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CHEMICAL SIGNATURE OF GROUNDWATER IN COVER OVERLYING DULUTH COMPLEX NI-CU-PGE DEPOSITS, NE MINNESOTA

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The U.S. Geological Survey initiated a project in 2015 aimed at evaluating geochemical exploration methods for covered deposits in the northern Midcontintent Rift, employing both site-scale studies and regional geochemical databases. A first group of groundwater samples was collected from unconsolidated material overlying the Spruce Road, Wyman Creek, and Skibo deposits in the Duluth Complex to determine effective sampling methods, characterize the groundwater chemical signature of these deposits, and determine chemical evolution along flow paths. Twenty-seven samples were collected from mini-piezometers at depths <5 m and analyzed for major and trace element chemistry and stable isotopes of water. Ten samples were also analyzed for groundwater age tracers, including noble gases, ^{3}H, He isotopes, and chlorofluorocarbons. Site conditions presented challenges for deriving well-constrained specific ages. However, samples could be sorted into the following age categories by employing multiple tracers: <0.5 yr; 0.5 to 2 yr; 2 to 10 yr; and 15 to 30 yr. Cu and Ni concentrations over the deposits range from <0.5 to 150 µg/L and from <1 to 348 µg/L, respectively, and are commonly elevated above background. Cu and Ni are negatively correlated with pH (range of 5.7 to 8.6), probably due to progressively more adsorption on negatively charged mineral surfaces at higher pH. The pH also increases with groundwater age, likely due to weathering of abundant mafic minerals. As a result, Cu and Ni concentrations generally decrease with increasing age. These results suggest that pH provides an important limit on Cu and Ni mobility in the groundwater system, which must be taken into account in designing geochemical exploration approaches. In addition to site-scale work, a regional groundwater chemical database was compiled from available USGS (NWIS) and state databases. Initial examination reveals both geogenic and anthropogenic metal anomalies, and spatial analyses are ongoing.

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