U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Geochemical Data of Fumarolically Altered Rocks, Valley of Ten Thousand Smokes, Alaska

by

Terry E. C. Keith[1]

Open-File Report 95-47

[1]Anchorage, Alaska

1995

ABSTRACT

Selected major oxides, volatile elements, and trace elements were analyzed on sets of samples collected from fossil fumaroles in the fallout and ash-flow tuff emplaced during the 6-8 June 1912 eruption of Novarupta. Analytical results are presented in this report and references are given for publications in which the data is interpreted.

INTRODUCTION

The purpose of this report is to present the analytical results of samples from fumarolically altered parts of the ash-flow sheet and overlying fallout deposits from the 6-8 June 1912 eruption of Novarupta (Hildreth, 1983, 1987; Fierstein and Hildreth, 1992) in what is now Katmai National Park. Several papers already published are based on the data in this report (e.g., Keith, 1984, 1991a, 1991b; Kodosky and Keith, 1993, 1995). Papers by Papike and others (1991a, 1991b) include analytical data from some of the same samples but these data were obtained using different analytical techniques.

Samples were collected from ash-flow tuff that was altered by acidic fumarolic gases along vertical vent walls. Trace elements from the altered wallrock combined with the acid gases and were transported to the surface where rapid cooling took place. Minerals and unstable chemical phases sublimated onto clasts in the porous fallout deposits cementing the fallout adjacent to fumarolic vents. These features in the ash-flow sheet are very resistant to weathering and clearly define the fossil fumarole orifices (Keith, 1991a).

The leaching process continued in the fallout deposits at the surface as acid gases combined with surface waters to form sulfuric, hydrochloric and hydrofluoric acids. As the fumaroles cooled and died out, surface waters neutralized the surficial acids and the system equilibrated at the surface. Water soluble and metastable chemical phases and minerals containing abundant trace metals were removed from the system by dissolution in surface waters (Keith, 1991a).

SAMPLE COLLECTION AND NUMBERING

Fist- to golfball-sized samples were collected from exposures of fumarolically altered fallout and ash-flow tuff from selected fossil fumaroles throughout the Valley of Ten Thousand Smokes (VTTS). Each fossil fumarole site was given a number (fig. 1). Samples from each site were given two numbers designating the year collected, KAT for Katmai National Park, and the fossil fumarole site number. Capital letters beginning with A designate the location of the sample with respect to the fumarolic orifice for the site. The letter A signifies a sample very close to the vent, whereas succeeding letters are consecutively away from the vent. Some variances to

this scheme occur because of complex or multiple fumarolic vent geometry and complex alteration patterns. Thus, sample 79KAT-15A was collected in 1979 at Katmai National Park from fossil fumarole site 15 (fig. 1) and is the first in a sequence A through E (tables 1, 2). A few samples were split into subsets with another number following the letter, e.g., 79KAT-15A1.

The major component of most samples is pumice composed of altered to partially altered rhyolite, dacite, or andesite. Phenocrysts in the pumice include small percentages of plagioclase, clinopyroxene, orthopyroxene, and rare olivine (Hildreth, 1983). The specific composition of fumarolically altered ash-flow tuff and fallout depends partly on protolith composition. Rhyolite protolith is abundant in the lower VTTS and scarce in the middle and upper valley, dacite is the major component in the middle and upper VTTS ash-flow sheet and fallout units blanketing the ash-flow sheet, and andesite is more abundant in the Novarupta vent region relative to the rest of the VTTS.

Interpretation of fumarolic alteration and deposition in the 1912 deposits from which the analyzed samples were collected can be found in the papers listed in the references.

CHEMICAL DATA FOR FUMAROLICALLY ALTERED SAMPLES FROM THE VALLEY OF TEN THOUSAND SMOKES

All analyses were done by US Geological Survey (USGS) analysts in Menlo Park, CA and Denver, CO. Many sample splits submitted for analysis were smaller than the desired weight to obtain the best precision, especially some of those run for trace metals.

Major oxides on selected whole-rock samples (table 1) were analyzed using the wavelength-dispersive X-ray fluorescence (XRF) technique described by Taggart and others (1987). Analysts for samples in table 1 were J. Taggart, A. Bartel, E. Siems, J. Ardith, K. Bartel, K. Stewart, J. Carr, and L. Espos.

Analyses of FeO, H_2O^+, H_2O^-, and CO_2 were obtained on most of the same samples for which major oxides were analyzed (table 1). These components are known as the "XRF support package" by USGS because these are the major components which are volatile and listed as Loss on Ignition (LOI) in the XRF analysis. Techniques used for the VTTS samples are described by Jackson and others (1987). Analysts were T. Fries, S. Pribble, and S. Neil.

Cl, F, and total sulfur content of selected whole-rock samples were also run (table 1) using techniques described by Jackson and others (1987). Analysts were N. Elsheimer, S. MacPherson, G. Mason, J. Graves, and E. Engleman.

Semiquantitative emission spectrographic analyses for many samples (table 2) were done to determine relative depletions and enrichments of trace elements within fumarolic deposits. Techniques used are given in Golightly and others (1987), however, modifications were made to these techniques in order to attain lower limits of detection of some elements. The analyst for all

samples was C. Heropoulos, except those from sites 113 and 127 which were done by R. Lerner. Many of the samples were reanalyzed for chalcophile elements (As, Au, Bi, Cd, P, Te, Tl, Sb, Se, Zn, Hg) by C. Heropoulos using a short-wave radiation (SWR) technique which he adapted to obtain more precise values on small samples with low chalcophile element contents.

The following elements were sought using semiquantitative emission spectrographic analyses but were not found at the given limit of detection (in parts per million [ppm]): Ce (<50), Pd (<1), Pt (<5), Te (<1 by SWR), and U (<150). Semiquantitative spectrographic analysis includes Si, Al, Na, K, P, Fe, Mg, Ca, and Ti (in weight percent) and for Mn (in ppm) (table 2). Better analyses for these elements were obtained as major oxides by the XRF method (table 1), however, since many samples were not analyzed for major oxides, the semiquantitative spectrographic analytical results are included in table 2.

Limits of detection for semiquantitative emission spectrographic analysis are given in Golightly and others (1987). However, because of variations in the techniques used for the analyses in table 2, the limit of detection is given by less than (<) followed by the value. For samples from a given site, N means a particular element was not detected at the limit of detection heading that column. For example, Nb for site 15 has limit of detection of 10 ppm, so the first sample in the Nb column is given as N <10 ppm with following samples showing N, which means 10 ppm is the lower limit of detection for Nb in all the site 15 samples. Sample 79KAT-15E, however, shows a Nb value of 7 ppm because a larger sample was available for analysis and a lower limit of detection could be attained. Some of the limits of detection for the same element in a series of samples from a single fumarole site may be different because of sample size, e.g., for sample 82KAT-127A Mn is < 400 ppm but for 82KAT-127B Mn is 350 ppm; the difference being that 127A was a very small amount of sample. (Remember, all of these results are semiquantitative!)

REFERENCES

Fierstein and Hildreth, 1992, The plinian eruptions of 1912 at Novarupta, Katmai National Park, Alaska: Bulletin of Volcanology, v. 54, p. 646-684.

Golightly, D.W., Dorrzapf, A.F., Jr., Mays, R.E., Fries, T.L., Conklin, N.M., 1987, Analysis of geologic materials by direct-current spectrography and spectrometry, *in* Baedecker, P.A., ed., Methods for geochemical analysis: U.S. Geological Survey Bulletin 1770, p. A1-A13.

Hildreth, W., 1983, The compositionally zoned eruption of 1912 in the Valley of Ten Thousand Smokes, Katmai National Park, Alaska: Journal of Volcanology and Geothermal Research, v. 18, p. 1-56.

Hildreth, W., 1987, New perspectives on the eruption of 1912 in the Valley of Ten Thousand Smokes, Katmai National Park, Alaska: Bulletin of Volcanology, v. 49, p. 680-693.

Jackson, L.L., Brown, F.W., and Neil, S.T., 1987, Major and minor elements requiring individual determination, classical whole rock analysis, and rapid rock analysis, *in* Baedecker, P.A.,ed., Methods for geochemical analysis: U.S. Geological Survey Bulletin 1770, p. G1-G23.

Keith, T.E.C., 1984, Preliminary observations of fumarole distribution and alteration, Valley of Ten Thousand Smokes, Alaska; *in* Reed, K.M., and Bartsch-Winkler, S., eds., U.S. Geological Survey in Alaska: Miscellaneous Geologic Research 1982: U.S. Geological Survey Circular 939, p. 82-85.

