

BIOPOLISHING OF ZINC AND OTHER METALS BY PERIPHYTON COMMUNITIES AROUND A BASE METAL MINE

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ABSTRACT

Biological polishing of zinc and other heavy metals was studied in populations of periphyton at a polymetallic mine in Buchans, NFLD. The algal populations have been studied for two growing seasons in the effluent from an abandoned gloryhole.

A series of six polishing ponds were constructed near the effluent creek. The surface area for algal colonization was increased using brush cuttings. Flow rates through the ponds were variable and low, resulting in residence times ranging between 10 and 180 hours.

Accumulation of algal-precipitate biomass was monitored by collecting branches over two growing seasons in 1989 and 1990. The algal-precipitate mass was quantified by separating branch and algal-precipitate and drying both (60° C for 24 h).

Biomass of periphytic communities growing in seepages in the meadow was also collected. These samples were washed with tap water, cleaned of extraneous materials, and dried in the same manner as the algal-precipitate in the experimental ponds. Multi-elemental analysis was carried out on water and algal material using Inductively Coupled Plasma Spectrophotometry (ICP) by a certified laboratory (Assayers Ontario, Ltd.). Water was filtered through a 0.45 µm membrane filter, acidified to pH 1 or less.

The periphyton population growing on the branches in the polishing ponds was dominated by the green alga *Microspora* spp. and the diatom, *Achnanthes linearis*. The algae in the seeps were dominated by a population of *Ulothrix* spp. Reproductive structures have not been seen in the green algae, inhibiting species identification.

Bio-accumulation of metals by the two periphytic communities is described by calculated concentration factors based on a wet to dry weight ratio of 10. The *Ulothrix* population in the meadow contained 1.8% zinc, a concentration factor of only 104 (Table I). In contrast, the same water concentration of zinc, the polishing pond community accumulated 500 x ambient zinc (Table II). Barium in *Ulothrix* community was about 12,000 times over ambient levels as compared to 22,900 times in the *Microspora-Achnanthes* community.

Table I: Concentrations of metals in the *Microspora-Achnanthes* community.

ELEMENT	WATER (mg/L)	ALGAE ($\mu\text{g/gdw}$)	CONC.
Ba	0.01<	2287	>22,900
Cd	0.01<	40	>400
Co	0.01<	43	>430
Cr	0.01<	39	>390
Cu	0.01<	210	>210
Ni	0.01<	50	>500
Pb	0.01<	638	>640
Sr	2.4	125	4
Zn	16	81000	500

The zinc concentration differences in the periphyton communities are related to the presence of zinc and iron hydroxide precipitates. The polishing pond community acts as a biosieve, accumulating precipitate as well dissolved zinc. This results in concentrations as high as 8% zinc on a dry weight basis (Table I).

Table II: Concentrations of metals in *Ulothrix* community in the meadow.

ELEMENT	WATER (mg/L)	ALGAE ($\mu\text{g/gdw}$)	CONC.
Ba	0.02	2331	11,655
Cd	0.01<	10	>100
Co	0.01<	70	>700
Cr	0.01<	36	>360
Cu	0.01<	62	>620
Ni	0.01<	26	>260
Pb	0.01<	122	>1,220
Sr	3.6	120	3
Zn	18	18800	104

Water sampled from the first and last (sixth) pond showed evidence of removing dissolved zinc (Figure 1), which appears to be related to environmental factors and biomass density (Figure 2). The increases of the algal-precipitate mass per unit branch appeared to be related to the increased biopolishing of zinc evident during the second growing season. Zinc concentrations in the incoming and outgoing water reached a maximum during the late summer of the second year, corresponding with the greatest biomass per branch (September 1990, Figure 1).

The ability of these algae to concentrate dissolved cations, and the sieving capability of the algal community in the polishing ponds, indicate that periphytic algal populations with the proper scale-up may provide assistance in polishing waste water from active and decommissioned base-metal mines.

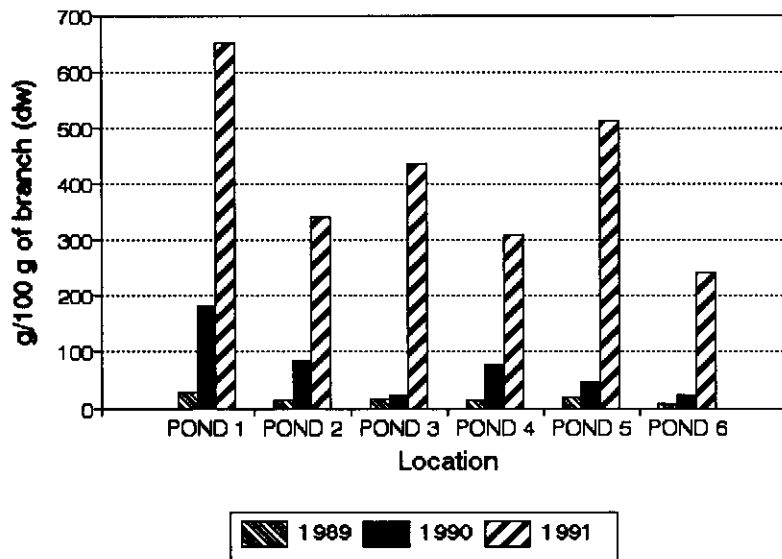


Figure 1: Dissolved zinc concentrations entering polishing pond 1 and leaving pond 6.

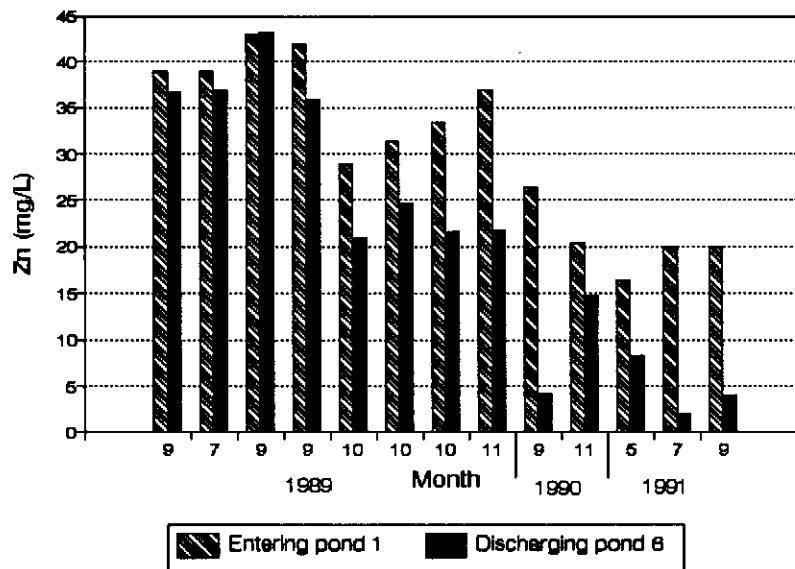


Figure 2: A comparison of *Microspora-Achnanthes* biomass (grams dry weight) per 100 g (dry weight) of branch between 1989 and 1990. Experiments were started in 1989.

Fig. 14a Buchans
Pond 1 - 6 Dissolved Zinc

