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GEOCHEMICAL DATA FROM SAMPLES COLLECTED IN 2023 FOR THE CHENA AND MOUNT HARPER PROJECTS, BIG DELTA, CIRCLE, FAIRBANKS, AND EAGLE QUADRANGLES, ALASKA

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INTRODUCTION

During the 2023 summer field season, geologists from the Alaska Division of Geological & Geophysical Surveys (DGGS) conducted 1:100,000-scale bedrock geologic mapping of ~5,750 mi^2 (~15,000 km^2) within the Big Delta and Circle quadrangles and parts of the Fairbanks and Eagle quadrangles, Alaska, to support the Chena and Mount Harper/Richardson mapping projects (fig. 1). Both mapping projects are part of the U.S. Geological Survey's Earth Mapping Resource Initiative (USGS Earth MRI) program. A goal of Earth MRI is to update the nation's surface and subsurface mapping to improve the knowledge of the overall geologic framework of the country, with the aim of identifying areas that may contain undiscovered critical mineral resources. This raw data file (RDF) includes major oxide and trace element geochemistry of metamorphic and igneous rocks and potentially mineralized rocks sampled from both the Chena and Mount Harper/Richardson project areas. Station location and field rock descriptions for the samples can be found in Gavel and others (2023). These geochemical analyses will further our understanding of potential mineral resources in the area, help distinguish between igneous and sedimentary protoliths in metamorphic rocks, and be used to characterize the Mesozoic and Cenozoic magmatic events.

The regional geology is composed of structurally bound assemblages of polydeformed Paleozoic metasedimentary and metaigneous rocks ranging from lower greenschist to upper amphibolite facies (Dusel-Bacon and others, 2006). These rocks are structurally overlain by allochthonous oceanic mafic and ultramafic rocks of the Seventymile terrane at Nail Ridge (Southworth, 1985). The metamorphic sequences are intruded by Cretaceous to Paleocene plutons. The Chena and Mount Harper/Richardson projects surround areas of historical mining activity, current production, and future potential mineral resource development. Granitic plutons were emplaced during multiple magmatic pulses in the mid-Cretaceous, spanning 115–90 Ma. This period of magmatism and deformation is associated with gold (± tellurium, bismuth, antimony, and arsenic) mineralization at the Pogo Mine and nearby prospects along the Pogo trend, including West Pogo, East Pogo, and Tibbs (Kreiner and others, 2023). Some latest Cretaceous to early Paleogene magmatism is associated with tungsten mineralization (Big Windy and Furs W skarn prospects). Tin- and rare earth element (REE)-bearing granites and peralkaline intrusions exist within the field areas as well as in historical and modern placer gold mines (Kreiner and others, 2021).

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The analytical data tables and accompanying analytical parameters associated with this RDF report are available in digital format as comma-separated value (CSV) files. All files can be downloaded from https://doi.org/10.14509/31123. All samples collected during this project, and associated geologic materials, will be stored at the DGGS office in Fairbanks in the short term. At the conclusion of the project, all material will be archived at the Geological Materials Center in Anchorage, and available for viewing upon request.

SAMPLE COLLECTION METHODS

Rock samples collected for geochemical analyses (fig. 1) fall into two categories with different purposes. Igneous, metaigneous, and metasedimentary rocks showing little alteration or weathering were collected for whole-rock major-oxide, minor-oxide, and trace-element analyses (MOX). These MOX samples are geographically dispersed and aid in rock classification, protolith identification, petrogenesis, and discrimination of tectonic setting. Additionally, any rock types with visible mineralization or alteration were preferentially collected and analyzed for trace-element geochemistry (GX). These GX samples serve to locate and characterize areas of possible mineral resource development.

