Whole-Rock Geochemical Data for the Goshen Pass Quadrangle, Utah

by

Adam P. McKean

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UTAH GEOLOGICAL SURVEY
contact
1594 W. North Temple, Suite 3110
Salt Lake City, UT 84116
telephone: 801-537-3300
website: geology.utah.gov

INTRODUCTION

This open-file report makes available data from laboratory analyses completed to determine the chemical composition of igneous rock samples collected during geologic mapping funded or supported by the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program and the Utah Geological Survey (UGS) (see McKean, 2018, in preparation). The samples were prepared by ALS Minerals, Inc., (Reno, Nevada, and North Vancouver, British Columbia) with analyses performed under contract to the UGS (see table 1). Analytical methods used can be accessed online at https://alsglobal.azureedge.net/-/media/als/resources/services-and-products/geochemistry/fee-schedules/als-geochemistry-fee-schedule-usd.pdf?rev=57d59187ce834511b6301dd3f2081dc2 and in appendix A of this report. These data are technical in nature and proper interpretation requires training in applicable geochemical techniques.

The analytical data can be accessed electronically as an Excel document attached to the PDF file of this report and available at https://ugspub.nr.utah.gov/publications/open_file_reports/ofr-701/ofr-701.xls.

DISCLAIMER

This open-file release is intended as a data repository for technical analytical information gathered in support of geologic mapping of the Goshen Pass quadrangle. These data may not conform to UGS technical or editorial standards. Therefore, it may be premature for an individual or group to take actions based on the contents of this report. The Utah Department of Natural Resources, Utah Geological Survey, makes no warranty, expressed or implied, regarding its suitability for a particular use. The Utah Department of Natural Resources, Utah Geological Survey, shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to claims by users of this product.

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McKean, A.P., 2018, Interim geologic map of the Goshen Pass quadrangle, Utah County, Utah: Utah Geological Survey Open-File Report 694DM, 15 p., 2 plates, scale 1:24,000.

McKean, A.P., in preparation, Geologic map of the Goshen Pass quadrangle, Utah County, Utah: Utah Geological Survey Map, 2 plates, scale 1:24,000.

Table 1. *Major- and trace-element whole-rock analyses from the Goshen Pass quadrangle, Utah.*

Sample Number	Map Unit	Unit Name	Rock Type	Rock Name	UTM easting	UTM northing	Latitude (°N)	Longitude (°W)
GP2018-41	Tb	Mosida Basalt	lava flow	basalt	414360	4446448	40.1640	-112.0057
GP2018-42	Tb	Mosida Basalt	lava flow	trachybasalt	414357	4446429	40.1639	-112.0057
GP2018-64	Tsa	Soldiers Pass Formation, andesite member	lava flow	andesite	413561	4444447	40.1459	-112.0148

Notes:

Rock name using total alkali-silica diagram of Le Bas and others (1986),
for values normalized to 100% based on a volatile free basis, using LOI, data not shown here

Location data based on NAD83

Major oxides reported in weight percent and trace elements reported in parts per million (ppm)

LOI is loss on ignition at 1000°C

Analysis Source:

Analyses by ALS Minerals, Inc., North Vancouver, British Columbia, Canada; major oxides results from x-ray fluorescence (XRF),
trace elements by inductively coupled plasma-mass spectrometry (ICP-MS), and 4 acid dissolution ICP for base metals (marked with an *)

Map Reference:

McKean, 2018

McKean, in preparation

Table 1. *Continued*

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	Cr_2O_3	TiO_2	MnO	P_2O_5	SrO	BaO	LOI	Total
GP2018-41	47.7	17.63	10.65	8.78	5.05	3.19	1.63	0.01	2.13	0.14	0.555	0.13	0.08	2.13	99.8
GP2018-42	42.83	19.86	14	2.2	1.09	1.64	2.82	<0.01	3.17	0.08	0.806	0.04	0.07	9.86	98.47
GP2018-64	56.26	14.54	8	7.24	4.44	3.32	2.32	0.03	1	0.14	0.369	0.1	0.16	2.03	99.95

