Modeling the migration of trace elements from tailings towards aquifers

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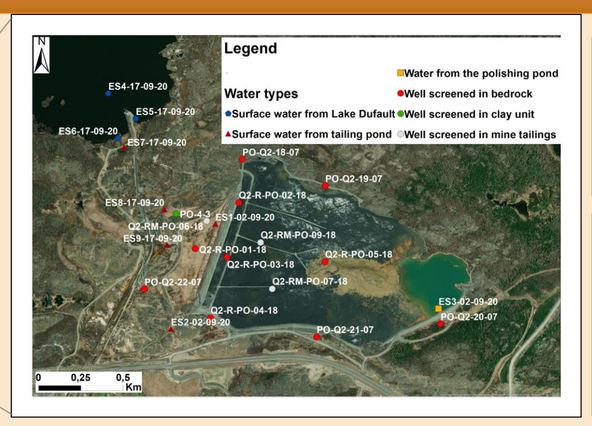
1. Introduction

Aim

Modeling of trace elements transport from mine tailings towards a local groundwater flow system located nearby a municipal water intake.



Ownership

Glencore Canada Corporation - Fonderie Horne (GCC-FH)

Location

The Quémont-2 tailing pond is located 2,5 km SE of Lake Dufault, Rouyn-Noranda, Québec, Canada (WSP.,2019a).

Figure 1 : Study area with the localisation of the Quémont-2 tailing pond and sampling sites

2. Objectives

Main objective

Establish the hydrogeochemical characteristics and processes of the Quémont-2 site which are required for evaluating and optimizing reclamation plans (MERN et MELCC., 2017), to predict the physicochemical changes resulting from reclamation, as well as for water quality monitoring.

Figure 2 : View of the Quémont-2 tailing pond

Specific objective

Development of a groundwater flow and mass transport models coupled to geochemical modeling for documenting the flux of trace elements from the tailing pond towards surrounding bedrock aquifers.

Groundwater flow and mass transport are simulated using SEEP/W and CTRAN/W

Saturation indices along flowpaths are calculated using PHREEQC.

3. Methodology

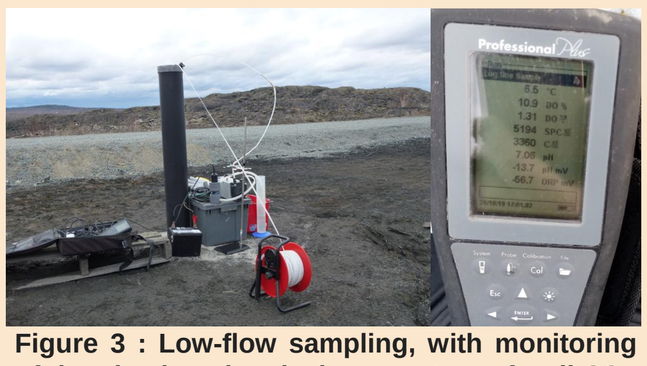


Figure 3 : Low-flow sampling, with monitoring of the physico-chemical parameters of well Q2--R-PO-02-18 on Quémont-2 site

A seasonal sampling program (Autumn 2019 and Summer 2020)

Analytical program

Groundwater wells were pumped of one well volume using a low-flow sampling procedure (CEAEQ.,2008) and *in situ* monitoring of physico-chemical parameters (Temperature, pH, redox potential (ORP), dissolved oxygen (DO), electrical conductivity (EC)) were subsequently measured at five minutes intervals using a YSI 556 Professional Plus multi-parameters probe. Groundwater samples were collected once stable values were obtained for three consecutive readings. Samples were filtered on site at 0,45 µm. Surface water sampling was conducted using semi-rigid HDPE tubing with a one-liter HDPE bottle at the end. Samples were analyzed at a laboratory accredited by the Quebec Ministry of the Environment.