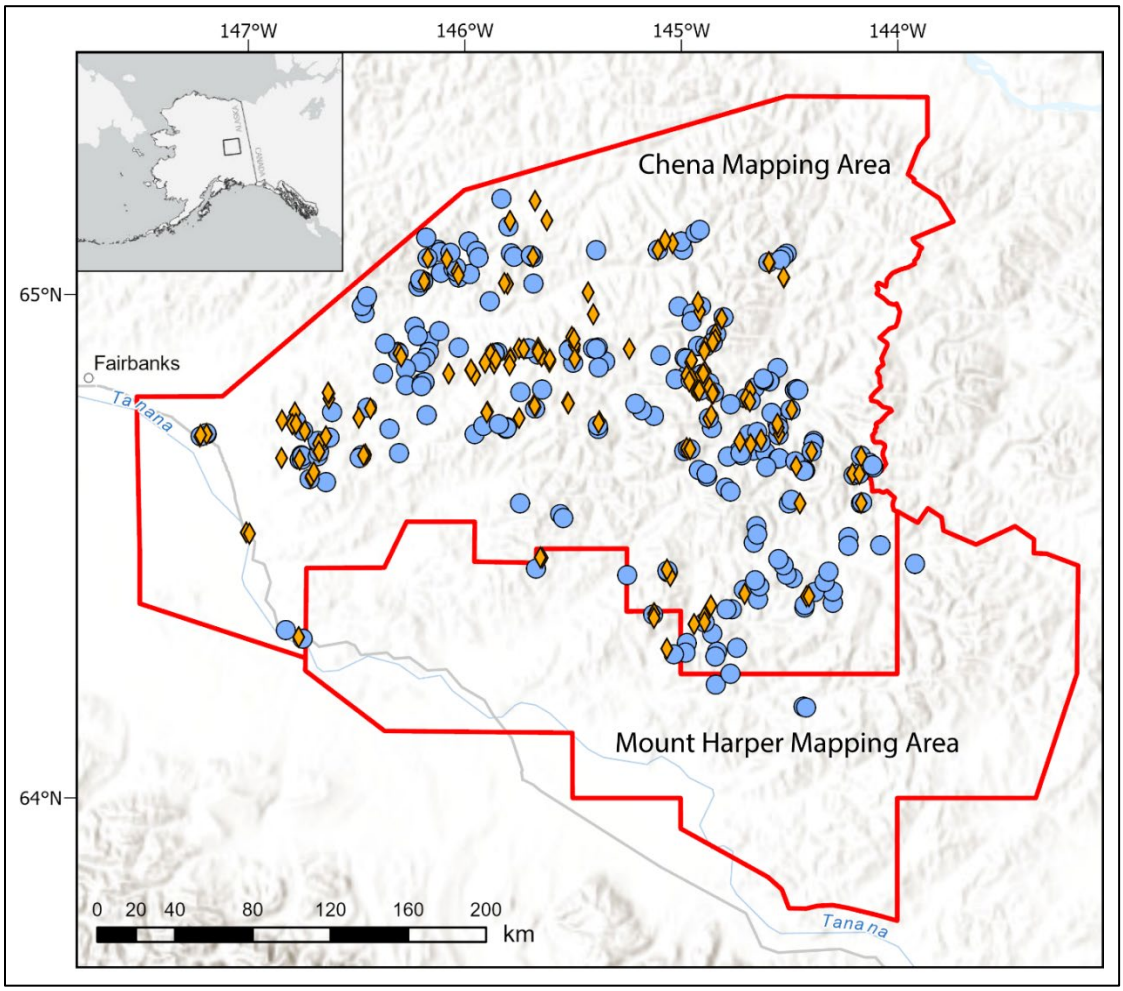

Figure 1. The location of MOX samples (blue circles) and GX samples (orange diamonds) collected during the summer 2023 mapping campaign.

Location data for field stations, where the MOX and GX samples were collected, were captured using GPS-enabled tablets running the ESRI Field Maps application and have reported errors of 10 to 12 m. Data from each geologist's tablet were compiled and merged into an ArcGIS geodatabase. Location data and supporting metadata can be found in Gavel and others (2023).

SAMPLE PREPARATION

DGGS staff trimmed MOX samples to remove weathering, small alteration zones, or any other heterogeneities before they were sent for analysis. GX samples were left as collected in the field. All samples were processed and analyzed by Bureau Veritas Commodities Canada Ltd. Mineral Laboratories (BV). All samples were crushed to greater than 70 percent passing through a 2-mm screen, and a 250-g split was pulverized to greater than 85 percent passing through a 75-micron screen (BV package PRP70-250).

ANALYTICAL METHODS

Different BV packages of analytes and methods were used for the MOX and GX samples and are described in detail below. Data standards were monitored by BV's accredited (ISO/IEC 17025) internal quality-control program, and DGGS submitted one blind reference-material standard per every 20 samples for additional data quality control. For each sample, the data tables contain either analytical values or coded-value placeholders (null = not analyzed; -1 = the element's assay result is less than the lower detection limit for the method; -2 = the element's assay result is greater than the upper detection limit for the method). Detection limits for each reported value are documented in the database output. Samples that exceeded detection limits for elements of interest were reanalyzed using specific elemental tests with methods proper for the expected concentrations.

MOX ANALYTICAL METHODS

All MOX samples were analyzed with BV package LF202, which includes the following analytes and methods: LF300, GRAV, LF100, TC000, and AQ200.

