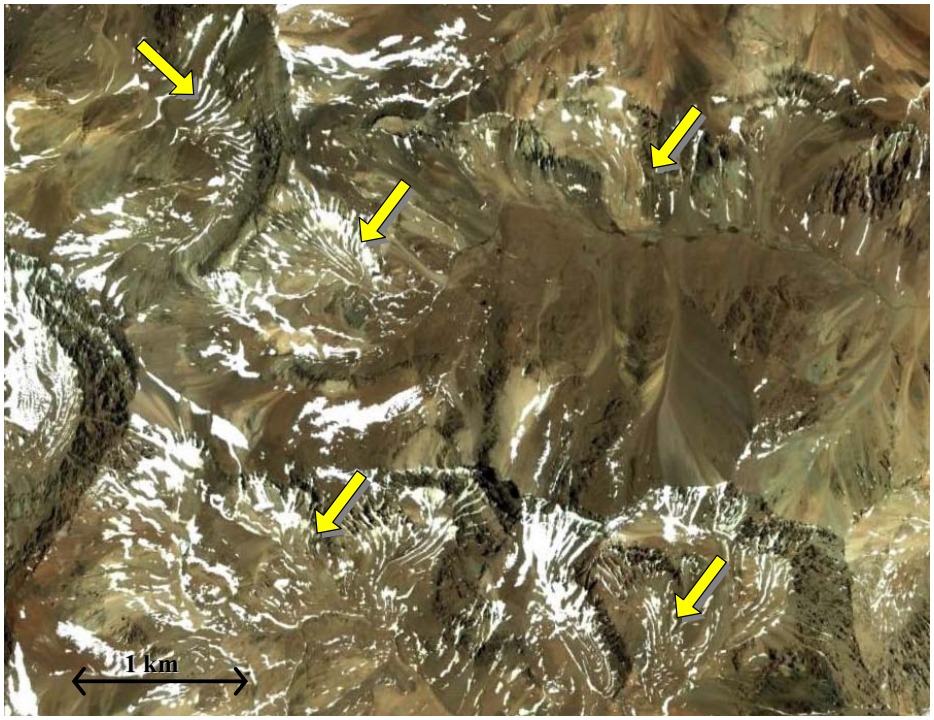

Figure 1. Rock glacier (arrows) identification using satellite images in Google Earth (31°37'S / 70°24'W).

Figure 2. Permafrost , frozen soil sample from a test pit in Central Andes.

Figure 3. Ground temperature monitoring station with data logger and air temperature sensor.

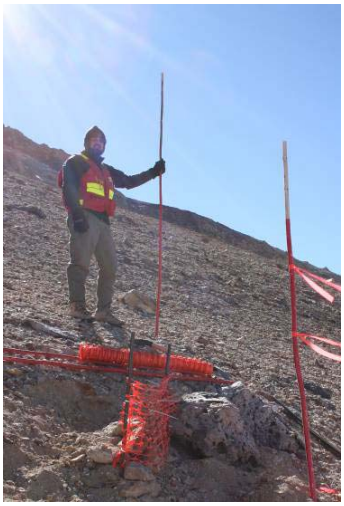

Figure 4. Typical ground surface temperature monitoring station in Central Andes.