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MAJOR-OXIDE, MINOR-OXIDE, AND TRACE-ELEMENT GEOCHEMICAL DATA FROM ROCKS AND STREAM SEDIMENTS IN THE WRANGELLIA MINERAL ASSESSMENT AREA, GULKANA, HEALY, MOUNT HAYES, AND TALKEETNA MOUNTAINS QUADRANGLES, ALASKA

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INTRODUCTION

Magmatic sulfide mineralization with elevated concentrations of nickel, copper, cobalt, and platinum-group elements (PGEs) occurs in some Late Triassic mafic to ultramafic intrusions in the Wrangellia terrane. These intrusions have been the subject of study and exploration, mostly in the Kluane Ranges of the Yukon Territory (Hulbert, 1997), where a resource has been defined at the Wellgreen deposit (Tetra Tech Wardrop, 2012), and at several prospects in the Mount Hayes Quadrangle in the eastern Alaska Range (Bittenbender and others, 2007; Barker, 1988). Mapping in the Talkeetna Mountains B-4 Quadrangle (Werdon and others, 2002; Schmidt and others, 2003) and geophysical interpretation (Glen and others, 2007) indicate that these mafic–ultramafic intrusions and their extrusive equivalent, the Nikolai Greenstone, continue at least 60 km to the southwest of the previously mapped extent shown by Csejtey and others (1978). This observation opens up geologic potential for Late Triassic magmatic Ni–Cu–Co–PGE deposits to occur in the Talkeetna Mountains.

Mineral-resources geologists from the Alaska Division of Geological & Geophysical Surveys (DGGS) carried out a helicopter-supported geological and geochemical resource assessment project in the Gulkana, Healy, Mount Hayes, and Talkeetna Mountains quadrangles from July 29 through August 16, 2013. The objectives of this assessment were to improve the publicly-available geological, geophysical, and geochemical data in the area of known occurrences in the Mount Hayes Quadrangle, and to extend this coverage and any gained insight westward into the less-explored extension of the Wrangellia terrane. This program of stream-sediment, pan-concentrate, and rock sampling was conducted as part of the State's *Strategic Minerals Assessment* project, an initiative designed to evaluate Alaska's potential for rare-earth elements, PGEs, and other similarly supply-challenged resources.

Highlights of this project include identification, sampling, and characterization of previously unmapped mafic to ultramafic intrusions and Nikolai Greenstone, modern geochemical characterizations of Ni–Cu–Co–PGE, skarn, vein, and basalt-hosted Cu mineralization, and documentation of regional-scale patterns in PGE enrichment across western Wrangellia.

The analytical data tables associated with this report are being released in digital format as comma-delimited text (CSV) files. A complete explanation of the data file structure and contents as well as full details about the sampling project can be found in the metadata file associated with the digital version of this report, which is available from the DGGS website (http://www.dggs.alaska.gov/pubs/id/27181) at no charge.

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DOCUMENTATION OF METHODS

SAMPLE COLLECTION

Rock samples were collected for two different purposes. Samples of visibly mineralized or altered rock were preferentially collected and analyzed for trace-element geochemistry. Most samples are "grab" samples, which were randomly collected at a location; however, a few samples are "select" samples, which were deliberately collected from a specific feature, as noted in the sample field description. Igneous and meta-igneous rocks showing little alteration or weathering were collected for whole-rock major-oxide, minor-oxide, and trace-element analyses to aid in classification and study of petrogenesis and tectonic setting. For fine-grained rocks, whole-rock analyses were performed by direct XRF of rock slabs.

Stream-sediment sample locations were selected either to characterize stream sediments draining known Ni–Cu–PGE occurrences, or to target areas with similar prospective geology, geophysical signature, or geochemistry.

In the field, sample areas were selected by visual inspection from the helicopter, and were based on the availability of sample material and a suitable landing zone. Stream sediment samples were taken from overbank flood deposits, moss mats, or other fine sediment. Samples were collected with a shovel and wet screened to -10 mesh, then bagged in permeable cloth sample bags and air dried at camp. To ensure a sufficient volume of fine sediment, 7×12-inch sample bags were filled to capacity.

