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Pushing the limits of electrical resistivity tomography measurements on a rock glacier at 5500 m a.s.l. on the Tibetan Plateau: Successes and Challenges

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Geophysical methods provide a powerful tool to understand the internal structure of active rock glaciers. We applied Electrical Resistivity Tomography (ERT) to a rock glacier at an elevation of 5500 m a.s.l. in the semi-arid Nyainqêntanglha mountain range on the Tibetan plateau, China. The investigations comprised three transects across the rock glacier and its catchment, each spanning over a distance of 296 m up to 396 m, equipped with 75 up to 100 electrodes respectively. Our measurements were successful in revealing internal structures of the rock glacier, but were also accompanied by challenges.

We successfully detected first-order permafrost structures, such as a shallow about 4 m thick active layer of low electrical resistivity values that was underlain by potentially ice rich zones of high resistivity. Further high-resistivity zones were found and interpreted as dense bed rock of adjacent slopes that undergird the loose rock glacier debris.

Challenges, we faced in the application of ERT, were mainly posed by the morphology and internal structure of the rock glacier itself. Coarse debris created a rough surface that prevented a uniform setup with accurate 4 m spacing. The presence of loosely nested blocks of pebble size up to boulders with large interspaces resulted in high contact resistances. The consequent low injection current densities and possible noisy voltage readings downgraded part of the data, causing low data density and resolution. Coupling was partly improved by attaching salt-watered sponges to the electrodes and adding more conductive fine-grained materials to the electrodes. The detected high resistivity ice layer impeded deep penetration of electrical currents, which caused that the lower limit of the permanently frozen zone could not be defined.

Despite these challenges, the captured ERT profiles are an indispensable contribution to the sparse field data on the internal structure of rock glaciers on the Tibetan plateau. Our results contribute to a better understanding of the prospective evolution of rock glaciers in dry, high mountain ranges under a changing climate.