Anions (Br, Cl, F, NO_2, NO_3, SO_4), ammonia nitrogen, inorganic phosphorus, dissolved organic carbon, trace metals and total alkalinity

Stables isotopes of the water molecule (δ^2H-$\delta^{18}O$), chlorine ($\delta^{37}Cl$) and bromine ($\delta^{81}Br$)

4. Prelimenary results

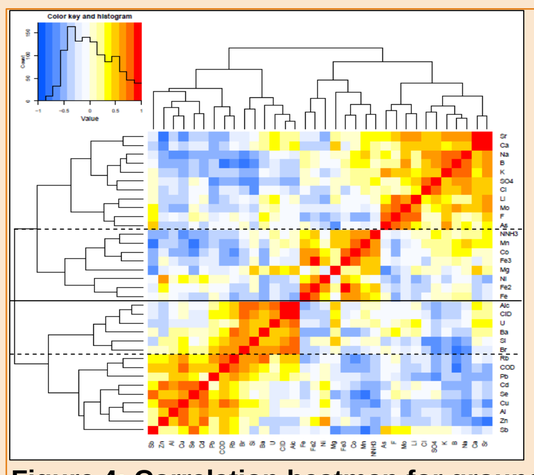


Figure 4: Correlation heatmap for groundwater and surface water samples

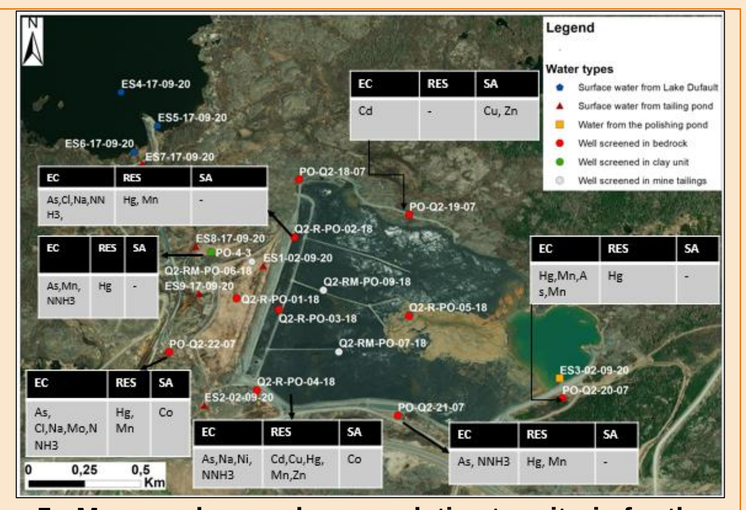


Figure 5 : Measured exceedances relative to criteria for the analyzed parameters in Autumn 2019 and Summer 2020.

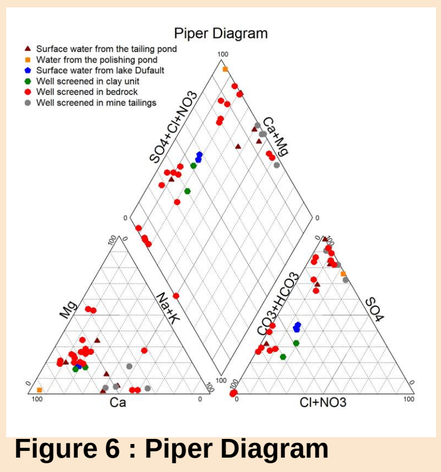


Figure 6 : Piper Diagram

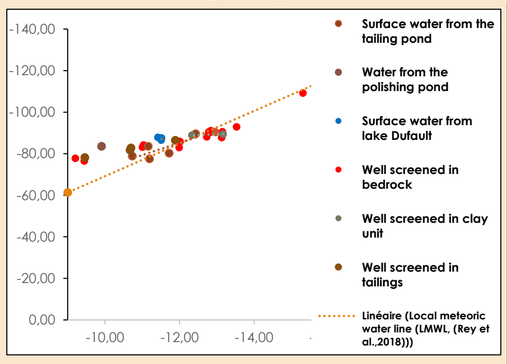


Figure 7: Isotopic composition of water samples

The concentrations of major and trace elements measured in groundwater from the sampling wells were compared to groundwater criteria for resurgence in surface water (RES), drinking water (EC) and alert threshold (SA) as established by the Quebec Ministry of the Environment (MELCC., 2019).

Dominant water types:

- Ca-Mg-HCO_3, Ca-Mg-SO_4, Na-SO_4, Ca-SO_4

5. Ongoing work and expected outcomes

The ongoing work consists in calibrating the SEEP/W and CTRAN/W models in order to document the transport mechanisms that are likely to control the migration of trace elements from the Quémont-2 site. This step of the research project will allow a quantitative evaluation of the hydrogeochemical exchanges between the tailings pond to the surrounding bedrock aquifer. Ultimately, this project will allow evaluating and optimizing reclamation plans aimed at minimizing the risks associated with the migration of trace elements towards potential receptors.

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