Keith, T.E.C., 1991a, Fossil and active fumaroles in the 1912 eruptive deposits, Valley of Ten Thousand Smokes, Alaska: Journal of Volcanology and Geothermal Research, v. 45, p. 227-254.

Keith, T.E.C., 1991b, Argillic alteration in the Novarupta vent region, Katmai National Park, Alaska: Geophysical Research Letters, v. 18, p. 1533-1536.

Kodosky, L.G., and Keith, T.E.C., 1993, Factors controlling the geochemical evolution of fumarolic encrustations, Valley of Ten Thousand Smokes, Alaska: Journal of Volcanology and Geothermal Research, v. 55, p. 185-200.

Kodosky, L.G., and Keith, T.E.C., 1995, Further insights into the geochemical evolution of fumarolic alteration, Valley of Ten Thousand Smokes, Alaska: Journal of Volcanology and Geothermal Research, v. in press

Papike, J.J., Keith, T.E.C., Spilde, M.N., Shearer, C.K., Galbreath, K.C., and Laul, J.C., 1991a, Major and trace element mass flux in fumarolic deposits, Valley of Ten Thousand Smokes, Alaska: rhyolite-rich protolith: Geophysical Research Letters, v. 18, p. 1545-1548.

Papike, J.J., Keith, T.E.C., Spilde, M.N., Galbreath, K.C., Shearer, C.K., and Laul, J.C., 1991b, Geochemistry and mineralogy of fumarolic deposits, Valley of Ten Thousand Smokes, Alaska: bulk chemical and mineralogical evolution of dacite-rich protolith: American Mineralogist, v. 76, p. 1662-1673.

Taggart, J.E., Jr., Lindsay, J.R., Scott, B.A., Vivit, D.V., Bartel, A.J., and Stewart, K.C., 1987, Analysis of geologic materials by wavelength-dispersive X-ray fluorescence spectrometry, *in* Baedecker, P.A., ed., Methods for geochemical analysis: U.S. Geological Survey Bulletin 1770, p. E1-E19.

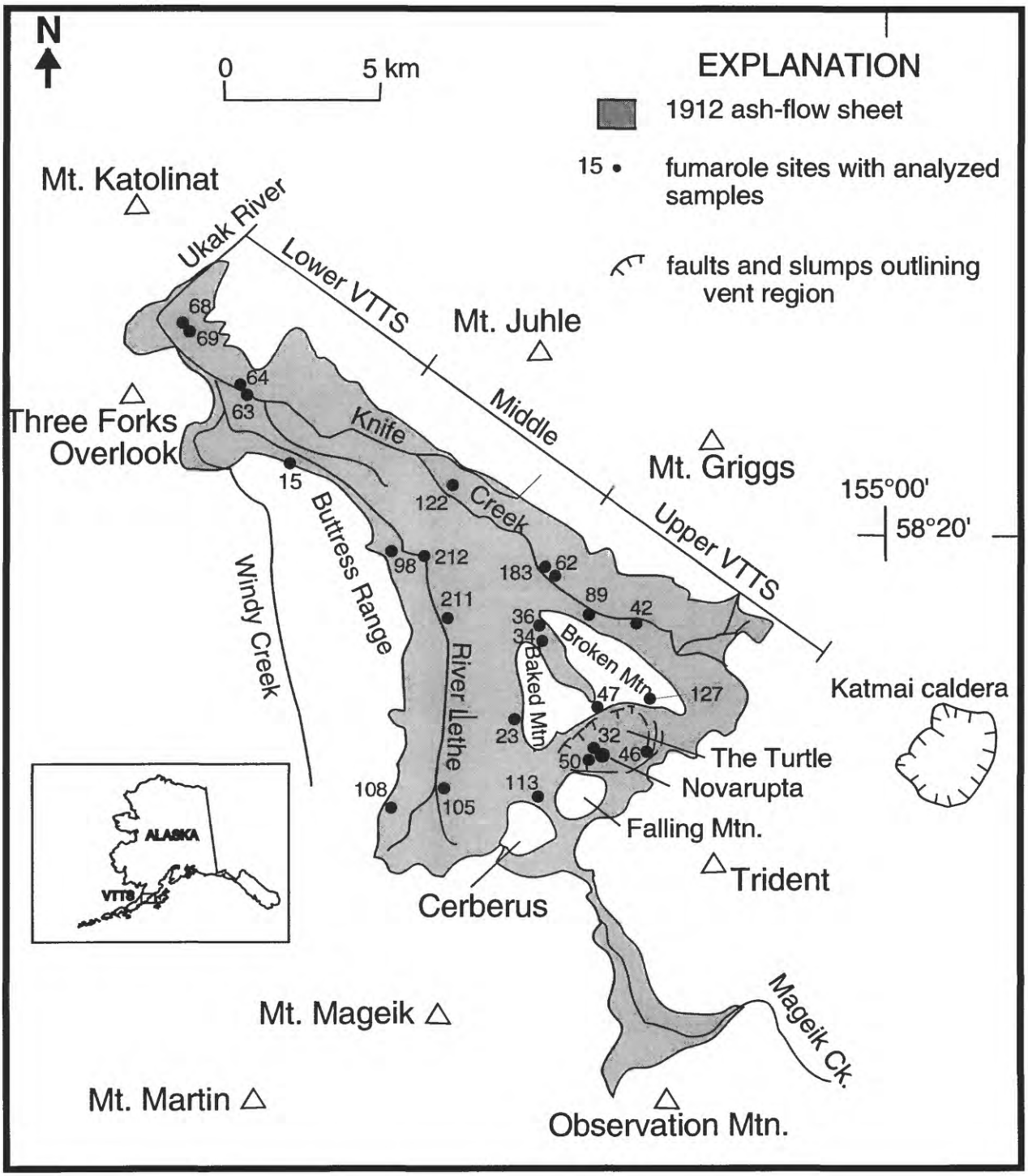

Figure 1. Location of Valley of Ten Thousand Smokes (VTTS), Katmai National Park, Alaska, showing sites of fossil fumaroles from which samples were taken for chemical analysis.

Table 1. Major oxides, volatile compounds and elements, and total S analyses for whole-rock samples of fumarolically-altered ash-flow tuff and fallout from the 1912 eruption of Novarupta. Values are given in weight percent, although mineralogical complexity of sample composition leaves totals at variance with 100%. See text for analysts and methods. NA = not analyzed; ND = not determined.

Sample number		SiO2	Al2O3	FeTO3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI 900C	Total	FeO	H2O+	H2O-	CO2	Cl	F	Total sulfur
Site 15	Lower Valley																			
79KAT-15A1																		1.82	9.35	0.49
79KAT-15B																		1.99	9.73	0.95
79KAT-15C	NO MAJOR OXIDES ANALYZED FOR SITE 15																	1.44	10.7	0.46
79KAT-15D																		0.17	0.07	0.38
79KAT-15E																		0.38	0.47	0.09
Site 23	West side Baked Mountain																			
79KAT-23A		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.03	13.2	0.124
79KAT-23B		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.03	3	0.011
79KAT-23C		58.73	15.96	7.51	2.79	4.12	3.36	1.03	0.73	0.14	0.107	NA	ND	2.24	2.48	2.01	0.07	0.014	0.42	0.289
79KAT-23D		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.009	0.26	0.007
79KAT-23E		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.028	1.4	0.013
79KAT-23E-1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.21	1.34	0.05
Site 32	Novarupta																			
79KAT-32-1	NO MAJOR OXIDES ANALYZED FOR SITE 32																	0.04	0.2	2.43
79KAT-32-2																		0.03	0.08	1.74
Site 34	NW end Baked Mountain																			
79KAT-34A		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.42	38.5	0.5
79KAT-34B		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.045	9.2	0.158
79KAT-34C		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.5	14.5	0.229
79KAT-34D		58.21	18.96	5	0.88	1.79	1.53	0.58	0.79	0.15	0.032	NA	ND	0.96	7.15	3.14	0.04	0.355	1.7	0.2
79KAT-34E		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.668	3.1	0.175
79KAT-34F		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002	0.07	0.055
79KAT-34G		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.065	5.4	0.071
79KAT-34H		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.236	1.6	1
Site 36	NW end Baked Mountain																			
79KAT-36A		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.415	16.9	0.092
79KAT-36B		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0305	0.45	1.67
79KAT-36C		57.06	18.33	3.46	1.38	1.67	2	1.2	0.86	0.14	0.055	NA	ND	1.54	6.89	3.09	0.05	0.305	0.47	2.23
79KAT-36D		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.55	20.1	0.37
79KAT-36E		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.28	0.24	0.02
79KAT-36F		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.14	1.1	0.13