Pan-concentrate sampling targeted, in order of decreasing preference: gravel/cobble-armored riffles, log/boulder/plunge-pool eddies, gravel/cobble-armored point bars, point bars, overbank flood deposits, and moss mats. Samples were collected with a shovel and screened using a "Garrett's Combination Sifter" with a 0.483-inch, square-hole mesh. The resulting undersized material was collected in a 14-inch-diameter "Garrett's Gold Trap" gold pan. Sediments were screened until the gold pan was level full with –0.483-inch material. Using alternating shaking and washing motions, the sediment was reduced to visible heavy minerals or a volume of approximately 30 ml. This concentrate was then washed into Nasco Whirl-Pak plastic sample bags and placed in a cloth bag.

Location data were collected using Trimble Juno T41/5 WAAS-enabled GPS devices running ArcGIS for Windows Mobile. Data were merged into an ArcGIS geodatabase. WAAS-enabled GPS devices have a reported error of about 1 m. Latitude and longitude are reported in the WGS84 datum.

SAMPLE PREPARATION

Rock samples were processed by ALS Minerals using their PREP-31 package. The samples were crushed to better than 70 percent passing 2 mm, and a 250 g split was pulverized to better than 85 percent passing 75 microns. Prior to crushing, samples for whole-rock analysis were trimmed by DGGS staff to remove weathering, and cut surfaces were sanded to remove any saw metal.

Slab XRF samples were cut into rough discs 4 cm in diameter and polished on a lapidary wheel.

Stream-sediment samples were submitted to ALS Minerals and prepped by the PREP-41 package. Samples were logged, air-dried at low temperature, and dry-sieved to -180 microns (-80 mesh). The fine fraction was further pulverized prior to analysis.

Pan-concentrate samples were dried at DGGS using a drying oven and disposable paper trays, split using a Sepor™ splitter, and then pulverized to better than 85 percent passing 75 microns by ALS Minerals (PREP-31 package).

ANALYTICAL METHODS

Samples were analyzed for a variety of suites of major and trace elements depending on the sample type. In addition to ALS Minerals' accredited (ISO/IEC 17025–2005) internal quality-control program, DGGS monitored analysis quality with one standard reference material per batch of 20 analyses.

a. Major- and trace-element compositions for stream-sediment, pan-concentrate, and rock samples were determined by ALS Minerals method ME-ICP61: Four-acid digestion followed by inductively coupled plasma–atomic emission spectrometry (ICP-AES) and inductively coupled plasma–mass spectroscopy (ICP-MS).

b. Platinum, palladium, and gold values were analyzed by 30 g fire assay with ICP-MS finish (ALS Minerals method PGM-MS23) for all samples except slab XRF.

c. Samples that exceeded detection limits for elements of interest were reanalyzed using specific elemental tests. Over-limit values for Ag, Cu, and Ni were reanalyzed using four-acid digestion and ICP-AES (ALS Minerals procedure ME-OG62): Over-limit values for Au were reanalyzed by 30 g fire assay with atomic absorption (AA) finish (ALS Minerals procedure Au-AA25). Over-limit values for Pt and Pd were reanalyzed by 30 g fire assay with ICP-AES finish (ALS Minerals procedure PGM-ICP27).

d. For whole-rock geochemistry samples, major and minor oxides were analyzed by lithium metaborate fusion digestion and ICP-AES (ALS Minerals method ME-ICP06). Trace elements, including rare-earth elements, were determined using lithium metaborate fusion digestion and ICP-MS (ALS Minerals method ME-MS81). Ag, Cd, Co, Cu, Li, Mo, Ni, Pb, Sc, and Zn were determined by four-acid digestion and ICP-AES (ALS Minerals method ME-4ACD81); and As, Bi, Hg, Sb, Se, and Te were determined by aqua regia digestion followed by ICP-MS (ALS Minerals method ME-MS42). Total C and S were analyzed by Leco furnace (ALS Minerals method ME-IR08).