Sample Number	Ag*	As*	Cd*	Co*	Cu*	Li*	Mo*	Ni*	Pb*	Sc*	Tl*	Zn*	Ba	Ce	Cr	Cs	Dy	Er	Eu	Ga	Gd	Hf
GP2018-41	<0.5	8	<0.5	38	28	20	2	31	8	16	<10	110	720	79.5	50	51.3	4.17	1.91	2.05	21	5.87	4.6
GP2018-42	<0.5	390	<0.5	33	24	110	2	27	7	16	<10	168	741	129	40	7.79	6.03	2.55	3	28.4	8.94	7.7
GP2018-64	<0.5	79	<0.5	29	43	30	1	65	35	22	<10	100	1590	82	270	6.81	3.44	1.73	1.56	20	5.2	4.8

Sample Number	Ho	La	Lu	Nb	Nd	Pr	Rb	Sm	Sn	Sr	Ta	Tb	Th	Tm	U	V	W	Y	Yb	Zr
GP2018-41	0.74	38.7	0.22	31.3	38.9	9.77	16.6	7.79	1	987	1.6	0.77	4.84	0.23	1.05	229	<1	18.4	1.57	200
GP2018-42	1.05	65.4	0.26	55.5	63.6	16.25	64.4	12.1	2	372	2.9	1.11	7.84	0.35	1.97	262	6	25.6	1.95	322
GP2018-64	0.67	41.5	0.24	10.9	36.1	9.85	49.5	6.87	1	870	0.5	0.66	6.31	0.26	1.56	174	2	17.6	1.61	199

APPENDIX A

ANALYTICAL METHODS

Sample Preparation Package

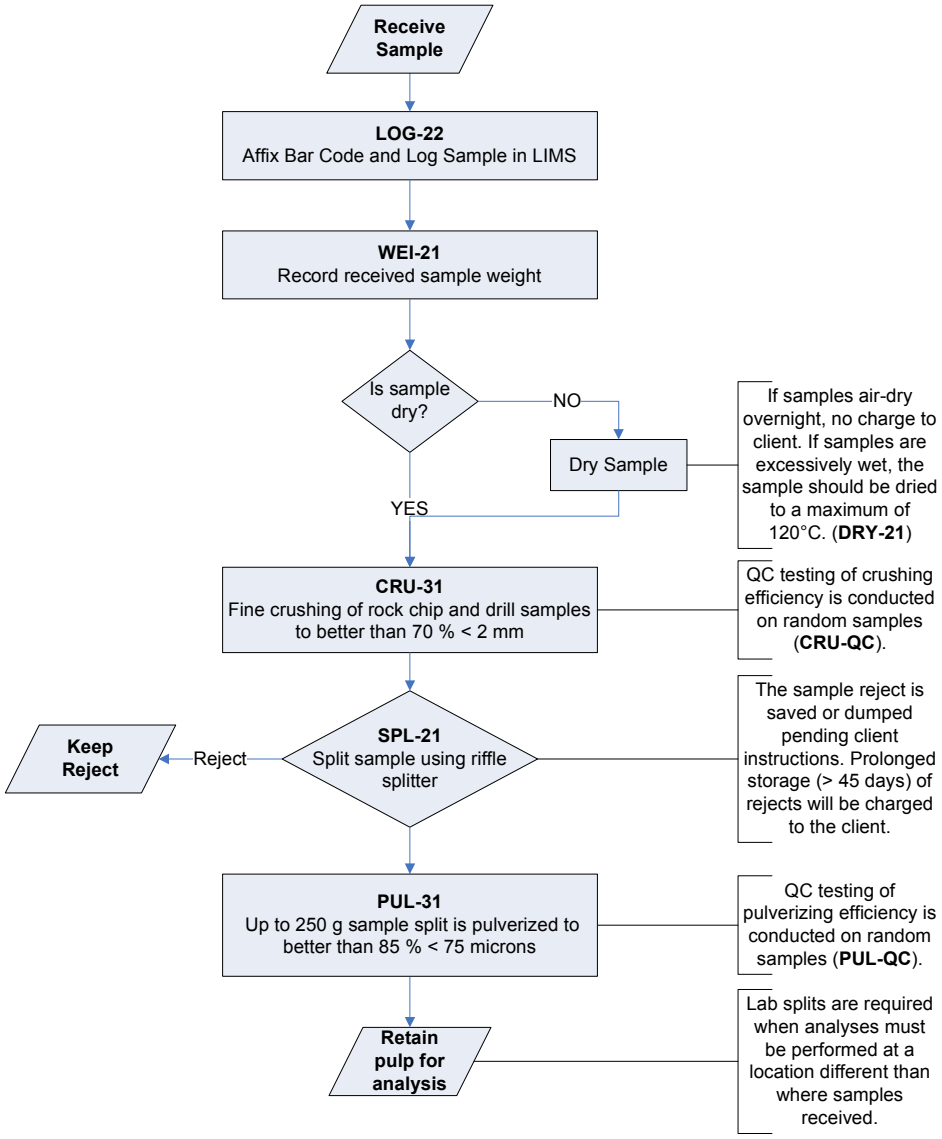
PREP-31
Standard Sample Preparation: Dry, Crush, Split and Pulverize

