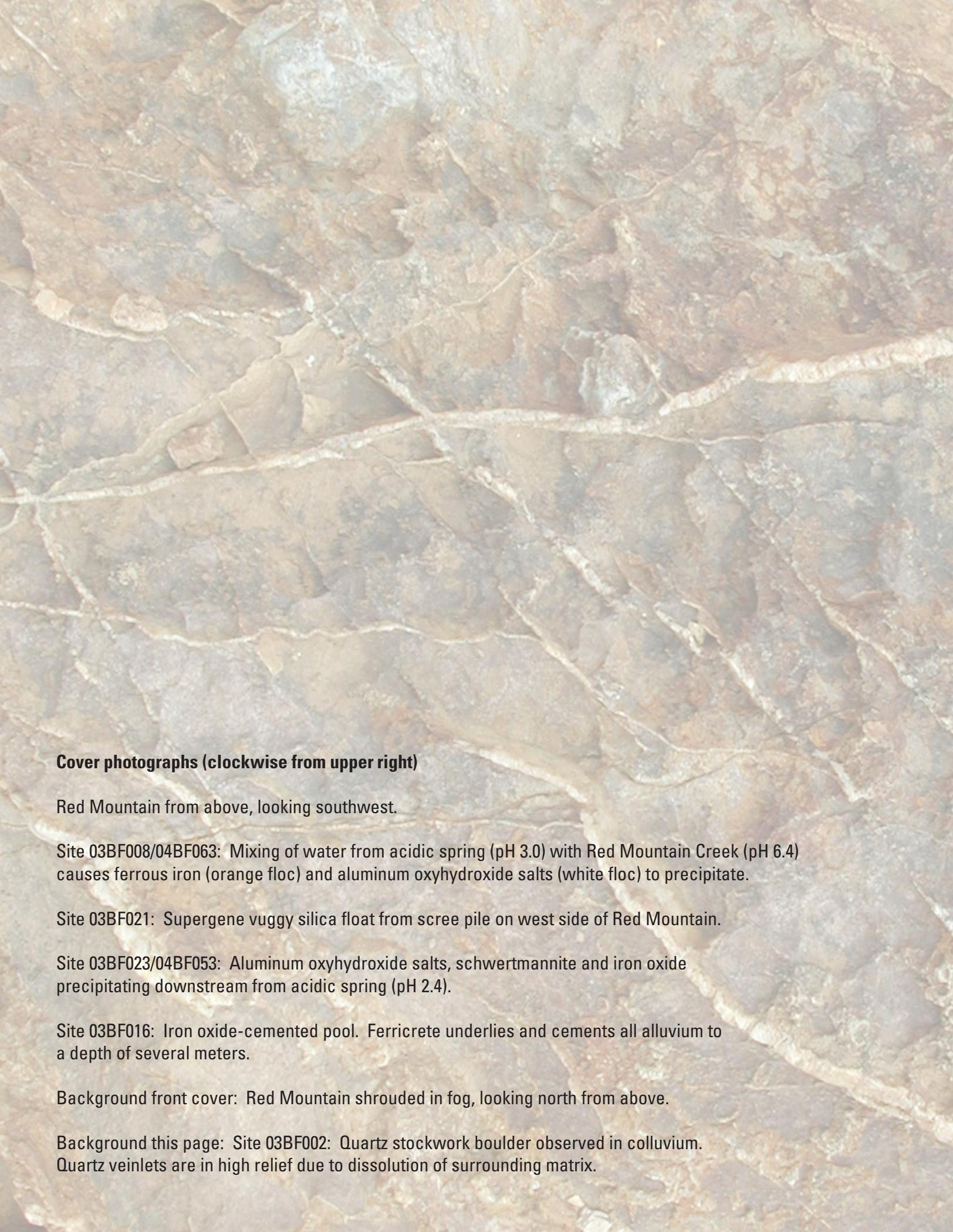


# Geochemical Data for Stream-Sediment, Surface-Water, Rock, and Vegetation Samples from Red Mountain (Dry Creek), an Unmined Volcanogenic Massive Sulfide Deposit in the Bonnifield District, Alaska Range, East-Central Alaska



Data Series 204

U.S. Department of the Interior  
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**Cover photographs (clockwise from upper right)**

Red Mountain from above, looking southwest.

Site 03BF008/04BF063: Mixing of water from acidic spring (pH 3.0) with Red Mountain Creek (pH 6.4) causes ferrous iron (orange floc) and aluminum oxyhydroxide salts (white floc) to precipitate.

Site 03BF021: Supergene vuggy silica float from scree pile on west side of Red Mountain.

Site 03BF023/04BF053: Aluminum oxyhydroxide salts, schwertmannite and iron oxide precipitating downstream from acidic spring (pH 2.4).

Site 03BF016: Iron oxide-cemented pool. Ferricrete underlies and cements all alluvium to a depth of several meters.

Background front cover: Red Mountain shrouded in fog, looking north from above.

Background this page: Site 03BF002: Quartz stockwork boulder observed in colluvium. Quartz veinlets are in high relief due to dissolution of surrounding matrix.

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**U.S. Department of the Interior  
U.S. Geological Survey**

**U.S. Department of the Interior**  
DIRK KEMPTHORNE, Secretary

**U.S. Geological Survey**  
Mark D. Myers, Director

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The U.S. Geological Survey cannot verify the accuracy of the data contained within the electronic files of this report if the data were obtained from a source other than the U.S. Geological Survey.

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# Geochemical Data for Stream-Sediment, Surface-Water, Rock, and Vegetation Samples from Red Mountain (Dry Creek), an Unmined Volcanogenic Massive Sulfide Deposit in the Bonnifield District, Alaska Range, East-Central Alaska

By Stuart A. Giles,<sup>1</sup> Robert G. Eppinger,<sup>1</sup> Matthew Granitto,<sup>1</sup> Philip P. Zelenak,<sup>1</sup> Monique G. Adams,<sup>1</sup> Michael W. Anthony,<sup>1</sup> Paul H. Briggs,<sup>1</sup> Larry P. Gough,<sup>2</sup> Philip L. Hageman,<sup>1</sup> Jane M. Hammarstrom,<sup>2</sup> John D. Horton,<sup>1</sup> Stephan J. Sutley,<sup>1</sup> Peter M. Theodorakos,<sup>1</sup> and Ruth E. Wolf<sup>1</sup>

## Introduction

The Modeling Near-Surface Processes in Mineral Systems project is investigating the environmental geochemistry of a group of unmined volcanogenic massive sulfide (VMS) deposits in the Bonnifield mining district, Alaska Range, east-central Alaska. The pyrite-rich Red Mountain (also known as Dry Creek) deposit is the best exposed of these deposits and displays a remarkable environmental footprint of natural acid generation, metal dissolution, metal precipitation, and self-mitigation processes. The well-exposed deposit and associated alteration halo are dissected by three drainages, allowing for sample collection above, within, and downstream from the deposit and halo.

The Red Mountain deposit is located along the north flank of the Alaska Range in east-central Alaska, approximately 50 mi (80 km) south of Fairbanks (fig. 1). Topography is steep and rugged, with elevations in the area of the deposit ranging from about 2,700 ft to about 5,000 ft (about 820 m to about 1,520 m) (U.S. Geological Survey and The Land Information Technology Company Ltd., 1997). The Red Mountain ecoregion is described as located within the polar domain, subarctic regime mountains division, Alaska Range humid tayga-tundra-meadow province, Alaska Mountains section (USDA Forest Service, 2004). Climate is characterized by average daily temperatures between 20° and 25°F (−6.6° to −3.8°C), with maximum extremes ranging between 75° and 81°F (24° to 27°C) and minimum extremes between −50° and −41°F (−46° to −41°C) (National Oceanic and Atmospheric Administration, 2002). Annual precipitation for Red Mountain ranges between 40 and 50 inches (100 – 130 cm), and annual snowfall ranges between 144 and 240 inches (3.7 – 6.1 m) (National Oceanic and Atmospheric Administration, 2002). Sampling sites at lower elevations trend toward the lower end

of the range for precipitation and snowfall and toward the higher end of the range for temperature. Access is by helicopter or wintertime snowmobile because of a lack of roads, trails, or airstrips in the area.

Red Mountain is unforested, and vegetation is dominated by alpine shrubs, grasses, sedges, and forbs. The deposit itself is sparsely vegetated due to rubble and scree slopes and highly altered bedrock that inhibit plant growth (Eppinger and others, in press). Vegetation in lower elevations consists of spruce, alder, and willow along with the plants listed. The riparian zone adjacent to permanent streams is dominated by feltleaf and diamondleaf willow, grasses, and sedges. In springs, seeps, and intermittent creeks within the altered zone, submerged and emergent aquatic vegetation, where present, consists of acidophilic or possibly heavy metal-requiring bryophyte assemblages and liverworts, and adjacent vegetation in the splash zone consists of various lichens and mosses (Gough and others, 2006).

This data series contains the geochemical data for stream sediment, surface-water, rock, precipitate, and vegetation samples from Red Mountain. This report describes the deposit's geologic setting, the methods of study including sample collection, preparation, and analytical techniques and the database files. Cited references for both the report and database are included in the "References" section of this report. Figure 1 contains maps of Alaska and the Bonnifield district focus area. Figure 2 is a map of the Red Mountain study area and the sampling sites. Appendix A details the database tables and fields within the tables. Appendix B provides sampling-site photograph descriptions and thumbnail images linked to the photograph files. Appendix C lists the limits of determination for the analytical methods.

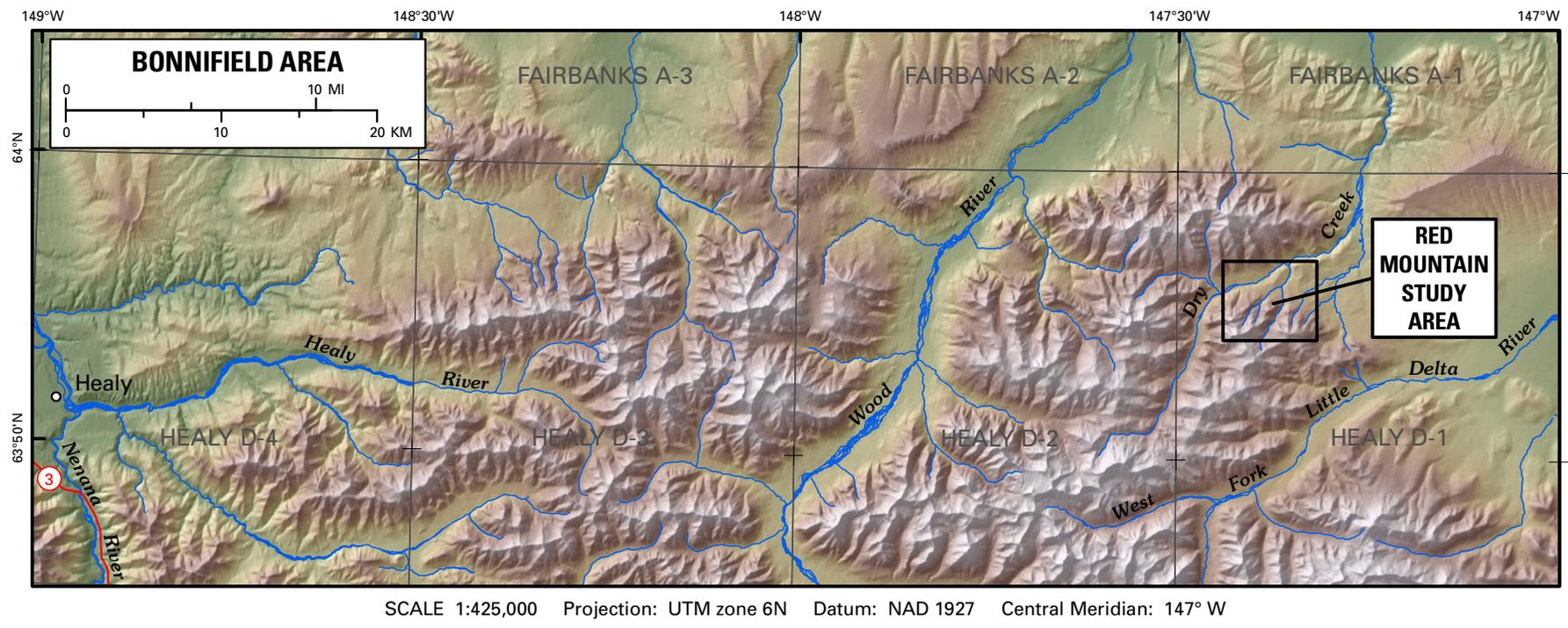
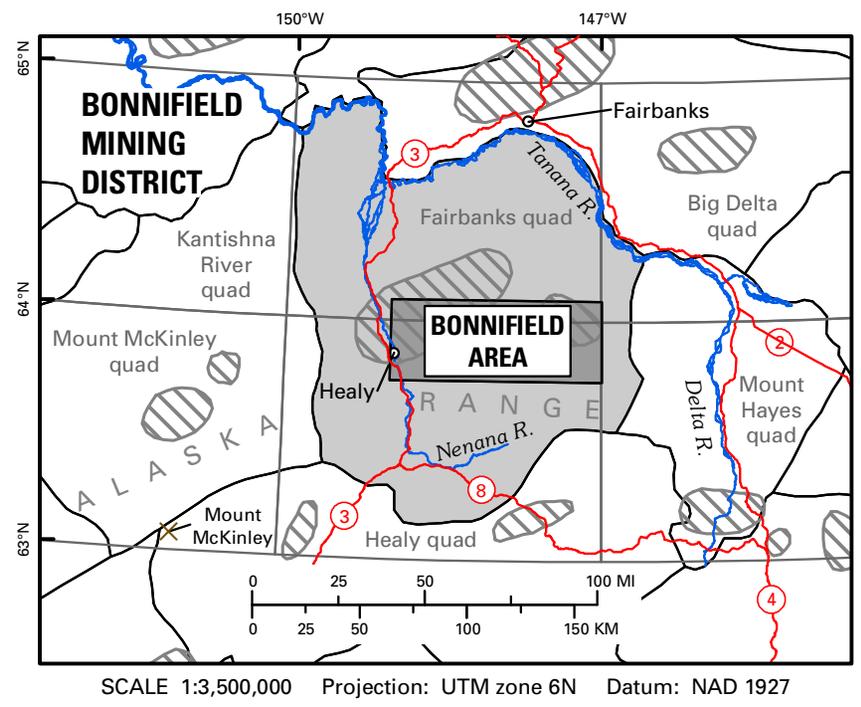
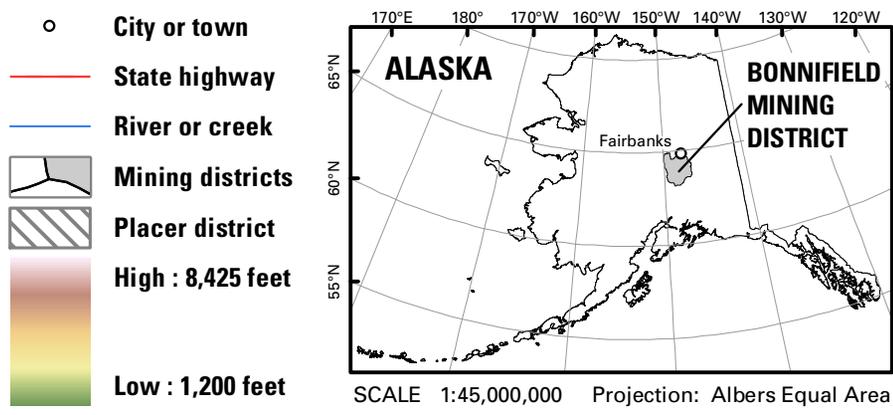
Comprehensive interpretations of the deposit, mineralization, alteration products and processes, geochemistry, and biogeochemistry can be found in Dusel-Bacon and others (2004 and 2006); Eppinger and others (2004, 2005, 2006, and in press; and Gough and others (2006).

<sup>1</sup> U.S. Geological Survey, Denver, Colorado.

<sup>2</sup> U.S. Geological Survey, Reston, Virginia.

### Figure 1. Alaska and Bonnifield district area maps

Geochemical data for stream-sediment, surface-water, rock, and vegetation samples from Red Mountain (Dry Creek), an unmined volcanogenic massive sulfide deposit in the Bonnifield district, Alaska Range, east-central Alaska



## Geologic Setting

The Bonfield mining district includes 26 known VMS prospects (Newberry and others, 1997), which are located north of the Hines Creek strand of the Denali fault system and occur within a greenschist-facies assemblage of metavolcanic and metasedimentary rocks in the Yukon-Tanana terrane (Dusel-Bacon and others, 2004). Protoliths consist of varying amounts of felsic and mafic volcanic and subvolcanic rocks interfingering with carbonaceous and siliciclastic sediments (Wahrhaftig, 1970; Gilbert, 1977; Gilbert and Bundtzen, 1979; Dusel-Bacon and others, 2006).

