

Discontinuities detection in low permeability rocks using electrical resistivity imaging

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In the context of nuclear waste storage, low permeability clays are investigated as potential geological barrier. Discontinuities in such formations might facilitate the radionuclide transport to the environment. The underground experimental platforms of Tournemire (Aveyron, France) and Mont Terri (Jura, Switzerland) present the opportunity to perform in-situ experiments to evaluate in particular the capacity of geophysical methods to detect and characterize the presence of discontinuities. Here we apply electrical resistivity imaging at different scales to detect variations of water saturation, degree of fracturation or presence of voids in the clay medium. Gallery section imaging is first presented to localise the excavation damage zone (EDZ) from data acquired at the Mont Terri site. At the Tournemire massif scale, tectonic faults with an extension of several hundreds of meters are investigated in order to characterise their geometry.

For both experiments presented, specific arrays of electrodes were set up, adapted to the geometrical configuration of the studied objects. In the EDZ study, electrodes were placed on rings at the circumference of the gallery. For the characterisation of the tectonic faults, electrodes were placed at the surface of the massif as well as in the underground gallery to force electric current lines to sound deeper regions of the massif. 3D models considering the gallery geometry, the topography or the injection of current in transmission through the massif were developed for the analysis of such particular data sets. For the reconstruction of the medium electrical resistivity, the parametrization of the inverse problem were adapted to the experimental geometry in a scope to reduce the inversion under-determination. Images obtained highlight the heterogeneity of the EDZ and locate the fractured zones due to the medium perturbation. For the massif scale experiment, images show a conductive signal that may be correlated with a path of water circulation. The presence of a resistive region also arise that might reflect the presence of a karstic system at the interface between the clay layer and the limestone medium.