Removal of Arsenic from mine drainage in New Zealand using AMD precipitates[1]

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ABSTRACT

Batch and column experiments were performed to determine the ability of acid mine drainage (AMD) precipitate to remove arsenic through adsorption from mine drainage. AMD precipitate was sourced from (1) sludge from AMD neutralisation at the Stockton Coal Mine (ST sludge), and (2) sludge naturally precipitating from untreated AMD at the abandoned Blackball Coal Mine (BB Sludge). The precipitate contained Fe_2O_3 at concentrations of 13 wt% (ST) and 74 wt% (BB). Water was obtained from the abandoned Waiuta Gold Mine, and contained up to 61 mg/L As (Table 1). All three mines are located on the West Coast, New Zealand. Rapid reduction in As concentrations occurred within 15 hr in all batch experiments, with BB sludge consistently performing better than ST sludge (Figures 1 and 2). After 48 hr at a ratio of 50 g sludge to 1 L water As concentrations were lowered to 0.0017 mg/L (BB) and 0.008 mg/L (ST).

Table 1: Waiuta mine water chemistry

		Waiuta water
pH	pH Units	3.9
Total Alkalinity	g/m^3as $CaCO_2$	<1.0
Dissolved Aluminium	g/m^3	0.44
Dissolved Arsenic	g/m^3	61
Dissolved Calcium	g/m^3	15
Dissolved Iron	g/m^3	0.38
Dissolved Magnesium	g/m^3	3.2
Dissolved Manganese	g/m^3	0.11
Dissolved Nickel	g/m^3	0.013
Dissolved Potassium	g/m^3	1.5
Dissolved Sodium	g/m^3	3.7
Dissolved Zinc	g/m^3	0.41
Chloride	g/m^3	4.4
Nitrite-N	g/m^3	<0.0020
Nitrate-N	g/m^3	0.46
Nitrate-N + Nitrite-N	g/m^3	0.46
Dissolved Reactive Phosphorus	g/m^3	19
Sulphate	g/m^3	15

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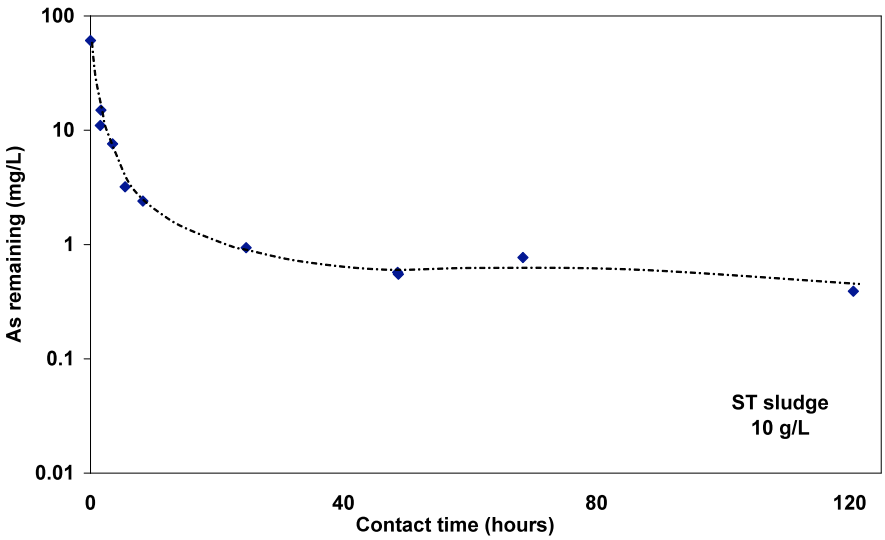

Figure 1: Arsenic concentration in water over time when in contact with ST sludge during batch experiments.

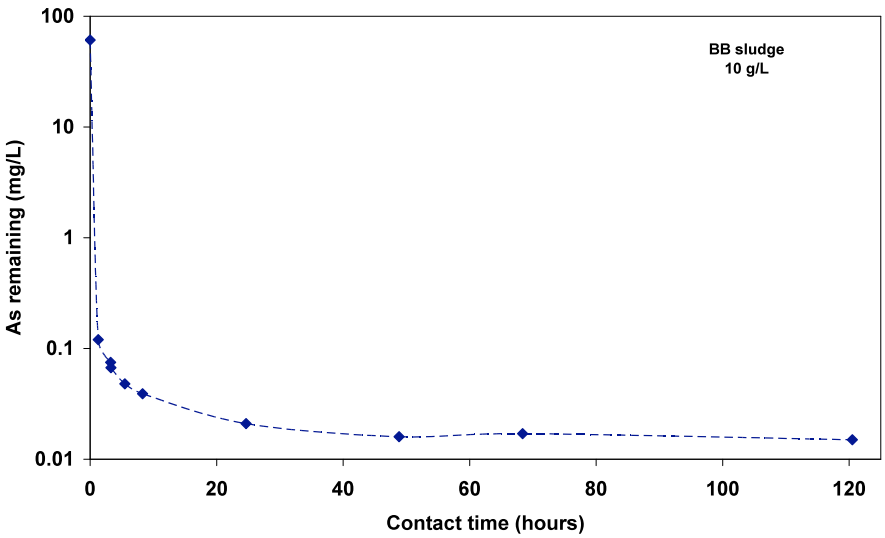

Figure 2: Arsenic concentration in water over time when in contact with BB sludge during batch experiments.

