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Major- and Trace-Element Concentrations in Rock Samples from the Sleetmute 1:250,000-Scale Quadrangle, Alaska

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U.S. Department of the Interior
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By Edward P. Klimasauskas, U.S. Geological Survey, Marti L. Miller, U.S. Geological Survey, and William J. Keith, U.S. Geological Survey, Retired

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Conversion Factors

Multiply	By	To Obtain
ounce, fluid (fl. oz)	29.57	milliliter (mL)
pound, avoirdupois (lb)	0.4536	kilogram (kg)

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations and Acronyms

Abbreviation and Acronyms	Meaning
AA	atomic absorption
CVAA	cold vapor atomic absorption spectrometry
DIBK	diisobutylketone
DCP	directly coupled plasma
FA	fire assay
ICP-AES	inductively coupled plasma atomic emission spectrometry
QA/QC	quality assurance and quality control
RSD	relative standard deviation
USGS	U.S. Geologicial Survey
%	percent
<	signal was detected but any results obtained fell below the lower reporting limit
N	no signal was detected
ins	insufficient sample to obtain an analysis
ppm	parts per million

Major- and Trace-Element Concentrations in Rock Samples from the Sleetmute 1:250,000-Scale Quadrangle, Alaska

By Edward P. Klimasauskas[1], Marti L. Miller[1], and William J. Keith[2]

Abstract

This report consists of geochemical data for rock samples collected in the Sleetmute 1:250,000-scale quadrangle by the U.S. Geological Survey between 1993 and 1999. Data were primarily used to conduct a mineral resource assessment of this quadrangle. The analytical results are presented here as digital tabular data with no interpretation.

Introduction

The Kuskokwim mineral belt of Bundtzen and Miller (1997) forms an important metallogenic region in southwestern Alaska (fig. 1) that has yielded more than 3.2 million ounces of gold, 412,000 ounces of silver, and 3 million pounds of mercury. The Sleetmute 1:250,000-scale quadrangle encompasses part of this mineral belt and contains Late Cretaceous to early Tertiary igneous rocks that elsewhere are associated with precious-metal and related mineral deposits. Previously published reports include a preliminary geologic map (Miller and others, 1989) and stream sediment and heavy mineral concentrate data from select areas (Gray and others, 1995; Gray and others, 1997; Gray and others, 1999). A summary of the mines, prospects, and occurrences in this region is provided in Bundtzen and Miller (2004). To assess the potential for additional undiscovered metallic resources in this poorly known area, the U.S. Geological Survey (USGS) conducted geologic mapping and geochemical sampling in the Sleetmute 1:250,000-scale quadrangle intermittently between 1993 and 1999.

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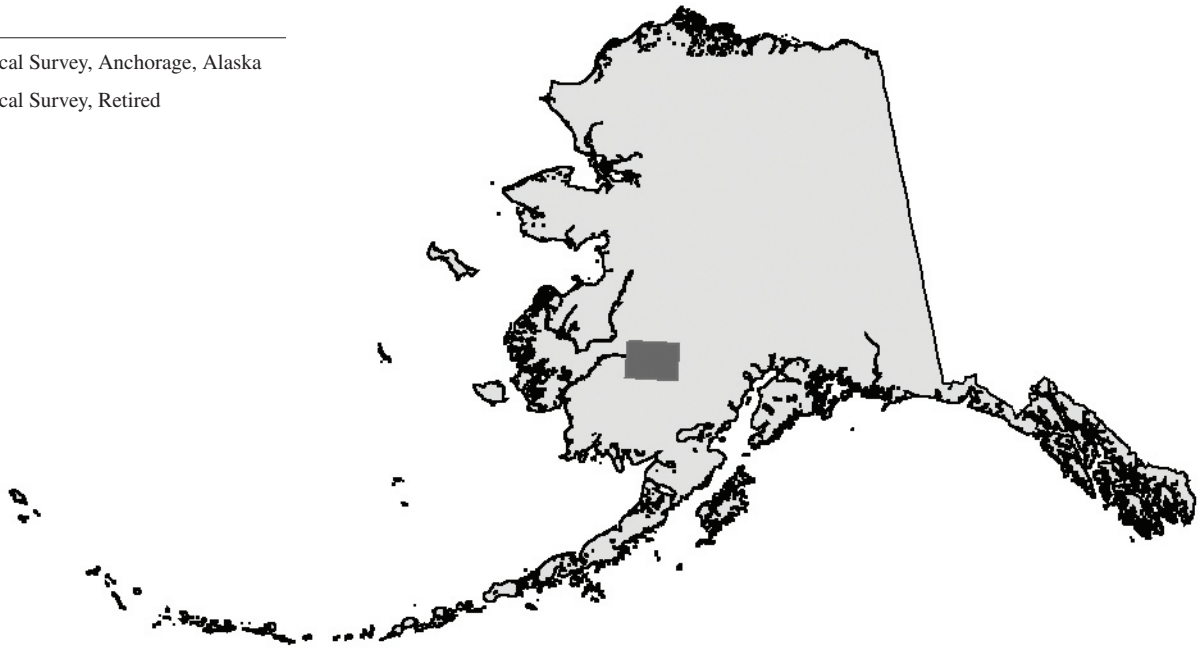