At Red Mountain, mineralized rocks are located within the Totatlanika Schist near the contact between the phyllitic felsic metavolcanic and subordinate carbonaceous rocks of the Mystic Creek Member and the overlying metasedimentary rocks of the Sheep Creek Member (Newberry and others, 1997; Smit, 1999; Dusel-Bacon and others, 2006). Detailed geologic mapping and geophysical studies of the Red Mountain area (Grayd Resources Corporation, 1998) have identified several massive and semimassive sulfide horizons, and a series of felsic metavolcanic units consisting of phyllitic and rhyodacitic metatuffs, possible rhyodacite flows, metagraywacke, tuffite, a chertlike unit of metamorphosed and locally silicified welded tuff, and metarhyolite or possibly welded tuff sills (Eppinger and others, 2004; Eppinger and others, in press). Two forms of deposit mineralized rock have been identified: (1) Massive to semimassive Zn-Pb-Ag-rich sulfides that occur within and at the base of an aphanitic, intensely quartz-sericite-pyrite (QSP) altered siliceous rock termed “mottled metarhyolite,” and (2) disseminations, wispy laminations, and zones of semimassive to massive pyrite, sphalerite, galena, and chalcopyrite, all hosted by a brown pyritic mudstone (Smit, 1999).

A dense network of north-, east-, and northwest-trending faults and fracture zones has segmented many of the mineralized horizons of the deposit. The deposit is tilted to the north, exposing underlying quartz stockwork veins in the lower (southern) section of the deposit and massive sulfide horizons in hanging-wall rocks in the higher (northern) section. A visibly demarcated alteration zone indicated by intense orange and maroon colors along with a general lack of vegetation extends for approximately 1 mi<sup>2</sup> (2.5 km<sup>2</sup>) around exposed portions of the deposit (Eppinger and others, in press).

## Methods of Study

### Sample Media

Water and (or) stream-sediment samples were collected from 36 sites above, within, and below the alteration zone surrounding Red Mountain, primarily at locations of streams, stream confluences, and ground-water springs and seeps (fig. 2).

Secondary weathering products sampled include efflorescent salts that coat rock outcrops and precipitate in splash zones and on vegetation in wet areas. Also sampled were precipitates that form ferricrete (Fe-oxyhydroxide-cemented alluvium) deposits in streambeds and at springs and seeps and at six locations of observed bryophytes. Soil samples were collected near five bryophyte collection sites. Willow vegetation samples were collected at eight of the sites. Rock samples were collected locally. Photographs were made of each sampling site. Descriptions of each photograph and thumbnail links to the photograph files are in [Appendix B](#).

## Sample Collection and Preparation

The sampling strategy for collecting surficial material was modified from methods described by Smith and others (2000). A count of the various types of samples collected in this study is listed in [table 1](#).

**Table 1.** Count of types of samples collected in this study.

Sample type	Total
Stream sediments	
2003	18
2004	9
Rock	
2003	14
2004	3
Precipitates	
2003	13
2004	13
Water	
2003	26
<i>Site duplicates, 2003</i>	1
2004	12
<i>Site duplicates, 2004</i>	1
Samples for leach tests	
2004	17
Soil	
2004	5
Vegetation	
2003	9
2004	16

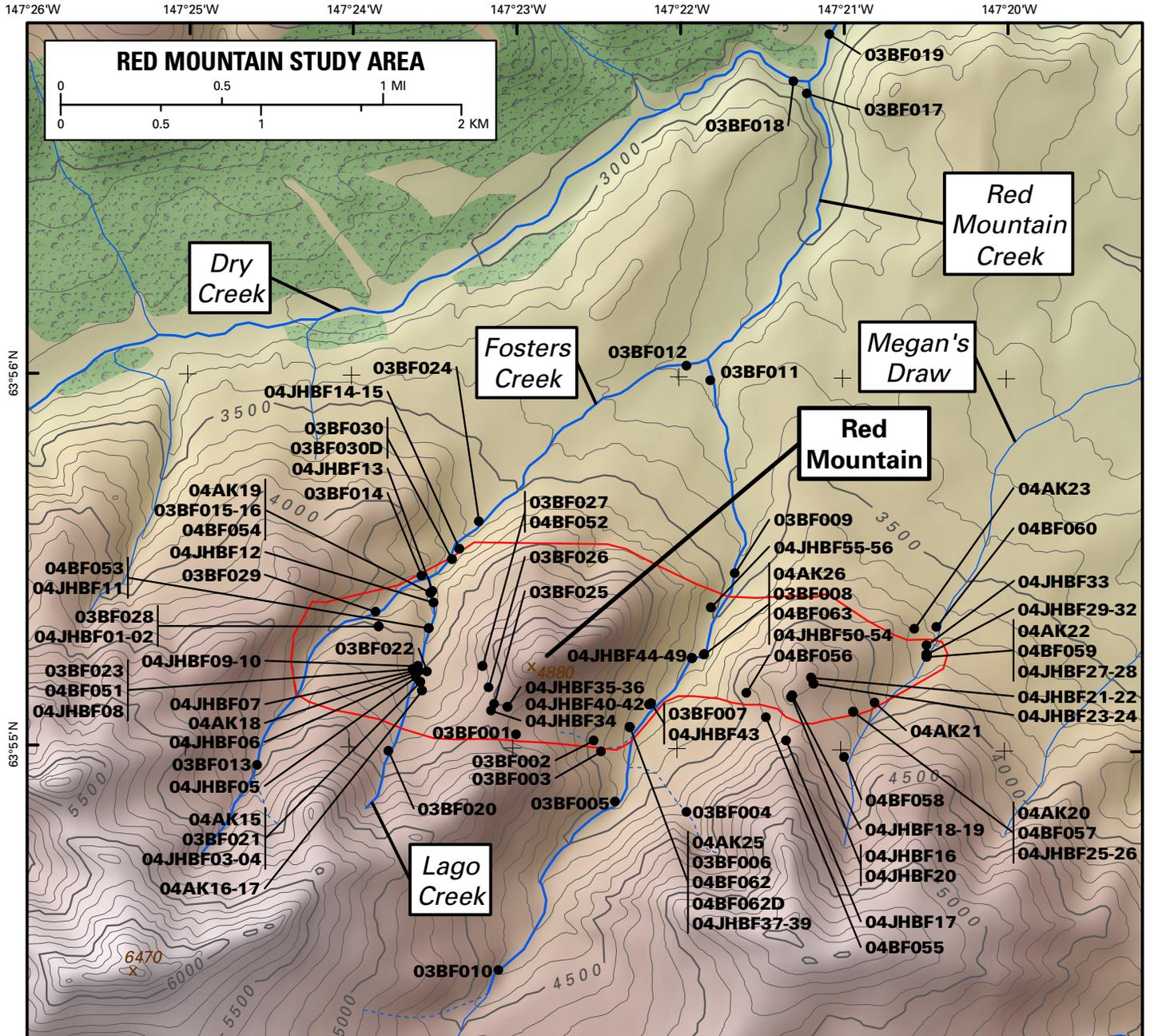
### Stream Sediments, Rock, and Precipitates

Bedload stream-sediment samples were collected from active alluvium at 20 of the stream-water sampling sites. The samples were composited by collecting 30 or more sediment increments from several places at the sampling site, generally

**Figure 2.** Map of the Red Mountain study area

*Geochemical data for stream-sediment, surface-water, rock, and vegetation samples from Red Mountain (Dry Creek), an unmined volcanogenic massive sulfide deposit in the Bonfield district, Alaska Range, east-central Alaska*

- **Sampling sites**
  - **Approximate extent of altered bedrock**
  - **Creek**
  - - - **Tributary / Intermittent tributary**
  - **Trees - spruce, alder, willow**
- Created July 2006 by Stuart A. Giles, U.S. Geological Survey  
 Elevation dataset: USGS Seamless Data Distribution System  
 Hydrology: National Hydrologic Dataset  
 Vegetation, contours, and creeks: USGS topographic map of the Healy D-1 quadrangle  
 Cities, towns, and placer districts: Alaska Department of Natural Resources, Land Records Information Section  
 Mining districts: Alaska Division of Geological and Geophysical Surveys  
 Digitized by John Horton, U.S. Geological Survey  
 State highways: Alaska Department of Transportation and Public Facilities



SCALE 1:30,000 Projection: UTM zone 6N Datum: NAD 1927 Central Meridian: 147° W Contours at 100-ft intervals

along a 33-ft (10-m) reach of the channel. The sediment was sieved onsite with a 10-mesh (2-mm particle size) stainless-steel screen, and an approximate 2-lb (1-kg) sample was collected. In the laboratory, sediments were air-dried and sieved at 80-mesh (0.177-mm particle size). The <80-mesh fractions were pulverized to approximately <100-mesh (0.149-mm particle size) for analysis. Clean quartz sand was pulverized between each sample to minimize intersample contamination.

Ferricrete samples in association with bryophytes consisted of the topmost 0.5 inch (1 cm) of sediment that also contained the bryophytes. About 1 lb (0.5 kg) of composited sediment material was collected. In the laboratory, prior to analysis, the sediments were disaggregated to pass a 10-mesh (2-mm particle size) sieve and then ground to approximately <100-mesh (0.149-mm particle size).

## Water

Spring- and stream-water samples were collected from 33 sites in July of 2003 under low-flow conditions during a precipitation-free period. Selected resampling for verification purposes was done in 2004 during similar flow conditions. Onsite measurements included pH, specific conductance, alkalinity, acidity, dissolved oxygen, water temperature, ferrous iron content, turbidity, and a qualitative discharge estimate. Water pH was determined using a Corning Model 315 meter. The meter was calibrated at each site by using three standard buffers with pH values of 4.01, 7.00, and 10.01. Specific conductance was determined using a Corning Model 316 meter. The meter was calibrated at each site by using either high or low conductivity standards, depending on the specific conductance of the water to be sampled. Field alkalinity was determined using portable CHEMetrics, Inc., titration test kits. More detailed information on this field test method is found in the “**Alkalinity by Titration**” section of this report. Acidity was determined using the portable Hach, Inc., titration kit Model AC-6. Dissolved oxygen was determined using the CHEMetrics, Inc., colorimetric test kit #K-7512. Water temperature was determined using the Corning pH meter. Ferrous iron content was determined using the CHEMetrics, Inc., test kit #K-6210. More detailed information on this field test method is found in the “**Ferrous Iron by Colorimetry**” section of this report. Water turbidity was determined using a CHEMetrics, Inc., turbidity meter #I-4300. The qualitative water-discharge estimate was determined either visually or, for small, confined springs and streams, was calculated by timing the filling of a vessel of known volume. Method of discharge estimate is recorded in the database. Because of the qualitative nature of the discharge calculation, the flow estimates reported here should be used with caution.

A width-integrated (collected across the source) and depth-integrated (collected below riffles) representative water sample was collected at each site in a 1-liter polypropylene bottle. The samples were filtered onsite at 0.45 micrometer using disposable filters. Subsamples for cation analysis were collected in

acid-rinsed polypropylene bottles and acidified with ultrapure nitric acid. Subsamples for Fe<sup>2+</sup> analysis were filtered as above and collected into acid-rinsed amber polypropylene bottles and acidified with ultrapure hydrochloric acid. Subsamples for mercury analysis were collected in acid-rinsed glass bottles with Teflon lids and preserved with ultrapure nitric acid/potassium dichromate. Filtered, unacidified subsamples for anion analysis and unfiltered, unacidified subsamples for laboratory alkalinity analysis were refrigerated until analyzed. Clean procedures were used throughout, following the procedures outlined in Ficklin and Mosier (1999).

## Leachate

Selected disaggregated bedrock samples were collected for laboratory leach experiments. At each site, the sample was collected by compositing approximately 30 increments of disaggregated bedrock and sieving it through a 10-mesh (2-mm particle size) screen. Approximately 1 lb (0.5 kg) of the <10-mesh material was collected for analysis. In the laboratory, leach tests were performed following the procedure of Hageman and Briggs (2000) and Hageman (2005) or that of Winland and others (1991).

## Soils and Vegetation

About 1 lb (0.5 kg) of a composited soil sample, mineral A1-horizon through C-horizon (channel sample), was collected and stored in paper USGS sampling bags. In the laboratory the soils were disaggregated to pass a 10-mesh (2-mm particle size) sieve and then ground to approximately <100-mesh (0.149-mm particle size).

Samples of the terminal 4–6 inches (10–15 cm) new growth of diamondleaf willow stems were collected and placed in Hubco™ polypropylene/cotton sampling bags. In the laboratory the material was rinsed thoroughly in deionized water, dried, and ground in a Wiley Mill to pass a 10-mesh screen (2-mm particle size), then a split was ashed at 500°C.

## Analytical Techniques

A large number of chemical constituents were determined, using a variety of quantitative and semiquantitative analytical techniques. U.S. Geological Survey laboratories in Denver, Colo., analyzed all water, leachate, and vegetation samples. USGS laboratories also analyzed samples requiring characterization by X-ray diffraction or scanning electron microscopy. Geochemical analyses on all rock, all precipitate, most sediment, and most soil samples were performed by XRAL Laboratories Inc., now SGS Canada, Inc., of Don Mills, Ontario, Canada, under a contract with the USGS. Selected soil and sediment samples collected in 2004 were analyzed by both USGS and SGS Canada laboratories. The analytical methods used by SGS Canada are proprietary but generally follow published USGS references listed herein. General descriptions of these

methods are provided in the following sections. For specific information regarding the proprietary analytical procedures done by SGS Canada, Inc., refer to SGS Canada, Inc. (2006). More detailed descriptions of USGS sample preparation, sample digestion, analytical methods, and quality-assurance/quality-control (QA/QC) protocol are found in Arbogast (1996), Crock and others (1999), and Taggart (2002).

Quality-assurance/quality-control concerns were addressed through the use of site duplicates (approximately 1 for every 20 sites), analytical duplicates, blanks, and standards, which together accounted for approximately 15 percent of the water/sediment samples analyzed and 10 percent of plant, soil, and associated sediment samples analyzed. **Table 2** describes the laboratory analysis codes and methods. **Table 3** shows the various constituents determined and analytical methods used for each of the sample media collected in the study. A brief description and references for each analytical method is given herein. Tables listing limits of determination for the analysis methods are in **Appendix C**.

## Techniques Used on Stream-Sediment, Rock, and Selected Precipitate Samples

### Inductively Coupled Plasma–Atomic Emission and Mass Spectrometry (4-Acid Digestion)

Forty-two major, minor, and trace elements were determined in geologic materials using inductively coupled plasma–atomic emission spectrometry (ICP–AES) and mass spectrometry (ICP–MS). This analysis method is designated “MS42” in **tables 2 and 3** and in the data files. Sediment samples were analyzed using the procedure of Briggs and Meier (2002) that incorporates the optimal benefits from both ICP–AES and ICP–MS, or by similar proprietary methods of SGS Canada, Inc. Samples (0.2 g) were digested using a mixture of hydrochloric (HCl), nitric (HNO<sub>3</sub>), perchloric (HClO<sub>4</sub>) and hydrofluoric (HF) acids and were heated at low temperature until dry. Residues were dissolved with additional HClO<sub>4</sub>, HNO<sub>3</sub>, and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>),

**Table 2.** Laboratory analysis codes and methods.

Code	Laboratory analysis method	
Solid samples		
CT	Coulometric titration	
CV	Flow injection-cold vapor–atomic absorption spectrometry	
DI	Calculated difference	
FA	Fire assay direct coupled plasma–optical emission spectrometry	
HY	Hydride generation–atomic absorption spectrophotometry	
LE	LECO analyzer	
MS-ACID	(USGS) 4-Acid digestion inductively coupled plasma–mass spectrometry	
MS42	4-Acid digestion	Inductively coupled plasma–atomic emission spectrometry
		Inductively coupled plasma–mass spectrometry
MS55	Sodium peroxide sinter	Inductively coupled plasma–atomic emission spectrometry
		Inductively coupled plasma–mass spectrometry
PCT	Calculated weight percent	
TI	Titration for ferrous oxide	
XRD	X-ray powder diffractometry	
Liquid samples		
AF	Flow injection-cold vapor–atomic fluorescence spectrometry	
CO	Colorimetric method, Hach spectrophotometer	
EW	Inductively coupled plasma–atomic emission and mass spectrometry	
IC	Ion chromatography	
MW	Inductively coupled plasma–mass spectrometry	
PPM	Total hardness, expressed as equivalent calcium carbonate	
TA	Titration for alkalinity	

