SEASONAL AND OPERATIONALLY LINKED SULFUR GEOCHEMICAL CHARACTERIZATION OF A MINE OXIDATION RESERVOIR AND ITS INPUTS

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The presence of sulfur oxidation intermediates (SOIs; e.g. $S_2O_3^{2-}$, SO_3^-, S^0, etc.) in mining wastewater is a significant industry-wide concern because of the potential for acidification and toxicity of receiving water bodies, resistance to treatment and the current lack of monitoring tools. Bacterially catalyzed transformation of sulfur species under real world conditions remains poorly constrained, limiting the development of biologically integrated indicators. As part of a larger project investigating the microbial links to mine water S chemistry for the water system of Ni, Cu mines in Northern Ontario, the objective of this investigation is to characterize the *in situ* S geochemistry of Glencore's Oxidation Reservoir (Onaping, ON) over seasonal, operational and annual scales. As the Reservoir receives diverse water inputs from three mining companies, waste rock, tailings lines and multiple watersheds, these are also being assessed over seasonal scales to establish their contributions to observed Reservoir geochemistry.

To date, water column survey data (pH, temperature, dissolved oxygen, conductivity, and oxidation-reduction potential) and samples (minimum of two depths per campaign), have been collected from the Reservoir and input sources at seven time points between September 2014 and May 2016 (Figure 1). In addition, two sampling campaigns in July 2015 bracketed effects related to mill production changes, i.e. the reduction and elimination of tailings discharge, may have had on the S geochemistry of the Oxidation Reservoir. For each water sample microbial bulk community structure (functional

metagenomics - Illumina HiSeq), and geochemical characterization (S: H_2S, SOIs, SO_4^{2-}, total S; Organic carbon: TOC, DOC; Fe: Fe^{2+}, Fe^{3+}, total Fe; and N: NH_4^+, NO_2^-, NO_3^-) were carried out. The techniques used to gather such data include ICP-AES for total sulfur, HPLC for SOIs, ferrozine method for iron analyses, TOC analyzer for organic carbon, and colorimetric spectrophotometry for determination of the remaining species of sulfur and nitrogen.

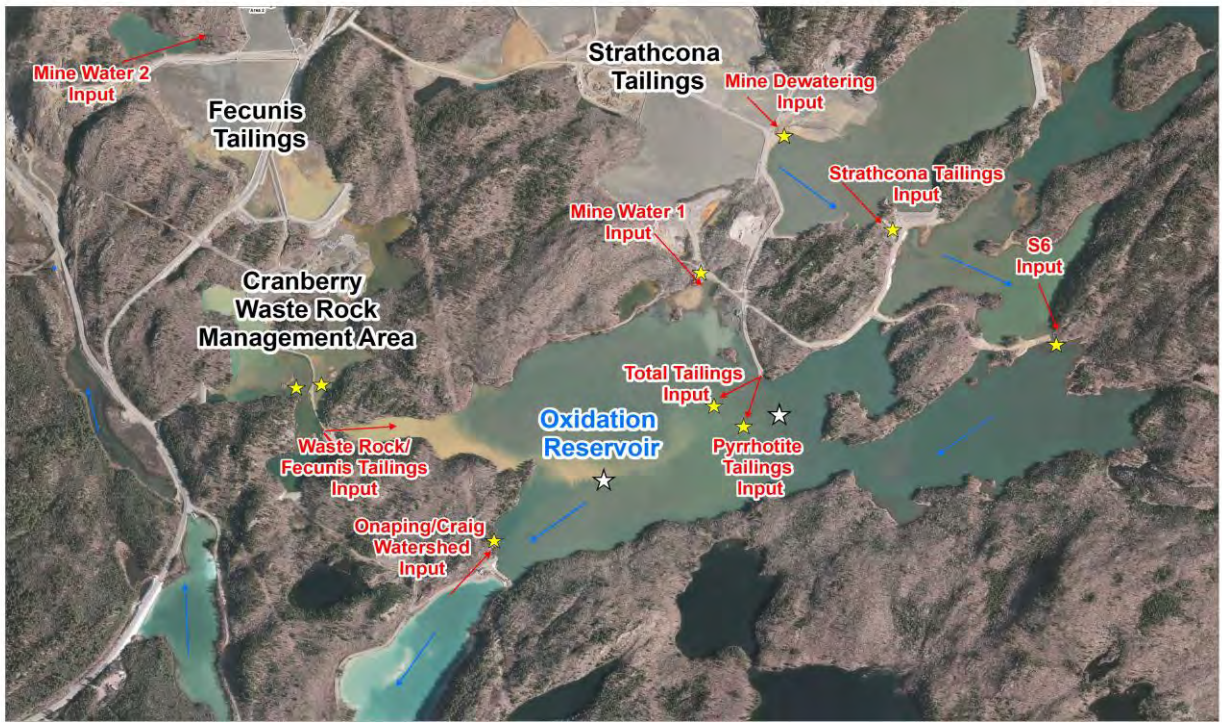

Figure 1. Sample locations within the Strathcona Tailings Management System. Inputs (yellow stars) and the Oxidation Reservoir (white stars) denote the specific sampling locations.