A column leaching experiment was conducted to determine long-term adsorption potential. Water was passed through columns, at an average flow rate of 1.8 L/day, with sand coated in the powdered AMD sludge for 10 days at a constant contact residence time of 1 day (Figure 3). Two columns were packed at a ratio of 50 g sludge to 1 L water (ST and BB) and one at a ratio of 10 g sludge to 1 L water (BB). All columns lowered As concentrations to <0.01 mg/L for the first 2 days. The columns with ST sludge at a ratio of 50:1 and BB sludge at a ratio of 10:1 showed a steady increase in effluent As concentrations after 2 days, suggesting that adsorption sites were being exhausted (Figure 4). The column with the BB sludge at a ratio of 50:1 lowered As concentrations to <0.01 mg/L for 9 days, increasing to 0.04 mg/L on day 10, suggesting many more available adsorption sites on the naturally-precipitated AMD sludge (Figure 4). A toxicity characteristic leaching procedure test on the BB sludge/sand mixture packed at the 50:1 ratio showed As <0.021 mg/kg, indicating relatively good stability of the adsorbed As. These results suggest that As can be treated

successfully with AMD sludge if ratio of sludge to water and contact residence time are optimised.

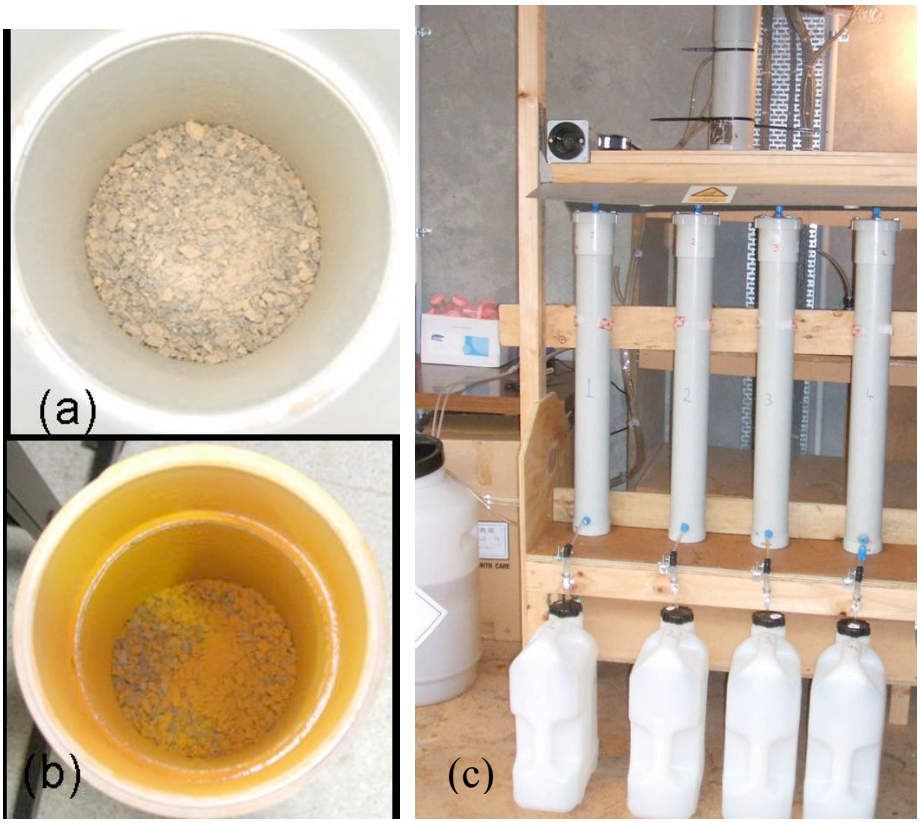

Figure 3: Column experimental setup. (a) ST sludge. (b) BB Sludge (c) Contaminated water reservoir far left, PVC columns with effluent capture container.

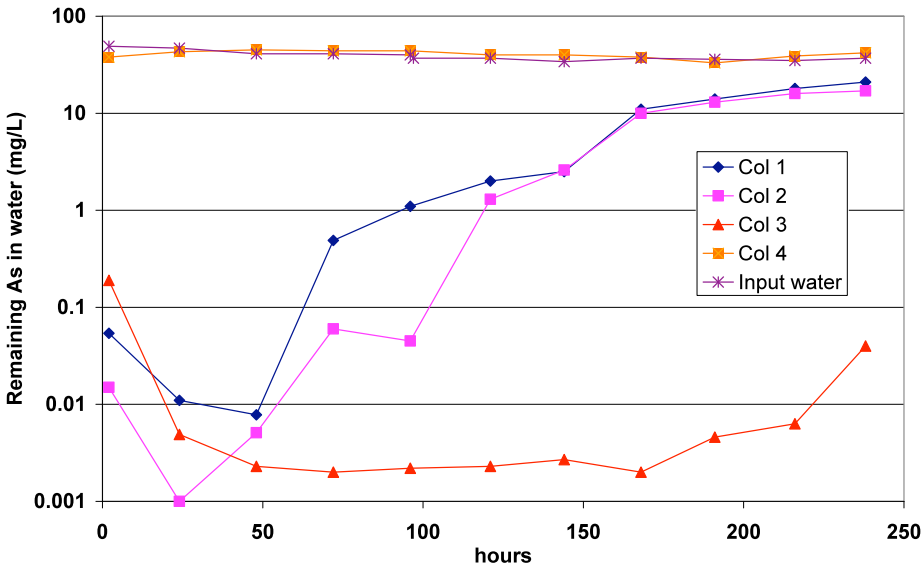

Figure 4: Arsenic concentration in effluent over time for column experiments. Col 1=ST sludge 50 g/litre input water, Col 2=BB sludge 10 g/litre input water, Col 3=BB sludge 50 g/litre input water, Col 4= No sludge only sand, control.

Additional Key Words: iron hydroxide, adsorption. acid mine drainage, gold mines, coal mines

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