**Table 3.** Elements and compounds determined for each sample medium.

Sample media	Method	Unit	Elements and compounds determined	
Sediment	MS42	%	Al, Ca, Fe, K, Mg, Na, S, Ti	
		PPM	Ag, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Ga, In, La, Li, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Sc, Sn, Sr, Te, Th, Tl, U, V, W, Y, Zn	
	FA	PPM	Au	
	LE	%	S (total), C (total)	
	CT	%	C (carbonate), CO <sub>2</sub>	
	DI	%	C (organic)	
	TI	%	FeO	
	CV	PPM	Hg	
	HY	PPM	Se	
	MS55	%	Al, Ca, Fe, K, Mg, Mn, P, Ti,	
		PPM	Ag, As, Ba, Be, Bi, Cd, Co, Cr, Cs, Cu, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, La, Li, Lu, Mo, Nb, Nd, Ni, Pb, Pr, Rb, Sc, Sm, Sn, Sr, Ta, Tb, Th, Tl, Tm, U, V, W, Y, Yb, Zn, Zr	
	Rock	MS42	%	Al, Ca, Fe, K, Mg, Na, S, Ti
			PPM	Ag, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Ga, In, La, Li, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Sc, Se, Sn, Sr, Te, Th, Tl, U, V, W, Y, Zn
		FA	PPM	Au
LE		%	C (total)	
CT		%	C (carbonate), CO <sub>2</sub>	
DI		%	C (organic)	
TI		%	FeO	
CV		PPM	Hg	
HY		PPM	Se	
MS55		%	Al, Ca, Fe, K, Mg, Mn, P, Ti	
		PPM	Ag, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, La, Li, Lu, Mo, Nb, Nd, Ni, Pb, Pr, Rb, Sc, Sm, Sn, Sr, Ta, Tb, Th, Tl, Tm, U, V, W, Y, Yb, Zn, Zr	
Precipitate		MS42	%	Al, Ca, Fe, K, Mg, Na, S, Ti
			PPM	Ag, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Ga, In, La, Li, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Sc, Sn, Sr, Te, Th, Tl, U, V, W, Y, Zn
		FA	PPM	Au
	LE	%	C (total)	
	CT	%	C (carbonate), CO <sub>2</sub>	
	DI	%	C (organic)	
	TI	%	FeO	
	CV	PPM	Hg	
	HY	PPM	Se	
	XRD	%	(mineralogy)	

## 8 Geochemical Data from Red Mountain, Alaska Range, Alaska

**Table 3.** Elements and compounds determined for each sample medium.—Continued

Sample media	Method	Unit	Elements and compounds determined
Water Filtered/Unacidified (FU)	IC	mg/L	F <sup>-</sup> , Cl <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup> , NO <sub>3</sub> <sup>-</sup>
Water Filtered/Acidified (FA)	EW	mg/L	Ca, K, Mg, Na, Si
		μg/L	Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, P, Pb, Sb, Sr, Ti, V, Zn
		mg/L	Ca, K, Mg, Na, Si, SO <sub>4</sub> <sup>2-</sup>
	MW	μg/L	Ag, Al, As, Au, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Ho, In, La, Li, Lu, Mn, Mo, Nb, Nd, Ni, P, Pb, Pr, Rb, Re, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr
	PPM	PPM	Hardness
Water Unfiltered/Acidified (RA)	EW	mg/L	Ca, K, Mg, Na, Si
		μg/L	Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, P, Pb, Sb, Sr, Ti, V, Zn
		mg/L	Ca, K, Mg, Na, Si, SO <sub>4</sub> <sup>2-</sup>
	MW	μg/L	Ag, Al, As, Au, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Ho, In, La, Li, Lu, Mn, Mo, Nb, Nd, Ni, P, Pb, Pr, Rb, Re, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr
Water Filtered/Acidified (Fe <sup>2+</sup> )	CO	mg/L	Fe <sup>2+</sup>
Water Filtered/Preserved (HG)	AF	μg/L	Hg
Leachate Unacidified (ALK)	TA	PPM	Alkalinity
Leachate Filtered/Unacidified (FU)	IC	mg/L	Cl <sup>-</sup> , F <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup>
Leachate Filtered/Acidified (FA)	EW	mg/L	Ca, K, Mg, Na, Si
		μg/L	Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, P, Pb, Sb, Sr, Ti, V, Zn
		mg/L	Ca, K, Mg, Na, Si, SO <sub>4</sub> <sup>2-</sup>
	MW	μg/L	Ag, Al, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Ho, La, Li, Lu, Mn, Mo, Nb, Nd, Ni, P, Pb, Pr, Rb, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr
Leachate HCL leach of split (HCL)	EW	mg/L	Ca, K, Mg, Na, P, SiO <sub>2</sub>
		μg/L	Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, Pb, Sb, Sr, Ti, V, Zn
		mg/L	Ca, K, Mg, Na, P, SiO <sub>2</sub> , SO <sub>4</sub> <sup>2-</sup>
	MW	μg/L	Ag, Al, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Ho, La, Li, Lu, Mn, Mo, Nb, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr
Leachate Filtered/Preserved (HG)	AF	μg/L	Hg
Soil		%	Al, Ca, Fe, K, Mg, Na, Ti
	MS-ACID	PPM	Ag, As, Ba, Be, Bi, Cd, Ce, Co, Cr, Cs, Cu, Ga, La, Li, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Sc, Sr, Th, Tl, U, V, Y, Zn
Vegetation	PCT	%	Ash
	CV	PPM	Hg
	HY	PPM	As, Se
	LE	PCT	S
	MS-ACID	PPM	Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cu, Cs, Fe, Ga, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Sb, Sc, Sr, Th, Ti, Tl, U, V, W, Y, Zn

and the samples were heated in a drying oven. The final volume was diluted to a 1:10 solution with dilute  $\text{HNO}_3$  before analysis. The ICP–AES is calibrated by standardizing with digested rock reference materials and a series of multielement solution standards. The ICP–MS is calibrated with aqueous standards, and internal standards are used to compensate for matrix effects and internal drifts. Limits of determination (LOD) for 42-element 4-acid digestion ICP–AES and ICP–MS are shown in [table C1 of Appendix C](#). *Analytical Performance:* Data were deemed acceptable if recovery for all 42 elements was  $\pm 15$  percent at five times the Lower Limit of Determination (LLD) and the calculated Relative Standard Deviation (RSD) of duplicate samples was no greater than 15 percent.

### Inductively Coupled Plasma–Atomic Emission and Mass Spectrometry (Sodium Peroxide Sinter)

Due to the incomplete digestion of some refractory, resistant, and secondary minerals by the 4-acid digestion, sediment and rock samples were also analyzed for 55 elements by ICP–AES and ICP–MS following a sodium peroxide ( $\text{Na}_2\text{O}_2$ ) sinter digestion. This method is designated “MS55” in [tables 2 and 3](#) and in the data files. These samples were analyzed by SGS Canada, Inc., following a procedure similar to that described by Meier and Slowik (2002), for analysis of rare-earth elements (REE) by ICP–MS with a sodium peroxide sinter. Samples (0.1 g) were weighed into graphite crucibles, thoroughly mixed with dry sodium peroxide ( $\text{Na}_2\text{O}_2$ ), then placed into a preheated muffle furnace at  $425^\circ\text{C}$  for 30 minutes, removed, and allowed to cool (Richard O’Leary, U.S. Geological Survey, oral commun., 2006). Deionized water, dilute nitric acid, and tartaric acid were used to dissolve the resultant cake, and aliquots of the digested sample were aspirated into the ICP–AES and ICP–MS. The ICP–AES is calibrated by standardizing with digested certified rock reference materials and a series of multielement solution standards. ICP–MS is calibrated with aqueous standards, and internal standards are used to compensate for matrix effects and internal drifts. Limits of determination for 55-element sodium peroxide sinter ICP–AES and ICP–MS are shown in [table C2 of Appendix C](#). *Analytical Performance:* Data were deemed acceptable if recovery for all 55 elements was  $\pm 15$  percent at five times the LLD and the calculated RSD of duplicate samples was no greater than 15 percent.

### Gold by Fire Assay Direct Coupled Plasma–Optical Emission Spectrometry

Gold in stream-sediment, rock, and precipitate samples was determined by direct coupled plasma–optical emission spectrometry (DCP–OES) after collection by fire assay. This method is designated “FA” in [tables 2 and 3](#) and in the data files. These samples were analyzed by SGS Canada, Inc., using a proprietary method. In the fire assay method, a mixture of finely pulverized sample and about three parts of a flux are fused until the product is molten. A lead compound in the

flux is reduced by other flux constituents to metallic lead. The metallic lead collects all gold, together with silver, platinum metals, and small quantities of certain base metals present in the sample, and falls to the bottom of the crucible to form a lead button. The choice of a suitable flux depends on the character of the ore. The lead button is cupelled to oxidize the lead, leaving behind a doré bead containing the precious metals. The doré bead is then transferred to a test tube, dissolved with aqua regia, diluted to a specific volume, and determined by DCP–OES. Limits of determination for gold by fire assay DCP–OES are shown in [table C4 of Appendix C](#). *Analytical Performance:* Data were deemed acceptable if recovery of gold was  $\pm 20$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 20 percent.

### Total Carbon by LECO Analyzer

A LECO analyzer was used to determine total carbon in stream sediment, rock, and precipitate samples. This method is designated “LE” in [tables 2 and 3](#) and in the data files. These samples were analyzed for total carbon by SGS Canada, Inc., following a proprietary procedure similar to that described by Brown and Curry (2002a). A 0.25-g sample was combusted in an oxygen atmosphere to oxidize carbon to carbon dioxide. Moisture and dust were removed, and the carbon dioxide gas was measured by a solid-state infrared detector. The operating range for total carbon is from 0.05 percent to about 30 percent. *Analytical Performance:* Data were deemed acceptable if recovery of total carbon was  $\pm 15$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 15 percent.

### Total Sulfur by LECO Analyzer

A LECO analyzer was used to determine total sulfur in the sediment samples. This method is designated “LE” in [tables 2 and 3](#) and in the data files. These samples were analyzed for total sulfur by SGS Canada, Inc., following a proprietary procedure similar to that described by Brown and Curry (2002b). A 0.25-g sample was mixed with iron chips and LECOCEL, then combusted in an oxygen atmosphere at high temperature to oxidize sulfur to sulfur dioxide. Moisture and dust were removed and the sulfur dioxide gas was measured by a solid-state infrared detector. The operating range for total sulfur is 0.05 percent to 35 percent. *Analytical Performance:* Data were deemed acceptable if recovery of total sulfur was  $\pm 15$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 15 percent.

### Carbonate Carbon by $\text{CO}_2$ Calculations

Carbonate carbon was calculated from the value obtained for carbonate as  $\text{CO}_2$  by coulometric titration. This method is designated “CT” in [tables 2 and 3](#) and the data files.

### Carbonate as CO<sub>2</sub> by Coulometric Titration

Carbonate was determined as carbon dioxide (CO<sub>2</sub>) by coulometric titration. This method is designated “CT” in tables 2 and 3 and in the data files. These samples were analyzed for carbonate carbon by SGS Canada, Inc., following a proprietary procedure similar to that described by Brown and others (2002b). The samples were treated with hot 2N perchloric acid, and the evolved carbon dioxide was passed into a cell containing a solution of monoethanolamine. The carbon dioxide, quantitatively absorbed by monoethanolamine, was coulometrically titrated using platinum and silver/potassium-iodide electrodes. The lower reporting limit is 0.01 percent carbon dioxide, and samples containing up to 50 percent carbon dioxide may be analyzed. Sample size was adjusted from 0.5 g for the range 0.01 to 5 percent carbon dioxide, 0.1 g for the range 5 to 10 percent carbon dioxide, and 0.02 g for greater than 10 percent carbon dioxide. *Analytical Performance:* Data were deemed acceptable if recovery of carbonate carbon was ±15 percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 15 percent.

### Organic Carbon Calculations

Organic carbon was determined arithmetically as the difference between total carbon and carbonate carbon. This method is designated “DI” in tables 2 and 3 and in the data files.

### Ferrous Oxide by Titration

Ferrous oxide (FeO) was determined by titration. This method is designated “TI” in tables 2 and 3 and in the data files. These samples were analyzed by SGS Canada, Inc., following a proprietary method that demonstrates an analytical performance identical to or exceeding the performance described in Papp and others (1996). A 0.5-g sample was digested using a mixture of sulfuric, hydrofluoric, and hydrochloric acids. The solution was titrated with potassium dichromate using sodium diphenylamine sulfonate as an indicator. The lower reporting limit is 0.01 percent FeO. *Analytical Performance:* The data were deemed acceptable if recovery of FeO was ±15 percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 15 percent.

### Mercury by Cold Vapor–Atomic Absorption Spectrometry

Mercury (Hg) was determined by cold vapor–atomic absorption spectrometry (CV–AAS). This method is designated “CV” in tables 2 and 3 and in the data files. These samples were analyzed by SGS Canada, Inc., using a proprietary method that demonstrates an analytical performance identical to or exceeding the performance described in Brown and others (2002a). Samples (0.1 g) were digested with a mixture of nitric and hydrochloric acids. Potassium permanganate, sulfuric acid, potassium persulfate, and a sodium chloride-hydroxylamine solution were added and the samples were

then diluted with water to 25 mL. The samples were mixed thoroughly, allowed to settle, and transferred to a Perkin-Elmer Flow Injection Mercury System (FIMS–100). Hg (II) was reduced to Hg<sup>0</sup> and liberated as vapor by the addition of a stannous chloride reducing agent, then the vapor was separated and absorption of the sample was measured with a mercury lamp at 253.7 nm. The lower reporting limit is 0.02 ppm mercury for solid-phase samples. *Analytical Performance:* Data were deemed acceptable if recovery of mercury was ±20 percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 20 percent.

### Selenium by Hydride Generation–Atomic Absorption Spectrophotometry

Selenium in stream-sediment samples was determined by continuous-flow hydride generation–atomic absorption spectrophotometry. This method is designated “HY” in tables 2 and 3 and in the data files. These samples were analyzed by SGS Canada, Inc., using a proprietary method that demonstrates an analytical performance identical to or exceeding the performance described in Hageman and Welsch (1996) and Hageman and others (2002). The samples (0.25 g) were digested by adding concentrated nitric, perchloric, and hydrofluoric acids and heating. After cooling, hydrochloric and nitric acids were added and the solutions again heated and cooled. The samples were diluted and selenium concentration was determined using a hydride generation–atomic absorption spectrophotometer. Limits of determination are listed in table C4 of Appendix C. *Analytical Performance:* Data for selenium were deemed acceptable if recovery of that element was ±20 percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 20 percent.

### Mineralogy by X-Ray Diffraction

Precipitate sample mineralogy was characterized with X-ray powder diffractometry analysis. This method is designated “XRD” in tables 2 and 3 and in the data files. These samples were analyzed using a method similar to that found in Jenkins and Snyder (1996). Samples were split, pulverized to a <200 mesh, packed in an aluminum holder or placed on a glass slide, and analyzed using a Philips automated goniometer with a copper target. Values should be considered semiquantitative and are reported in weight percent (trace = less than 5 percent, minor = greater than 5 percent to less than 25 percent, and major = greater than 25 percent).

### Techniques Used on Water and Leachate Samples

#### Alkalinity by Titration

Onsite alkalinity tests were done on all water samples having pH values greater than 6.0 using field-portable CHEMets®, titration kits (kits K-9810, K-9815, and K-9820, CHEMetrics, Inc.), following the method of the American

Society for Testing and Materials (2001b). At sites where water samples were turbid or had low alkalinities (less than 25 ppm as  $\text{CaCO}_3$ ) with the field-portable test, unfiltered-unacidified samples were also collected for laboratory alkalinity determination. All field and leachate samples collected for laboratory alkalinity tests were kept cool from time of collection until they were analyzed.