Sample preparation is the most critical step in the entire laboratory operation. The purpose of preparation is to produce a homogeneous analytical sub-sample that is fully representative of the material submitted to the laboratory.

The sample is logged in the tracking system, weighed, dried and finely crushed to better than 70 % passing a 2 mm (Tyler 9 mesh, US Std. No.10) screen. A split of up to 250 g is taken and pulverized to better than 85 % passing a 75 micron (Tyler 200 mesh, US Std. No. 200) screen. This method is appropriate for rock chip or drill samples.

Method Code	Description
LOG-22	Sample is logged in tracking system and a bar code label is attached.
CRU-31	Fine crushing of rock chip and drill samples to better than 70 % of the sample passing 2 mm.
SPL-21	Split sample using riffle splitter.
PUL-31	A sample split of up to 250 g is pulverized to better than 85 % of the sample passing 75 microns.

Flow Chart - Sample Preparation Package – PREP-31
Standard Sample Preparation: Dry, Crush, Split and Pulverize



OA-GRA06
LOI for Whole Rock Geochemistry

Analytical Method:

Gravimetric

OA-GRA06:

A 3g sample is weighed into a ceramic crucible and put into a furnace at 1000°C. After cooling, the sample is weighed again and the difference in weights is used to calculate the loss on ignition (LOI) at 1000°C. The prepared, ashed sample is then fused with lithium borate flux to create a glass disc for analysis by ME-XRF06.

Analyte	Symbol	Units	Lower Limit	Upper Limit
Loss on Ignition	LOI	%	0.01	100

NOTE: Negative LOI values may be attributed to oxidation of samples during the LOI process. For example, FeO may oxidize to Fe_2O_3 and result in weight gain.

ALS Chemex

Whole Rock Geochemistry – ME-XRF06

Sample Decomposition: 50% $Li_2B_4O_7$ – 50% $LiBO_2$ (WEI-GRA06)
Analytical Method: X-Ray Fluorescence Spectroscopy (XRF)

A calcined or ignited sample (0.9 g) is added to 9.0g of Lithium Borate Flux (50 % - 50 % $Li_2B_4O_7$ – $LiBO_2$), mixed well and fused in an auto fluxer between 1050 - 1100°C. A flat molten glass disc is prepared from the resulting melt. This disc is then analysed by X-ray fluorescence spectrometry.

Element	Symbol	Units	Lower Limit	Upper Limit
Aluminum Oxide	Al_2O_3	%	0.01	100
Barium Oxide	BaO	%	0.01	100
Calcium Oxide	CaO	%	0.01	100
Chromium Oxide	Cr_2O_3	%	0.01	100
Ferric Oxide	Fe_2O_3	%	0.01	100
Potassium Oxide	K_2O	%	0.01	100
Magnesium Oxide	MgO	%	0.01	100
Manganese Oxide	MnO	%	0.01	100
Sodium Oxide	Na_2O	%	0.01	100
Phosphorus Oxide	P_2O_5	%	0.01	100
Silicon Oxide	SiO_2	%	0.01	100
Strontium Oxide	SrO	%	0.01	100

Element	Symbol	Units	Lower Limit	Upper Limit
Titanium Oxide	TiO_2	%	0.01	100
Loss On Ignition	LOI	%	0.01	100
	Total	%	0.01	101

Note: Since samples that are high in sulphides or base metals can damage Platinum crucibles, a ME-ICP06 finish method can be selected as an alternative method.

