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Monitoring water infiltration in an experimental mine rock waste pile with time-lapse ERT and multi-parameter data collection

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Waste rock piles are made of non-economic coarse-grained rock mined to reach the ore and disposed in piles at ground surface. If small amounts of sulphide minerals are present in the waste rocks, flow of water and supply of oxygen in the pile may generate contaminated neutral drainage (CND) capable of leaching, transporting, and releasing metals in the environment. In order to limit generation of CND, an original way to construct waste rock piles with thin inclined compacted layers was proposed. The thin inclined layer made of finer-grained material placed over the coarse waste rocks can act as a capillary barrier, diverting and channelling water downslope, and leaving the reactive core with little moisture. The modified design was numerically modelled. In order to test the concept, an experimental waste rock pile has been build at the Lac Tio ilmenite and hematite mine site in 2014-2015. The waste rock pile is 60 m-long, 10m-wide at the top, and its top surface dips at 5%. Waste rocks are made of low reactive anorthosite (low sulphide content). A 70cm surface cover made of two layers of fine-grained material (crushed anorthosite overlying medium-fine sand) has evenly been laid at the pile surface. The waste rock core reaches 7m-high and it lies over a horizontal 70cm fine-grained layer at the base. Below the last layer, 6 lysimeters are used to collect infiltrated water to monitor physico-chemical properties, such as water volume, geochemistry and electrical conductivity.

To model water moisture content with time and therefore to monitor water flow in the pile, TDR and suction probes have been inserted in the pile, including top and bottom sand layers. Two layers of electrodes, consisting each in 96 circular stainless steel disks spaced every 2m, were installed: one in the surface anorthosite layer and one in the sand layer at the bottom of the pile. Within the uppermost waste rock and sand layers, as well as within the sand layer at the bottom of the pile, a DTS fiber optic cable has been laid to monitor temperature distribution, which will enable to deduce the water content of the rock along the cables. Monitoring of all these parameters is done using a dedicated acquisition system. Some specific induced infiltration tests are also being carried out. Time-lapse electrical resistance tomography (ERT) data collection will be processed and multi-parameter data integrated in order to map volumetric water content and water flows. Special ERT acquisition protocols are needed to optimize high resolution imaging of water content within the coarse core and the upper and lower fine-grained layers. In this poster, we will present the experimental waste rock pile and how we are planning ERT measurements.