Table 1 continued

Sample number		SiO2	Al2O3	FeTO3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI 900C	Total	FeO	H2O+	H2O-	CO2	Cl	F	Total sulfur
Site 42	Upper Knife Creek																			
79KAT-42A		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.22	0.21	0.0495
79KAT-42B		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23	0.09	0.0051
79KAT-42C		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.15	0.11	0.014
79KAT-42C-1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.16	0.13	0.36
79KAT-42D		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.094	0.22	0.135
79KAT-42E		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1	0.17	0.36
79KAT-42F		50.29	22.4	3.76	2.23	5.57	2.77	0.76	0.64	0.17	0.093	NA	ND	2.22	5.85	2.94	0.03	0.365	1.9	0.775
79KAT-42G		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.062	2.7	0.205
79KAT-42H		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.092	0.11	0.045
Site 46	Turtle																			
79KAT-46A1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.002	0.09	3.56
79KAT-46A2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.01	0.07	1.86
79KAT-46A3		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.01	0.07	2.79
79KAT-46B		37.94	33.27	0.96	<0.02	0.15	1.02	0.76	1.26	0.25	<0.002	NA	ND	0.27	13.88	1.49	0.43	<0.002	0.1	2.89
79KAT-46C		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.026	0.07	2.68
79KAT-46D		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.09	0.07	0.23
79KAT-46E		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.09	0.06	0.2
79KAT-46F		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.09	0.06	0.12
79KAT-46G1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.02	0.39	0.15
79KAT-46G2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.02	0.42	0.64
79KAT-46G3		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.106	0.18	1.26
79KAT-46H		72.53	14.58	2.48	0.21	0.14	0.62	0.1	2.3	0.09	0.01	NA	ND	0.34	6.03	1.11	0.23	0.022	0.2	0.093
Site 47	Pea Soup Pass																			
79KAT-47A																		0.05	0.08	1.5
79KAT-47B																		0.04	0.06	2.37
79KAT-47C	NO MAJOR OXIDES ANALYZED FOR SITE 47																	0.04	0.04	2.05
79KAT-47D																		0.03	0.06	0.54
79KAT-47E																		0.08	0.05	1.09
Site 50	Novarupta																			
79KAT-50A		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.024	0.24	2.21
79KAT-50B		45.27	27.09	4.04	0.43	0.92	1.43	0.75	1.21	0.18	0.033	NA	ND	1.79	11.51	1.71	5.83	0.063	0.79	1.09
Site 62	Upper Knife Creek																			
79KAT-62		49.93	22.27	3.76	2.57	5.79	2.9	0.81	0.68	0.4	0.09	NA	ND	2.38	5.63	2.07	0.03	0.73	3.7	0.285
Site 63	Three Forks																			
82KAT-63A																		0.15	1.7	0.1
82KAT-83B																		0.57	0.8	0.02
82KAT-63D																		0.16	2.6	0.07
82KAT-63E	NO MAJOR OXIDES ANALYZED FOR SITE 63																	0.25	0.25	<0.01
82KAT-63F																		0.47	0.13	5.44
82KAT-63G																		0.39	0.32	0.02
82KAT-63H																		0.14	0.13	<0.01

Table 1 continued

Sample number		SiO2	Al2O3	FeTO3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI 900C	Total	FeO	H2O+	H2O-	CO2	Cl	F	Total sulfur
Site 64	Three Forks																			
82KAT-64A																				
82KAT-64B																				
82KAT-64D																				
82KAT-64E	NO MAJOR OXIDES ANALYZED FOR SITE 64																			
82KAT-64F																				
82KAT-64G																				
Site 68	Lower Valley																			
82KAT-68A																				
82KAT-68B																				
82KAT-68C																				
82KAT-68D																				
82KAT-68E	NO MAJOR OXIDES ANALYZED FOR SITE 68																			
82KAT-68F																				
82KAT-68G-1																				
82KAY-68H1																				
Site 69	Lower Valley																			
82KAT-69A																		0.16	0.02	0.31
82KAT-69B																		0.15	0.03	0.14
82KAT-69C																		0.14	0.04	<0.01
82KAT-69D	NO MAJOR OXIDES ANALYZED FOR SITE 69																	0.17	0.03	0.32
82KAT-69E																		0.15	0.03	<0.01
82KAT-69F																		0.14	0.06	0.09
Site 89	Upper Knife Creek																			
82KAT-89A																				
82KAT-89B																				
82KAT-89C	NO MAJOR OXIDES ANALYZED FOR SITE 89																			
82KAT-89D																				
82KAT-89E																				
Site 98	Mid valley, River Lethe side																			
82KAT-98B																				
82KAT-98C	NO MAJOR OXIDES ANALYZED FOR SITE 98																			
82KAT-98D																				
Site 105	Upper River Lethe, altered ash-flow tuff																			
82KAT-105A	most leached	86.9	1.73	0.2	<0.1	0.26	0.55	0.12	0.76	<0.05	<0.02	8.01	98.53	NA	NA	NA	NA	0.4	0.28	<0.01
82KAT-105B	pink, leached	78.4	7.21	2	1.31	1.8	2.08	1.2	0.68	<0.05	0.06	4.83	99.57	NA	NA	NA	NA	0.11	0.04	<0.01
82KAT-105C	gray, leached	64.5	15.1	4.8	1.37	5.52	3.45	1.63	0.52	0.12	0.07	2.91	99.99	NA	NA	NA	NA	0.3	1.3	<0.01

Table 1 continued

Sample number		SiO2	Al2O3	FeTO3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI 900C	Total	FeO	H2O+	H2O-	CO2	Cl	F	Total sulfur
Site 108	Bench along Buttress Range, upper valley																			
82KAT-108A																				
82KAT-108B																				
82KAT-108C																				
82KAT-108D																				
82KAT-108E																				
82KAT-108F																				
82KAT-108G																				
82KAT-108H	NO MAJOR OXIDES ANALYZED FOR SITE 108																			
82KAT-108I																				
82KAT-108J																				
82KAT-108K																				
82KAT-108L																				
82KAT-108M																				
82KAT-108N																				
82KAT-108O																				
82KAT-108P																				
82KAT-108Q																				
Site 113	Katmai Pass																			
82KAT-113A																				
82KAT-113B																				
82KAT-113C																				
82KAT-113D																				
82KAT-113E	NO MAJOR OXIDES ANALYZED FOR SITE 113																			
82KAT-113F																				
82KAT-113G																				
82KAT-113H																				
82KAT-113I																				
82KAT-113J																				
Site 122	Middle Knife Creek																			
82KAT-122A																		1.3	7.5	0.75
82KAT-122B																		0.26	0.08	0.37
82KAT-122C																		0.32	0.09	<0.01
82KAT-122D																		0.1	0.33	0.34
82KAT-122E																		0.46	3.2	0.02
82KAT-122F	NO MAJOR OXIDES ANALYZED FOR SITE 122																	0.54	2.4	<0.01
82KAT-122G																		0.016	0.19	0.08
82KAT-122H																		0.029	0.08	<0.01
82KAT-122I																		0.67	1.9	0.01
82KAT-122J																		0.11	0.32	<0.01
82KAT-122K																		0.11	12.3	0.3