The laboratory alkalinity method is designated “TA” in tables 2 and 3 and in the data files. In the laboratory, an Orion 960 Autochemistry System was used for endpoint titration analysis, using a method described by Theodorakos (2002c). The titrant ( $\text{H}_2\text{SO}_4$ ) was added to 50 mL of sample until a pH of 4.5 was achieved. Alkalinity was then calculated and reported in units of parts per million as  $\text{CaCO}_3$ . The LLD for this method is 1 ppm. *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

### Anions by Ion Chromatography

The anions fluoride ( $\text{F}^-$ ), chloride ( $\text{Cl}^-$ ), sulfate ( $\text{SO}_4^{2-}$ ), and nitrate ( $\text{NO}_3^-$ ) were determined sequentially by ion chromatography on filtered-unacidified water and leachate samples following the methods of d’Angelo and Ficklin (1996) and Theodorakos (2002a). This method is designated “IC” in tables 2 and 3 and in the data files. The water samples were kept cool from the time of collection until they were analyzed. The samples were injected into an ion chromatograph where ions of interest separate along an ion-exchange separator column at different rates, depending on the affinity of each species for the ion-exchange resin. Samples then passed into a flow-through conductivity cell where the anions were detected and their peak heights were recorded. Samples were compared with peak heights of calibration standards to determine sample concentrations. Limits of determination for anions in raw water samples and leachates are shown in table C7 of Appendix C. *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

### Cations by Inductively Coupled Plasma–Atomic Emission and Mass Spectrometry

Acidified-filtered and acidified-unfiltered water samples, and acidified-filtered leachate samples were analyzed for major (Al, Ca, Fe, K, Mg, Na, and Si) and selected trace elements following the ICP–AES method of Briggs and Fey (1996), revised in Briggs (2002). This method is designated “EW” in tables 2 and 3 and in the data files. Samples weighing 4.0 grams were transferred to a test tube. Samples were aspirated directly into an argon plasma, and element concentrations were determined by ICP–AES. Limits of determination for the multielement ICP–AES method for water samples are shown in table C5 of Appendix C. *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at

five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

Acidified-filtered and acidified-unfiltered water samples and acidified-filtered leachate samples were analyzed to determine over 50 constituents by ICP–MS by using a method developed by the USGS (Meier and others 1994; method revised in Lamothe and others, 2002). This method is designated “MW” in tables 2 and 3 and in the data files. The method is used to determine numerous elements directly in the water sample without the need for preconcentration or dilution. Element detection limits are in the sub-part-per-billion range, and the working linear range is six orders of magnitude or more. By using derived response curves, percentage of ionization, and natural isotopic abundances, estimates of concentrations for the elements can be determined in samples without the need of a calibration standard for every element. The method is most useful for trace elements in the parts-per-billion range; analyses for major elements in the parts-per-million range are less accurate, and ICP–AES data should be used. Limits of determination for ICP–MS with water samples are shown in table C6 of Appendix C. *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

### Mercury by Flow Injection–Cold Vapor–Atomic Fluorescence Spectrometry

Mercury in water and leachate samples was analyzed by flow injection–cold vapor–atomic fluorescence spectrometry (CV–AFS), following the method described in Hageman (2002). This method is designated “AF” in tables 2 and 3 and in the data files. In the laboratory, preserved samples were mixed with stannous chloride. Mercury (II) was reduced to  $\text{Hg}^0$  in a flow-injection manifold. The mercury vapor was purged from the aqueous phase with argon, passed through a drying tube, separated, and measured using flow injection–cold vapor–atomic fluorescence spectrometry. For water and leachate samples, the LLD for this method is 5 parts per trillion (PPT). *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

### Ferrous Iron by Colorimetry

In the summer of 2003, ferrous iron was determined in the field by visual colorimetry, using a portable CHEMets® test method (kit K–6210, CHEMetrics, Inc.; American Society for Testing and Materials, 2001a). This method is designated “FE2+” in the data files. In the ferrous iron CHEMets® test method, ferrous iron reacts with 1,10-phenanthroline to form an orange-colored complex, whose intensity is in proportion to the ferrous iron concentration. The sample was collected in a glass ampoule containing the reagent and mixed for 1 minute. Then the ampoule was placed into a comparator containing standards of known

ferrous iron concentration and the concentration was visually estimated. The LLD for this method is 0.1 ppm.

Because concentrations exceeded the upper range limit (3 ppm) for this portable test method, selected sites were resampled in 2004 for analysis in USGS laboratories, following the method described in Theodorakos (2002b), which is similar to, but with more dynamic range than, the portable method previously described. This method is designated “CO” in [tables 2 and 3](#) and in the data files. The LLD for this method is 0.1 ppm. *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

## Techniques Used on Soil and Vegetation Samples

### Inductively Coupled Plasma–Mass Spectrometry (4-Acid Digestion)

The ash of the vegetation samples was analyzed for 39 elements, and the soil samples were analyzed for 37 elements by inductively coupled plasma–mass spectrometry. This method is designated “MS–ACID” in [tables 2 and 3](#) and in the data files. For vegetation samples only, values for elements determined by the MS–ACID method were converted to dry weight from ash weight basis by multiplying by ash percent (Paul Lamothe, U.S. Geological Survey, written commun., 2006). All samples were analyzed in USGS laboratories, following the method described for determination of 42 elements in geologic materials by ICP–MS in Briggs and Meier (2002). Samples (0.2 g) were digested using a mixture of hydrochloric (HCl), nitric (HNO<sub>3</sub>), perchloric (HClO<sub>4</sub>), and hydrofluoric (HF) acids and were heated until dry. Additional perchloric acid was added to the residue and heated to complete dryness. Nitric acid and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) were added to the residue. The samples were then heated in a drying oven at 100°C for 30 minutes. The final volume was diluted to a 1:10 solution by taking 0.5 mL of sample solution and diluting with 4.5 mL of dilute nitric acid before analysis. The ICP–MS is calibrated with aqueous standards, and internal standards are used to compensate for matrix effects and internal drifts. Limits of determination for 42-element 4-acid digestion ICP–MS are shown in [table C3 of Appendix C](#). *Analytical Performance:* Data were accepted if recovery was  $\pm 15$  percent at five times the LLD and the RSD was less than 15 percent for the duplicate samples.

### Ash Percent, Calculated

Vegetation sample splits were analyzed for weight percent ash. This method is designated “PCT” in [tables 2 and 3](#) and in the data files. All samples were analyzed in USGS laboratories following the method described in Peacock and Crock (2002). The samples were rinsed, transferred to a colander for drying until brittle, milled in a grinder, and then mixed using

a rotary tumbling device. Aliquots of 10 g were spread evenly across Vitreosil dishes and placed in an ashing furnace. The samples were ashed at 500°C for 13 hours, then allowed to cool. The ash must be mixed and reduced in volume as it tends to be highly charged with static electricity, so the samples were placed into 0.5-oz pillboxes with solid 5-mm borosilicate beads, then shaken for 10–60 seconds in a Spex 8000 mixer/mill. Weight percent of ash was determined mathematically by using measurements of the empty vessel, the combined weight of the vessel and sample aliquot before ashing, and the weight of the cooled vessel and ashed sample. Minimum measurement of ash content is 0.01 percent. *Analytical Performance:* Data were accepted if recovery was  $\pm 15$  percent at five times the LLD and the RSD was less than 15 percent for the duplicate samples.

### Mercury by Cold Vapor–Atomic Absorption Spectrometry

Mercury in unashed vegetation samples was analyzed by flow injection-cold vapor–atomic absorption spectrometry (CV–AAS). This method is designated “CV” in [tables 2 and 3](#) and in the data files. All samples were analyzed in USGS laboratories following the method described in Brown and others (2002a). Samples (0.1 g) were weighed into test tubes, then HNO<sub>3</sub> and sodium dichromate were added to wet the samples. The samples were heated and cooled, then diluted with deionized (DI) water and analyzed in a Perkin-Elmer 3030B AAS Spectrometer. For solid-phase samples, the LLD for this method is 0.02 part per million. *Analytical Performance:* Data were deemed acceptable if recovery was  $\pm 10$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 10 percent.

### Total Sulfur by LECO Analyzer

Total sulfur in unashed vegetation samples was determined by using an automated sulfur analyzer. This method is designated “LE” in [tables 2 and 3](#) and in the data files. All samples were analyzed in USGS laboratories, following the method described in Brown and Curry (2002b). Samples (0.25 g) were mixed with a flux, then placed in a LECO SC–432 analyzer and combusted in an oxygen atmosphere at 1,350°C to oxidize sulfur to sulfur dioxide. Moisture and dust were removed, and the resultant sulfur dioxide gas was measured by a solid-state infrared detector. Limits of determination for this method are listed in [table C4 of Appendix C](#). *Analytical Performance:* Data were accepted if recovery was  $\pm 15$  percent at five times the LLD and the RSD was less than 15 percent for the duplicate samples.

### Arsenic and Selenium by Hydride Generation–Atomic Absorption Spectrophotometry

Arsenic and selenium in unashed vegetation samples were determined by continuous-flow hydride generation–atomic absorption spectrophotometry. This method is designated “HY” in [tables 2 and 3](#) and in the data files. All samples were

analyzed in USGS laboratories, using the method described in Hageman and Welsch (1996) and Hageman and others (2002). The samples (1.0 g) were digested by adding concentrated nitric, perchloric, and sulfuric acids and heating. After cooling, hydrochloric and nitric acids were added, and the solutions were heated, cooled, and diluted for analysis. For arsenic, an aliquot of the sample was treated with potassium iodide and ascorbic acid prior to determination. Selenium and arsenic concentrations were determined using a hydride generation–atomic absorption spectrophotometer. Limits of determination for this method are listed in [table C4](#) of [Appendix C](#). *Analytical Performance*: Data were accepted if recovery of an element was  $\pm 20$  percent at five times the LLD and the calculated percent RSD of duplicate samples was no greater than 20 percent.

## Which technique should I use?

This section is provided as guidance for those cases where multiple values are listed for a given element in a sample. In these instances the same element was determined by more than one analytical technique ([table 3](#)).

Filtered-acidified and unfiltered-acidified water samples were analyzed by both ICP–AES and ICP–MS. In general, the ICP–AES data are preferred to ICP–MS in those instances where values are given by both methods. This is particularly true for the major elements Al, Ca, Fe, K, Mg, Na, and Si, located at the light end of the periodic table where space-charge effects in the plasma cause interference and reduce accuracy (D.L. Fey, U.S. Geological Survey, written commun., 2006).

Stream-sediment, rock, and leach (solid-phase) samples were decomposed by two laboratory methods and subsequently analyzed by ICP–AES and ICP–MS. The MS42 method uses a near-total decomposition, 4-acid digestion (HF, HCl, HNO<sub>3</sub>, and HClO<sub>4</sub>) at low temperature, and the MS55 method involves total decomposition using a sodium peroxide sinter. Thus, slight differences in values for a given element are to be expected, particularly for elements that reside in oxides and other resistant minerals.

## Description of Data Files

The analytical data files are provided in two formats, as relational tables in a Microsoft Access 2003 database and as separate, nonrelational Microsoft Excel 2003 files with the same name and fields. Detailed descriptions of the tables and their fields are in [Appendix A](#).

## Abbreviations

Abbreviations used in the database tables are listed in [table 4](#). Individuals listed in the table are all USGS scientists who were involved in the Red Mountain study.

## Field Numbers

The field number coding scheme is as follows: The first two numbers indicate the year the sample was collected, except for field blanks, which have the prefix “FB”. The next two or four letters are various regional codes used by the sample collectors: BF, Eppinger-Bonnifield; AK, Gough-Alaska; JHBF, Hammarstrom-Bonnifield. The next digits indicate the sampling site number. Field numbers that end in “D” are site duplicates for QA/QC. Collectively, these four parameters make up the Site ID. Following the Site ID are suffixes to indicate sample media type and, if applicable, a number or letter to indicate multiple samples from one sampling site location. The Site ID and media suffix together make up the sample Field Number. Examples are: 03BF001R = collected in 2003, Eppinger-Bonnifield, sampling site #1, rock; 04AK26V = collected in 2004, Gough-Alaska, sampling site #26, vegetation. [Table 5](#) lists the suffixes and sample media types for each table in the database.

**Table 4.** Abbreviations.

Abbreviation	Meaning
AK	Alaska
ARDF	Alaska Resource Data File
BEH	Bernard E. Hubbard
C	Celsius
ChB	Charles Bacon
CD-B	Cynthia Dusel-Bacon
cfs	cubic feet per second
CR	Cameron Rombach
Cr.	Creek
DC	Dry Creek
DD	decimal degrees
DI	deionized water
diss	dissolved
DOP	degree of precision
FeOx (FeO)	iron oxide
FTU	formazine turbidity unit
GIS	geographic information systems
gpm	gallons per minute
GPS	global positioning system
GX	geochemistry
HCl	hydrochloric acid
HS	hand sample
ID	identification
JMH	Jane M. Hammarstrom
L/Min	liters per minute
Lat	latitude
LLD	lower limit of determination
LOD	limit of determination

**Table 4.** Abbreviations.—Continued

Abbreviation	Meaning
Long	longitude
LPG	Larry P. Gough
mg/L	milligrams per liter
MH	Melanie Hopkins
Mm	millimeters
MIN	binocular mineralogy
MnOx (MnO)	manganese oxide
NAD27	North American datum of 1927
NF-A	Nora Foley-Ayuso
ng/L	nanograms per liter
PCT	percentage
PHB	Paul H. Briggs
PPB	parts per billion
PPM	parts per million
QA/QC	quality assurance/quality control
RGE	Robert G. Eppinger
RH	relative humidity
RSD	relative standard deviation
SEM	scanning electron microscope
SG	Stuart Giles
ug/L (µg/L)	micrograms per liter
uS/cm (µS/cm)	microsiemens per centimeter
VMS	volcanogenic massive sulfide
WGS84	world geodetic system of 1984
XRD	X-ray powder diffractometry

## Coordinates

Sampling-site location latitude and longitude coordinates are given in the tblSampleSiteInfo table both as degrees-minutes-decimal seconds and decimal degrees. Also listed for most samples are the GPS-derived coordinate XY error in feet, the number of visible GPS satellites, the GPS-derived degree of coordinate precision, elevation, datum, spheroid, and the source of the coordinates. All coordinates were collected with GPS units, using the World Geodetic System of 1984 (WGS84) datum and spheroid.

For mapping purposes (see [figs. 1 and 2](#)), coordinates were projected into the projection native to the Healy D-1 quadrangle digital raster graphic: North American Datum of 1927 (NAD27) (U.S. Geological Survey and The Land Information Technology Company Ltd., 1997). An Alaska-specific transformation was applied to the reprojection to correct any systematic errors resulting from the shift of datum and spheroid.

## Geochemical Analyses

All geochemical data are given in the following format. Field identifiers consist of a single line. The first one or two letters give the chemical element symbol, then units of measurement, and finally a code for the analytical method used for the element in that particular column. The three items are separated by underscores. Element names and associated symbols are listed in the various tables of [Appendix C](#). [Table 6](#) lists the various units of measurements cited in this data release; not all units are used in the data files themselves. Codes for the analytical methods used are in [table 2](#). For all geochemical data, a negative sign (–) in front of the value indicates that an element was not observed at the lower limit of determination shown. A blank entry indicates that a sample was not analyzed for that particular element.

**Table 5.** Sample media suffixes.

Table	Suffix	Sample media type
tblSedimentChemData	S	Sediment
tblRock&LeachSolidChemData	R	Rock
	L	Leach of rock solid phase
tblPrecipitateChemData	P	Precipitate
tblWaterChemDataAnionsFU	FU	Filtered/Unacidified water, for anion analysis
tblWaterChemDataCationsFA	FA	Filtered/Acidified water, for cation analysis
tblWaterChemDataCationsRA	RA	Unfiltered/Acidified water, for cation analysis
tblWaterChemDataFe2+	FE	Filtered/Acidified water, for Fe <sup>2+</sup> analysis
tblWaterChemDataHG	HG	Filtered/Preserved water, for Hg analysis
tblLeachWaterChemDataALK	LFU	Filtered/Unacidified leachate, for alkalinity analysis
tblLeachWaterChemDataAnionsFU	LFU	Filtered/Unacidified leachate, for anion analysis
tblLeachWaterChemDataCationsFA	LFA	Filtered/Acidified leachate, for cation analysis

**Table 5.** Sample media suffixes.—Continued

Table	Suffix	Sample media type
tblLeachWaterChemDataHCL	L	HCL leach of split
tblLeachWaterChemDataHG	LFA	Filtered/Preserved leachate, for Hg analysis
tblSoilChemData	(none)	Soil
tblVegetationChemData	V	Vegetation
	P	Polytrichum
	SPL	Salix pulchra leaves
	SUL	Salix alaxensis leaves
	PC	Polytrichum
	PC2L	Polytrichum (duplicate sample)

**Table 6.** Units of measurement.

Unit	Name
Weight	
μg	microgram
mg	milligram
g	gram
kg	kilogram
oz	ounce
lb	pound
Proportion	
ppm	parts per million
ppb	parts per billion
ppt	parts per trillion
PCT	percent
%	percent
Rate	
L/min	liters per minute
gpm	gallons per minute
cfs	cubic feet per second
ft <sup>3</sup> /s	cubic feet per second
Concentration	
mg/L	milligrams per liter
μg/L	micrograms per liter
ng/L	nanograms per liter
Length	
nm	nanometer
mm	millimeter
m	meter
Temperature	
C	Celsius
F	Fahrenheit

Unit	Name
Volume	
mL	milliliter
Turbidity	
FTU	formazine turbidity unit
Conductivity	
μS/cm	microsiemens per centimeter

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**Appendixes A–C**

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# Appendix A

## Descriptions of Tables and Fields within Tables

Below are descriptions of the various tables and fields contained within the tables. First are tables containing sample and site descriptive information, sample media information, photograph information, and references. Next are tables containing sample collection and analysis information, then geochemistry tables for each sample type. Fields common to most or all information and geochemistry tables are listed together at the beginning of each section.