Figure 1. Location of the Sleetmute 1:250,000-scale quadrangle, Alaska.

This report provides analytical results for major- and trace-elements for 1,551 rock samples collected from the Sleetmute quadrangle (fig. 2) in Excel (*.xls) and comma delimited (*.csv) formats (available at http://pubs.usgs.gov/of/2007/1126/). Fields for each sample include descriptive information, location in latitude and longitude (decimal degrees), and analytical results. Column headings for analytical results in the data table include a two-letter symbol representing the element analyzed (Au, Pb, etc.), data units in percent (%) or parts per million (ppm), and a suffix designating the analytical method used (ICP40, ICP10, FA, CVAA, or AA). Some analytical results in the data table are preceded by a symbol such as "<" or "N." In these cases the value following the symbol represents the lower reporting limit. The "N" symbol indicates no signal was detected for that particular element. A "<" symbol indicates a signal was detected but that any results obtained fell below the lower reporting limit. An "ins" value indicates there was insufficient sample to obtain an analysis.

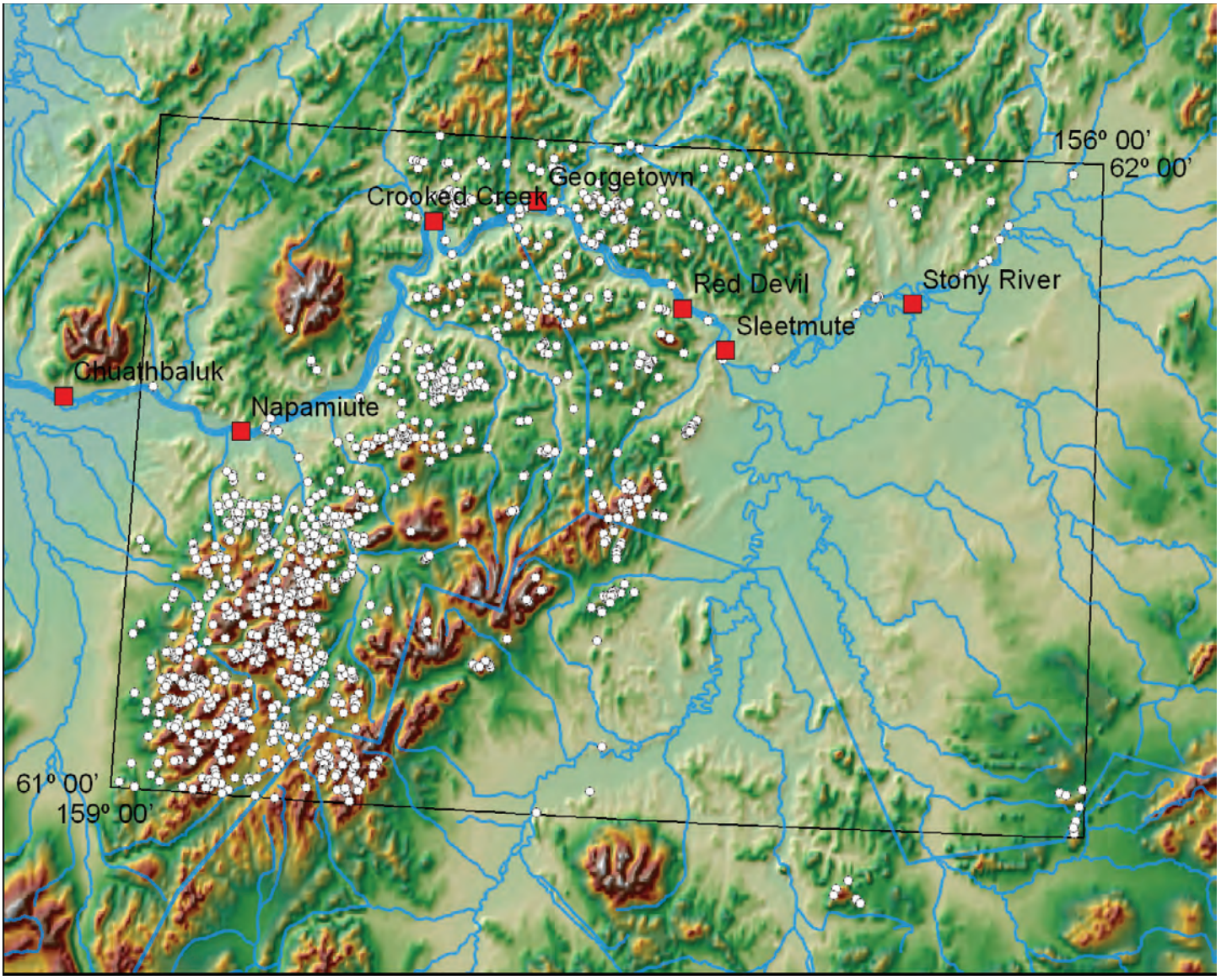

Figure 2. Location of rock samples collected in the Sleetmute 1:250,000-scale quadrangle, Alaska, by the U.S. Geological Survey between 1993 and 1999.

Sample Preparation and Analysis

Samples were prepared for analysis at the USGS laboratories in Denver, Colorado. Rock samples were crushed in a jaw crusher, then ground in a vertical pulverizer with ceramic plates to less than 100 mesh (less than 150 microns), and followed by thorough mixing to ensure homogeneity. Additional details of the sample preparation procedures are available in Taylor (1990) and Taylor and Theodorakos (1996). Approximately one-third of the samples were analyzed by the USGS laboratory in Denver, Colorado. The rest of the samples were analyzed by XRAL Laboratories in Don