THE CONTRASTING GEOCHEMISTRY OF SURFACE WATER IN THE TAILINGS OF CENTRAL MANITOBA GOLD MINE, CANADA[1]

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Extended Abstract Heterogeneous distribution of minerals within a tailings deposit can lead to long-term establishment of different ecosystems. The 70 year old tailings deposit at the Central Manitoba Gold Mine contains two shallow ponds. The Blue Pond, which is about 1 m deep and 100 m in diameter, has a pH of 4.4 and is barren whereas the shallower Green Pond, 150 m away, is neutral (pH 7-8) with vegetation. The objective of study was to discover the reason for this difference in aqueous geochemistry and revegetation.

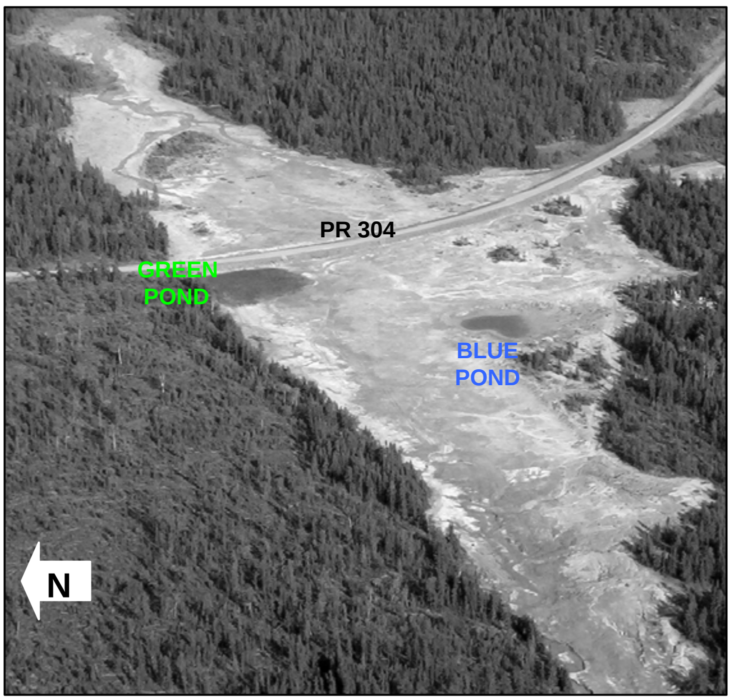

Figure 1. Central Manitoba Tailings, (500 m N-S and 1.5 km E-W). Discharge is presumed to be just south of the Blue Pond.

Additional keywords: acid mine drainage

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Water was collected from both ponds and from the surface and groundwater of the tailings, filtered and preserved on site for cation and anion analysis. Eh, pH, DO and conductivity were measured at the time of collection. Samples of the unoxidized tailings were collected by auger at 1 m depth, in a line at 10 m intervals between the ponds. The water samples were analyzed for cations and anions and the solid tailings for sulfide and carbonate. Speciation of ions in the water samples and the saturation indices of minerals in equilibrium with them were obtained using the aqueous chemistry modeling program computer, WATEQ4f. The net neutralizing potential (NNP) was calculated for the solid samples.

A unique feature of Central Manitoba tailings deposit is that, overall, there are equal amounts of carbonate and sulfide but NNP changes from -50 to + 10 across the deposit. The Blue Pond is located close to the former mill discharge point (Fig. 1). It is about 1 m deep and 100 m in diameter. Here, acidic steams and ground water feeding the Blue Pond water pass through acidic sulfide-enriched sediments (with a negative NNP) becoming enriched in Cu^{+2} (<2103 mg/L), Fe^{+2} (16 mg/L) and SO_4^{-2} (7200 mg/L). In the pond, further acidity is produced by schwertmannite precipitation but the pH is buffered at 4.4 by the reaction

$$Al(OH)_{3(aq.)} + 3H^{+} \rightarrow Al^{+3} + 3H_2O$$

The low pH prevents the precipitation of Cu minerals, causing a high concentration of blue Cu^{+2} and the lack of plants.

The Green Pond is about 150 m north of the Blue pond and 300 m from the discharge point. It is fed by surface streams with a neutral pH due to the higher concentrations of calcite further from the discharge point and the positive NNP of tailings. Metal and SO_4^{-2} concentrations in the streams are lower (Cu^{+2} 0.083 mg/L, Fe^{+2} <0.05 mg/L and SO_4^{-2} 143 mg/L). The acidity produced in the Green Pond by the precipitation of goethite and ferrihydrite is neutralized by the abundant carbonate.

Differential settling of sulfides (pyrite and chalcopyrite) and calcite controls the geochemical evolution of the site producing two ponds with very different geochemistry. The difference in geochemistry of the surface ponds affects the natural revegetation of the tailings.