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Combined 2D Resistivity Imaging and Penetrometer-Based Resistivity Profiling – example of field studies

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SUMMARY

Single 2D Resistivity Imaging (ERT) survey was conducted perpendicularly to a located pipeline. Also, 21 Penetrometer-Based Resistivity Profilings (PBRP) were made along the same survey line. Correlation between the ERT and PBRP data is visible in the interpreted resistivity section combined with profiling curves. However, the PBRP method has a higher vertical resolution than the ERT method, thus, we can differentiate some additional layers or local zones characterized by relatively small resistivity changes. The presented example of application of both the methods allows to create a more reliable subsurface zone model.

Introduction

The Electrical Resistivity Tomography (ERT), often referred to as Resistivity Imaging, is used, among others, to identify geological structure of subsurface zone (Dahlin 1996). The method's vertical resolution is a complicated function and mostly depends on electrode spacing and array type (Loke 2010). In practice, relatively small structures may not be distinguished during inversion. In order to identify wider subsurface zone, other additional methods can be applied, e.g. the Penetrometer-Based Resistivity Profiling (PBRP) (Fejes & Josa 1990). This method is characterized by high vertical resolution equal to a profiling step. It is possible then to differentiate the layers not visible for ERT method. The paper presents the combined application of the methods for better recognition of subsurface zone.

Method

PBRP was made 0.3 m from 1.8 m deep excavation wall. There is a 0.3 m in diameter metal pipeline buried at the depth of 1.5 m. The PBRP setup is shown in Fig. 1. The probe is a 2 m long, 1 cm in diameter steel tube. At the end of the probe is a steel electrode separated from the tube with non-conducting material. The total grounding resistance of the electrodes A and B is measured with the use of a digital multimeter. Next, using the probe's coefficient, k , the resistivity is calculated. The k parameter was previously determined by calibration in controlled conditions in a water tank (Mościcki 1998). During the profiling, the probe was driven with a 2 cm profiling step (vertical resolution) maximum up to 1.5 m deep. Fig. 2. presents the result of PBRP and a photography of the excavation wall. Diversification of resistivity can be noticed on the chart. The biggest resistivity variability is observed between the B and C layer.

8 months after the excavation was filled, a single 2D ERT survey was conducted perpendicularly to the pipeline. It is located on 11.8 m of the survey line and the excavation walls are located at 11.0 and 12.5 m. The ERT survey was carried out with basic electrode spacing $a = 0.5$ m, 10 Wenner array spacings $1a, 2a, 3a, 4a, 5a, 6a, 8a, 11a, 15a, 20a$. The ERT survey line was 47.5 m long. 21 PBRPs with spacings of 2 m were also made starting at 4th meter of the survey line and finishing at 44th meter. The ERT data was inverted with Res2dinv software (Loke 2003). Robust inversion (Loke et al. 2003) was applied, because sharp boundaries were expected in inverted model. 2D ERT inversion results and PBRP curves are shown in Fig. 3.

Figure 1 The PBRP setup.

Figure 2 The PBRP result from the excavation surroundings and outcrop photography.

Figure 3 2D ERT inversion results combined with the PBRP curves.

Conclusions

In the Fig. 3. correlation between the ERT and PBRP results is visible. For instance, the boundary between layer A and C is clearly noticeable. Additionally, the PBRP curves suggest the presence of the B layer (Fig. 2) which continues through almost the whole survey line (Fig. 3). However, the B layer is hard to distinguish from the ERT interpreted section itself. Because the PBRP method has higher vertical resolution than the ERT method, we can differentiate some additional layers or local zones characterized by relatively small resistivity changes. The presented example of application of the both methods allows to create a more reliable subsurface zone model.

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