Minnesota USGS: http://mn.water.usgs.gov/
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Assessing the Influence of Natural Copper-Nickel Bedrocks on Water Quality

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Introduction

Mineral exploration is occurring and mines are being proposed for northeastern Minnesota to extract copper, nickel, cobalt, titanium, and platinum-group-metals (PGM) from the basal part of the Duluth Complex. Minnesota faces a unique opportunity to balance economic development through copper-nickel-PGM mining in northeastern Minnesota while simultaneously protecting existing water quality and ecosystems.

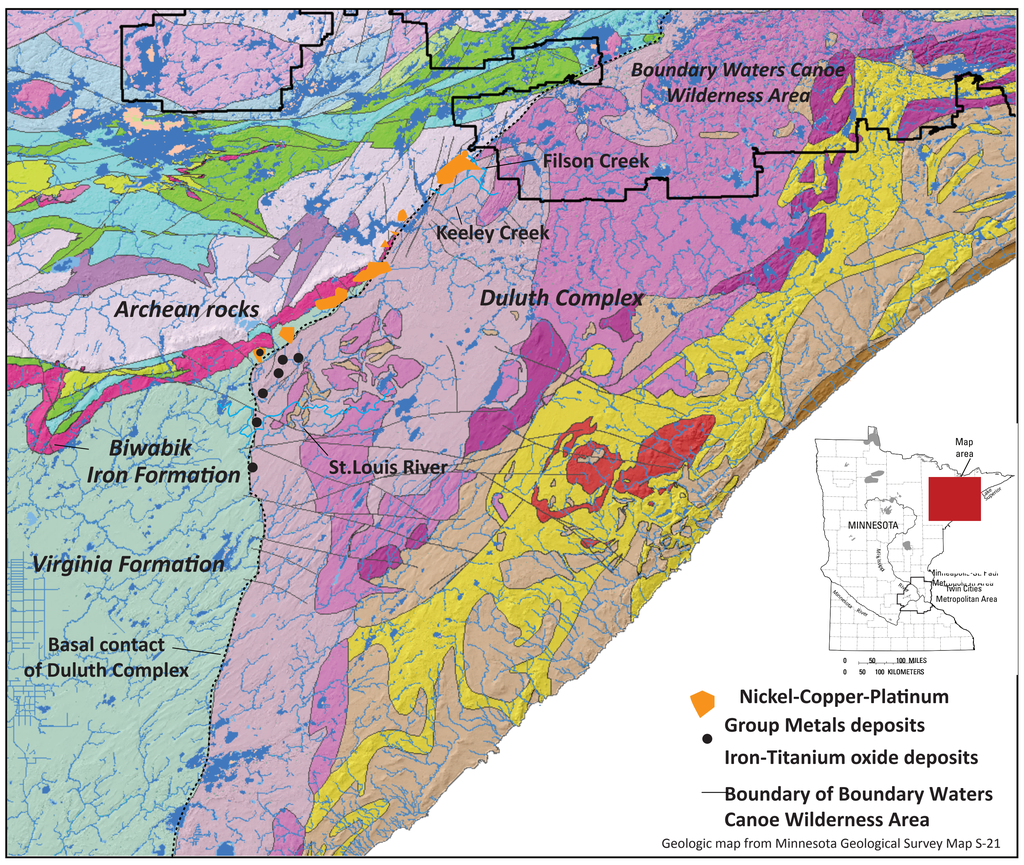

Figure 1. Bedrock geology of the Duluth Complex, northeastern Minnesota. Large nickel-copper-platinum group metals and small iron-titanium oxide deposits are located along much of the lower part of the Compelx.

The U. S. Geological Survey (USGS), Natural Resources Research Institute, and Minnesota Department of Natural Resources are conducting a three-year study (July 2013 - June 2016) to: 1) assess copper, nickel, and other metal concentrations in surface water, rocks, streambed sediments, and soils in watersheds where the basal part of the Duluth Complex is present; and 2) determine if these concentrations are currently influencing regional water quality in areas of potential base-metal mining.

Water-quality, streambed-sediment, soil (including parent material), and bedrock samples will be collected and analyzed in three unmined watersheds with different mineral-deposit settings: (1) copper-nickel-cobalt-platinum group metal mineralization (Filson Creek watershed), (2) titanium-oxide mineralization (St. Louis River watershed), and (3) no identified mineralized deposits (Keeley Creek watershed).

