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Detection and monitoring of leakages in embankments using Induced Polarization tomography

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Embankment dams and dikes can be weakened by internal erosion and suffusion phenomena due to preferential flow paths and this on-going weakening can cause their failure. Predicting the occurrence of hydraulically induced damage in such geological structures constitutes a major challenge in subsurface engineering and geotechnical studies. Geophysical imaging can provide non-invasive methods to investigate this issue. In this study, we test the ability of Time domain Induced polarization (TDIP) method to detect leaks in dams. During an induced polarization survey, both electrical conductivity and chargeability are imaged. A total of 7 profiles were collected over a test site in which a controlled artificial leakage can be generated in an embankment surrounding an experimental basin. 3D tomography of the conductivity and normalized chargeability are performed during such a controlled leakage. Conductivity and induced polarization measurements at different water saturations were also performed on a core sample from the site. The sample was also characterized in terms of porosity and cation exchange capacity. Combining the 3D survey, the laboratory measurements and using recently developed petrophysical models (which provide a consistent picture of conductivity and normalized chargeability in terms of water and clay contents of soils), a 3D tomogram of the relative variation in water content (before leakage and during leakage) was estimated. The tomograms show the ground water flow path through the embankment from the outlet of the tube used to generate the leak to the bottom of the embankment. In addition, a self-potential survey was performed over the zone of leakage at different time points (before, during and after leakage). This survey evidences also the projection of the groundwater flow path over the ground surface. Both methods are found to provide a consistent picture of the water flow path. Furthermore, a 2.5D time lapse tomography of the electrical conductivity and normalized chargeability was also performed (over one profile) and evidences the position of the preferential flow paths below the profile. These results confirm the ability and efficiency of induced polarization to provide reliable information pertaining to the detection of leakages in dams and embankments.