Using of GPR method for examination of post-glacial deposits in the alp of Ornak (the Tatra Mountains)

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The aim of the study presented in the paper was the assessment of Quaternary glacial sediments thickness in the Western Tatra using the Ground Penetrating Radar (GPR). The experimental measurements were carried out on the alp of Ornak. The incentive for undertaking GPR measurements in this region were the results of practically first laboratory investigation of glacial sediments in this area, obtained from three boreholes executed on the alp of Ornak, described by Kenig and Lindner. The results of Kenig and Lindner indicate that the depth of the investigated deposits is highly variable. The depth of the glacial sediments in three different boreholes varied from 2 to almost 8 m. They reported that in the upper part of Koscieliska Valley three separate layers of moraine deposits, separated by sediments of various fractions appeared. The bottom part consists mainly of coarse and middle-grained gravel fraction, containing crystalline rocks, a small proportion of sand fraction, and a few percent of loamy fraction. We expected that our preliminary GPR studies to the depth of 20 m would permit to assess whether with this method the results obtained in few points in boreholes could be extended on the whole alp of Ornak, and possibly on the whole Tatra mountains.

GPR surveys were conducted along three profiles, which were designed in the central part of the alp of Ornak. Measurements, in the mode of constant-offset reflection profiling, were carried out using RAMAC/GPR georadar system from MALA Geoscience. Results of measurements with GPR method depend mainly on contrasts between dielectric constants ε_r [-] of different geological media. A qualitative measure of the ability of boundary between to layers of rocks to be registered by GPR is the reflection coefficient. It tells us what fraction of GPR electromagnetic signal is reflected from boundary between two layers with different complex dielectric constant. When the contrast is sufficient, the reflexes from boundary can be recorded in radargrams. Crystal basement (Tatra granite) has a small porosity and therefore should have a lower dielectric constant. Different electrical properties of crystal basement and sediments should make the boundary between them a good reflector and should form a well visible boundary. It seemed that the GPR method could be useful for investigation the boundary between crystal basement and Quaternary deposits.

Quite different problem is the depth penetration of GPR waves. When the electrical conductivity and frequency increase, the attenuation coefficient increases too, and the vertical range of penetration decreases. Therefore, the GPR measurements were conducted in this site after long time without precipitation, which allowed to record reflexes from considerable depths, even though geological medium in this site was build of till. Taking into account information mentioned above the GPR measurements were made with relatively low frequency (50 MHz) which permits for deep penetration.

A point that should be mentioned is, however, that Kenig and Lindner report the depths of the boreholes, but do not state that they completely penetrated the Quaternary sediments and reached the rocky bottom. In this situation our preliminary GPR measurements were carried out to confirm hypothesis presented by Kenig and Linder. Preliminary results of borehole measurements and 2D GPR surveys seem to be promising. However, for quantative interpretation 3D GPR measurements and additional boreholes are needed.