e. For slab XRF samples, polished sample slabs were directly analyzed using the PANalytical Axios wavelength-dispersive XRF and SuperQ™ software at the University of Alaska Fairbanks. Nb, Rb, Sr, Y, and Zr were measured using the 37mmRbSrYZr analytical routine; other elements were measured with the IQ+37mmVac analytical routine. The 37mmRbSrYZr routine uses specific predetermined peak and background positions for which X-ray intensities are measured for 2–800 seconds (depending on the element). The intensity of the Rh Compton peak is used to estimate mass-absorption coefficients (MACs) for both unknowns and well-characterized natural standards. Peak intensities are computed and converted to concentrations using calibration curves employing at least ten natural rock standards. These procedures are routinely checked by analysis of secondary natural standards that were not employed in making the calibration curves. Elemental abundances are typically within 2–5% of the amount present for concentrations >10 times the detection limit; within 5–10% of the amount present for concentrations 4–10 times the detection limit and within 30% of the amount present for concentrations near the detection limit. The IQ37mmVac program scans over a series of energies corresponding to a range from Ce K-alpha to O K-alpha. Peak heights and backgrounds, and X-ray elemental interferences are picked with the software and checked manually to ensure quality control. Elemental abundances for all elements with atomic numbers between 8 and 92 are estimated from artificial standards; these estimations are used to calculate MACs for each element present above the detection limit. Revised concentrations are employed to calculate revised MACs until a stable solution is determined. Elemental abundances are then normalized to 100%. The software is routinely checked using pressed pellets of well-characterized natural rock standards. Elemental abundances are within 1–2% of the amount present for major elements, 2–5% of the amount present for minor elements, and 5–10% of the amount present for trace elements.

Detection limits for each of the reported elemental values obtained by the various methods are documented in the metadata file.

The data tables contain negative numbers representing coded value place-holders of non-valid analytical data, including analyses that were outside the detection limit range; these coded values are documented in the metadata. Detection limits for each of the reported elemental values obtained by the various methods are documented in the metadata file.

REFERENCES

Barker, J.C., 1988, Distribution of platinum-group elements in an ultramafic complex near Rainbow Mountain, east-central Alaska Range, *in* Vassilou, A.H., Hausen, D.M., and Carson, D.J.T, eds., Process Mineralogy VII—Applications to mineral beneficiation: Proceedings of the Metal Society SME/AIME Joint [Annual] Meeting, Denver, CO, p. 197–220.

Bittenbender, P.E., Bean, K.W., Kurtak, J.M., and Deininger, J., 2007, Mineral assessment of the Delta River mining district area, east-central Alaska: U.S. Bureau of Land Management Alaska Technical Report 57, 697 p.

Csejtey, Bela, Jr., Nelson, W.H., Jones, D.L., Silberling, N.J., Dean, R.M., Morris, M.S., Lanphere, M.A., Smith, J.G., and Silberman, J.L., 1978, Reconnaissance geologic map and geochronology, Talkeetna Mountains quadrangle, northern part of Anchorage quadrangle, and southwest corner of Healy quadrangle, Alaska: U.S. Geological Survey Open-File Report 78-558-A, scale 1:250,000, 1 sheet, 62 p.

Glen, J.M.G., Schmidt, J., and Morin, R., 2007, Gravity and magnetic character of south-central Alaska—Constraints on geologic and tectonic interpretations and implications for mineral exploration: Geologic Society of America Special Paper 431, p. 593–622.

Hulbert, L.J., 1997, Geology and metallogeny of the Kluane mafic–ultramafic belt, Yukon Territory, Canada—Eastern Wrangellia, a new Ni-Cu-PGE metallogenic terrane: Geological Survey of Canada Bulletin 506, 265 p.

Schmidt, J.M., Werdon, M.B., and Wardlaw, B., 2003, New mapping near Iron Creek, Talkeetna Mountains, indicates presence of Nikolai Greenstone, *in* Clautice, K.H., and Davis, P.K., eds., Short Notes on Alaska Geology 2003: Alaska Division of Geological & Geophysical Surveys Professional Report 120, 118 p.

Tetra Tech Wardrop, 2011, Wellgreen project preliminary economic assessment, Yukon, Canada: Report prepared for Prophecy Platinum by Tetra Tech Wardrop, August 1, 2012.

Werdon, M.B., Riehle, J.R., Schmidt, J.M., Newberry, R.J., and Pessel, G.H., 2002, Geologic map of the Iron Creek area, Talkeetna Mountains B-5 Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2002-4,1 sheet, scale 1:63,360.