Table 1 continued

Sample number		SiO2	Al2O3	FeTO3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI 900C	Total	FeO	H2O+	H2O-	CO2	Cl	F	Total sulfur
Site 127	warm, shoulder of Broken Mountain																			
82KAT-127A1																				
82KAT-127A2																				
82KAT-127B																				
82KAT-127C	NO MAJOR OXIDES ANALYZED FOR SITE 127																			
82KAT-127D																				
82KAT-127E																				
Site 183	Upper Knife Creek																			
79KAT-183	leached fallout	76.02	10.86	1.03	0.59	2.06	2.58	1.5	0.83	0.07	0.021	NA	ND	0.56	2.32	2.1	0.04	0.27	0.31	0.011
Site 211	Mid valley, River Lethe area, leached ash-flow tuff																			
87KAT211A	most leached	72.5	12.3	2.04	1.71	3.28	3.52	1.77	0.57	<.05	0.06	1.61	99.36	1.4	0.45	1.13	0.07	0.19	0.02	<0.01
87KAT211B		70.7	13.8	2.51	1.86	3.58	3.72	1.96	0.57	<.05	0.06	1.13	99.89	1.62	0.47	0.56	0.04	0.14	0.04	0.04
87KAT211C	least leached	65.1	15.8	4.7	2.21	4.84	3.72	1.76	0.55	0.09	0.07	1.01	99.85	1.95	0.75	0.23	0.01	0.1	0.11	0.16
Site 212	Mid valley, River Lethe area																			
87KAT212A	ht,gt-rich	51.6	16.8	3.56	2.25	5.64	2.72	0.88	0.61	0.16	0.05	13.9	98.17	1.3	4.83	1.86	0.03	0.35	6.84	0.16
87KAT212B		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.38	4.45	<0.01
87KAT212C		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.24	2.03	<0.01
87KAT212D		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.29	0.82	<0.01
87KAT212E	mt-rich	59.2	15.9	5.47	1.9	5.93	3.04	0.58	0.58	0.18	0.09	5.39	98.26	2.19	1.69	1.24	0.05	0.31	2.83	<0.01
87KAT212F		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.12	1.36	<0.01
87KAT212G		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.22	1.84	0.01
87KAT212H		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.15	1.51	<0.01
87KAT212J	most leached	79	6.71	1.47	1.2	1.73	1.93	0.99	0.61	<0.05	0.03	5.48	99.15	0.89	1.38	3.41	0.02	0.57	0.04	0.04
87KAT212K		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.18	0.03	0.13
87KAT212L		68.3	15.1	2.31	1.8	3.93	3.8	1.93	0.5	0.07	0.06	1.88	99.68	1.41	0.87	0.54	0.04	0.11	0.03	0.14
87KAT212M		66.9	15.9	2.4	1.96	4.2	3.63	1.85	0.5	0.11	0.07	2.38	99.9	1.48	1.17	0.94	0.01	0.073	0.03	0.07
87KAT212N		66.2	15.3	4.32	2.11	4.54	3.72	1.88	0.49	0.08	0.08	0.98	98.66	1.78	0.52	0.44	<0.01	0.082	0.04	<0.01
87KAT212O	least leached	65.1	16.5	2.84	1.88	4.14	3.38	1.75	0.49	0.11	0.07	3.56	99.82	1.39	1.75	1.62	0.04	0.023	0.03	0.05

Table 2. Trace element analyses for whole-rock samples of fumarolically-altered ash-flow tuff and fallout from the 1912 eruption of Novarupta. Values in parts per million (ppm) unless otherwise indicated. See text for analysts and methods. N = not detected at limit of detection given for first sample in series (see text), SWR = analyzed by short-wave radiation technique (see text), H = interference, usually by high Fe or organic material.

Sample	Description	Si(%)	Al(%)	Na(%)	K(%)	P(%)	Fe (%)	Mg (%)	Ca(%)	Ti(%)	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr
Site 15	Lower Valley					SWR							SWR				SWR	SWR		
79KAT-15A1		10	5	1	0.7	0.07	2	0.3	0.3	0.3	N <0.2	1000	N <0.2	700	150	N <0.7	5	1.5	2	15
79KAT-15B		N	3	0.3	0.7	0.07	1.5	0.15	0.07	0.3	N	3000	N	1500	70	N	3	2	N <1	10
79KAT-15C		N	5	1	1	0.05	2	0.5	0.15	0.2	N	2000	N	700	100	N	10	1.5	1	20
79KAT-15D		N	7	2	1.5	0.15	3	0.7	1	0.3	1	SWR 30	N	15	500	1	3	N <0.2	7	10
79KAT-15E		N	0.15	0.07	0.05	0.005	0.2	0.02	0.015	0.05	N	SWR 100	N	7	10	N	N <0.2	N	N	1.5
Site 23	West side Baked Mountain																			
79KAT-23A	(no SWR,	7	3	0.5	0.7	0.07	0.7	0.3	0.1	0.15	N <0.2	30	N <0.2	500	70	N <0.7	1	N <0.2	1	5
79KAT-23B	except 23E-1)	>10	10	3	1	0.05	7	2	7	0.2	0.5	50	N	50	500	3	N <0.2	0.5	15	20
79KAT-23C		>10	7	2	1	0.03	3	1.5	2	0.2	0.3	200	N	150	300	N	N	0.2	15	15
79KAT-23D		>10	10	3	1	0.05	5	3	5	0.3	0.5	70	N	70	500	N	2	0.5	20	20
79KAT-23E		>10	10	2	1	0.05	3	2	5	0.3	N	50	N	70	300	1	N	0.7	15	15
79KAT-23E-1*		>10	7	3	1	SWR 0.02	7	1.5	7	0.3	N	SWR 100	SWR <0.2	30	500	1	SWR 0.2	SWR 5	10	20
Site 32	Novarupta					SWR						SWR	SWR				SWR	SWR		
79KAT-32-1		10	5	1	0.2	0.07	5	0.3	0.15	0.3	N <0.2	70	N <0.2	N <2	200	N <0.7	N <0.2	N <0.2	1.5	30
79KAT-32-2		10	5	0.7	0.2	0.15	1.5	0.5	0.2	0.5	N	20	N	N	300	N	N	N	5	15
Site 34	NW end Baked Mountain																			
79KAT-34A	(no SWR)	0.7	7	1.5	0.3	0.2	1	3	0.5	0.03	N <0.2	200	N <0.2	150	50	N <0.7	1	N <0.2	N <1	5
79KAT-34B		10	7	0.15	N	0.07	3	0.3	3	0.02	N	100	N	5	150	N	5	0.3	30	15
79KAT-34C		10	5	0.7	0.3	0.03	1.5	1	0.2	0.2	N	300	N	150	100	N	5	0.3	3	7
79KAT-34D		N	7	0.7	0.5	0.07	2	0.7	0.5	0.5	N	700	N	7	300	N	20	N	10	10
79KAT-34E		N	7	0.7	0.2	0.1	2	1	7	0.3	N	70	N	50	200	N	10	0.2	20	10
79KAT-34F		N	10	3	1.5	0.03	3	1.5	5	0.3	1	50	N	30	500	1	20	1	20	15
79KAT-34G		N	7	1.5	0.7	0.03	7	3	7	0.5	N	500	N	20	300	3	10	1.5	20	15
79KAT-34H		10	10	1	0.2	0.1	5	1.5	1.5	0.2	N	150	N	70	300	N	N <0.2	0.3	7	20
Site 36	NW end Baked Mountain																			
79KAT-36A	(no SWR)	N	5	0.7	0.5	0.02	>10	1	10	0.07	N <0.2	100	N <0.2	70	200	N <0.7	3	0.7	15	15
79KAT-36B		N	7	1.5	0.5	0.03	2	1	2	0.1	N	15	N	30	200	N	2	0.5	15	10
79KAT-36C		N	5	1.5	0.7	0.05	2	0.3	0.3	0.1	N	50	N	10	200	N	N <0.2	N <0.2	3	7
79KAT-36D		N	5	0.7	0.2	0.05	0.7	0.3	0.01	0.3	N	100	0.3	700	200	N	0.3	0.3	N <1	5
79KAT-36E		N	0.3	0.1	N	0.007	1.5	0.03	0.05	0.05	N	200	N	50	70	N	1	N	N	N <0.7
79KAT-36F		N	2	0.5	0.5	0.03	1	0.05	0.2	1.5	N	20	N	50	300	N	N	N	N	3

