GEOCHEMICAL CONTROLS ON MANGANESE CONCENTRATIONS IN THE CUNNINGHAM MINE PIT LAKE AND DOWNGRADIENT GROUNDWATERS. D. Langmuir, M. A. Williamson[1], and A. Montana, [1]Adrian Brown Consultants, 333 W. Bayaud Avenue, Denver CO 80223, USA.

The Cunningham Hill gold mine is located in the Ortiz Mountains in northern New Mexico. The mine operated until 1987, since which time ground and surface water has been filling the open pit. Pit lake pH was constant at 7.8±0.3 from July 1987 through August 1996, after which time through March 1997, pH values dropped as low as 6.3. From July 1987 through March 1997, HCO_3^- continuously declined from 220 mg/L to less than 50 mg/L. Mn^{2+} concentrations remained between about 1 and 2 mg/L until August 1996 after which they rose to 3-4 mg/L. These changes apparently reflect the fact that acidity from pyrite oxidation has gradually depleted the calcite in pit wall rocks and the dissolved bicarbonate in the lake.

In support of this conclusion, geochemical modeling shows calcite at saturation in the lake with its saturation index (SI_c) equal to 0.80±0.30 through August 1996, but with SI_c dropping to negative values thereafter[1]. Prior to August 1996, increasing Mn^{2+} concentrations may have been limited by precipitation of rhodocrosite ($MnCO_3$) for which the saturation index (SI_r) averaged 0.24±0.20. Thereafter SI_r values became negative and averaged -0.55±0.13, indicated undersaturation. After August 1996 at pH values which were generally below about 7.5, Mn^{2+} concentrations may have been limited by Mn^{2+} adsorption onto ferric oxyhydroxides produced by the oxidation of Fe^{2+} from groundwater seeps and pyrite in the pit walls.. Consistent with this possibility, diffuse layer modeling of the proposed adsorption reaction can duplicate the trend of increasing Mn^{2+} concentrations with decreasing pH below pH 7.5.

Groundwaters from six wells in the plume moving downgradient from the pit lake have an average pH of 7.7, and average HCO_3^-, Ca^{2+} and Mn^{2+} concentrations of 248, 32, and 0.38 mg/L, respectively. Geochemical modeling indicates that these waters are saturated with respect to both calcite and rhodocrosite, and that additional Mn^{2+} that might be introduced into the groundwater from the pit lake is unlikely to exceed existing average concentrations of 0.38-0.75 mg/L because of rhodocrosite precipitation.

---

[1]SI values of positive sign indicate a water is at or above saturation with respect to the mineral of interest. SI values of negative sign indicate undersaturated conditions.