New approaches for the prediction of contaminated neutral drainage

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Context and objectives

Contaminated neutral drainage (CND) is the presence of metal concentrations above regulatory requirements at circumneutral pH in mine drainage [1]. The generation of CND by tailings and waste rocks is a growing concern for the mining industry due to increasingly restrictive regulatory requirements. Difficulties in CND prediction arise from the low oxidation rates of sulfide minerals and from the metal retention potential within the wastes. The latter induces an important delay in the formation of CND conditions [2]. For now, it is not possible to account for this delay using prediction techniques developed for acid-mine drainage (AMD) prediction, such as humidity cells, columns and lysimeters. This presentation aims to present (1) the main differences in AMD and CND predictions, and (2) new approaches currently under study for CND prediction.

Overcoming the metal retention prediction challenge

The main challenge of CND prediction is to quantify the metal retention potential of mine wastes, especially when sorption phenomena are involved in metal retention [1]. Three approaches are currently used to overcome this difficulty. Firstly, the sorption potential is estimated using batch sorption studies [2, 3]. The second approah consists of artificially saturating the sorption potential of the mine waste [4]. This can be done by contact with a contaminated leachate in sorption-enabling conditions until saturation of the retention potential. These approaches both require that the possible metals involved in CND are known prior to the tests, which require an exhaustive material characterization. Although they enable the qualitative estimation of the retention potentials of mine wastes, their results are virtually impossible to scale up from the lab to the field. A third approah currently under study is to inhibit metal sorption at the source using complexing agents. The ideal complexing agent for this matter would inhibit sorption phenomena by chelating the metals generated by sulfide oxidation, therefore disabling it from any other geochemical reaction, while it would not interfere with any other geochemical processes involved.

Conclusion

New approaches are currently developped to define the sorption potential and its impact in the mobilization of metals for CND prediction. These approaches will help in the development of a CND-specific protocol for the prediction of mine drainage quality.

[1] Nicholson (2004). *MEND Workshop, Sudbury*. [2] Plante, Benzaazoua & Bussière. (2011) *Mine Water Envir* **30**, 2-21. [3] Plante et al. (2010). Appl Geochem 25, 1200-1233. [4] Plante, Benzaazoua & Bussière (2011). *Mine Water Envir* **30**, 22-37

Impact of biological Mn(II) oxidation on the fate of subsurface U(IV)

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Uranium contamination of the subsurface, resulting from mining and processing of the radionuclide, is a concern in numerous locales. The oxidized form of U, hexavalent uranium (U(VI)), is soluble and mobile. Therefore, understanding its fate and transport is critical for the management of contaminated environments. U(VI) can be biologically reduced to U(IV) species that are less soluble, such as the mineral uraninite (UO_2) or monomeric U(IV). Stimulating biological activity in the subsurface has emerged as a possible remediation strategy for uranium contamination and would result in the formation of an *in situ* waste form consisting of U(IV). However, the long-term stability of U(IV) in the subsurface is still poorly understood. In particular, the formation of biogenic manganese oxides, known to rapidly oxidize UO_2 [1], may significantly impact the persistence of U(IV). This study focuses on probing the occurrence of Mn oxidation in the subsurface at a U contaminated site (Rifle, CO USA) and the ultimate fate of U in the system. Agarose gel pucks, containing Mn oxidizing spores and reduced U, were prepared as initial probes of the U/Mn redox system to determine if U(VI) was released from the gel after oxidation of U(IV) by Mn oxides. Initial results indicate extensive Mn oxidation within gels and almost no release of U from the gels after a month. U was present as U(VI) in the gels and X-ray absorption results indicate it may be a sorbed species. To investigate such reactions at the field scale, columns containing sediment previously enriched with reduced U *in situ* were prepared for deployment in the same aquifer's sub-oxic zone under Mn oxidizing conditions. Initial results from these experiments indicate U oxidation and release over a two month period. In order to more accurately pinpoint cause and effect in this system, laboratory columns were prepared with the same sediment and artificial groundwater. These experiments will determine the relative contribution of O_2 and Mn(IV) to U(IV) oxidation. Furthermore, TEM and XAS analysis of both field and lab sediments will determine spatial location of U in relation to Mn. These combined methods will give a more detailed view of the interactions between Mn and U in the subsurface. Because bioremedation technology is contingent on the product being stable, this is valuable information which can help evaluate the viability of future remediation approaches.

[1] Chini (2008) *Environ. Sci. Technol.* **42**, 8709-8714.