Table 2 continued

Sample	Description	Cu	Ga	Hg	La	Mo	Mn	Nb	Ni	Pb	Sb	Sc	Se	Sn	Sr	Tl	V	W	Y	Yb	Zn	Zr
Site 15	Lower Valley			SWR							SWR		SWR			SWR					SWR	
79KAT-15A1		7	10	N <1	N <7	10	200	N <10	N <0.7	50	30	20	N <5	500	70	20	150	N <10	10	2	70	50
79KAT-15B		15	7	N	N	50	50	N	N	300	50	15	N	1000	70	20	100	N	20	3	70	70
79KAT-15C		100	30	N	N	20	200	N	N	200	30	15	N	1000	30	50	100	N	15	1.5	150	70
79KAT-15D		15	20	N	50	N <2	1000	N	2	20	N <1	20	N	5	300	1	150	N	30	5	150	200
79KAT-15E		3	1	3	N	N	20	7	N	7	N	2	N	3	2	N <1	5	N	N <7	N <0.7	1.5	30
Site 23	West side Baked Mountain																					
79KAT-23A	(no SWR,	15	7	NA	N <7	N <2	150	N <10	N <0.7	2	2	20	NA	N <2	20	NA	30	N <10	7	0.7	7	100
79KAT-23B	except 23E-1)	10	30	N <1	30	N	700	N	7	150	7	30	N <5	50	500	5	70	N	30	3	10	70
79KAT-23C		15	20	N	15	30	500	N	5	70	20	30	N	50	300	1.5	100	N	15	2	10	70
79KAT-23D		20	20	N	20	N	700	N	7	70	7	50	N	30	500	N <1	100	N	30	3	50	100
79KAT-23E		15	30	N	15	N	500	N	7	100	7	30	N	20	300	3	100	N	30	3	50	100
79KAT-23E-1		10	20	N	30	N	1500	N	15	30	SWR 3	20	N	30	300	1.5	100	N	20	3	SWR 200	70
Site 32	Novarupta			SWR							SWR		SWR			SWR					SWR	
79KAT-32-1		7	20	N <1	10	N <2	300	N <10	0.7	10	N <1	15	N <5	N <2	150	N <1	200	N <10	7	2	50	100
79KAT-32-2		10	20	N	20	N	500	N	2	7	N	30	N	N	100	N	150	N	15	1.5	70	200
Site 34	NW end Baked Mountain																					
79KAT-34A	(no SWR)	5	10	N <1	10	N <2	200	N <10	N <0.7	5	2	70	N <5	10	30	10	50	N <10	50	3	1	N <3
79KAT-34B		20	10	N	10	N	100	N	7	50	10	50	N	50	200	1.5	150	N	15	1.5	20	N
79KAT-34C		7	7	1	7	N	200	N	0.7	10	5	20	20	15	30	50	70	N	15	1.5	10	70
79KAT-34D		20	10	1	7	N	200	N	5	7	20	20	50	5	300	1	100	N	15	2	10	70
79KAT-34E		15	10	N	10	N	200	N	7	10	20	30	N	7	300	1	100	N	20	3	20	50
79KAT-34F		70	30	1	20	10	700	N	5	100	5	30	N	10	500	10	100	N	30	5	200	100
79KAT-34G		15	20	N	30	N	700	N	5	20	2	30	N	15	500	10	150	N	50	2	20	150
79KAT-34H		7	30	N	10	N	300	N	5	10	10	30	N	100	300	N <1	200	N	15	2	15	30
Site 36	NW end Baked Mountain																					
79KAT-36A		15	H	N <1	N <7	10	300	N <10	5	200	20	20	N <5	H	700	10	150	N <10	50	H	30	300
79KAT-36B		20	20	1	N	N <2	500	N	5	70	10	20	N	70	200	N <1	100	N	15	3	20	150
79KAT-36C		15	20	1.5	N	N	300	N	N <0.7	15	15	15	N	N <2	100	1	70	N	10	2	7	150
79KAT-36D		7	15	N	N	N	30	N	N	10	10	10	N	50	5	20	50	N	15	1	1	200
79KAT-36E		5	N <0.7	2	N	N	30	N	N	20	10	N <0.7	N	N	7	2	15	N	N <7	1	1	50
79KAT-36F		7	15	2	N	N	100	N	N	5	5	5	N	N	30	N	15	N	15	3	5	200

Table 2 continued

Sample	Description	Si(%)	Al(%)	Na(%)	K(%)	P(%)	Fe (%)	Mg (%)	Ca(%)	Ti(%)	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr
Site 42	Upper Knife Creek																			
79KAT-42A	(no SWR)	>10	2	1.5	0.7	0.03	3	1	1	0.15	N <0.2	5	N <0.2	30	200	N <0.7	0.5	0.2	30	10
79KAT-42B		>10	10	2	0.7	0.03	3	1.5	5	0.15	N	10	N	20	200	N	0.2	0.3	20	10
79KAT-42C		5	7	1.5	0.5	0.05	3	1.5	3	0.1	N	10	N	20	200	N	5	N <0.2	30	30
79KAT-42C-1		>10	7	2	1.5	SWR 0.05	1.5	0.7	5	0.3	N	N <150	N	5	500	N	N <0.2	N	7	15
79KAT-42D		>10	7	1.5	0.5	0.02	2	0.7	3	0.15	N	20	N	15	200	N	N	N	7	7
79KAT-42E		>10	7	1.5	0.7	0.03	2	0.3	1.5	0.1	N	50	N	30	300	N	15	N	7	10
79KAT-42F		>10	7	1.5	0.5	0.05	2	0.7	1.5	0.1	N	20	N	50	200	N	5	N	7	10
79KAT-42G		>10	7	2	0.7	0.07	10	1.5	3	0.1	N	200	N	20	200	N	N	0.2	15	20
79KAT-42H		>10	7	1.5	0.3	0.03	3	0.3	1.5	0.1	N	50	N	50	700	N	0.5	N	7	7
Site 46	Turtle					SWR							SWR				SWR	SWR		
79KAT-46A1		10	5	0.15	0.1	0.03	1.5	0.2	0.03	0.3	N <0.2	20	N <0.2	3	150	N <0.7	N <0.2	N <0.2	10	7
79KAT-46A2*	SWR	10	3	0.3	0.15	0.03	3	0.5	0.15	0.3	N	N <150	N	N <2	150	N	N	N	5	15
79KAT-46A3*	SWR	10	5	0.15	0.15	0.007	2	0.3	0.05	0.5	N	N	N	N	70	N	N	N	5	15
79KAT-46B		10	5	0.3	0.3	0.1	0.5	0.02	0.01	0.3	N	7	N	N	200	N	N	N	N <1	15
79KAT-46C		N	7	1.5	0.7	0.07	1.5	1	0.3	0.2	N	20	N	3	300	N	N	N	7	15
79KAT-46D*	SWR	N	7	2	2	0.05	2	0.7	3	0.3	N	N	N	7	500	N	N	N	5	20
79KAT-46E*	SWR	N	7	3	2	0.02	1.5	0.3	1.5	0.3	N	N	N	15	500	N	N	N	2	15
79KAT-46F*	SWR	N	7	2	2	0.02	1.5	0.5	1	0.5	N	N	N	15	500	N	N	N	5	15
79KAT-46G1*	SWR	N	0.3	0.1	0.1	0.003	1	0.015	0.07	0.15	N	N	N	N	50	N	N	N	3	5
79KAT-46G2*	SWR	N	0.3	0.1	0.1	0.01	2	0.02	0.05	0.2	N	N	N	N	50	N	N	N	1.5	7
79KAT-46G3		N	0.15	0.02	N	0.003	1.5	0.01	0.01	0.01	N	50	N	20	15	N	N	N	10	3
79KAT-46H		N	5	0.1	0.07	0.05	1.5	0.07	0.03	0.7	0.5	50	N	30	300	N	3	N	5	10
Site 47	Pea Soup Pass					SWR							SWR				SWR	SWR		
79KAT-47A		N	5	1.5	1	0.03	1.5	0.3	0.3	0.2	N <0.2	N <150	N <0.2	N <2	300	N <0.7	N <0.2	0.2	15	20
79KAT-47B		N	7	2	1	0.07	1.5	0.5	0.5	0.3	N	N	N	N	300	N	N	0.2	7	30
79KAT-47C		N	7	2	1	0.03	2	0.7	2	0.3	N	N	N	N	300	N	N	0.2	10	20
79KAT-47D		N	10	0.1	1	0.02	3	0.5	0.3	0.5	N	N	N	N	300	N	N	N <0.2	1.5	30
79KAT-47E		N	7	2	1	0.15	3	0.7	3	0.3	N	N	N	N	300	N	N	0.2	15	30
Site 50	Novarupta																			
79KAT-50A		10	5	0.15	0.5	0.3	0.7	0.15	0.02	0.2	N <0.2	150	N <0.2	70	300	N <0.7	50	N <0.2	5	10
79KAT-50B		10	5	0.3	0.5	0.02	1.5	0.2	0.1	0.3	N	50	N	150	200	N	5	N	7	10
Site 62	Upper Knife Creek																			
79KAT-62		>10	5	1	0.3	0.05	2	0.7	1.5	0.1	N <0.2	30	N <0.2	70	150	N <0.7	3	N <0.2	7	15
Site 63	Three Forks					SWR						SWR	SWR				SWR	SWR		
82KAT-63A		>10	5	2	2	0.012	7	0.7	0.5	0.1	N <0.2	170	N <0.2	20	700	1.5	500	1.8	5	3
82KAT-63B		<10	7	2	3	0.064	5	0.7	2	0.1	0.3	63	N	100	1000	1.5	16	10	15	20
82KAT-63D		<10	7	1.5	2	0.074	5	0.3	5	0.15	0.3	120	N	70	1000	2	500	1.2	50	15
82KAT-63E		<10	2	1.5	2	0.0075	0.7	0.07	0.3	0.15	N	16	N	30	1000	N <0.7	7.8	0.59	N <1	N <0.7
82KAT-63F		<10	1.5	2	2	0.065	0.7	0.03	0.15	0.07	N	45	N	50	300	N	N <0.2	N <0.2	N	10
82KAT-63G		<10	5	2	2	0.015	3	0.3	0.5	0.15	N	15	N	20	1000	1.5	4.9	N	10	7
82KAT-63H		<10	7	2	2	0.023	2	0.3	0.7	0.2	0.2	12	N	30	1000	2	8	0.6	15	10

