Near Surface Geophysical Measurements in the Vicinity of Lake Merzbacher First Results from the 2009 Inylchek Expedition (Kyrgyz Republic)

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INTRODUCTION

The facilities of the GFZ-CAIAG Global Change Observatory "Gottfried Merzbacher" enabled an insight in the glaciated region of the former confluence of the Southern and Northern Inylchek Glacier with intensive geophysical measurements (Figure 1). In detail we conducted electrical resistivity tomography (ERT), using a GEOTOM4MK100 of GEOLOG2000 company with 1 or 2 m electrode spacing. The profiles were obtained by roll along measurements and resistivity of subsurface layers was calculated with the RES2DINV software. Additionally we applied multifrequent electromagnetics (mfEM) using a GEM2 from GEOPHEX company.



RESULTS

ERT measurements were conducted in two test sites, namely close to the Global Change Observatory "Gottfried Merzbacher", also termed Poljana, and at the Peremitschka, the area between Lower and Upper Lake Merzbacher in the valley of the Northern Inylchek Glacier.



Figure 1: Geoscientific research during the 2009 Inylchek expedition in the Tien-Shan, west of Khan Tengri (Eastern Kyrgyz Republic) at approx. 3500m altitude.

RESULTS - POLJANA

a) The 200 m ERT profile was situated at a steep left lateral moraine of a smaller tributary glacier. The section crosses the Paleozoic limestone formation in the western part of the profile as characterized by light blue to green colors in the cross section. Blue colors indicating low resistivity zones (mainly in the upper 2-3m in the western part of the profile) represent a thick soil layer (Rendsina) at Poljana and match the local excavations in the course of foundation works for the Observatory. At approximately running meter 80 an abrupt change of resistivity values appears in the profile, indicating the change from soft-rock to an ice covered subsurface. The eastern part of the profile is characterized by a debris fan of carbonate rocks (Figure 2). The moraine covered ice detected in the ERT profile is the major source for a well discharging about 0.3 l/s which supports the entire Observatory with fresh water.



RESULTS - PEREMITSCHKA

At the Peremitschka site we conducted an 800m profile crossing the Northern Inylchek Valley (Figure 4). In contrary to the Poljana test site, no bigger ice cores are exposed between the Lower and Upper "Lake Merzbacher", except along the river slope at the northwestern beginning of the profile. Sliding and slumping structures as well as thermokarst features in the size of only few meters indicate local ice cores below, which cannot be identified from the surface, however.

The flat ERT-profile shows an undulated multilayer resistivity distribution. The uppermost 3-5 m of the profile show low resistivities ranging from 10 to about 200 ohm.m, indicating fine clastic sediments. In this area the surface of the whole test area is covered by silt and sand. The second "layer" below this low resistivity

zone to the final depth of the profile in approximately 45 m consists of dead ice of the former Northern Inylchek Glacier.

Figure 4: Oblique view on the Peremitschka plain and the terminal moraine of the Northern Inylchek Glacier. The ERT profile (blue line) crosses the Northern Inylchek





Figure 2: Side moraine south of the Observatory "Gottfried Merzbacher" (left) and ERT profile along the left lateral moraine of a tributary glacier bordering the Poljana (right). Red color indicates dead ice covered by moraine debris.

b) The 580 m long ERT profile (Figure 3) conducted westward of the Observatory reaches from the Paleozoic limestone south of the Western Inylchek Glacier towards the middle of the glacier. Lobes of large mass movements from the left lateral moraine cover the southernmost ice stream, which is characterized by dark debris and cliffs of melting dead ice (Figure 3). The profile starts in the steep northern slope of the Poljana, which is characterized by rock fall and debris flow. Due to a difficult coupling of the electrodes in the subsurface the underlying limestone shows a relatively high resistivity distribution. After crossing the lowest part of the section at approximately running meter 220 a lateral transition from debris to ice can be identified in the profile. As observed from the surface the section crosses a bright ice-stream, which is covered by granite debris and boulders and ends at running meter 580 in another ice-stream

Valley in west-east direction.



CONCLUSIONS:

From our ERT measurements in the valleys of the former Southern and Northern Inylchek Glacier we conclude that lateral moraines as well as the annually flooded plain between Lower and Upper Lake Merzbacher (Peremitschka) are underlain by dead ice of a decaying glacier. Mass movements such as creeping and sliding of rock debris as well as the displacement of moraine sediments, and thermokarst features can be "obviously" interpreted – but only indirectly detected by geophysical measurements – as a result of melting dead-ice in the subsurface.

Hence geophysical measurements enable sound interpretations of the local geomorphology which then consequently can be classified in remote sensing images (see Poster contribution of LEBER et al. 2009).

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Figure 3: View from the Global Change Observatory "Gottfried Merzbacher" towards the ERT profile (blue lines) crossing the Western Inylchek Glacier. Red color indicates dead ice from the decaying glacier.



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