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## Tables containing sample and site descriptive information

**Table A1.** Fields in the tblSampleSiteInfo table.

tblSampleSiteInfo	Table of information relevant to all sampling sites	
Fields	Field type	Contents
Site_ID	text	sampling site ID
Coincident_Site_IDs	text	site IDs for sites co-located at this spot; from different sample collectors or resample at different time period
LatDeg	number	latitude degrees
LatMin	number	latitude minutes
LatSec	number	latitude seconds
LongDeg	number	longitude degrees
LongMin	number	longitude minutes
LongSec	number	longitude seconds
LatitudeDD	number	latitude in decimal degrees
LongitudeDD	number	longitude in decimal degrees
XYError_ft	number	location error in X and Y directions as given by GPS unit, in feet
No_Satellites	number	number of satellites for the GPS location fix
DOP	number	degree of precision for GPS location fix
Elev_ft	number	elevation of site, in feet
Elev_By	text	how elevation was obtained
Datum	text	map datum used for coordinate determination
Spheroid	text	map spheroid used in conjunction with datum
Coord_Source	text	source of coordinates (GPS, digitizing, other)
1X3Quadrangle	text	1-degree by 3-degree quadrangle containing site
15'Quadrangle	text	15-minute quadrangle containing site
County	text	county or borough (Alaska) containing site
State	text	State containing site
Date_Coll	date/time	date sample was collected
Time_Coll	date/time	time sample was collected
Collectors	text	sample collectors
Study	text	study under which site was visited/samples were collected and analyzed
Location_Info	text	site-specific location information
Site_Description	text	description of site
ARDF_Number	text	USGS Alaska Resource Data File database ID number
Deposit_Type	text	mineral deposit type
Deposit_Name	text	mine/prospect/deposit name
Mine_District	text	mining district
Weather	text	weather at time site was visited/samples were collected
Relative_Humidity	number	relative humidity in percent
Air_Temp_C	number	air temperature (Celsius) at time site was visited/samples were collected
Geologic_Info_Bedrock	memo	bedrock geology description at site
Contamination_at_Site	text	anthropogenic contamination at site
Site_Photos	number	number of photographs taken at site (see tblPhotoInfo)
Photo_Note	text	note on photographs for this particular site; for detailed photograph information, see tblPhotoInfo

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**Table A1.** Fields in the tblSampleSiteInfo table.—Continued

<b>tblSampleSiteInfo</b>		<b>Table of information relevant to all sampling sites</b>	
<b>Fields</b>	<b>Field type</b>	<b>Contents</b>	
Princ_Reference	text	primary geologic and(or) geochemical reference(s) for the site; generally used for a mine or prospect	
Published_As	text	indicates publication of the geochemical data and interpretations related to this site	
Other_Information	memo	additional information	

**Table A2.** Fields in the tblSampleMediaLog table.

<b>tblSampleMediaLog</b>		<b>Table of all sites and sample media collected at each site</b>	
<b>Fields</b>	<b>Field type</b>	<b>Contents</b>	
Site_ID	text	sample site ID	
QA/QC_Sample	text	quality-assurance/quality-control information	
Water_FU	number	filtered, unacidified water sample for anion analysis	
Water_RA	number	unfiltered, acidified water sample for cation analysis	
Water_FA	number	filtered, acidified water sample for cation analysis	
Water_HG	number	filtered, preserved water sample for Hg analysis	
Water_FE2+	number	filtered, acidified water sample for Fe <sup>++</sup> analysis	
Water_ALK	number	unfiltered, unacidified water sample for laboratory alkalinity analysis	
Stream_Sed	number	stream-sediment sample	
Rock	number	rock sample	
Soil	number	soil sample	
Leach	number	sample for leach test	
Precipitate	number	precipitate sample	
Vegetation	number	vegetation sample	
Notes	text	any additional notes regarding samples collected	

**Table A3.** Fields in the tblPhotoInfo table.

<b>tblPhotoInfo</b>		<b>Table of all photographs with descriptions</b>	
<b>Fields</b>	<b>Field type</b>	<b>Contents</b>	
Site_ID	text	unique sampling site ID	
Photo1	text	filename of photo #1	
Photo1_Description	text	brief description of photo #1	
Photo2	text	filename of photo #2	
Photo2_Description	text	brief description of photo #2	
Photo3.	text	filename of photo #3	
Photo3-Description	text	brief description of photo #3	
Photo4	text	filename of photo #4	
Photo4_Description	text	brief description of photo #4	
Photo5	text	filename of photo #5	
Photo5_Description	text	brief description of photo #5	

**Table A3.** Fields in the tblPhotoInfo table.—Continued

tblPhotoInfo		Table of all photographs with descriptions	
Fields	Field type	Contents	
Photo6	text	filename of photo #6	
Photo6_Description	text	brief description of photo #6	
Photo7	text	filename of photo #7	
Photo7_Description	text	brief description of photo #7	
Photo8	text	filename of photo #8	
Photo8_Description	text	brief description of photo #8	
Photo9	text	filename of photo #9	
Photo9_Description	text	brief description of photo #9	
Photo10	text	filename of photo #10	
Photo10_Description	text	brief description of photo #10	

**Table A4.** Fields in the tblReferences table.

tblReferences		Table of references	
Fields	Field type	Contents	
Princ_Reference	text	abbreviated reference, as listed in tblSampleSiteInfo	
Reference_Full	memo	full citation for reference	
Note	text	note on reference	

## Tables containing sample collection and analysis information

**Table A5.** Fields common to sample collection and analysis information tables.

Common fields for sample collection and analysis tables		
Common fields	Field type	Contents
Site_ID	text	sampling site ID
Field_No	text	unique sample field number
Sample_Description	text	brief description of sample
Character	text	how sample was collected, grab or composite
Source	text	source of sample
Increments:Area	text	for composite sample, number of subsample increments per approximate area sampled in square feet

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**Table A6.** Fields in the tblLeachInfo table.

tblLeachInfo		Table of all leach sample collection and analysis info	
Fields	Field type	Contents	
Leach_For	text	intent of sample: GX (geochemistry), HS (hand sample), XRD (X-ray diffraction), leach, water leach test	
QA/QC_Info	text	quality-assurance/quality-control information	
Sieve_Size	text	sieve size used in laboratory preparation; given in both mesh size and millimeter opening size	
Leach_Method_Used	text	Hageman Field Leach Test (Hageman and Briggs, 2000) or modification of Winland and others, 1991	
Extractant_pH	text	pH of initial extractant used for leaching; Hageman field leach method used DI water w/ pH 5.6	
XRD_Leach	text	minerals identified by X-ray diffraction, not quantified	
XRD_Leach_Major	text	major minerals identified by X-ray diffraction, more than 25 percent (qualitative estimate by analyst)	
XRD_Leach_Minor	text	minor minerals identified by X-ray diffraction, 5 to 25 percent (qualitative estimate by analyst)	
XRD_Leach_Trace	text	trace minerals identified by X-ray diffraction, less than 5 percent (qualitative estimate by analyst)	
pH_Final	number	final pH of leachate	
Temp_C_Final	number	final temperature of leachate, degrees Celsius	
Conductivity_uS/cm_Final	number	final conductivity of leachate, in microsiemens per centimeter	
Date_Leach_Done	date/time	date leach was done	

**Table A7.** Fields in the tblPrecipitateInfo table.

tblPrecipitateInfo		Table of all precipitate sample collection and analysis information	
Fields	Field type	Contents	
Precip_For	text	intent of sample: GX, geochemistry; HS, hand sample; XRD, X-ray mineral identification; leach, water leach test; MIN, binocular mineralogy	
XRD_Major	text	major minerals identified by X-ray diffraction, more than 25 percent (qualitative estimate by analyst)	
XRD_Minor	text	minor minerals identified by X-ray diffraction, 5 to 25 percent (qualitative estimate by analyst)	
XRD_Trace	text	trace minerals identified by X-ray diffraction, less than 5 percent (qualitative estimate by analyst)	
Other_Information	text	any other associated notes	

**Table A8.** Fields in the tblRockInfo table.

tblRockInfo		Table of all rock sample collection and analysis information	
Fields	Field type	Contents	
Rock_For	text	intent of sample: GX, geochemistry; HS, hand sample; XRD, X-ray mineral identification; PET, petrography; leach, water leach test; MIN, binocular mineralogy	
XRD_Major	text	major minerals identified by X-ray diffraction, greater than 25 percent (qualitative estimate by analyst)	
XRD_Minor	text	minor minerals identified by X-ray diffraction, 5 to 25 percent (qualitative estimate by analyst)	
XRD_Trace	text	trace minerals identified by X-ray diffraction, less than 5 percent (qualitative estimate by analyst)	
Additional_Note	text	additional notes	

**Table A9.** Fields in the tblSedimentInfo table.

<b>tblSedimentInfo</b>	<b>Table of all sediment sample collection and analysis information</b>	
<b>Fields</b>	<b>Field Type</b>	<b>Contents</b>
Sed_For	text	intent of sample: GX, geochemistry; HS, hand sample; XRD, X-ray mineral identification; leach, water leach test
Organic_Content	text	relative organic content in sample collected
Sieve_Size	text	sieve size used in laboratory preparation; given in both mesh size and millimeter opening size
Staining_on_Alluvium	text	iron oxide, manganese oxide, or other staining observed on alluvium at site
Geologic_Info_Alluvium	memo	geologic description of alluvium at site

**Table A10.** Fields in the tblSoilInfo table.

<b>tblSoilInfo</b>	<b>Table of all soil sample collection and analysis information</b>	
<b>Fields</b>	<b>Field type</b>	<b>Contents</b>
Soil_For	text	intent of sample: GX, geochemistry; HS, hand sample; XRD, X-ray mineral identification; leach, water leach test
Horizon	text	soil horizon sampled
Sieve_Size	text	sieve size used in laboratory preparation; given in both mesh size and millimeter opening size
Organic_Content	text	relative organic content in sample collected

**Table A11.** Fields in the tblVegetationInfo table.

<b>tblVegetationInfo</b>	<b>Table of all vegetation sample collection and analysis information</b>	
<b>Fields</b>	<b>Field type</b>	<b>Contents</b>
Veg_For	text	intent of sample: GX, geochemistry; HS, hand sample; XRD, X-ray mineral identification; leach, water leach test
Species	text	species name for sampled vegetation
Other_Information	text	additional information

**Table A12.** Fields in the tblWaterSiteInfo table.

<b>tblWaterSiteInfo</b>	<b>Table of all water sample collection and analysis information</b>	
<b>Fields</b>	<b>Field type</b>	<b>Contents</b>
Temp_C	number	temperature of sampled water, degrees Celsius
Flow_Rate	number	estimated water flow rate
FlowUnitsOfMeas	text	units of measurement for flow rate; CFS, cubic feet per second; GPM, gallons per minute; L/min, liters per minute; standing, no flow
HowFlowCalculated	text	how was flow calculated—estimated or calculated?
pH	number	pH of sampled water
Conduct_uS/cm	number	specific conductance of sampled water, microsiemens per centimeter
Turbidity_FTU	number	turbidity of sampled water, Formazine turbidity units (equivalent to nephelometric turbidity units), done in field using CHEMetrics, Inc. instrument

**Table A12.** Fields in the tblWaterSiteInfo table.—Continued.

tblWaterSiteInfo	Table of all water sample collection and analysis information	
Fields	Field type	Contents
Qual_Turbidity	text	qualitative description of turbidity of water
Diss_O2_ppm	number	dissolved oxygen of sampled water, parts per million
Alkalin_ppm	number	alkalinity of sampled water; done in field using CHEMetrics, Inc. titration kit; parts per million; performed on most samples with pH greater than 4.5
Acidity_ppm	number	acidity of sampled water; done in field using Hach titration kit; parts per million; performed on most samples with pH less than 7
Fe2+_ppm	text	ferrous iron content of sampled water; done in field using CHEMetrics, Inc., colorimetric kit; parts per million; kit range is 0 to 10 ppm
Water_Source	text	source of sampled water
Type_of_Site	text	descriptive information on water site
Water_Color	text	qualitative description of color of water
Water_Odor	text	qualitative description of odor of water
Channel_Bed_Description	text	description of channel bed for water sampling site
Additional_Note	text	any additional note regarding water sampling site or samples collected

## Tables containing geochemical analyses

All fields in the geochemical analyses tables have “number” as the field type except where noted.

**Table A13.** Fields common to all geochemistry tables.

Common fields for all geochemistry tables		
Common fields	Field type	Contents
Site_ID	text	sampling site ID
Field_No	text	unique sample field number
Lab_No	text	unique sample laboratory number assigned by USGS Sample Control; this is the record number in the USGS National Geochemical Database
Job_No	text	job number assigned by USGS Sample Control
Lab	text	laboratory where analyses were performed, USGS or XRAL (contract lab, now called SGS Canada, Inc.)
QA/QC_Info	text	quality-assurance/quality-control information
USGS_Analyst	text	USGS analyst(s) who performed the analyses
Actual_Sample_Analyzed	text	specific description of sample analyzed
Analytical_Note	memo	notes regarding analyses

**Table A14.** Fields in the geochemistry tables.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Ag_PPM_MS_ACID	silver by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>
Ag_PPM_MS42	silver by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Ag_PPM_MS55	silver by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Ag_ug/L_EW	silver by ICP–AES, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Ag_ug/L_HCL_EW	silver by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Ag_ug/L_HCL_MW	silver by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Ag_ug/L_MW	silver by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Al_PCT_MS42	aluminum by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Al_PCT_MS55	aluminum by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Al_PCT_MS_ACID	aluminum by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	<b>tblSoilChemData</b>
Al_PPM_MS_ACID	aluminum by ICP–MS following a multi-acid digestion, solid sample, parts per million	<b>tblVegetationChemData</b>
Al_ug/L_EW	aluminum by ICP–AES, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Al_ug/L_HCL_EW	aluminum by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Al_ug/L_HCL_MW	aluminum by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Al_ug/L_MW	aluminum by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Alk_PPM_TA	alkalinity by titration; 50-mL sample, H <sub>2</sub> SO <sub>4</sub> added until pH 4.5 reached, parts per million as CaCO <sub>3</sub> ; by definition, samples with pH < 4.5 have zero alkalinity	<b>tblLeachWaterChemDataALK</b>
As_PPM_HY	arsenic by hydride generation–atomic absorption, solid sample, parts per million (reference: USGS Open-File Report 2002-0223, Chapter L)	<b>tblVegetationChemData</b>

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
As_PPM_MS42	arsenic by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
As_PPM_MS55	arsenic by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
As_PPM_MS_ACID	arsenic by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
As_ug/L_EW	arsenic by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
As_ug/L_HCL_EW	arsenic by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
As_ug/L_HCL_MW	arsenic by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
As_ug/L_MW	arsenic by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ash_PCT	ash weight percent, calculated	tblVegetationChemData
Au_PPM_FA	gold by fire assay directly coupled plasma–optical emission spectrometry, solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Au_ug/L_MW	gold by ICP–MS, water, µg/L (ppb)	tblWaterChemDataCationsFA tblWaterChemDataCationsRA
B_ug/L_EW	boron by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
B_ug/L_HCL_EW	boron by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ba_PPM_MS42	barium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Ba_PPM_MS55	barium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Ba_PPM_MS_ACID	barium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Ba_ug/L_EW	barium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ba_ug/L_HCL_EW	barium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ba_ug/L_HCL_MW	barium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Ba_ug/L_MW	barium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Be_PPM_MS42	beryllium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Be_PPM_MS55	beryllium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Be_PPM_MS_ACID	beryllium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Be_ug/L_EW	beryllium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Be_ug/L_HCL_EW	beryllium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Be_ug/L_HCL_MW	beryllium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Be_ug/L_MW	beryllium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Bi_PPM_MS42	bismuth by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Bi_PPM_MS55	bismuth by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Bi_PPM_MS_ACID	bismuth by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Bi_ug/L_HCL_MW	bismuth by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Bi_ug/L_MW	bismuth by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ca_mg/L_EW	calcium by ICP–AES, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ca_mg/L_HCL_EW	calcium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ca_mg/L_HCL_MW	calcium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ca_mg/L_MW	calcium by ICP–MS, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
Ca_PCT_MS42	calcium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Ca_PCT_MS55	calcium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	tblRock&LeachSolidChemData tblSedimentChemData
Ca_PCT_MS_ACID	calcium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblSoilChemData
Ca_PPM_MS_ACID	calcium by ICP–MS following a multi-acid digestion, solid sample, parts per million	tblVegetationChemData
CC_PCT_CT	Carbonate carbon, calculated from value for CO2_PCT_CT	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Cd_PPM_MS42	cadmium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Cd_PPM_MS55	cadmium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Cd_PPM_MS_ACID	cadmium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Cd_ug/L_EW	cadmium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Cd_ug/L_HCL_EW	cadmium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Cd_ug/L_HCL_MW	cadmium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Cd_ug/L_MW	cadmium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ce_PPM_MS42	cerium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Ce_PPM_MS55	cerium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Ce_PPM_MS_ACID	cerium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Ce_ug/L_HCL_MW	cerium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ce_ug/L_MW	cerium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Cl-_mg/L_IC	chloride by ion chromatography, mg/L (ppm)	tblLeachWaterChemDataAnionsFU tblWaterChemDataAnionsFU