Table 2 continued

Sample	Description	Cu	Ga	Hg	La	Mo	Mn	Nb	Ni	Pb	Sb	Sc	Se	Sn	Sr	Tl	V	W	Y	Yb	Zn	Zr
Site 42	Upper Knife Creek																					
79KAT-42A		50	30	N <1	N <7	N <2	1000	N <10	10	5	2	15	N <5	N <2	100	N <1	100	N <10	15	5	10	200
79KAT-42B		15	50	N	N	N	1000	N	5	15	2	20	N	N	500	1.5	70	N	15	5	10	150
79KAT-42C		70	70	N	N	N	700	N	10	7	3	15	N	N	300	N	150	N	15	7	5	150
79KAT-42C-1		20	15	N	15	N	1000	N	3	N <7	SWR 5	30	N	N	300	N	100	N	20	2	SWR 100	100
79KAT-42D		30	20	N	N	N	500	N	2	5	2	15	N	N	300	N	70	N	15	3	7	150
79KAT-42E		10	20	1.5	N	N	300	N	3	15	20	15	N	50	150	N	70	N	20	5	5	200
79KAT-42F		20	20	N	N	N	500	N	3	10	150	15	N	70	200	N	70	N	10	3	30	100
79KAT-42G		70	H	N	N	N	500	N	5	1000	5	20	N	H	500	20	150	N	20	H	30	150
79KAT-42H		30	30	2	N	N	300	N	3	50	5	15	N	N	200	1.5	100	N	30	7	5	200
Site 46	Turtle			SWR							SWR		SWR			SWR					SWR	
79KAT-46A1		30	15	N <1	10	N <2	150	N <10	3	50	1	20	N <5	N <2	30	1	70	N <10	15	3	20	200
79KAT-46A2*	SWR	20	15	N	N	N	500	N	2	10	N <1	20	N	5	70	N <1	100	N	10	2	70	200
79KAT-46A3*	SWR	30	7	N	N	N	200	N	1	7	N	20	N	N	20	N	100	N	10	1.5	30	500
79KAT-46B		20	10	N	10	N	30	N	5	15	N	7	N	N	70	N	100	N	N <7	N <0.7	10	70
79KAT-46C		20	20	N	7	N	30	N	2	10	N	20	N	N	300	N	70	N	15	2	5	50
79KAT-46D*	SWR	10	15	N	20	N	700	N	2	7	2	50	N	N	300	N	70	N	30	3	70	200
79KAT-46E*	SWR	20	20	N	20	N	500	N	1	10	1.5	20	N	N	150	N	50	N	30	3	30	200
79KAT-46F*	SWR	30	20	N	20	N	500	N	2	N <7	3	20	N	N	150	N	50	N	30	3	70	300
79KAT-46G1*	SWR	15	7	5	N	N	20	N	1.5	N	3	2	N	N	7	N	5	N	N	0.7	10	70
79KAT-46G2*	SWR	15	15	2	N	N	30	N	1	N	3	3	N	N	5	N	10	N	N	1	1.5	100
79KAT-46G3		20	N <0.7	N	N	N	10	N	5	2	N	N <0.7	N	N	3	N	5	N	N	N	5	15
79KAT-46H		20	20	N	15	3	70	15	3	20	5	20	N	5	150	1	70	N	20	5	10	300
Site 47	Pea Soup Pass			SWR							SWR		SWR			SWR					SWR	
79KAT-47A		50	15	2	10	N <2	200	N <10	5	N <7	N <1	20	N <5	N <2	150	N <1	70	N <10	20	2	50	150
79KAT-47B		30	15	1	N	N	700	N	7	N	N	20	N	N	200	N	100	N	15	2	70	100
79KAT-47C		30	20	N <1	10	N	1000	N	5	N	N	30	N	N	200	1	70	N	15	2	70	150
79KAT-47D		20	30	N	30	N	200	7	1	7	3	30	N	5	200	N	70	N	15	2	30	200
79KAT-47E		30	20	N	N	N	1000	N	7	N	N	30	N	3	300	N	100	N	15	3	150	70
Site 50	Novarupta																					
79KAT-50A		15	20	20	15	N <2	150	N <10	2	20	15	15	N <5	N <2	200	2	70	N <10	20	2	10	200
79KAT-50B		10	15	15	15	N	200	N	2	30	2	15	N	N	300	N <1	100	N	10	2	10	150
Site 62	Upper Knife Creek																					
79KAT-62		15	20	1	N	N <2	500	N <10	2	10	30	20	N <5	150	100	1	100	N <10	10	3	5	150
Site 63	Three Forks			SWR							SWR		SWR			SWR					SWR	
82KAT-63A		20	30	N <1	N	N <2	150	N <10	3	50	N <1	15	N <5	30	100	27	300	N <10	50	5	52	150
82KAT-63B		70	15	N	20	N	700	N	10	70	N	15	N	15	300	N <1	100	N	50	5	300	200
82KAT-63D		70	30	27	20	N	200	N	5	150	N	10	N	100	500	8	150	N	30	3	100	200
82KAT-63E		5	10	15	20	5	200	N	N <0.7	15	N	7	N	N <2	70	N	5	N	50	5	46	200
82KAT-63F		2	15	20	N	3	100	N	N	10	N	5	N	N	70	N	50	N	10	1.5	14	70
82KAT-63G		70	15	15	15	N	200	N	5	10	N	10	N	5	100	N	30	N	50	5	42	150
82KAT-63H		20	20	15	30	N	300	N	5	10	N	15	N	5	200	N	50	N	70	7	21	200

