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Processing of geoelectrical monitoring data. Unconventional approach to detection of local subsurface heterogenety

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Time-lapse electrical resistivity tomography (ERT) has proved to be an effective electrical monitoring tool. The use of ERT predefines techniques of the time-lapse data processing and interpretation. Common approach considers some inversion scheme to be used first to obtain resistivity cross-sections or volumes. Then difference images are analyzed to monitor time-related changes in resistivity. Unfortunately, despite numerous attempts currently no effective way exists to completely avoid inversion artifacts. The presence of noise in the field data and the lack of sensitivity of ERT with depth make things even worse. We investigated various approaches, using both real and model data, and have come to a conclusion that working with the original data, i.e. apparent resistivity, in many cases, may lead to more stable results.

Here, we present an approach to analyze non-inverted apparent resistivity data as a possible way for identification and monitoring time-related changes in the subsurface. The field data is expected to be acquired using forward and reverse pole-dipole array. This allows us to convert the apparent resistivity to a difference parameter (specifically, by point-to-point subtracting one pseudosection from another one). The difference parameter has proved to be very sensitive to time-related local subsurface heterogeneity. We also investigated how temperature and moisture affected this parameter to perform correction of monitoring data. To distinguish between time-lapse noise and true anomalies, we applied a statistical technique.

The proposed methodology has been tested on both synthetic and real field data and showed its efficiency. Among others, we monitored the process of near-surface tunnel drilling (diameter - 1.5 m at depth - 6 m). Using fixed monitoring system with just 2 current and 19 potential electrodes we were able to track tunnel face location with fairly high accuracy (spatial - 1 m, temporary - 3 h).