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Co_PPM_MS42	cobalt by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Co_PPM_MS55	cobalt by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Co_PPM_MS_ACID	cobalt by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>
Co_ug/L_EW	cobalt by ICP–AES, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Co_ug/L_HCL_EW	cobalt by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Co_ug/L_HCL_MW	cobalt by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Co_ug/L_MW	cobalt by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
CO2_PCT_CT	carbonate by coulometric titration, solid sample, percent, data good to two decimal places	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
CO <sub>r</sub> _PCT_DI	organic carbon, calculated as difference between total carbon (C <sub>To</sub> ) and carbonate carbon (C <sub>C</sub> ), solid sample, percent	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Cr_PPM_MS42	chromium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Cr_PPM_MS55	chromium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Cr_PPM_MS_ACID	chromium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>
Cr_ug/L_EW	chromium by ICP–AES, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Cr_ug/L_HCL_EW	chromium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Cr_ug/L_HCL_MW	chromium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Cr_ug/L_MW	chromium by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Cs_PPM_MS_ACID	cesium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
Cs_PPM_MS42	cesium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Cs_PPM_MS55	cesium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Cs_ug/L_HCL_MW	cesium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Cs_ug/L_MW	cesium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
CTo_PCT_LE	Total carbon by LECO analyzer, solid sample, percent, data good to two decimal places	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Cu_PPM_MS42	copper by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Cu_PPM_MS55	copper by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Cu_PPM_MS_ACID	copper by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Cu_ug/L_EW	copper by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Cu_ug/L_HCL_EW	copper by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Cu_ug/L_HCL_MW	copper by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Cu_ug/L_MW	copper by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Dy_PPM_MS55	dysprosium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Dy_ug/L_HCL_MW	dysprosium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Dy_ug/L_MW	dysprosium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Er_PPM_MS55	erbium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Er_ug/L_HCL_MW	erbium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL

**Table A14.** Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
Er_ug/L_MW	erbium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Eu_PPM_MS55	europium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Eu_ug/L_HCL_MW	europium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Eu_ug/L_MW	europium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
F-_mg/L_IC	fluoride by ion chromatography, mg/L (ppm)	tblLeachWaterChemDataAnionsFU tblWaterChemDataAnionsFU
Fe_PCT_MS42	iron by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Fe_PCT_MS55	iron by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	tblRock&LeachSolidChemData tblSedimentChemData
Fe_PCT_MS_ACID	iron by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblSoilChemData
Fe_PPM_MS_ACID	iron by ICP–MS following a multi-acid digestion, solid sample, parts per million	tblVegetationChemData
Fe_ug/L_EW	iron by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Fe_ug/L_HCL_EW	iron by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Fe_ug/L_HCL_MW	iron by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Fe_ug/L_MW	iron by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Fe2+_mg/L_CO	Fe <sup>2+</sup> by colorimetric method, mg/L (ppm), analyzed in laboratory with Hach spectrophotometer	tblWaterChemDataFe2+
Fe2+_mg_GBreit	Fe <sup>2+</sup> check by George Breit at Paul Briggs request, mg/L (ppm)	tblWaterChemDataFe2+
FeO_PCT_TI	FeO by titration, near-total extraction (HF, HCl, H <sub>2</sub> SO <sub>4</sub> digestion), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Ga_PPM_MS42	gallium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Ga_PPM_MS55	gallium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Ga_PPM_MS_ACID	gallium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
Ga_ug/L_HCL_MW	gallium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ga_ug/L_MW	gallium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Gd_PPM_MS55	gadolinium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Gd_ug/L_HCL_MW	gadolinium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Gd_ug/L_MW	gadolinium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ge_PPM_MS55	germanium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Ge_ug/L_HCL_MW	germanium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ge_ug/L_MW	germanium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Hardness_PPM	total hardness, expressed as equivalent $\text{CaCO}_3$ , = <sub>2.5</sub> (Ca ppm) + <sub>4.1</sub> (Mg ppm)	tblWaterChemDataCationsFA
Hf_PPM_MS55	hafnium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Hg_PPM_CV	mercury by cold vapor atomic absorption, solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData tblVegetationChemData
Hg_ug/L_AF	mercury by atomic fluorescence, µg/L (ppb)	tblLeachWaterChemDataHG tblWaterChemDataHG
Ho_PPM_MS55	holmium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Ho_ug/L_HCL_MW	holmium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ho_ug/L_MW	holmium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
In_PPM_MS42	indium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
In_PPM_MS55	indium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
In_ug/L_MW	indium by ICP–MS, water, µg/L (ppb)	tblWaterChemDataCationsFA tblWaterChemDataCationsRA
K_mg/L_EW	potassium by ICP–AES, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
K_mg/L_HCL_EW	potassium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
K_mg/L_HCL_MW	potassium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
K_mg/L_MW	potassium by ICP–MS, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
K_PCT_MS42	potassium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
K_PCT_MS55	potassium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	tblRock&LeachSolidChemData tblSedimentChemData
K_PCT_MS_ACID	potassium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblSoilChemData
K_PPM_MS_ACID	potassium by ICP–MS following a multi-acid digestion, solid sample, parts per million	tblVegetationChemData
La_PPM_MS42	lanthanum by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
La_PPM_MS55	lanthanum by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
La_PPM_MS_ACID	lanthanum by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
La_ug/L_HCL_MW	lanthanum by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
La_ug/L_MW	lanthanum by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Li_PPM_MS42	lithium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Li_PPM_MS55	lithium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Li_PPM_MS_ACID	lithium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Li_ug/L_EW	lithium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Li_ug/L_HCL_EW	lithium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
Li_ug/L_HCL_MW	lithium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Li_ug/L_MW	lithium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Lu_PPM_MS55	lutetium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Lu_ug/L_HCL_MW	lutetium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Lu_ug/L_MW	lutetium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Mg_mg/L_EW	magnesium by ICP–AES, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Mg_mg/L_HCL_EW	magnesium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Mg_mg/L_HCL_MW	magnesium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Mg_mg/L_MW	magnesium by ICP–MS, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Mg_PCT_MS42	magnesium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Mg_PCT_MS55	magnesium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	tblRock&LeachSolidChemData tblSedimentChemData
Mg_PCT_MS_ACID	magnesium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblSoilChemData
Mg_PPM_MS_ACID	magnesium by ICP–MS following a multi-acid digestion, solid sample, parts per million	tblVegetationChemData
Mn_PCT_MS55	manganese by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Mn_PPM_MS42	manganese by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Mn_PPM_MS_ACID	manganese by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Mn_ug/L_EW	manganese by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Mn_ug/L_HCL_EW	manganese by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Mn_ug/L_HCL_MW	manganese by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Mn_ug/L_MW	manganese by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Mo_PPM_MS42	molybdenum by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Mo_PPM_MS55	molybdenum by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Mo_PPM_MS_ACID	molybdenum by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Mo_ug/L_EW	molybdenum by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Mo_ug/L_HCL_EW	molybdenum by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Mo_ug/L_HCL_MW	molybdenum by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Mo_ug/L_MW	molybdenum by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Na_mg/L_EW	sodium by ICP–AES, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Na_mg/L_HCL_EW	sodium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Na_mg/L_HCL_MW	sodium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Na_mg/L_MW	sodium by ICP–MS, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Na_PCT_MS42	sodium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Na_PCT_MS_ACID	sodium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblSoilChemData
Na_PPM_MS_ACID	sodium by ICP–MS following a multi-acid digestion, solid sample, parts per million	tblVegetationChemData
Nb_PPM_MS42	niobium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Nb_PPM_MS55	niobium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Nb_PPM_MS_ACID	niobium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>
Nb_ug/L_HCL_MW	niobium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Nb_ug/L_MW	niobium by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Nd_PPM_MS55	neodymium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Nd_ug/L_HCL_MW	neodymium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Nd_ug/L_MW	neodymium by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Ni_PPM_MS42	nickel by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Ni_PPM_MS55	nickel by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Ni_PPM_MS_ACID	nickel by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>
Ni_ug/L_EW	nickel by ICP–AES, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Ni_ug/L_HCL_EW	nickel by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Ni_ug/L_HCL_MW	nickel by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Ni_ug/L_MW	nickel by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
NO3-_mg/L_IC	nitrate by ion chromatography, mg/L (ppm)	<b>tblLeachWaterChemDataAnionsFU</b> <b>tblWaterChemDataAnionsFU</b>
P_mg/L_HCL_EW	phosphorus by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
P_mg/L_HCL_MW	phosphorus by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
P_PCT_MS55	phosphorus by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
P_PPM_MS42	phosphorus by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
P_PPM_MS_ACID	phosphorus by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
P_ug/L_EW	phosphorus by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
P_ug/L_MW	phosphorus by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Pb_PPM_MS42	lead by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Pb_PPM_MS55	lead by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Pb_PPM_MS_ACID	lead by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Pb_ug/L_EW	lead by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Pb_ug/L_HCL_EW	lead by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Pb_ug/L_HCL_MW	lead by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Pb_ug/L_MW	lead by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Pr_PPM_MS55	praseodymium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Pr_ug/L_HCL_MW	praseodymium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Pr_ug/L_MW	praseodymium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Rb_PPM_MS42	rubidium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Rb_PPM_MS55	rubidium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Rb_PPM_MS_ACID	rubidium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
Rb_ug/L_HCL_MW	rubidium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Rb_ug/L_MW	rubidium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Re_ug/L_MW	rhenium by ICP–MS, water, µg/L (ppb)	tblWaterChemDataCationsFA tblWaterChemDataCationsRA
S_PCT_MS42	total sulfur by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
S_PCT_LE	total sulfur by LECO analyzer, solid sample, percent (using method in USGS Open-File Report 2002-0223, Chapter Q)	tblVegetationChemData
Sb_PPM_MS42	antimony by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Sb_PPM_MS_ACID	antimony by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Sb_ug/L_EW	antimony by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Sb_ug/L_HCL_EW	antimony by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Sb_ug/L_HCL_MW	antimony by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Sb_ug/L_MW	antimony by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Sc_PPM_MS42	scandium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Sc_PPM_MS55	scandium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Sc_PPM_MS_ACID	scandium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Sc_ug/L_HCL_MW	scandium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Sc_ug/L_MW	scandium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Se_PPM_HY	selenium by hydride generation atomic absorption, solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData tblVegetationChemData

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Se_ug/L_HCL_MW	selenium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Se_ug/L_MW	selenium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Si_mg/L_EW	silicon by ICP–AES, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Si_mg/L_MW	silicon by ICP–MS, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
SiO2_mg/L_HCL_EW	SiO <sub>2</sub> by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), mg/L (ppm)	tblLeachWaterChemDataHCL
SiO2_mg/L_HCL_MW	SiO <sub>2</sub> by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), mg/L (ppm)	tblLeachWaterChemDataHCL
Sm_PPM_MS55	samarium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Sm_ug/L_HCL_MW	samarium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Sm_ug/L_MW	samarium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Sn_PPM_MS42	tin by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Sn_PPM_MS55	tin by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
SO4--_mg/L_HCL_MW	sulfate by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), mg/L (ppm)	tblLeachWaterChemDataHCL
SO4--_mg/L_IC	sulfate by ion chromatography, mg/L (ppm)	tblLeachWaterChemDataAnionsFU tblWaterChemDataAnionsFU
SO4--_mg/L_MW	sulfate by ICP–MS, water, mg/L (ppm)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Sr_PPM_MS42	strontium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Sr_PPM_MS55	strontium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Sr_PPM_MS_ACID	strontium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Sr_ug/L_EW	strontium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Sr_ug/L_HCL_EW	strontium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Sr_ug/L_HCL_MW	strontium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Sr_ug/L_MW	strontium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
STo_PCT_LE	total sulfur by LECO analyzer, solid sample, percent	tblSedimentChemData
Ta_PPM_MS55	tantalum by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Ta_ug/L_HCL_MW	tantalum by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ta_ug/L_MW	tantalum by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Tb_PPM_MS55	terbium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Tb_ug/L_HCL_MW	terbium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Tb_ug/L_MW	terbium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Te_PPM_MS42	tellurium by ICP–AES and ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Th_PPM_MS42	thorium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Th_PPM_MS55	thorium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Th_PPM_MS_ACID	thorium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Th_ug/L_HCL_MW	thorium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Th_ug/L_MW	thorium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ti_PCT_MS42	titanium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Ti_PCT_MS55	titanium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, percent	tblRock&LeachSolidChemData tblSedimentChemData

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Ti_PCT_MS_ACID	titanium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, percent	tblSoilChemData
Ti_PPM_MS_ACID	titanium by ICP–MS following a multi-acid digestion, solid sample, parts per million	tblVegetationChemData
Ti_ug/L_EW	titanium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Ti_ug/L_HCL_EW	titanium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ti_ug/L_HCL_MW	titanium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Ti_ug/L_MW	titanium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Tl_PPM_MS_ACID	thallium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Tl_PPM_MS42	thallium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock & LeachSolidChemData tblSedimentChemData tblSoilChemData
Tl_PPM_MS55	thallium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock & LeachSolidChemData tblSedimentChemData
Tl_ug/L_HCL_MW	thallium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Tl_ug/L_MW	thallium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Tm_PPM_MS55	thulium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock & LeachSolidChemData tblSedimentChemData
Tm_ug/L_HCL_MW	thulium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Tm_ug/L_MW	thulium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
U_PPM_MS42	uranium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock & LeachSolidChemData tblSedimentChemData tblSoilChemData
U_PPM_MS55	uranium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock & LeachSolidChemData tblSedimentChemData tblVegetationChemData
U_PPM_MS_ACID	uranium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData
U_ug/L_HCL_MW	uranium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL

Table A14. Fields in the geochemistry tables.—Continued.

Field contents and associated geochemistry tables		
Field name	Contents	Tables with field
U_ug/L_MW	uranium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
V_PPM_MS42	vanadium by ICP–AES, and ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
V_PPM_MS55	vanadium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
V_PPM_MS_ACID	vanadium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
V_ug/L_EW	vanadium by ICP–AES, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
V_ug/L_HCL_EW	vanadium by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
V_ug/L_HCL_MW	vanadium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
V_ug/L_MW	vanadium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
W_PPM_MS42	tungsten by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
W_PPM_MS55	tungsten by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
W_ug/L_HCL_MW	tungsten by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
W_ug/L_MW	tungsten by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Y_PPM_MS42	yttrium by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblPrecipitateChemData tblRock&LeachSolidChemData tblSedimentChemData tblSoilChemData
Y_PPM_MS55	yttrium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData
Y_PPM_MS_ACID	yttrium by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	tblSoilChemData tblVegetationChemData
Y_ug/L_HCL_MW	yttrium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	tblLeachWaterChemDataHCL
Y_ug/L_MW	yttrium by ICP–MS, water, µg/L (ppb)	tblLeachWaterChemDataCationsFA tblWaterChemDataCationsFA tblWaterChemDataCationsRA
Yb_PPM_MS55	ytterbium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	tblRock&LeachSolidChemData tblSedimentChemData

**Table A14.** Fields in the geochemistry tables.—Continued.

<b>Field contents and associated geochemistry tables</b>		
<b>Field name</b>	<b>Contents</b>	<b>Tables with field</b>
Yb_ug/L_HCL_MW	ytterbium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Yb_ug/L_MW	ytterbium by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Zn_PPM_MS42	zinc by ICP–AES or ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblPrecipitateChemData</b> <b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b> <b>tblSoilChemData</b>
Zn_PPM_MS55	zinc by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Zn_PPM_MS_ACID	zinc by ICP–MS, near-total extraction (HF, HCl, HNO <sub>3</sub> , HClO <sub>4</sub> digestion at low temperature), solid sample, parts per million	<b>tblSoilChemData</b> <b>tblVegetationChemData</b>
Zn_ug/L_EW	zinc by ICP–AES, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Zn_ug/L_HCL_EW	zinc by ICP–AES, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Zn_ug/L_HCL_MW	zinc by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Zn_ug/L_MW	zinc by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>
Zr_PPM_MS55	zirconium by ICP–AES or ICP–MS, total extraction (sodium peroxide sinter), solid sample, parts per million	<b>tblRock&amp;LeachSolidChemData</b> <b>tblSedimentChemData</b>
Zr_ug/L_HCL_MW	zirconium by ICP–MS, leachate following a hydrochloric acid leach of the solid sample (using procedure of Winland and others, 1991), µg/L (ppb)	<b>tblLeachWaterChemDataHCL</b>
Zr_ug/L_MW	zirconium by ICP–MS, water, µg/L (ppb)	<b>tblLeachWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsFA</b> <b>tblWaterChemDataCationsRA</b>

## Appendix B

### Descriptions of Photographs

Abbreviations used in photograph descriptions are in [table 4](#).