Table 2 continued

Sample	Description	Si(%)	Al(%)	Na(%)	K(%)	P(%)	Fe (%)	Mg (%)	Ca(%)	Ti(%)	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr
Site 64	Three Forks					SMR						SMR	SMR				SMR	SMR		
82KAT-64A		<10	5	2	2	0.011	2	0.2	0.5	0.15	N <0.2	18	N <0.2	20	1000	N <0.7	2	N <0.2	1.5	5
82KAT-64B		<10	2	2	2	0.012	1.5	0.3	0.5	0.15	N	12	N	30	1000	1	2.2	N	2	5
82KAT-64D		<10	7	3	3	0.014	1.5	0.3	1	0.15	N	14	N	30	1000	1.5	1.9	N	3	5
62KAT-64E		<10	3	2	2	0.01	1	0.2	0.5	0.15	N	9.8	N	15	1000	1	1.8	0.57	3	5
82KAT-64F		<10	5	3	3	0.0085	2	0.3	0.7	0.15	N	17	N	20	1000	1	1.9	0.57	2	5
82KAT-64G		<10	3	2	3	0.008	2	0.2	0.5	0.15	N	14	N	30	1000	1	1.8	0.56	2	5
Site 68	Lower Valley					SMR						SMR	SMR				SMR	SMR		
82KAT-68A		<10	5	3	3	0.02	1	0.3	1.5	0.3	N <0.2	130	N <0.2	20	1000	1	N <0.2	N <0.2	2	N <0.7
82KAT-68B		<10	5	2	3	0.032	5	0.2	0.5	0.15	N	20	N	10	1000	1	1.2	N	N <1	7
82KAT-68C		<10	7	2	3	0.058	5	0.3	0.5	0.15	N	12	N	10	1000	N <0.7	2.2	0.56	1.5	20
62KAT-68D		5	0.7	1	0.7	0.038	0.3	0.07	10	0.15	N	16	N	100	300	N	4.3	N	N	5
82KAT-68E		10	2	1.5	1	0.07	10	2	3	0.15	N	280	N	100	500	1	10	12	50	5
82KAT-68F		<10	5	3	2	0.025	2	0.5	1	0.2	0.2	85	N	15	1000	N	27	1.6	7	7
82KAT-68G-1		<10	2	2	1	0.056	<10	1	0.7	0.15	N	44	N	100	300	N	69	0.95	20	5
82KAY-68H1		3	2	3	1	0.054	0.3	0.15	0.1	0.1	N	13	N	70	50	N	4.6	N	N	5
Site 69	Lower Valley					SMR						SMR	SMR				SMR	SMR		
82KAT-69A		<10	5	2	2	0.022	1	0.3	0.7	0.2	N <0.2	14	N <0.2	20	1000	1.5	1.9	0.58	3	7
82KAT-69B		<10	3	2	2	0.019	1.5	0.3	1	0.15	N	14	N	20	1000	1	1.9	0.59	5	5
82KAT-69C		<10	5	2	2	0.013	2	0.3	1	0.15	0.2	12	N	20	1000	1.5	2.4	0.56	7	10
62KAT-69D		<10	3	2	3	0.016	1	0.2	0.5	0.15	0.5	13	N	20	1000	1.5	2	0.56	3	7
82KAT-69E		<10	5	3	3	0.011	1	0.3	1	0.15	0.2	8	N	20	1000	2	1.8	0.55	3	5
82KAT-69F		<10	5	3	3	0.016	1.5	0.5	1	0.2	N	12	N	20	1000	N <0.7	1.9	N <0.2	5	7
Site 89	Upper Knife Creek											SMR	SMR				SMR	SMR		
82KAT-89A		>10	10	3	1.5	0.16	7	1.5	3	0.5	0.3	316	N <0.1	100	700	N <0.7	11	5.2	30	20
82KAT-89B		>10	7	3	1	0.14	5	1	3	0.3	N <0.2	334	N	7	500	N	23	N <.04	10	15
82KAT-89C		>10	7	2	1	0.12	7	1	5	0.3	N	1000	N	100	500	N	13.6	N	7	30
82KAT-89D		>10	7	2	1	0.26	2	0.5	0.5	0.2	N	342	N	300	300	N	14.6	N	3	15
82KAT-89E		>10	5	3	1	0.056	1	0.5	0.3	0.3	N	374	N	70	150	N	10	N	5	10
Site 98	Mid valley, River Lethe side											SMR	SMR				SMR	SMR		
82KAT-98B		>10	7	2	2	0.13	>10	0.5	0.3	0.2	0.7	700	N <0.1	200	700	N <0.7	126	9.6	7	30
82KAT-96C		10	7	3	0.7	0.45	0.15	1	0.5	0.7	N <0.2	176	N	500	700	N	32	N <.04	N <1	3
82KAT-98D		>10	7	2	2	0.49	>10	0.3	1	0.2	N	44	N	15	700	N	7.4	1	5	30
Site 105	Upper River Lethe, altered ash-flow tuff					SMR						SMR	SMR				SMR	SMR		
82KAT-105A	most leached	>10	0.5	0.3	0.2	0.008	0.15	0.05	0.15	0.5	1	200	N <0.2	30	70	N <0.7	1.9	0.81	N <1	3
82KAT-105B	pink, leached	>10	3	1.5	1	0.027	1.5	0.7	1.5	0.7	N <0.2	72	N	7	700	N	N <0.2	N <.04	7	30
82KAT-105C	gray, leached	>10	7	2	1.5	0.056	2	0.5	3	0.5	N	170	N	150	700	N	10	4.6	15	20

Table 2 continued

Sample	Description	Cu	Ga	Hg	La	Mo	Mn	Nb	Ni	Pb	Sb	Sc	Se	Sn	Sr	Tl	V	W	Y	Yb	Zn	Zr
Site 64	Three Forks			SWR							SWR		SWR			SWR					SWR	
82KAT-64A		3	15	10	10	N <2	200	N <10	N <0.7	15	N <1	7	N <5	N <2	150	N <1	15	N <10	50	5	36	200
82KAT-64B		5	15	15	15	N	300	N	2	10	N	7	N	N	150	N	15	N	50	5	36	300
82KAT-64D		10	15	14	20	5	500	N	5	15	N	10	N	5	150	N	20	N	70	7	46	500
82KAT-64E		30	15	14	20	3	500	N	1.5	15	N	7	N	N	100	N	15	N	50	5	29	200
82KAT-64F		10	15	N <1	20	3	300	N	1	15	N	10	N	5	150	N	20	N	50	7	29	500
82KAT-64G		5	15	N	15	2	300	N	1	15	N	10	N	N	150	N	15	N	50	7	28	300
Site 68	Lower Valley			SWR							SWR		SWR			SWR					SWR	
82KAT-68A		7	15	N <1	20	7	300	N <10	N <0.7	15	N <1	7	N <5	3	200	N <1	20	N <10	30	7	31	300
82KAT-68B		7	20	N	15	N <2	300	N	N	20	N	7	N	7	200	N	50	N	50	7	35	150
82KAT-68C		10	20	N	15	N	300	N	N	20	N	10	N	5	500	N	500	N	50	7	30	300
82KAT-68D		1	5	N	15	2	70	N	N	N <7	18	10	N	N <2	700	12	20	N	50	2	4.1	70
82KAT-68E		100	20	N	10	N	500	N	7	20	N	7	N	15	500	2.8	70	N	20	2	64	50
82KAT-68F		20	20	N	N	N	500	N	2	150	20	10	N	70	150	33	10	N	30	5	98	150
82KAT-68G-1		50	30	N	N	N	700	N	10	30	N	7	N	N	150	1	30	N	20	2	72	30
82KAY-68H1		2	7	N	N	N	150	N	N	N	N	10	N	N	30	N	150	N	N <7	N <0.7	14	10
Site 69	Lower Valley			SWR							SWR		SWR			SWR					SWR	
82KAT-69A		15	15	N <1	15	3	500	N <10	1	20	N <1	15	N <5	N <2	150	N <1	50	N <10	30	5	28	300
82KAT-69B		10	15	N	20	3	500	N	1	15	N	10	N	N	150	N	50	N	50	5	36	300
82KAT-69C		30	15	N	20	7	500	N	3	15	N	10	N	5	150	N	70	N	50	7	34	300
82KAT-69D		30	15	13	20	7	300	N	7	15	N	10	N	3	150	N	30	N	50	5	32	500
82KAT-69E		10	15	N	20	7	500	N	1.5	30	N	7	N	3	150	N	20	N	50	7	41	200
82KAT-69F		20	20	N	20	7	500	N	3	20	N	15	N	3	200	N	50	N	50	7	37	300
Site 89	Upper Knife Creek																				SWR	
82KAT-89A		70	15	N <2	N <7	N <2	1500	N <10	20	300	23	30	N <5	150	500	60	200	N <10	20	N <0.7	300	150
82KAT-89B		50	20	N	N	N	1000	N	7	15	13	20	N	50	300	200	100	N	10	N	100	70
82KAT-89C		30	30	N	N	N	700	N	3	7	21	15	63	100	300	116	300	N	20	2	66	70
82KAT-89D		20	20	N	N	N	300	N	1.5	100	39	15	57	50	150	186	100	N	7	N	46	70
82KAT-89E		5	10	N	N	N	300	N	1.5	N <7	68	20	N	30	100	N <1	200	N	7	N	48	30
Site 98	Mid valley, River Lethe side																				SWR	
82KAT-98B		200	70	N <2	N <7	200	300	N <10	7	1000	76	10	138	100	150	1000	500	N <10	15	N <0.7	500	200
82KAT-98C		15	10	N	N	100	50	N	N <0.7	70	64	20	N <5	10	50	132	50	N	15	N	36	100
82KAT-98D		30	50	N	N	N <2	500	N	N	20	28	10	N	30	200	N <1	150	N	15	N	78	150
Site 105	Upper River Lethe, altered ash			SWR							SWR		SWR			SWR					SWR	
82KAT-105A	most leached	15	3	6.9	N <7	7	30	N <10	N <0.7	50	135	N <0.7	N <10	15	15	N <2	3	N <10	N <7	1	18	150
82KAT-105B	pink, leached	30	10	26	N	7	700	N	3	30	24	15	N	20	200	N	30	N	30	3	37	500
82KAT-105C	gray, leached	20	20	N <2	20	5	500	N	5	500	23	15	N	100	300	43	150	N	50	7	500	500

