

Acid mine drainage multi-step passive treatment system: the Lorraine case study

THOMAS GENTY^{1*}, BRUNO BUSSIÈRE¹, CARMEN NECULITA¹,
MOSTAFA BENZAAZOUA¹, AND GÉRALD J. ZAGURY²

¹Université du Québec en Abitibi-Témiscamingue, Institut de recherche Mines et Environnement, Thomas.genty@uqat.ca (*presenting author), Bruno.bussiere@uqat.ca, Carmen.neculita@uqat.ca, Mostafa.benzaazoua@uqat.ca

²École Polytechnique de Montréal, Département de génie civil, géologique et des mines, gerald.zagury@polymtl.ca

Introduction

At the closure stage of a mine site, passive treatment systems are an interesting alternative to reduce environmental impacts of acid mine drainage (AMD) [1] because they require low investments and maintenance, and natural organic materials (like manure and compost) or by-products (like wood ashes) can be used to build them. However, passive treatment of AMD with high iron concentrations is still a major challenge for system efficiency.

The Lorraine site is an AMD generating site in Quebec province reclaimed in 1999. Although the reclamation strategy is effective to limit the generation of new AMD, contaminated water (especially characterized by a high iron loading of 2020 mg/L) in the tailings pores will take time before being leached out. Laboratory studies have shown that a system composed of only one unit passive treatment system, such as sulfate-reducing passive biofilter (SRPB) or anoxic limestone drain, is not efficient to treat this type of AMD [2,3]. Therefore, a multi-step treatment system was designed and built [3]. The first step is a SRPB (containing 50%wt limestone and 50%wt mixture of chicken manure, vegetable compost, wood chips, and sand), which allows pH increasing and a partial dissolved metal removal. The second step is a wood ash filter, for iron removal, mainly. The third step consists of a second SRPB, which allows the removal of sulfates and residual metals.

A 120 m³ system (40 m long x 3 m wide x 1 m high) was built in August 2011 and allows treating 1L/min (Figure 1).

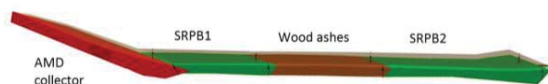


Figure 1: Multi-step treatment system design

Preliminary results

Results from the first four months of operation (see Table 1) showed a promising removal percentage for iron and sulfates (respectively 93% and 59% on average).

Parameter	pH	Fe (mg/L)	SO ₄ ²⁻ (mg/L)
AMD	5.5	2020	4784
After treatment	6.4	150	1992

Table 1: Average water quality after treatment

[1] Neculita *et al.* (2007) *J. Env. Qual.* **36**, 1-16. [2] Potvin (2009) *PhD thesis*, 335 pp. [3] Genty (2011) *PhD thesis*, 252 pp.

Silicon Isotopes – A Global Weathering Proxy?

R.B. GEORG

Water Quality Centre, Trent University, Peterborough, Ontario, K9J 7B8 (rgeorg@trentu.ca)

Silicon stable isotopes are one example of the large group of so called “novel stable isotope tools” that became routinely available over the past decade. Advances in mass-spectrometry, especially ICP-MS and gas source mass-spectrometry, provided the technical means for determining Si isotope ratios with unprecedented precision and accuracy. These technical advances opened up new ways to study low-temperature processes, such as weathering reactions, in greater detail. Silicon is ubiquitous in the environment and the isotope system is therefore predestined to be a useful tracer for processes controlling the Si budget in the weathering zone.

Two major fractionation pathways have been identified; (1) biological uptake of Si and (2) the formation of secondary weathering products. Both of these fractionation processes discriminate against the heavier isotopes and produce dissolved Si in surface waters that is usually enriched in heavy Si isotopes. The global runoff has a $\delta^{30}\text{Si}$ of about +1.1‰ (De La Rocha *et al* 2005, Georg *et al* 2009), which reflects isotope fractionation due to a combination of biological processes and weathering processes. The interesting questions would be: which of the two major fractionation pathways dominates and produces the positive isotope composition of the global runoff?

The biological part of the continental Si cycle is often being perceived as the dominant one resulting in large biogenic Si fluxes. A fast turnover of biogenic silica, however, mitigates larger fractionation effects on the dissolved Si load in rivers. The formation of secondary clays represents a more effective way of removing Si from the weathering zone and therefore causing a much greater net fractionation.

I will present a fractionation model of the continental Si cycle that takes into account the interactions between various Si pools and isotopic evolution as a function of the two major fractionation processes. Results show that the formation of secondary minerals is the main driver behind the positive isotope composition in rivers. Although more Si is cycling through the biosphere, the fast turnover means that the biological Si cycle is mostly self-supporting and does not require larger inputs of fresh Si from weathering. Hence the net isotope fractionation is mitigated when biogenic silica is returned to the soil system. The biological cycle has a larger net effect only when significant amounts of biogenic silica are stored in long-term sinks (phytoliths). The typical positive Si isotope composition can only be achieved when significant proportions of Si are being locked-up in clays. In other words, the positive isotope composition of the global runoff reflects a slightly dominating inorganic Si cycle, e.g. dissolution of crustal material and formation of secondary weathering products. There appears to be some systematic change in the isotope composition of the runoff with weathering rates and intensities and in periods with extensive recycling of previously weathered materials, the Si isotope composition of the global runoff can be expected to be lighter than the modern value.

Silicon isotopes could potentially be used to track changes in continental weathering over time, providing a suitable archive exists, such as marine shales (see Savage *et al* – session 12c).

References:

De La Rocha *et al* (2005) – *Marine Geology* 215, pp 267
Georg *et al* (2009) – *EPSL* 283, pp 67