Mills, Ontario, Canada, under contract to the USGS. Rock reference materials and a series of multi-element solution standards were used for calibration and quality-assurance and quality-control (QA/QC) purposes. Detailed descriptions of QA/QC procedures are available in Arbogast (1990) and Taggart (2002).

Analytical Methods

ICP-AES 40-Element (ICP40)

A 0.2-gram portion of each sample was decomposed by using a mixture of hydrochloric, nitric, perchloric, and hydrofluoric acids at low temperature. Digested samples were analyzed for 40 major, minor, and trace elements simultaneously by inductively coupled plasma atomic emission spectrometry (ICP-AES) (Briggs, 1996). Data were considered acceptable if recovery for all 40 elements is plus or minus 15 percent at 5 times the lower reporting limit and the calculated Relative Standard Deviation (RSD) of duplicate samples is no greater than 15 percent. Lower reporting limits are shown in table 1.

ICP-AES 10-Element (ICP10)

All samples were analyzed for 10 loosely bound trace metals (Ag, As, Au, Bi, Cd, Cu, Mo, Pb, Sb, and Zn) by using ICP-AES (table 2). A 1.0-gram sample was partially dissolved with a hydrochloric acid-hydrogen peroxide solution followed by extraction of organic halides with a 10-percent aliquot 336-diisobutylketone (DIBK) solution. Organic halide solutions were then analyzed by using ICP-AES (Motooka, 1996). Lower reporting limits for samples analyzed by the USGS changed between 1993 and 1994 for this method. The higher cutoff for most elements analyzed after 1993 reflect changes in laboratory methodology and instrumentation. In a few cases samples were of insufficient quantity to provide data within the range of the detection limits given (D. Detra, oral commun., 2006). These samples have even higher detection limits and are highlighted in bold red in the data table.

Table 1. Lower reporting limits for analyses by 40-element ICP-AES in the U.S. Geological Survey and XRAL laboratories.

