Magmatic Source and Controls on Plutonic Hydrothermal Mineralization in the Western Yukon Tanana Uplands, Alaska

M. L. Barrera[1, 2], S. P. Regan[2], Evan Twelker[1], R. J. Newberry[1], J. W. Buchanan[1], and T. J. Naibert[1]

[1]Alaska Division of Geological & Geophysical Surveys, [2]University of Alaska, Fairbanks

The western Yukon Tanana Uplands (YTU) hosts several significant precious and base metal deposits, including the producing Fort Knox and Pogo mines. The origin of the Fort Knox deposit and related systems is magmatic-hydrothermal, manifesting as intrusion-hosted sheeted veins and disseminated deposits, proximal skarns and veins, and distal veins and replacement deposits. In contrast, the Pogo deposit is disputed, with some workers proposing an orogenic origin with no clear relationship between magmatism and mineralization. Outside of the main areas of Pogo and Fairbanks, minimal historic hardrock metal production is recorded. However, previous studies, Alaska Resource Data Files, and placer production in the region suggest there are additional significant precious and base metal mineralization, including gold, silver, antimony, tungsten, tin, uranium, and REE, all of which have varying associations with plutonism. Magmatism ranges from syn-late regional metamorphism to post-tectonic from ~113 Ma to ~55 Ma, with emplacement of the main pulses at ~110 Ma to 100 Ma, ~95 Ma to ~89 Ma, ~72 to 66 Ma, and ~60 Ma to ~55 Ma. Although the Igneous Related Gold model posits that magmatic oxidation state is important to the genesis of these gold deposits, the degree to which melt protolith exerts a control on fertility and oxygen fugacity remains enigmatic.

The Mineral Section of the Alaska Division of Geological and Geophysical Surveys is conducting ongoing bedrock geologic mapping funded by the United States Geological Survey Earth Mineral Resources Initiative. We aim to classify and determine the origin of significant periods of plutonic activity and assess the prospectivity for specific metal associations. In addition to previously published data, samples were collected during bedrock geologic mapping in the summers of 2022 to 2025. Select samples were analyzed for major and minor element concentrations, U-Pb zircon geochronology, zircon hafnium isotope analysis, and rare earth element analysis in zircon.

Major and minor element analyses will aid in (1) differentiating the plutonic units observed in the field, (2) understanding the petrogenesis of the igneous suites, and (3) understanding processes driving compositional diversification across YTU. U-Pb zircon geochronology via LA-ICP-MS will define the crystallization ages of individual plutons in addition to defining the duration of significant periods of magmatism and magmatic lulls. Zircon trace element analysis of rare earth elements via LA-ICP-MS will provide insight into oxygen fugacity during crystallization, magmatic fluid content, and potential resource fertility. Hafnium isotope systematics are a powerful petrogenetic tracer widely used to determine the source melt of selected intrusions. When synthesized, these integrated data will enable the classification of intrusive units into plutonic suites based on temporal and geochemical similarities. Ultimately, data compilation will facilitate analysis using the ArcPro GIS program to quantify spatial relationships and trends, providing insight into the framework of regional geology.