The environmental survey data and associated cycling of sulfur, carbon, and nitrogen have been highly variable over space and time for both the inputs and the Reservoir (Figure 2). Preliminary analysis highlights the importance of inputs in observed Reservoir geochemical characteristics. Sulfur geochemical results indicate the widespread and often dominant presence of colloidal elemental sulfur (S^0) as a key SOI species (Warren et al. 2016). Collectively results indicate that Oxidation Reservoir S geochemistry will reflect input, seasonal, operational and microbial influences.

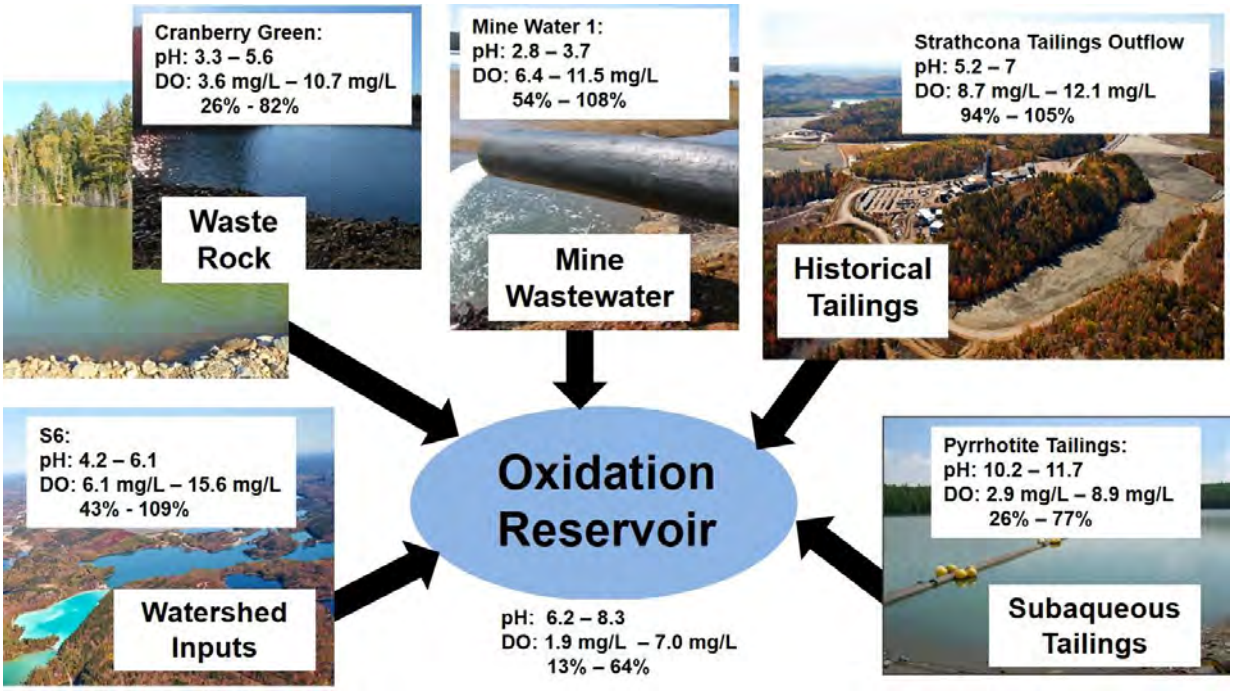

Figure 2. Spatial and seasonal variability of pH and dissolved oxygen (DO) of selected inputs and the Oxidation Reservoir from nine sample points during September 2014 to May 2016.

These results will establish the importance of the various inputs as well as climatic and operational variability in overall S geochemistry in this system. Their integration with microbial and experimental results will generate new understanding of the potential importance, roles and outcomes of bacterial activity on water quality.

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Literature Cited

Warren, L.A., Nelson, T.C., Marshall, S., Bennett, D., and S. Apte. Sulphur geochemistry of mining wastewaters. *Minerals*. Forthcoming 2016.

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