Discovery-Ormsby and Clan Lake are areas of active gold exploration in the north end of the Yellowknife Greenstone Belt, Northwest Territories, Canada. Gold occurs principally within silicified and sulfidized metavolcanic rocks of the Archean Banting Group (2.69-2.66 Ga). Discovery-Ormsby is hosted within a narrow and elongate mafic unit, which is surrounded by voluminous metasedimentary rocks. Clan Lake is hosted in a larger, intermediate to felsic, metavolcanic-volcaniclastic complex. Mineralization in both areas is characterized by arsenopyrite followed by pyrrhotite ± native gold. The deposits occur along a N-NE trend associated with regional faulting and present an opportunity to determine if their ores are related to similar hydrothermal systems whose chemistries differ as a function of host lithology, or are instead the result of chemically distinct hydrothermal systems.

Quartz veins from Ormsby have δ18O values of 13.0-15.2‰ V-SMOW, which are interpreted to reflect dominance of metasedimentary-derived fluids that reacted with the mafic metavolcanic host rocks. In contrast, Clan Lake’s quartz veins have values of 11.3-15.2‰, which are interpreted to indicate both metavolcanic and metasedimentary sources. Similar influence of both metavolcanic and metasedimentary fluid sources has been documented previously for the hydrothermal system responsible for the world-class gold deposits of the Giant mine at the southern end of the greenstone belt. Wall rock oxygen isotope values are 8.5-12.3‰ for the Discovery-Ormsby area and 7.7-12.8‰ for the Clan Lake area. Tyhee Gold Corporation’s large lithogeochemical data set for 150 drill cores from Clan Lake permits us to link values with host rock chemistry. 3-D modeling of δ18O values defines a volume of rock with higher values that coincides with elevated gold concentrations. This suggests that oxygen isotope values may be useful in defining the size of the Clan Lake mineralizing system and may be helpful as an exploration tool and ore guide. Based on this reasoning and drilling to date, a northern edge of an economically mineralized portion of the alteration zone has been defined. To the south-southwest, the high-oxygen isotope, high-gold trend appears to continue, indicating a potential vector for future exploration efforts. Lithogeochemical data were also used to reconstruct volcanic protoliths at Clan Lake and to determine if there is a preferred ore-hosting chemistry or lithology. Immobile element ratios (Zr/Ti and Cr/Al) of altered rocks at Clan Lake reflect dominantly intermediate composition protoliths, with a minor felsic component. Samples that were initially suspected to be mafic have immobile element ratios more consistent with intermediate rock protoliths. A plot of gold grade versus Zr/Ti ratios suggests that there is a preferred chemistry of intermediate rocks associated with gold deposition, with Zr (ppm)/Ti (%) ratios between 350 and 560. 3-D modeling of lithogeochemistry indicates that geochemical trends crosscut lithological boundaries. This suggests that the favored gold-hosting chemistry likely corresponds to rocks with enhanced porosity and permeability that were more reactive with the ore fluids during the gold mineralizing event, rather than to a particular lithologic unit.