[**Abbreviations:** ICP-AES, inductively coupled plasma atomic emission spectrometry; ppm, parts per million]

Element	Lower reporting limit	
	XRAL	U.S. Geological Survey
	Percent	
Aluminum, Al	0.005	0.005
Calcium, Ca	.005	.005
Iron, Fe	.02	.02
Potassium, K	.01	.01
Magnesium, Mg	.005	.005
Sodium, Na	.005	.006
Phosphorus, P	.005	.005
Titanium, Ti	.005	.005
	Parts per million	
Arsenic, As	10	10
Barium, Ba	1	1
Beryllium, Be	1	1
Bismuth, Bi	10	10
Cadmium, Cd	2	2
Cerium, Ce	5	5
Chromium, Cr	2	2
Cobalt, Co	2	2
Copper, Cu	2	2
Europium, Eu	2	2
Gallium, Ga	4	4
Gold, Au	8	8
Holmium, Ho	4	4
Lanthanum, La	2	2
Lead, Pb	4	4
Lithium, Li	2	2
Manganese, Mn	4	4
Molybdenum, Mo	2	2
Neodymium, Nd	9	9
Nickel, Ni	3	3
Niobium, Nb	4	4
Scandium, Sc	2	2
Silver, Ag	2	2
Strontium, Sr	2	2
Tantalum, Ta	40	40
Thorium, Th	6	6
Tin, Sn	5	5
Uranium, U	100	100
Vanadium, V	2	2
Ytterbium, Yb	1	1
Yttrium, Y	2	2
Zinc, Zn	2	2

Table 2. Lower reporting limits for analyses by 10-element ICP-AES in the U.S. Gelogical Suvey and XRAL laboratories.

[**Abbreviations:** ICP-AES, inductively coupled plasma atomic emission spectrometry; ppm, parts per million]

Element	Lower reporting limit (ppm)		
	XRAL	U.S. Geological Survey	
		Through 1993	From 1994
Antimony, Sb	1	0.67	1.0
Arsenic, As	1	.67	1.0
Bismuth, Bi	1	.67	1.0
Cadmium, Cd	.05	.05	.05
Copper, Cu	.05	.05	.05
Gold, Au	.1	.1	.1
Lead, Pb	1	.67	1.0
Molybdenum, Mo	.1	.06	1.0
Silver, Ag	.08	.067	.08
Zinc, Zn	.05	.03	.03

Gold by Fire Assay (FA)

All samples were analyzed for gold (Au) by fire assay. For each sample a 10-gram aliquot was fused with a flux at high temperature to produce a dore bead. Dore beads were then digested with aqua regia, diluted, and analyzed by using directly coupled plasma (DCP) or atomic absorption (AA) spectrometry (O'Leary and Meier, 1996). Samples analyzed by the USGS laboratory had a lower reporting limit of 0.002 ppm for those analyzed by AA and 0.05 ppm for those analyzed by DCP. The lower reporting limit was 0.005 ppm for samples analyzed by XRAL (D. Detra, oral commun., 2006).

Mercury by Cold Vapor Atomic Absorption Spectrometry (CVAA)

All samples were analyzed for mercury (Hg) by digestion of 0.1 gram of sample in a mixture of nitric and hydrochloric acids. Addition of potassium permanganate, sulphuric acid, and potassium persulphate, followed by a sodium-chloride-hydroxylamine solution and dilution completed the sample preparation. Mercury concentrations were determined by using a Perkin-Elmer Flow Injection Mercury System, FIMS-100. The lower reporting limit was 0.006 ppm for samples analyzed by the USGS laboratory and 0.02 ppm for samples analyzed by XRAL (Brown and others, 1997).

Tellurium by Flame Atomic Absorption Spectrometry (AA)

A total of 179 samples collected during the 1993 field season were analyzed for tellurium at the USGS laboratory in Denver. Digestion of 2.0 grams of sample was accomplished by using a mixture of hydrofluoric and sulfuric acids with heat. The residue was treated with hydrocloric acid and hydrogen peroxide. Tellurium was selectively extracted as an organic halide that was subsequently analyzed by flame atomic absorption spectrometry. The lower reporting limit was 0.1 ppm (O'Leary, 1996).

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