Monitoring the Excavation Damaged Zone in Opalinus clay by three dimensional reconstruction of the electrical resistivity in the Mont Terri gallery G-04

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The characteristics of opalinus clay have been studied in the last years for its capacity to retain radionuclide transport as a low permeable rock. This formation presents thereby suitable properties for hosting repository sites of radioactive waste. The Mont Terri underground rock laboratory (Switzerland) has been excavated in opalinus clay layer in order to develop experiences improving the knowledge on the physico-chemical properties of the rock.
The study of electrical properties furnishes information on the rock structure, its anisotropy and the changes of these properties with time (Nicollin et al., 2010 ; Thovert et al., 2011). Here the three dimensional reconstruction of the electrical resistivity aims at monitoring the temporal evolution of the excavation damaged zone. Three rings of electrodes have been set-up around the gallery and voltage is measured between two electrodes while a current is injected between two others (Gibert et al., 2006). Measurements have been achieved from July 2004 until April 2008 before, during and after the excavation of the gallery 04.
In this study we develop a computational approach to reconstruct three dimensional images of the resistivity in the vicinity of the electrodes. A finite element model is used to represent the complex geometry of the gallery. The measurements inferred from a given resistivity distribution are estimated using the software EIDORS (Adler and Lionheart, 2006), this constitutes the forward problem. The reconstruction of the media resistivity is then implemented by fitting the estimated to the measured data, \textit{via} the resolution of an inverse problem. The parameters of this inverse problem are defined by mapping the forward problem elements into a coarser mesh. This allows to reduce drastically the number of unknowns and so increases the robustness of the inversion. The inversion is executed with the conjugate gradient method regularised by an analysis of the Jacobian singular values.
The results show an evolution of the resistivity with time as the gallery excavation is carried on. They indicate physically plausible resistivity patterns, corresponding to known changes in the rock structure.

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