Hydrogeophysical monitoring of water infiltration in an experimental waste rock pile using 3D time-lapse Electrical Resistivity Tomography

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Hydrogeological behaviour of heterogeneous and non-saturated media can be complex and challenging to assess, especially where classical hydrogeological instrumentation can't be directly applied - such as in the core of waste rock piles. In this paper, the authors will present the results of several 3D ERT surveys carried out in 2016 and 2017 for time-lapse monitoring of water infiltration events in an experimental waste rock pile. This 60 m-long, 10 m-wide, 7 m-high pile was built according to a new waste rock disposal method at the Rio Tinto Fer et Titane hemo-ilmenite Lac Tio mine (Havre St. Pierre, QC). This pile includes inclined layers of relatively fine-grained compacted materials (sand and crushed anorthosite) on the surface, which creates capillary barrier effects that divert water from the reactive core, thus limiting metal leaching and contamination of the effluent. The pile has been instrumented with probes to monitor moisture content and pore water pressure near the surface and at the base. Six lysimeters collect percolating water, and serve to measure water flow and assess chemical composition and electrical conductivity of the leachates. In addition, 192 circular electrodes are buried in the pile (96 at the top and 96 at the bottom) according to a regular 2m-spaced grid. These 192 electrodes are used to carry time-lapse measurements every hour with an optimized protocol of 1000 configurations uploaded on the Terrameter LS (ABEM) to monitor internal flow of water sprinkled on the pile with a water truck. Time-lapse 3D ERT data were inverted using E4D (Johnson et al., 2010) to yield the 3D model of bulk resistivity over time before, during and after artificial infiltration events. While resistivity results show consistent variations due to moisture distribution, conversion of bulk resistivity into volumetric water content is not straightforward. This challenge is related in part to the interaction between water and the conductive water rock in the core of the pile (ilmenite). Laboratory column measurements have also been conducted to assess the relationship between bulk conductivity, water conductivity and moisture content with waste rock samples from the pile. The 3D images of water content will also be compared with hydrogeological measurements and modelling.

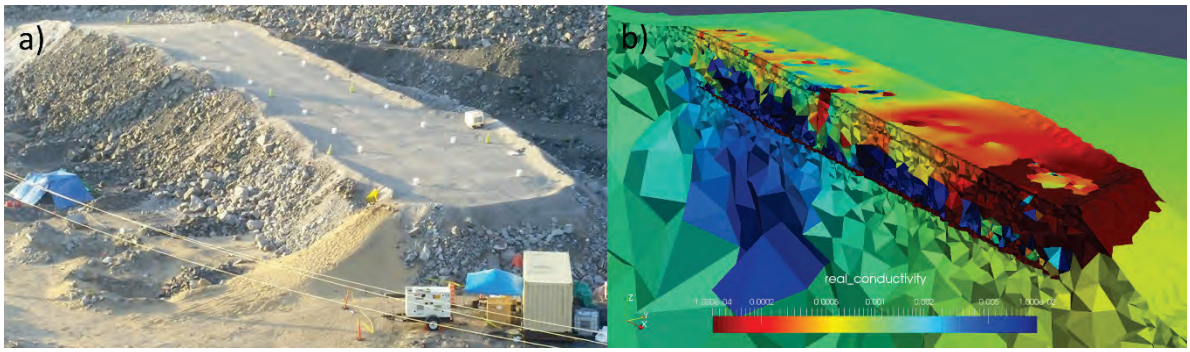

Figure: a) Photography of the experimental waste rock pile instrumented with 192 geophysical electrodes; b) 3D resistivity model of the pile: red areas correspond to the resistive sand and anorthosite while blue areas correspond to conductive ilmenite-rich waste rock.