- LF300: analytes–SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, MnO, and Cr_2O_3; The sample was mixed with lithium metaborate/tetraborate flux and fused in a furnace. The cooled bead was dissolved in ACS grade nitric acid and analyzed by inductively coupled plasma atomic emission spectroscopy (ICP-AES).
- GRAV: analyte–Loss on Ignition (LOI); LOI is determined by igniting a sample split then measuring the weight loss.
- LF100: analytes–Ba, Be, Ce, Co, Cs, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Lu, Nb, Nd, Ni, Pr, Rb, Sc, Sm, Sn, Sr, Ta, Tb, Th, Tm, U, V, W, Y, Yb, and Zr; the sample was mixed with lithium metaborate/tetraborate flux and fused in a furnace. The cooled bead was dissolved in ACS-grade nitric acid and analyzed by inductively coupled plasma mass spectrometry (ICP-MS).
- TC000: analytes–C and S; total values are attributed to the elements occurring in all forms. Induction flux is added to the prepared sample then ignited in an induction furnace. A carrier gas sweeps up released C and S to be measured by adsorption in an infrared spectrometric cell.
- AQ200: analytes–Ag, As, Au, Bi, Cd, Cu, Hg, Mo, Ni, Pb, Sb, Se, Tl, and Zn; the prepared sample is digested with a modified Aqua Regia solution of equal parts concentrated HCl, HNO_3, and DI H_2O for one hour in a heating block or hot water bath. The sample is made up to volume with dilute HCl and the sample is analyzed by ICP-MS.

All MOX samples were analyzed with BV packages for either Au or Au, Pt, and Pd, depending on the possibility of the rock sample including Platinum Group Elements (PGEs).

- FA330: analyte–Au; 30 g of prepared sample is custom-blended with fire-assay fluxes, PbO litharge and a silver inquart. Firing the charge at 1050˚C liberates Ag, Au, and PGEs that report to the molten Pb-metal phase. After cooling the Pb button is recovered, placed in a cupel and fired at 950˚C to render an Ag, Au, and PGEs doré bead. The bead is then either digested with nitric or hydrochloric acid and measured by inductively coupled plasma optical emission spectroscopy (ICP-OES).
- FA130: analytes–Au, Pt, Pd; 30 g of prepared sample is custom-blended with fire-assay fluxes, PbO litharge and a silver inquart. Firing the charge at 1050˚C liberates Ag, Au, and PGEs that report to the molten Pb-metal phase. After cooling the Pb button is recovered, placed in a cupel and fired at 950˚C to render an Ag, Au, and PGEs doré bead. The bead is then either digested with nitric or hydrochloric acid and measured by ICP-MS.

Only six MOX samples were analyzed with additional packages to provide elemental information not covered in other analytical packages.

- AQ251: analytes–Ag, Al, As, Au, B, Ba, Bi, Ca, Cde, Co, Cr, Cu, Fe, Ga, Hg, K, La, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Sc, Se, St, Te, Th, Ti, Tl, U, V, W, and Zn; the prepared sample is digested with a modified Aqua Regia solution of equal parts concentrated HCl, HNO_3 and DI H_2O for one hour in a heating block or hot water bath. The sample is made up to volume with dilute HCl and the sample is analyzed by ICP-OES.

GX ANALYTICAL METHODS

All GX samples were analyzed with BV package MA250 for major- and trace-element values which includes the following analytes and methods.

- MA250: analytes-Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Hf, Ho, In, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Pr, Rb, Re, S, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, and Zr; the prepared sample is digested to complete dryness with an acid solution of (2:2:1:1) H_2O–HF–$HClO_4$–HNO_3. Fifty percent HCl is added to the residue and heated using a mixing hot block. After cooling, the solutions are transferred to test tubes and brought to volume using dilute HCl, and then the sample is analyzed by either ICP-OES or ICP-MS.

All GX samples were analyzed with BV packages for either Au (FA330) or Au, Pt, and Pd (FA130) with the same methods described above. Eighteen GX samples were analyzed with AQ251 for additional elements with the same methods described above.

OVERLIMIT ANALYTICAL METHODS

Nine GX samples had individual elemental analyses over the upper detection limit of the methods described above and were reanalyzed with methods more suited for higher concentrations, as described below.

- MA370: analytes-Ag, Al, As, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Sr, W, and Zn; the prepared sample split is digested to complete dryness with an acid solution of H_2O-HF-$HClO_4$-HNO_3. Fifty percent HCl is added to the residue and heated using a mixing hot block. After cooling, the solutions are transferred to test tubes and brought to volume using dilute HCl, and then the sample is analyzed by ICP-OES.
- FA530: analyte-Au; 30 g of prepared sample is custom blended with fire-assay fluxes, PbO litharge, and a silver inquart. Firing the charge at 1050˚C liberates Ag, Au, and PGEs that report to the molten Pb-metal phase. After cooling, the Pb button is recovered, placed in a

cupel, and fired at 950°C to render an Ag, Au, and PGEs dore bead. The bead is then weighed and parted with nitric acid to dissolve Ag and PGEs, leaving Au, which is weighed directly.

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