Chemical variations in the waters draining the HI-YU Mine

John M. Clark, Department of Geology & Geophysics, University of Alaska, Fairbanks, AK

The Hi-Yu gold mine located on Moose Creek, approximately 56 kilometers (km) northeast of Fairbanks, consists of northwest-trending gold-quartz-sulfide veins. The veins are mostly quartz with sphalerite, pyrite, arsenopyrite, galena, stibnite and antimony sulfosalts. The gold is associated with the sphalerite and from polished section appears to either be enclosed by the sphalerite or at the edges the sphalerite and the quartz.

The mining and milling of gold bearing ore can result in the release of metals into the environment when the sulfide minerals contained in the ore and mine tailings are exposed to water and oxygen. There are two sources of contamination at the Hi-Yu mine: the 'mill seep' and the mine tailings. The 'mill seep' is a year-round spring emanating from just below the mill building. It has an acid pH (4.8) and contains high concentrations of Cd and Zn, ~21 parts per billion (ppb) and 2400 ppb respectively. Water draining the mine tailings contain ~284 ppb As and 27 ppb Sb. These concentrations are above the EPA and state Maximun Contaminant Levels (MCL). Because the mill does not contain any sulfides and simply weathering zinc metal will not produce the pH measured from the 'mill seep', I interpret the 'mill seep' as actually draining underground mine workings. I interpret the source for the elevated metal contents in the 'mill seep' to be the weathering of sphalerite + pyrite from the veins. Geochemical modeling of fluid-mineral interactions shows I can reproduce the composition and pH of the seep by reacting minerals known to be in the ore veins i.e. pyrite, sphalerite, muscovite with rain water. The source of As and Sb in water draining the tailings is from weathering of arsenopyrite and stibnite in the tailings. The 'mill seep' water flows through a portion of the tailings, keeping the pH near 4, and picks up more metals before mixing with Moose Creek. Another portion of the tailings, saturated with water, interacts with Moose Creek further downstream. Once the mill seep mixes with Moose Creek, the pH increases, leading to the precipitation of iron and manganese hydroxides with associated As, Cd, Sb, and, Zn. Samples of the iron precipitate contain > 10,000 parts per million (ppm) As, 19 ppm Cd, 240 ppm Sb, and 2600 ppm Zn. This precipitation of metals along with the interaction of organic material and dilution bring the metal contaminant levels down to below MCL levels within 0.8 km from where they mix.

Although technically a point source of pollution, the seep and tailings cause no significant increase in the metal content of Fairbanks Creek 1.2 km downstream of the Hi-Yu mine. In fact, Fairbanks Creek, which drains several other mines, has higher As and Sb concentrations than does Moose Creek. I suspect the relatively low sulfide content of the ore, the presence of secondary carbonates within the ore, and the adsorption of metals onto Fe and Al oxide and hydroxide phases make the discharge relatively benign, despite the ugly-looking iron hydroxide precipitate locally present.