Streamflow Monitoring

Two new stream gages will be installed to monitor continuous stream discharge at two sites: 1) the south fork of Filson Creek and 2) Keeley Creek at its mouth with Birch Lake. An existing USGS stream gage on the St. Louis River (St. Louis River near Skibo, MN, USGS site number 04015438) will be used to monitor stream discharge in the third watershed. Stream-flow data from these three USGS stream gages will be combined with existing and new water-quality data to develop hydrologic models for each watershed. All collected streamflow and water-quality data will be used to determine any discharge-water-quality relations and archivedin the USGS NWIS database system (http://waterdata.usgs.gov/mn/nwis/).

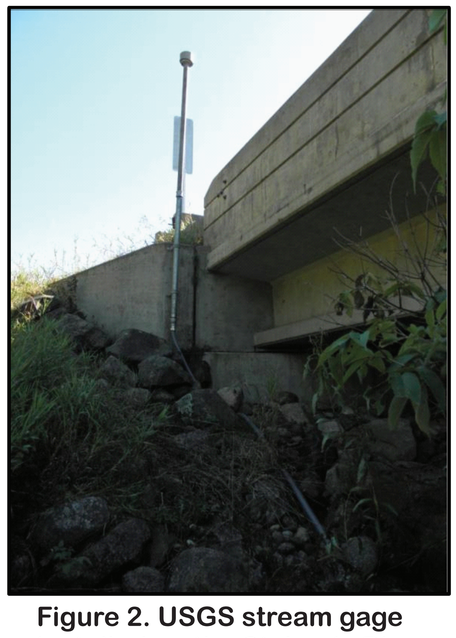

Figure 2. USGS stream gage installed on the St. Louis River.

Water-Quality Monitoring

Figure 3. Water quality sampling and discharge measurements at two sites on Keeley Creek. Water-quality sampling is being done in cooperation with the U.S. Forest Service.

In each watershed, water samples will be collected at four to five sites four times per year for two years (a total of 104 samples, 8 sampling events). The water samples will be analyzed for 12 trace metals (dissolved concentrations), 14 inorganic constituents (dissolved concentrations), alkalinity, and total and dissolved organic carbon. Total concentrations for 12 trace metals will be determined for samples collected at one of the sampling sites in each watershed for each of the 8 sampling events (total of 24 samples).

Soil, Streambed-sediment, and Bedrock Sampling

Figure 4. Streambed-sediment sampling in the St. Louis River. At this location, outside of the Duluth Complex, the river flows over graywacke and shale of the Virginia Formation.

Soil, streambed-sediment, and bedrock samples will be collected from each of the 3 watersheds. These samples will be analyzed for 45 major and trace elements, total and inorganic carbon, and 10 loosely bound metals to help characterize the regional geochemical 'background' within each watershed. These type of data, gathered before any mineral resource development, provide critical information on the natural distribution and concentration of elements in the environment.

Hydrologic/Biotic Modeling

For the three watersheds, hydrologic models will be constructed and used withexisting USGS biotic ligand models and any established discharge-water-quality relations to identify important hydrologic parameters that could be monitored to assess the nature and extent of possible mine development impacts on regional water quality. Water balances and hydrologic settings present in the watersheds prior to mine development will be established using the models.

The hydrologic modeling will **not** be used for making predictions of the impacts of potential individual mining projects.

The study is being funded through the Legislative-Citizen Commission on Minnesota Resources (LCCMR), USGS Cooperative Water Program, and USGS Midwest Mining Initiative.

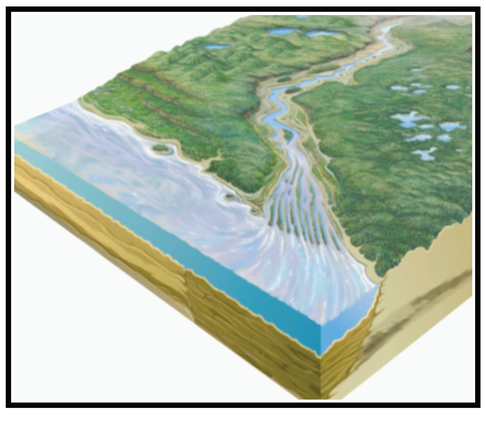

Figure 5. General Hydrologic Cycle.