Thumbnail	Photograph number	Description
	03BF001-1	Sampling site, acid spring on the E side of Red Mountain saddle; pH 3.5, specific conductance 568 μS/cm.
	03BF001-2	Detail of sampling site with ferricrete.
	03BF001-3	Detail of sampled white precipitate on colluvial cobbles in spring.
	03BF001-4	Detail of FeOx and liverwort at sampling site.
	03BF001-5	Looking N to PHB at sampling site and ridgeline climbing to Red Mountain.
	03BF002-1	View to NE at PHB at sampling site in foreground and Red Mountain Creek beyond; acid spring on the E side of Red Mountain saddle; pH 3.4, specific conductance 1,000 μS/cm.
	03BF002-2	Sampled spring and sulfate salts.
	03BF002-3	Colluvial flow from site looking W towards saddle. Flow also exhibits undulating waves, lobes, and so forth, like a rock glacier. It is likely ice cored.
	03BF002-4	Quartz stockwork observed in colluvium.
	03BF002-5	Quartz stockwork boulder observed in colluvium.
	03BF003-1	Sampling site, spring; note vegetation contrast from site 03BF002; spring pH 6.5, specific conductance 530 μS/cm.
	03BF003-2	Looking W to slope above sampling site.
	03BF003-3	PHB collecting willow.

Thumbnail	Photograph number	Description
	03BF003-4	Quartz stockwork in float.
	03BF003-5	View to WNW across Red Mountain Creek to sites 03BF001, 002, & 003. Note vegetation contrast.
	03BF004-1	Sampling site, intermittent stream in draw on E side of Red Mountain Creek; pH 6.5, specific conductance 541 $\mu\text{S}/\text{cm}$ .
	03BF004-2	Looking to SE upstream from sampling site.
	03BF004-3	Looking NW downstream from sampling site to Red Mountain Creek and altered rocks of Red Mountain across valley.
	03BF004-4	View to SE of sampled drainage from across valley. Altered bedrock is minimal.
	03BF005-1	View to SW of sampling site on Red Mountain Creek, just above alteration zone; pH 7.1, specific conductance 830 $\mu\text{S}/\text{cm}$ .
	03BF005-2	View to NE looking downstream from sampling site. Upper end of alteration zone visible on left.
	03BF005-3	Augen gneiss outcrop.
	03BF006-1	View to W of PHB and MH collecting at sampling site, acid spring at base of E side of saddle; pH 3.3, specific conductance 1,270 $\mu\text{S}/\text{cm}$ .
	03BF006-2	MH at sampling site, note extensive black liverwort.
	03BF006-3	Black liverwort at sampling site.
	03BF006-4	Black liverwort at sampling site.
	03BF006-5	Pyritic, altered metarhyolite bedrock at site with sampled salts on seams.
	03BF007-1	Sampling site, Red Mountain Creek just within alteration zone; pH 6.4, specific conductance 862 $\mu\text{S}/\text{cm}$ .
	03BF007-2	Looking upstream at PHB and sampling site with altered metarhyolite bedrock behind.

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Thumbnail	Photograph number	Description
	03BF007-3	Sampled salts weeping from folded, pyritic chlorite-muscovite schist. Adjacent to fault zone.
	03BF007-4	Detail of precipitates.
	03BF007-5	Detail of precipitates.
	03BF007-6	Quartz calcite vein in alluvial cobble from above water level.
	03BF007-7	Folds and salts at site.
	03BF007-8	Red Mountain Creek just downstream from sampling site.
	03BF008-1	View to NE of sampling site; acid spring on the E side of Red Mountain Creek; pH 3.0, specific conductance 3,410 μS/cm.
	03BF008-2	PHB and MH collecting sample at sampling site.
	03BF008-3	Ferrous iron from site is off scale at >10 ppm.
	03BF008-4	Ferricrete-cemented alluvium and black liverwort at site.
	03BF008-5	Detail of ferricrete with entrained organic material.
	03BF008-6	Detail of ferricrete and black liverwort.
	03BF008-7	Sampled spring at site with ferricrete.
	03BF008-8	Northerly view of mixing zone below site with sampled acidic spring on R flowing into aluminum-rich Red Mountain Creek on L.
	03BF008-9	Mixing zone below site with sampled acidic spring on R flowing into aluminum-rich Red Mountain Creek on L.

Thumbnail	Photograph number	Description
	03BF008-10	Detail of mixing of the acidic spring (above) with higher pH water of Red Mountain Creek (below).
	03BF009-1	Sampling site, Red Mountain Creek with abundant aluminum floc; just downstream from exposed altered rocks; pH 4.6, specific conductance 1,200 $\mu\text{S}/\text{cm}$ .
	03BF009-2	Looking to SW upstream from sampling site.
	03BF009-3	Aluminum oxyhydroxide at site (sampled).
	03BF010-1	MH at sampling site, upper Red Mountain Creek well above alteration zone; pH 6.6, specific conductance 651 $\mu\text{S}/\text{cm}$ .
	03BF010-2	MH collecting alkalinity data at sampling site.
	03BF010-3	View from air looking SW at sampling site in unaltered rocks on upper Red Mountain Creek.
	03BF011-1	Looking southerly at sampling site with PHB and MH, Red Mountain Creek just upstream from Fosters Creek; pH 4.8, specific conductance 1,280 $\mu\text{S}/\text{cm}$ .
	03BF011-2	Alluvial quartz-calcite vein cobble with calcite completely gone (consumed by acidic stream water) leaving irregular vugs.
	03BF011-3	Sampling site with aluminum floc settled in calm areas along stream edges.
	03BF011-4	Turbid stream due to aluminum floc and sampled willow beyond.
	03BF011-5	MH collecting willow.
	03BF012-1	View to SW of sampling site, mouth of Fosters Creek; pH 4.8, specific conductance 1,280 $\mu\text{S}/\text{cm}$ .
	03BF012-2	Detail of site with tan floc settled in calm edges of stream.
	03BF012-3	Alluvial quartz-calcite vein cobble with calcite completely gone (consumed by acidic stream water) leaving irregular vugs.
	03BF013-1	View to SW of MH collecting water at sampling site on upper Fosters Creek above alteration zone; pH 7.5, specific conductance 515 $\mu\text{S}/\text{cm}$ .

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Thumbnail	Photograph number	Description
	03BF013-2	Detail of sampling site.
	03BF013-3	Calcite boudinage (former vein?) cutting foliated muscovite schist.
	03BF013-4	Looking downstream to NE from sampling site to upper part of alteration zone on Fosters Creek.
	03BF014-1	Sampling site, Fosters Creek just above confluence with Lago Creek; pH 7.8, specific conductance 825 $\mu$ S/cm.
	03BF014-2	View to SW of Fosters Creek, looking upstream from vicinity of sampling site.
	03BF014-3	Well-developed stockwork in colluvial boulder from just upstream from sampling site.
	03BF014-4	View from air looking SW onto Fosters Creek (R) and Lago Creek (L). Note heavy white aluminum oxyhydroxide precipitation on Fosters Creek downstream from the confluence.
	03BF015-1	Sampling site, acid spring in fracture zone at mouth of Lago Creek; pH 2.7, specific conductance 2,920 $\mu$ S/cm.
	03BF015-2	View to SW of sampled acid spring (lower R) with sampled overlying willow.
	03BF015-3	Ferricrete and black liverwort just below spring.
	03BF015-4	Detail of ferricrete-cemented alluvium just below sampling site.
	03BF016-1	Sampling site, Lago Creek at mouth; pH 3.8, specific conductance 1,400 $\mu$ S/cm.
	03BF016-2	Sampling site, Lago Creek, FeOx-cemented pool. Ferricrete underlies and cements all alluvium.
	03BF016-3	Southerly view up Lago Creek valley from site. Red-orange scree on left slope is being shed from Red Mountain.
	03BF017-1	Sampling site, Red Mountain Creek at mouth, with abundant aluminum floc settled in calm areas; pH 4.2, specific conductance 1,180 $\mu$ S/cm.
	03BF017-2	Upstream view to S of turbid Red Mountain Creek from site.

Thumbnail	Photograph number	Description
	03BF017-3	View to NW of turbid Red Mountain Creek flowing into Dry Creek.
	03BF018-1	Westerly upstream view of sampling site in foreground, Dry Creek upstream from Red Mountain Creek; pH 7.5, specific conductance 587 $\mu\text{S}/\text{cm}$ .
	03BF018-2	Easterly downstream view from sampling site, Dry Creek (L) mixing with Red Mountain Creek (R).
	03BF018-3	Mixing zone of Red Mountain Creek (R) and Dry Creek (L), note FeOx staining on alluvium below.
	03BF018-4	Outcrop about 0.1 mile upstream from site with sheared siliceous pyritic veins.
	03BF019-1	View looking upstream to SW of sampling site, Dry Creek downstream from Red Mountain Creek; pH 7.1, specific conductance 577 $\mu\text{S}/\text{cm}$ .
	03BF019-2	Downstream view to NE from sampling site. Note FeOx staining on alluvium just above surface of stream.
	03BF019-3	Detail of FeOx-stained alluvium.
	03BF019-4	Detail of FeOx-stained stockwork in alluvium.
	03BF020-1	Sampling site, upper Lago Creek, above alteration zone; pH 7.6, specific conductance 740 $\mu\text{S}/\text{cm}$ .
	03BF020-2	View to SSW to unaltered rocks up valley from site. Note lack of FeOx-stained bedrock.
	03BF020-3	View to NE down valley. Altered rocks on lower slope of Red Mountain are visible on R.
	03BF020-4	View to SE to unaltered rocks south of Red Mountain.
	03BF020-5	MH and PHB processing water sample at site. Red Mountain visible behind.
	03BF021-1	View to E of sampling site in foreground and Red Mountain saddle behind, spring on W side of Red Mountain saddle; pH 4.4, specific conductance 918 $\mu\text{S}/\text{cm}$ .

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Thumbnail	Photograph number	Description
	03BF021-2	Sampling site with MH, PHB, CD-B, ChB, and CR. Note black liverwort.
	03BF021-3	View to S looking up valley with MH, PHB, CD-B, ChB, and CR at sampling site. Note vegetation-free altered scree on L and tundra-covered unaltered rocks on R.
	03BF021-4	Supergene vuggy silica float from scree pile shed from the W side of Red Mountain near site 05BF021.
	03BF022-1	Sampling site, acid spring on W side of Red Mountain saddle; pH 2.5, specific conductance 2,520 $\mu\text{S}/\text{cm}$ .
	03BF022-2	MH, PHB, and CR collecting sample at sampled spring.
	03BF022-3	View to E upstream to ridgeline above.
	03BF022-4	View to NW downstream towards Lago Creek.
	03BF022-5	Ferrous iron from site is off scale at >10 ppm.
	03BF022-6	View to E across Lago Creek to sites 03BFD021, 022, and 023.
	03BF023-1	Sampling site, acid spring on W side of Lago Creek; pH 2.4, specific conductance 3,080 $\mu\text{S}/\text{cm}$ .
	03BF023-2	PHB and CR collecting data at sampling site. Note abundant black liverwort.
	03BF023-3	Mixing zone below sampled clear spring visible on L edge of photograph. Black liverwort lines left bank.
	03BF023-4	Spring just below sampling site. Bright salmon-colored precipitate identified by XRD as dominantly schwertmannite.
	03BF023-5	Same sampled spring, farther downslope, just before it merges with Lago Creek.

Thumbnail	Photograph number	Description
	03BF023-6	Sampled spring (R) merging with Lago Creek (L).
	03BF023-7	Sampled spring (R) with white aluminum precipitate, mixing with Lago Creek (L).
	03BF023-8	Mouth of sampled spring (top) with Lago Creek (L). White precipitate is aluminum oxyhydroxide.
	03BF024-1	Sampling site, Fosters Creek below Lago Creek; pH 4.7, specific conductance 1,320 μS/cm.
	03BF024-2	View upstream to SW, looking up Fosters Creek from sampling site.
	03BF025	(No photographs taken at sampling site.)
	03BF026	(No photographs taken at sampling site.)
	03BF027-1	View to N of rock sampling site adjacent to blue backpack on W slope of Red Mountain.
	03BF027-2	Detail of sampled salts.
	03BF028-1	View to WSW at rock sampling site at Discovery zone.
	03BF028-2	Discovery zone sulfides with abundant pyrite.
	03BF028-3	Discovery zone sulfides with dissolution vugs.
	03BF028-4	Discovery zone sulfides.
	03BF028-5	View to SW of Discovery zone (bright orange area in foreground).
	03BF028-6	View to SW of Discovery zone (bright orange area upper left) and upper Fosters Creek on right.
	03BF029-1	Sampling site, spring on E side of Fosters Creek below Discovery zone; pH 5.1, specific conductance 878 μS/cm.
	03BF029-2	Detail of FeOx and calcite on joint surface of metarhyolite scree immediately below Discovery zone.

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Thumbnail	Photograph number	Description
	03BF029-3	View to SW of mineralized rocks above sampled spring. Spring is just below rusty pyritic zone. Fosters Creek in distance.
	03BF030-1	Sampling site, acid spring on E side of Fosters Creek downstream from Lago Creek; pH 3.4, specific conductance 2,930 $\mu\text{S}/\text{cm}$ .
	03BF030-2	PHB and CR filtering water sample at site.
	03BF030-3	Detail of water filtration at site.
	03BF030-4	Ferricrete at sampling site.
	03BF030-5	Ferricrete at drill site. Note drill-hole collar.
	03BF030-6	Ferricrete at sampling site with abundant cemented organic debris.
	03BF030-7	Ferricrete at site.
	03BF030-8	Salts on bedrock above acidic pool at site.
	04BF051-1	Sampled spring along Lago Creek, Red Mountain area; pH 2.4, specific conductance 2,500 $\mu\text{S}/\text{cm}$ . Reoccupation of sampling site 03BF023.
	04BF051-2	JEH collecting white aluminum precipitates on lower reach of spring.
	04BF052	Sampled scree and underlying soil for leaching, Red Mountain area. Reoccupation of sampling site 03BF027.
	04BF053-1	Sampling site along Lago Creek, Red Mountain area; stream pH 4.8, specific conductance 990 $\mu\text{S}/\text{cm}$ .
	04BF053-2	Detailed of sampled turbid Lago Creek with iron floc.
	04BF053-3	Possible soft-sediment deformation in carbonaceous metasediments (mapped as phyllitic ash tuff).
	04BF054-1	Sampled spring along Lago Creek near mouth, Red Mountain area; pH 2.5, specific conductance 3,100 $\mu\text{S}/\text{cm}$ . Reoccupation of sampling site 03BF015.

Thumbnail	Photograph number	Description
	04BF054-2	NF and JMH coring ferricrete at spring sampling site.
	04BF054-3	LPG collecting notes on vegetation at site.
	04BF054-4	JMH coring ferricrete at site.
	04BF055-1	Sampled seep spring, W side of saddle between Red Mountain Creek and Megan's Draw; pH 5.4, specific conductance 430 $\mu$ S/cm.
	04BF055-2	Sampled white salt and black liverwort at site.
	04BF055-3	Sampled white salt and black liverwort at site.
	04BF055-4	View to WNW from site across Red Mountain Creek to Red Mountain.
	04BF055-5	View to NW from site down Red Mountain Creek valley across to Dry Creek valley.
	04BF056	Sampled disaggregated bedrock for leaching, W side of saddle between Red Mountain Creek and Megan's Draw. View is to W with Red Mountain Creek in distance.
	04BF057-1	View to NW of PHB at sampled spring, E side of saddle between Red Mountain Creek and Megan's Draw; pH 3, specific conductance 2,300 $\mu$ S/cm.
	04BF057-2	Detail of sampled spring with abundant black liverwort.
	04BF057-3	Detail of sampled spring with salts and moose footprint.
	04BF057-4	Detail of sampled spring with moose footprint and lichen.
	04BF057-5	View to NW of JMH, NF-A, and PHB at site from distance with ridgeline of altered bedrock behind.
	04BF057-6	View to NW of JMH and NF-A at site from distance with ridgeline of altered bedrock behind.
	04BF058-1	Sampled stream upstream from alteration zone, Megan's Draw; pH 7.4, specific conductance 370 $\mu$ S/cm.

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Thumbnail	Photograph number	Description
	04BF058-2	View to NE looking downstream from site towards alteration zone, upper Megan's Draw.
	04BF058-3	View to S looking upstream from sampled site, Megan's Draw.
	04BF058-4	PHB collecting data at site.
	04BF058-5	View to N from site to altered rocks along ridgeline. PHB in foreground, JMH barely visible on R edge of photograph at site 04BF057.
	04BF059-1	PHB at sampled spring within lower part of alteration zone in lower Megan's Draw; pH 3.3, specific conductance 2,200 µS/cm.
	04BF059-2	Spring welling up at site.
	04BF059-3	View to N with PHB in foreground at sampled spring on R, JMH and NF-A in Megan's Draw below.
	04BF059-4	Altered quartz-chlorite-muscovite schist outcrop immediately NE of sampled spring.
	04BF059-5	LPG at altered quartz-chlorite-muscovite schist outcrop immediately NE of sampled spring.
	04BF060-1	Northerly view of PHB and sampled stream just downstream from lowermost outcrop of altered bedrock, lower Megan's Draw; pH 3.3, specific conductance 1,900 µS/cm.
	04BF060-2	Detail of sampled stream in Megan's Draw. Note intense FeOx staining.
	04BF060-3	Detail collecting pH of sampled stream in Megan's Draw.
	04BF062	LPG, JMH, PHB, and NF-A collecting various samples at sampling site; spring pH 3.3, specific conductance 1,400 µS/cm. Reoccupation of sampling site 03BF006.
	04BF063-1	Sampled spring along Red Mountain Creek; pH 3.2, specific conductance 4,800 µS/cm. Reoccupation of sampling site 03BF008.
	04BF063-2	PHB collecting water acidity data. Note heavy ferricrete precipitation.
	04BF063-3	LPG collecting soil sample adjacent to black liverwort.

