

Geochemistry of the Tailings - Pond Water Interface in the Flooded Tailings Pond at Stekenjokk, Northern Sweden

Björn Öhlander (bjorn.ohlander@sb.luth.se)¹ & Henning Holmström

¹ Division of Applied Geology, Luleå University of Technology, SE-97187 Luleå, Sweden

Various methods have been developed to prevent the formation of acid drainage from sulphide-bearing mining waste. One of the most promising methods is to limit the supply of oxygen by covering the waste with water. The tailings at the Stekenjokk mine in northern Sweden, situated in the Caledonian mountains at an altitude of c. 800 m above sea level with an annual mean temperature of c. 0°C and an annual precipitation of c. 1100 mm, have a strong acid producing capacity. Mining ceased 1988 and left waste rock dumps and some 4.4 million tons of tailings containing c. 20% sulphur, mainly occurring in pyrite, and up to 14% carbonates. A decommissioning programme based on flooding was completed 1991. Flooding was performed by raising the water level in the tailings and clarification pond (Broman and Göransson 1994). A geochemical field study of the efficiency of flooding to reduce sulphide oxidation was performed during 1995. The pond water was well mixed and oxic the whole year round, had a rather high pH between 7.2 and 7.8, and had higher concentrations of Ca (20±0.7 mg/l), S (11.1±0.3 mg/l), Zn (139±8 µg/l) and Cd (0.69±0.07 µg/l) than local background values (Ljungberg et al. 1997). The Cu-content was low (1.8±0.3 µg/l). Diffusion of metals from pore waters in the tailings was found to be the most important source to metals in the pond, especially from tailings which were oxidized before the flooding. Oxidation of resuspended sulphides was not an important metal source to the water column (Holmström et al. 2000).

To study the development with time at the tailings - pond water interface, we performed detailed studies of profiles of tailings and pore waters in the Stekenjokk pond. Oxygen saturation in the pore waters was measured with sub-mm resolution by using microelectrodes (Gundersen and Jørgensen, 1990). Tailings were sampled by using a modified Kajak gravity corer with a Plexiglass tube. The cores were cut into 0.5 cm subsamples, and pore water was extracted by vacuum filtering in a glove box filled with Ar. Tailings were analysed by ICP-AES and ICP-MS, and pore water analysed by ICP-AES and High Resolution ICP-MS (ICP-SMS).

A few mm thick layer rich in organic material as well as layers rich in Mn- and Fe-oxy-hydroxides have been developed

on the tailings since the flooding. The pore waters are saturated with dissolved oxygen at the tailings - pond water interface, and there is oxygen available down to a depth of between 14 and 17 mm (Holmström and Öhlander 1999). The oxygen consumption occurs in the tailings, below the organic layer. This indicates that some oxidation of sulphides still occur in the uppermost parts of the tailings, which is further supported by pore water concentration maxima of elements such as Cu, Zn, Ni, Co and Cd, released by sulphide oxidation just below the tailings - pond water interface.

Since the shallow pore waters have higher metal concentrations than the bottom waters in the pond, there is a diffusion of metals from the pore waters to the pond. However, an important part of the amount of upwards diffusing metals is retained by sorption to the Mn- and Fe-oxyhydroxide layers formed in the uppermost tailings. These layers function as a trap for the metals released by sulphide oxidation, thereby decreasing the diffusion rate at the tailings - pond water interface.

Our results suggest that it is possible for a deposit of flooded tailings to reach a state where it starts to partly function as a natural lake with layers rich in organic matter and Mn- and Fe-oxyhydroxides, which controls the diffusion of metals from the pore water in the tailings up into the pond water, a relatively short time after remediation.

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