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Subsurface image of the Mariánské Lázně Fault (Czech Republic) by 3-D GPR and DC resistivity measurement

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This study deals with application of two geoelectrical methods in order to study geophysical expression of logged geological structures exposed in an artificial trench and their continuation laterally and to the depth. The trench was excavated within the Mariánské Lázně fault zone, which borders the mountain front of the Krušné hory Mts towards the Cheb basin and intersects the seismoactive zone of Nový Kostel. The present geodynamic activity in the area of Cheb basin is manifested by earthquake swarms and ubiquitous emanations of mantle-derived carbon-dioxide. The trench survey has identified a subvertical fault plane whose recent activity is being investigated by structural and sedimentological analyses, and geochronological methods. Because the very narrow zone of faulting expression within the Quaternary deposits (few tens of cm) does not enable its direct identification by geophysical methods, we used ground truth information from the trench to study possible geophysical attributes of the fault.
To this purpose we applied 3D ground penetrating radar (GPR) survey and a 2D multi-electrode DC electrical resistivity tomography (ERT). The GPR survey was carried out using the shielded 250 MHz antenna on rectangular grid 40 x 60 meters. The detailed ERT measurements were performed on one profile of 200m length with 1 m electrode spacing and Wenner-Schlumberger electrode array. The ERT measurements have identified a shallow high-resistivity body, which corresponds to the sandy and gravelly deposits documented in the trench. The fault intersects the body on its southern margin, and the expected low-resistivity zone of the fault is thus masked by the high-resistivity sediments. The 3D GPR survey showed high amplitude reflections that are clearly associated with the high-resistivity body, which is separated from the surrounding area with missing reflections. Comparison with the ERT results shows that zones of attenuated GPR signal correspond to the lower resistive substratum (< 150 Ωm) of the clay-rich colluvium and deep-weathered crystalline basement. The stacked GPR time slices reveal that besides the strong reflections in the area of sands and gravels a distinct zone of scattered reflections occur along the expected direction of the fault, which corresponds to the fault strike measured in the trench. We presume that the reflections are created by a high-resistive material similar to that being associated to the sandy-gravelly body.
It turned out that application of the two geophysical methods itself would not be able to find the subsurface geophysical expression of the fault. Nevertheless, the geophysical survey was crucial for finding a prolongation of the fault further from the trench and also for tracking its occurrence in depth. This was possible thanks to the a-priori geological data obtained from the trench survey.

Keywords: the Mariánské Lázně Fault, Cheb basin, ground penetrating radar, electrical resistivity tomography, trenching