Thumbnail	Photograph number	Description
	04BF063-4	Mixing zone immediately downstream from sampling site; note iron (red) and aluminum (white) precipitates in mixing zone.
	04BF063-5	Mixing zone immediately downstream from sampling site; note iron (red) and aluminum (white) precipitates in mixing zone.
	04BF063-6	JMH collecting abundant aluminum floc settled in calm areas along Red Mountain Creek downstream from sampling site.
	04BF063-7	Floating, frothy aluminum floc in calm areas along Red Mountain Creek downstream from sampling site.
	04BF063-8	Floating, frothy aluminum floc in calm areas along Red Mountain Creek downstream from sampling site.
	04JHBF04	Yellow-orange precipitate coating streambed along headwaters of Lago Creek.
	04JHBF05	Mixing zone of pH 5 side stream coated with white precipitate (R) and pH 3 main channel of Lago Creek (L).
	04JHBF11	Pale orange precipitate downstream from mixing zone along Lago Creek.
	04JHBF12	Gelatinous aluminum- and iron-rich precipitate in evaporating side pool along Lago Creek.
	04JHBF14	Buff-colored aluminum- and iron-rich precipitate along Fosters Creek downstream from Lago Creek and all acidic inflows.
	04JHBF17-1	Efflorescent sulfate salts (halotrichite group minerals) in saddle between Red Mountain Cr. and Megan's Draw; relative humidity meter reads 32.8 percent RH.
	04JHBF17-2	Efflorescent salts under protected overhang in saddle between Red Mountain Cr. and Megan's Draw.
	04JHBF20	Prominent "white zone" sampled for soil on saddle between Red Mountain Cr. and Megan's Draw.
	04JHBF21	Prominent "red zone" sampled for soil on saddle between Red Mountain Cr. and Megan's Draw.
	04JHBF28	Goslarite (zinc-sulfate) salts precipitating on vegetation at seep along Megan's Draw.
	04JHBF29	White precipitate on rocks at confluence of seep and Megan's Draw.

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Thumbnail	Photograph number	Description
	04JHBF34	Efflorescent salts (pickeringite) on shaly metavolcanics in Red Mountain saddle.
	04JHBF35	White salts along fractures on shaly metavolcanics in Red Mountain saddle.
	04JHBF46	Thick white aluminum-rich precipitate along Red Mountain Creek (pH 5.5).
	04JHBF55	Observation of white aluminum-rich precipitates downstream along lower Red Mountain Creek.
	FB070904-1	PHB collecting blank at Buzby camp.
	FB070904-2	PHB collecting blank at Buzby camp.

## Appendix C

### Limits of Determination for Analytical Methods

Below are tables listing lower limits of determination (LLD) and upper limits of determination (ULD) for each analysis method used. Limits for analysis methods used on solid samples are listed first, followed by limits for methods used on liquid samples. Please see [table 2](#) for an explanation of the laboratory analysis codes and methods.

#### Limits of determination for solid sample analytical methods

**Table C1.** Limits of determination for 42-element, 4-acid digestion ICP–AES and ICP–MS [MS42].<sup>1</sup>

Element	LLD	ULD	Element	LLD	ULD
Percent			Parts per million		
Aluminum, Al	0.01	15	Indium, In	0.02	0.05%
Calcium, Ca	0.01	15	Lanthanum, La	0.5	0.1%
Iron, Fe	0.01	15	Lead, Pb	0.5	1%
Magnesium, Mg	0.01	15	Lithium, Li	1	5%
Phosphorus, P	50 ppm	1	Manganese, Mn	5	1%
Potassium, K	0.01	15	Molybdenum, Mo	0.05	1%
Sodium, Na	0.01	15	Nickel, Ni	0.5	1%
Sulfur, S	0.01	5	Niobium, Nb	0.1	0.1%
Titanium, Ti	0.01	15	Rubidium, Rb	0.2	1%
Parts per million			Scandium, Sc	0.1	0.1%
Antimony, Sb	0.05	1%	Silver, Ag	1	10
Arsenic, As	1	1%	Strontium, Sr	0.5	1%
Barium, Ba	5	1%	Tellurium, Te	0.1	0.05%
Beryllium, Be	0.1	100	Thallium, Tl	0.1	1%
Bismuth, Bi	0.04	1%	Thorium, Th	0.2	1%
Cadmium, Cd	0.1	1	Tin, Sn	0.1	0.1%
Cerium, Ce	0.05	0.1%	Tungsten, W	0.1	1%
Cesium, Cs	0.05	0.1%	Uranium, U	0.1	1%
Chromium, Cr	1	1%	Vanadium, V	1	1%
Cobalt, Co	0.1	1%	Yttrium, Y	0.1	1%
Copper, Cu	0.5	1%	Zinc, Zn	1	1%
Gallium, Ga	0.05	500			

<sup>1</sup> SGS Canada, Inc., Mineral Services Laboratory, 1885 Leslie St., Don Mills, Toronto, Ontario, Canada, M3B 2M3.

**Table C2.** Limits of determination for 55-element sodium peroxide sinter ICP–AES and ICP–MS [MS55].<sup>1</sup>

Element	LLD	ULD	Element	LLD	ULD
Aluminum, Al	0.01%	25%	Manganese, Mn	10 ppm	10%
Antimony, Sb	0.1 ppm	500 ppm	Molybdenum, Mo	2 ppm	1%
Arsenic, As	30 ppm	10%	Neodymium, Nd	0.1 ppm	1 %
Barium, Ba	0.5 ppm	1%	Nickel, Ni	5 ppm	1%
Beryllium, Be	5 ppm	0.25%	Niobium, Nb	1 ppm	1%
Bismuth, Bi	0.1 ppm	0.1%	Phosphorus, P	0.01%	0.25%
Cadmium, Cd	0.2 ppm	1%	Potassium, K	0.01%	25%
Calcium, Ca	0.01%	35%	Praesodymium, Pr	0.05 ppm	0.1 %
Cerium, Ce	0.1 ppm	1%	Rubidium, Rb	0.2 ppm	1%
Cesium, Cs	0.1 ppm	1%	Samarium, Sm	0.1 ppm	0.1%
Chromium, Cr	10 ppm	10%	Scandium, Sc	5 ppm	5%
Cobalt, Co	0.5 ppm	1%	Silver, Ag	1 ppm	0.1%
Copper, Cu	5 ppm	1%	Strontium, Sr	0.1 ppm	0.1%
Dysprosium, Dy	0.05 ppm	0.1%	Tantalum, Ta	0.5 ppm	1 %
Erbium, Er	0.05 ppm	0.1%	Thallium, Tl	0.5 ppm	0.1%
Europium, Eu	0.05 ppm	0.1%	Thorium, Th	0.1 ppm	0.1%
Gadolinium, Gd	0.05 ppm	0.1%	Thulium, Tm	0.05 ppm	0.1%
Gallium, Ga	1 ppm	0.1%	Tin, Sn	1 ppm	1%
Germanium, Ge	1 ppm	0.1%	Titanium, Ti	0.01%	25%
Hafnium, Hf	1 ppm	1%	Tungsten, W	1 ppm	1%
Holmium, Ho	0.05 ppm	0.1 %	Terbium, Tb	0.05 ppm	0.1 %
Indium, In	0.2 ppm	0.1%	Uranium, U	0.05 ppm	0.1%
Iron, Fe	0.01%	30%	Vanadium, V	5 ppm	1%
Lanthanum, La	0.1 ppm	1%	Ytterbium, Yb	0.1 ppm	0.1 %
Lead, Pb	5 ppm	1%	Yttrium, Y	0.5 ppm	1%
Lithium, Li	10 ppm	5%	Zinc, Zn	5 ppm	1%
Lutetium, Lu	0.05 ppm	0.1%	Zirconium, Zr	0.5 ppm	1%
Magnesium, Mg	0.01%	30%			

<sup>1</sup> SGS Canada, Inc., Mineral Services Laboratory, 1885 Leslie St., Don Mills, Toronto, Ontario, Canada, M3B 2M3.

**Table C3.** Limits of determination for 42-element, 4-acid digestion ICP–MS [MS-ACID].<sup>1</sup>

Element	LLD <sup>2</sup>	Element	LLD <sup>2</sup>
Parts per million		Parts per million	
Aluminum, Al	0.0036	Manganese, Mn	0.71
Antimony, Sb	0.043	Molybdenum, Mo	0.053
Arsenic, As	0.18	Nickel, Ni	0.26
Barium, Ba	0.26	Niobium, Nb	0.11
Beryllium, Be	0.029	Phosphorus, P	5.15
Bismuth, Bi	0.056	Potassium, K	15
Cadmium, Cd	0.0069	Rubidium, Rb	0.014
Calcium, Ca	130	Scandium, Sc	0.034
Cerium, Ce	0.09	Silver, Ag	0.0036
Cesium, Cs	0.003	Sodium, Na	27
Chromium, Cr	0.48	Strontium, Sr	0.83
Cobalt, Co	0.025	Sulfur, S	0.05%
Copper, Cu	1.4	Thallium, Tl	0.079
Gallium, Ga	0.013	Thorium, Th	0.095
Gold, Au	0.0033	Titanium, Ti	4.1
Iron, Fe	45	Uranium, U	0.023
Lanthanum, La	0.048	Vanadium, V	0.14
Lead, Pb	0.37	Yttrium, Y	0.047
Lithium, Li	0.31	Zinc, Zn	2.3
Magnesium, Mg	5.8		

<sup>1</sup> Briggs and Meier, 2002.

<sup>2</sup> Limits of determination shown here are nominal and limits may vary in the data files. The variability in limits of determination is due to variable sample weight used, dilution of the sample solution, and instrumental interference correction.

**Table C4.** Limits of determination for other analytical methods used on solid samples.<sup>1</sup>

Method (table 2)	Elements	LLD <sup>2</sup>	ULD <sup>3</sup>
CT	Carbonate C	0.01%	50%
CV	Hg	0.02 ppm	-
FA	Au	0.005 ppm	10 ppm
HY	As	rock	0.2 ppm
		vegetation	0.02 ppm
	Se	rock	0.1 ppm
		vegetation	0.02 ppm
LE	C (total)	0.05%	30%
	S (total)	0.05%	35%
PCT	Ash	0.01%	-
TI	FeO	0.01%	-
XRD	mineralogy <sup>4</sup>	major	25% (qualitative)
		minor	5% (qualitative)
		trace	-
			5% (qualitative)

<sup>1</sup> Taggart, 2002.

<sup>2</sup> Limits of determination shown here are nominal, and limits may vary in the data files. The variability in limits of determination is due to variable sample weight used, dilution of the sample solution, instrumental interference correction, and slight changes in methodology over time.

<sup>3</sup> Samples containing concentrations greater than the upper limits of determination listed here were diluted and reanalyzed.

<sup>4</sup> Weight percent is not a detection limit; value divisions are determined by the analyst.

## Limits of determination for aqueous sample analytical methods

**Table C5.** Limits of determination for aqueous sample 27-element ICP–AES [EW].<sup>1</sup>

Element	LLD <sup>2</sup>	ULD	Element	LLD <sup>2</sup>	ULD
Parts per million (mg/L)			Parts per billion (µg/L)		
Aluminum, Al	0.01	1,000	Cadmium, Cd	5	10,000
Calcium, Ca	0.1	1,000	Chromium, Cr	10	10,000
Iron, Fe	0.02	1,000	Cobalt, Co	10	10,000
Magnesium, Mg	0.1	1,000	Copper, Cu	10	10,000
Phosphorus, P	0.1	1,000	Lead, Pb	50	10,000
Potassium, K	0.1	1,000	Lithium, Li	1	10,000
Silicon, Si	0.1	1,000	Manganese, Mn	10	10,000
Silicon dioxide, SiO <sub>2</sub>	0.1	-	Molybdenum, Mo	20	10,000
Sodium, Na	0.1	1,000	Nickel, Ni	10	10,000
Parts per billion (µg/L)			Silver, Ag	1	1,000
Antimony, Sb	50	10,000	Strontium, Sr	1	10,000
Arsenic, As	100	10,000	Titanium, Ti	50	10,000
Barium, Ba	1	10,000	Vanadium, V	10	10,000
Beryllium, Be	10	10,000	Zinc, Zn	10	10,000
Boron, B	5	10,000			

<sup>1</sup> Briggs, 2002.<sup>2</sup> Limits of determination shown here are nominal, and limits may vary in the data files. The variability in limits of determination is due to variable sample weight used, dilution of the sample solution, and instrumental interference correction.

**Table C6.** Limit of determination for aqueous sample 44-element ICP–MS [MW].<sup>1</sup>

Element	LLD <sup>2</sup>	Element	LLD <sup>2</sup>
Parts per million (mg/L)		Parts per billion (µg/L)	
Calcium, Ca	0.327	Lead, Pb	0.0906
Magnesium, Mg	0.0105	Lithium, Li	1.53
Potassium, K	0.0419	Lutetium, Lu	0.0114
Silicon, Si	0.214	Manganese, Mn	0.252
Silicon dioxide, SiO <sub>2</sub>	0.2	Molybdenum, Mo	3.17
Sodium, Na	0.961	Neodymium, Nd	0.0105
Sulfate, SO <sub>4</sub> <sup>2-</sup>	6.54	Nickel, Ni	0.449
Parts per billion (µg/L)		Niobium, Nb	0.192
Aluminum, Al	2.32	Phosphorus, P	10
Antimony, Sb	0.427	Praseodymium, Pr	0.00288
Arsenic, As	1.08	Rhenium, Re	0.02
Barium, Ba	0.37	Rubidium, Rb	0.427
Beryllium, Be	0.05	Samarium, Sm	0.0148
Bismuth, Bi	0.353	Scandium, Sc	0.995
Cadmium, Cd	0.0177	Selenium, Se	1.1
Cerium, Ce	0.0165	Silver, Ag	2.04
Cesium, Cs	0.0328	Strontium, Sr	0.797
Chromium, Cr	1.88	Tantalum, Ta	0.183
Cobalt, Co	0.028	Terbium, Tb	0.00226
Copper, Cu	0.746	Thallium, Tl	0.261
Dysprosium, Dy	0.00392	Thorium, Th	0.289
Erbium, Er	0.00370	Thulium, Tm	0.00194
Europium, Eu	0.00428	Titanium, Ti	0.960
Gadolinium, Gd	0.00504	Tungsten, W	0.545
Gallium, Ga	0.0799	Uranium, U	0.233
Germanium, Ge	0.0689	Vanadium, V	0.789
Gold, Au	0.01	Ytterbium, Yb	0.00463
Holmium, Ho	0.0102	Yttrium, Y	0.00747
Indium, In	0.01	Zinc, Zn	0.85
Iron, Fe	48.2	Zirconium, Zr	0.296
Lanthanum, La	0.0129		

<sup>1</sup> Lamothe and others, 2002.<sup>2</sup> Limits of determination shown here are nominal, and limits may vary in the data files. The variability in limits of determination is due to variable sample weight used, dilution of the sample solution, and instrumental interference correction. Upper limits of determination are not shown because samples with high concentrations were diluted and reanalyzed.

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**Table C7.** Limits of determination for other analytical methods used on aqueous samples.<sup>1</sup>

Method (table 2)	Elements	LLD <sup>2</sup>	ULD <sup>3</sup>
TA	Alkalinity	1 ppm	-
IC	Chloride, Cl <sup>-</sup>	0.08 mg/L	4 mg/L
	Fluoride, F <sup>-</sup>	0.08 mg/L	4 mg/L
	Nitrate, NO <sub>3</sub> <sup>-</sup>	0.08 mg/L	4 mg/L
	Sulfate, SO <sub>4</sub> <sup>2-</sup>	1.2 mg/L	80 mg/L
AF	Hg	5 ng/L	-
CO	Fe <sup>2</sup>	0.1 ppm	-

<sup>1</sup> Taggart, 2002.

<sup>2</sup> Limits of determination shown here are nominal, and limits may vary in the data files. The variability in limits of determination is due to variable sample weight used, dilution of the sample solution, instrumental interference correction, and slight changes in methodology over time.

<sup>3</sup> Samples containing concentrations greater than the upper limits of determination listed here were diluted and reanalyzed.