

# Geochemistry of Improved Groundwater Quality Resulting from Adit Plugging, Glengarry Mine, New World District, Cooke City MT USA<sup>1</sup>

Lisa B. Kirk<sup>\*</sup>, Lauren R. Bozeman, Allan R. Kirk, and Mary Beth Marks<sup>2</sup>

**Abstract:** Construction of hydraulic adit plugs within the historically mined Glengarry Adit at Cooke City MT effectively reduced discharge by more than 95% and resulted in groundwater rebound that flooded underground workings. This study evaluated geochemical controls of groundwater quality through comparison of changes in mineral saturation states and metal sorption potential. Monitoring of water quality in the adit has occurred since the 1980s via collection of samples from the discharge at the adit portal prior to closure and from a monitoring well screened within the adit post-closure. Aseptic collection of biomass allowed characterization of microbial community present. The Geochemist Workbench SpecE8® and React® models were used to speciate the aqueous chemistry of the adit water, calculate changes in the relative equilibrium of the water with respect to Fe, Mn, and Al oxyhydroxide and sulfate minerals resulting from the adit closure, and to calculate potential for sorption of metals to precipitated ferrihydrite. Following closure, alkalinity rose from below detection to almost 5 mg/L in 2012, along with increased pH from an average of 3.5 to over 5.5 post-closure. This shift prompted precipitation of aluminum and iron-oxyhydroxide minerals followed by metal sorption and associated increases in dissolved iron and sulfate, primarily due to dissolution of jarosite. The closure design has thus successfully reduced sulfide oxidation substantially within the Glengarry adit, increased the stability of iron oxyhydroxide minerals able to sorb the trace metals Cu, Pb, and Zn, thus improving both surface and groundwater quality, which supports the use of this approach in other mine closure settings.<sup>3</sup>

**Additional Key Words:** hydraulic adit plug, ARD, jarosite, geochemical modeling.

1. Oral paper presented at the 2019 National Meeting of the American Society of Mining and Reclamation, Big Sky, MT. Welcome Back to Montana: The Land of Reclamation Pioneers, June 3–7, 2019.
2. Lisa B. Kirk (\* presenter), and Lauren R. Bozeman, Enviromin, Inc., 524 Professional Dr., Bozeman MT 59718; Allan R. Kirk Geomin Resources, Inc., 524 Professional Dr., Bozeman MT 59718; Mary Beth Marks, Gallatin National Forest, 10 East Babcock, Bozeman MT 59715.
3. Work reported here was conducted near 45° 0' 57.7620" N, 109° 54' 59.5800" W.