MINE CLOSURE STRATEGY IN THE NORTH: THE USE OF SEMI-PASSIVE BIOLOGICAL TREATMENT FOR REMOVAL OF As, Sb AND Se FROM MINE IMPACTED WATER

Dr. Amelie Janin[1], Dr. Steve Wilbur[2], Isobel Ness[1]

[1] Yukon Research Centre, Yukon College, Whitehorse, YT, Y1A 5M2

[2]Victoria Gold Corporation, Vancouver, BC, V7X 1K8

Key Words: bioremediation, passive water treatment, sulfate-reducing bacteria, anaerobic bioreactor

Passive water treatment technologies are increasingly being considered for mine site closure in the Yukon. Efforts are currently underway in Yukon to test, compare and contrast passive treatment technologies with conventional technologies. This study aimed to provide additional information about the effectiveness of passive treatment technologies for mine water treatment in cold climates. To test the hypothesis that bioreactors can effectively treat mine-impacted water at low temperatures, four bench-scale, continuous flow bioreactors were assessed for their potential to remove As, Se and Sb from mine effluent over a one year period. More specifically, the objectives of this study were to: 1) assess the efficiency of removal of As, Sb and Se from a synthetic drainage with relatively high initial concentrations of the three metals in cold conditions, as well as from actual leachate collected at the Eagle Gold site, a proposed gold mine in central Yukon, 2) evaluate the effect of using wood chips as part of the composition of the bioreactor, and 3) assess the effect of the freeze/thaw transition on the bioreactors' performance.

Protocols were: Phase 1 (P1), the bioreactors were operated with the addition of liquid methanol as a carbon source, and in an environment with uncontrolled temperature during the fall until the bioreactors froze solid; Phase 2 (P2), the bioreactors were thawed in a fridge at a stable temperature of 6°C; Phase 3 (P3), the bioreactors were operated and monitored at 6°C; Phase 4 (P4), the bioreactors were operated at 6°C in the same conditions but without the carbon addition.

Results show that all bioreactors significantly decreased As, Sb and Se concentrations when carbon was added independent of influent concentration. Using the highly concentrated synthetic metals drainage with an average of 4.9 mg/L As, 0.14 mg/L Sb and 0.47 mg/L Se with a 1% methanol addition, the removal efficiencies were >93% , >96%, and >99% for As, Sb, and Se, respectively over phases 1 to 3. The results indicate that the use of spruce chips in the bioreactor substrate (C10 and C11) helped improve removal efficiencies, while mitigating the effect of freeze/thaw . It is suggested that the wood chips provide an adequate support to either protect and/or favor biofilm growth, which may promote sulfate reduction and metal sulfides precipitation. Finally, the efficacy for adding carbon was assessed by comparing the results for a 153-day period with 1% methanol added to a 220-day period without methanol added. Sb and Se were affected by the lack of methanol but high performances were still achieved with >95% and >88% removal of Sb and Se respectively over the 220 days (The Sb performances figure is not shown here resemble Se removal shown in Fig 1). On the other hand, As concentration rose steadily in the effluent once liquid carbon addition was stopped (Fig 2), suggesting that supplementing the reactor with liquid substrate is required to remove As in cold temperature. We surmise that adding methanol provided an easily biodegradable carbon source, which is much needed by the microorganisms responsible for As removal at cold temperatures.

This study is one of very few studies reported in the literature that demonstrates Sb removal from water by an anaerobic bioreactor. Overall, it demonstrates the potential application of passive anaerobic bioreactors as a technique to remove As, Sb and Se from mine water effluent in a cold climate where freeze/thaw happens as long as easily biodegradable carbon is available to the microbes. It also suggests that the addition of liquid carbon to the bioreactor may be required, especially for As removal in cold temperatures and freeze/thaw conditions occur. Further study would be needed to identify the temperature threshold under which the addition of carbon source is required and to scale up the bioreactor. It is suspected that better flows (less preferential pathways) would be achieved in a larger unit and would support removal efficiencies.