Geochemical Procedure

ME-MS81
Ultra-Trace Level Methods

Sample Decomposition:

Lithium Metaborate Fusion (FUS-LI01)

Analytical Method:

Inductively Coupled Plasma - Mass Spectroscopy (ICP - MS)

A prepared sample (0.200 g) is added to lithium metaborate flux (0.90 g), mixed well and fused in a furnace at 1000˚C. The resulting melt is then cooled and dissolved in 100 mL of 4% HNO_3 / 2% HCl solution. This solution is then analyzed by inductively coupled plasma - mass spectrometry.

Element	Symbol	Units	Lower Limit	Upper Limit
Barium	Ba	ppm	0.5	10000
Cerium	Ce	ppm	0.5	10000
Cobalt*	Co	ppm	0.5	10000
Chromium	Cr	ppm	10	10000
Cesium	Cs	ppm	0.01	10000
Dysprosium	Dy	ppm	0.05	1000
Erbium	Er	ppm	0.03	1000
Europium	Eu	ppm	0.03	1000
Gallium	Ga	ppm	0.1	1000
Gadolinium	Gd	ppm	0.05	1000
Hafnium	Hf	ppm	0.2	10000
Holmium	Ho	ppm	0.01	1000
Lanthanum	La	ppm	0.5	10000
Lutetium	Lu	ppm	0.01	1000

Element	Symbol	Units	Lower Limit	Upper Limit
Molybdenum*	Mo	ppm	2	10000
Niobium	Nb	ppm	0.2	2500
Neodymium	Nd	ppm	0.1	10000
Praseodymium	Pr	ppm	0.03	1000
Rubidium	Rb	ppm	0.2	10000
Samarium	Sm	ppm	0.03	1000
Tin	Sn	ppm	1	10000
Strontium	Sr	ppm	0.1	10000
Tantalum	Ta	ppm	0.1	2500
Terbium	Tb	ppm	0.01	1000
Thorium	Th	ppm	0.05	1000
Thallium	Tl	ppm	0.5	1000
Thulium	Tm	ppm	0.01	1000
Uranium	U	ppm	0.05	1000
Vanadium	V	ppm	5	10000
Tungsten	W	ppm	1	10000
Yttrium	Y	ppm	0.5	10000
Ytterbium	Yb	ppm	0.03	1000
Zirconium	Zr	ppm	2	10000

*__Note__: Some base metal oxides and sulfides may not be completely decomposed by the lithium borate fusion. Results for Co and Mo will not likely be quantitative by this method.

Adding Base Metals – ME-AQ81, ME-4ACD81

Sample Decomposition: Aqua Regia (GEO-AR01) or 4-acid (GEO-4ACID)
Analytical Method: Inductively Coupled Plasma – Atomic Emission spectroscopy (ICP - AES)

The lithium metaborate fusion is not the preferred method for the determination of base metals. Many sulfides and some metal oxides are only partially decomposed by the borate fusion and some elements such as cadmium and zinc can be volatilized.

Base metals can be reported with ME-MS81 for either an aqua regia digestion (**ME-AQ81**) or a four acid digestion (**ME-4ACD81**). The four acid digestion is preferred when the targets include more resistive mineralization such as that associated with nickel and cobalt.

Element	Symbol	Units	Lower Limit	Upper Limit
Silver	Ag	ppm	0.5	100
Arsenic	As	ppm	5	10000
Cadmium	Cd	ppm	0.5	10000
Cobalt	Co	ppm	1	10000
Copper	Cu	ppm	1	10000
Mercury**	Hg	ppm	1	10000
Molybdenum	Mo	ppm	1	10000
Nickel	Ni	ppm	1	10000
Lead	Pb	ppm	1	10000
Zinc	Zn	ppm	2	10000

**Hg is only offered with the aqua regia digestion.