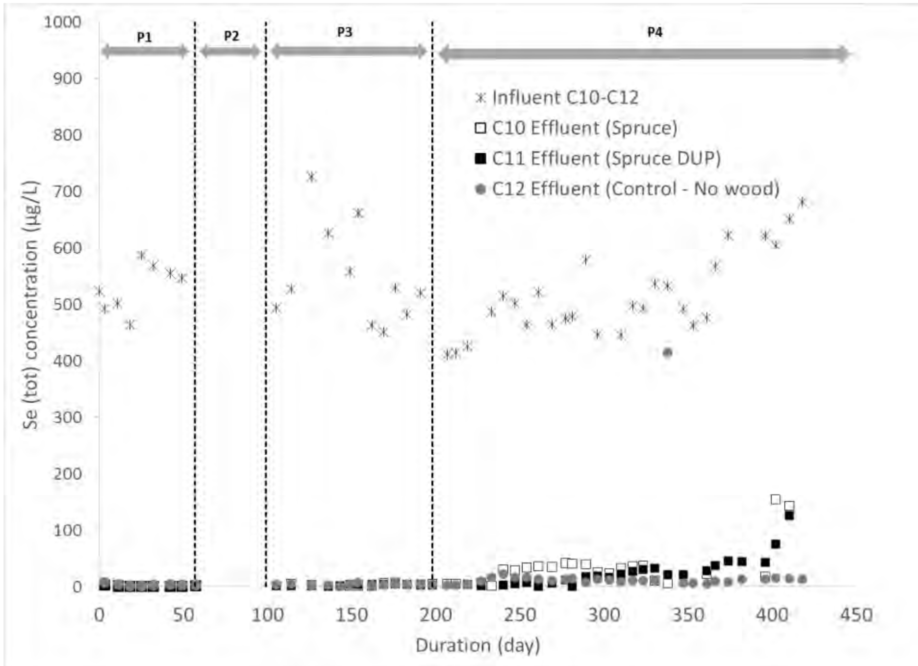

Figure 1. Se concentration in the influent and effluents from the C10-12 reactors (Phases 1-4; quantification limit is 0.7 ug/L, value below the limits are reported as 0.7)

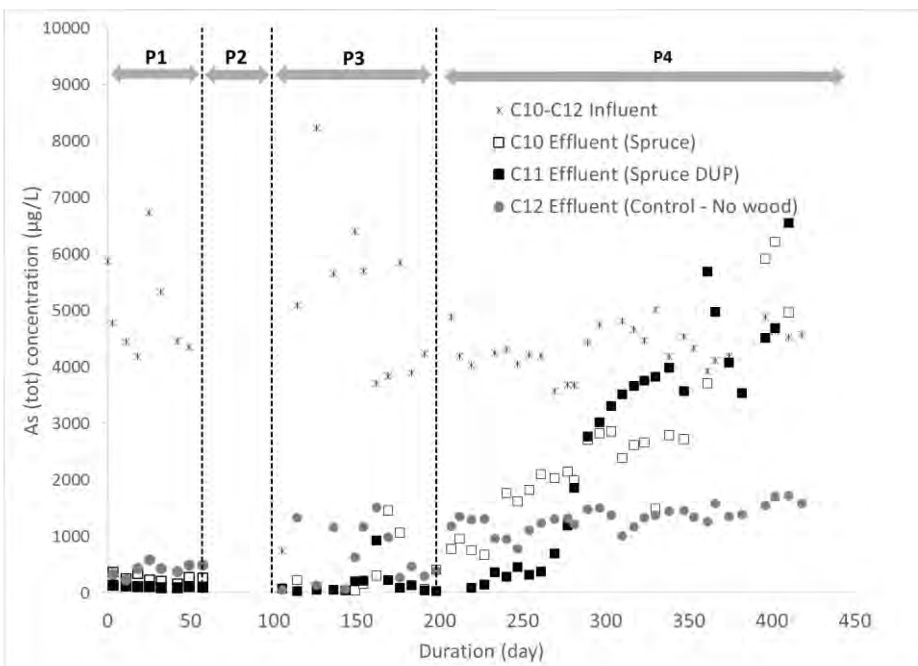

Figure 2. As concentrations before and after treatment by the bioreactors C10 and C11 (duplicates, wood-amended) and C12 (control, no organic amendment) (Phases 1-4; quantification limit is 0.8 ug/L, value below the limits are reported as 0.8)

41st CLRA National Annual General Meeting and Conference

McIntyre Arena, Timmins, Ontario

June 26-29, 2016

PROCEEDINGS

CLRA | ACRSD

Canadian Land Reclamation Association

Association canadienne de réhabilitation des sites dégradés