Table 2 continued

Sample	Description	Si(%)	Al(%)	Na(%)	K(%)	P(%)	Fe (%)	Mg (%)	Ca(%)	Ti(%)	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr
Site 108	Bench along Buttress Range, upper valley											SWR					SWR	SWR		
82KAT-108A		>10	10	3	1.5	0.06	7	1	5	0.3	N <0.2	268	N <0.1	15	500	N <0.7	1.9	1.5	10	20
82KAT-108B		>10	7	2	1.5	0.094	>10	1	3	0.2	N	264	N	20	500	N	10.8	N <.04	10	20
82KAT-108C		>10	7	3	1.5	0.1	7	1.5	3	0.3	N	300	N	20	500	N	3.9	N	10	30
82KAT-108D		>10	5	2	1.5	0.096	10	0.5	1	0.2	N	182	N	15	300	N	8	N	7	15
82KAT-108E		>10	7	2	1.5	0.086	5	1	3	0.3	N	134	N	7	500	N	22	2.6	15	20
82KAT-108F		>10	10	3	3	0.18	5	0.5	1.5	0.3	N	372	N	15	1000	N	18	3.8	7	15
82KAT-108G		>10	7	1	0.7	0.19	0.7	0.3	0.3	0.2	N	248	N	20	300	N	N <.04	N	3	10
82KAT-108H		>10	10	3	1	0.2	7	1	5	0.3	N	462	N	10	500	N	4.6	3.6	15	30
82KAT-108I		>10	10	3	1	0.12	5	1	5	0.5	N	122	N	30	500	N	2.1	2.3	10	15
82KAT-108J		>10	10	3	1	0.14	5	1.5	5	0.5	N	200	N	50	700	N	8.8	3.6	20	30
82KAT-108K		>10	10	3	2	0.14	7	0.5	1	0.3	0.2	236	N	30	1000	N	64	1.8	20	20
82KAT-108L		>10	10	3	2	0.013	5	1	3	0.5	N	34	N	15	700	N	8	N	7	20
82KAT-108M		>10	7	3	1.5	0.082	3	1	3	0.3	N	50	N	10	500	N	N	N	10	20
82KAT-108N		>10	5	3	3	0.0058	0.7	0.1	0.3	0.15	N	49	N	30	1000	N	1.5	N	N <1	N <0.7
82KAT-108O		>10	3	3	3	0.0078	0.7	0.1	0.3	0.1	N	71	N	30	1000	N	1.2	N	N	N
82KAT-108P		>10	7	3	3	0.11	5	0.5	0.3	0.2	N	1500	N	200	500	N	108	N	2	15
82KAT-108Q		>10	1	0.2	0.3	0.02	0.5	0.7	0.3	1	N	344	N	500	100	N	18	N	1	5
Site 113	Katmai Pass					SWR						SWR	SWR				SWR	SWR		
82KAT-113A		32	9.6	2.1	1.1	0.092	7.3	2	3.2	0.36	N <1	19	N <0.2	15	370	N <1	20	0.23	16	22
82KAT-113B		27	9.4	2.1	1.2	0.086	7.1	2.1	4.9	0.3	N	20	N	15	390	N	2	2	21	29
82KAT-113C		27	11	1.6	0.94	0.16	4.1	1.1	3.6	0.35	N	42	N	<10	370	N	8.8	1.1	17	35
82KAT-113D		29	11	2.5	1.3	0.068	5.5	2.5	6.4	0.4	N	69	N	18	430	N	6.4	1.8	20	35
82KAT-113E		22	7.4	2.8	1.1	0.049	>10	2.1	3.9	0.29	N	23	N	H	270	N	7	1.1	34	31
82KAT-113F		30	9	1.6	1.1	0.3	2.4	0.72	2	0.33	N	190	N	72	440	N	5.7	N <0.08	10	21
82KAT-113G		23	9.6	2.3	0.92	0.052	9.3	1.9	3.6	0.33	N	46	N	13	270	N	N <0.2	N	20	30
82KAT-113H		28	11	1.3	0.76	0.14	1.9	0.8	1.7	0.37	N	73	N	42	280	N	8.1	N	22	40
82KAT-113I		35	6.1	1.9	0.95	0.022	1.4	0.54	1.7	0.45	N	140	N	22	330	N	N	0.92	6.6	11
82KAT-113J		32	76	2.6	1.7	0.016	3.3	0.93	2.2	0.27	N	24	N	15	730	N	N	0.68	9.2	13
Site 122	Middle Knife Creek					SWR						SWR	SWR				SWR	SWR		
82KAT-122A		NA	NA	1.1	NA	0.38	0.6	0.2	0.46	0.24	N <2	420	N <0.2	800	400	N <2	16	N <0.08	6.2	38
82KAT-122B		22	11	64	0.46	0.0064	1.2	0.69	0.95	0.28	N <1	10	N	29	85	N <1	N	N	5.5	29
82KAT-122C		31	8.3	1.3	0.97	0.054	6.3	2.7	2.2	0.37	N	12	N	49	330	N	6.6	0.25	21	15
82KAT-122D		24	11	0.99	1.2	0.25	7.8	0.89	1.3	0.23	N	20	N	220	480	N	1	0.36	19	28
82KAT-122E		18	10	2.1	1.3	0.12	>10	0.94	5.8	0.11	N	320	N	H	850	N	46	2.7	32	18
82KAT-122F		24	9.4	1.9	1.8	0.057	9.9	2.4	4.8	0.11	N	268	N	280	660	2.2	7.7	4	24	22
82KAT-122G		28	10	2.5	1.3	0.079	4	1.9	3.6	0.47	N	170	N	75	380	N	11	1.7	13	19
82KAT-122H		35	8.4	1.4	1.7	0.02	3.1	1.5	2.8	0.28	N	54	N	34	650	N	8.9	1.3	12	20
82KAT-122I		27	10	2.1	1.4	0.062	9.5	2.4	5.4	0.36	N	190	N	820	360	N	13	1.7	26	22
82KAT-122J		20	<12	1.4	0.8	0.14	6.7	2.2	2.4	0.29	N	55	N	66	300	N	9.4	0.59	19	35
82KAT-122K		<10	<12	1.8	0.85	0.11	0.92	2.4	1.4	0.26	N	180	N	630	490	N	45	0.08	5.7	32

Table 2 continued

Sample	Description	Cu	Ga	Hg	La	Mo	Mn	Nb	Ni	Pb	Sb	Sc	Se	Sn	Sr	Tl	V	W	Y	Yb	Zn	Zr
Site 108	Bench along Buttress Range, upper valley																				SWR	
82KAT-108A		7	20	N <2	N <7	N <2	1000	N <10	7	10	20	50	N <5	20	500	N <1	200	N <10	15	2	100	100
82KAT-108B		30	20	N	N	N	700	N	7	20	24	10	N	150	300	N	200	N	20	2	90	70
82KAT-108C		10	20	N	N	N	700	N	7	10	33	20	N	30	300	N	200	N	15	1.5	76	70
82KAT-108D		15	30	N	N	N	500	N	3	15	38	10	N	10	150	N	200	N	7	N <0.7	80	50
82KAT-108E		15	20	N	N	N	700	N	7	50	N <1	15	N	20	300	60	200	N	20	2	150	150
82KAT-108F		30	20	N	30	50	500	N	5	300	43	20	N	50	300	36	500	N	50	7	500	500
82KAT-108G		7	7	N	N	2	150	N	30	5	40	10	N	20	100	N	500	N	10	1	78	150
82KAT-108H		30	30	N	15	N	700	N	10	100	22	20	N	100	500	32	500	N	15	N	200	100
82KAT-108I		20	20	N	10	10	1500	N	5	70	11	30	N	70	500	43	200	N	15	2	300	100
82KAT-108J		15	30	N	30	10	1500	N	15	200	20	30	N	100	500	50	300	N	20	2	300	150
82KAT-108K		100	20	N	10	50	500	N	20	700	25	15	N	70	300	97	200	N	30	5	500	300
82KAT-108L		30	20	N	10	N	700	N	3	20	N	20	N	7	300	12	150	N	20	3	58	200
82KAT-108M		10	20	N	N	N	1000	N	5	7	22	20	N	5	300	N	300	N	15	2	63	100
82KAT-108N		5	10	N	20	7	300	N	N <0.7	30	18	7	N	50	70	17	7	N	50	3	74	200
82KAT-108O		5	15	N	15	7	200	N	N	30	20	7	N	50	50	6.2	5	N	30	2	67	200
82KAT-108P		15	20	N	N	10	150	N	1	300	186	10	N	1000	100	168	200	N	20	2	66	70
82KAT-108Q		3	7	N	N	7	100	N	N	10	N	5	N	100	30	3.2	10	N	N <7	N	22	20
Site 113	Katmai Pass			SWR							SWR		SWR			SWR					SWR	
82KAT-113A		33	19	N <2	N <20	N <10	950	N <25	9.4	N <10	10	26	N <10	N <10	270	N <2	170	N <100	24	NA	86	130
82KAT-113B		29	19	N	N	N	1200	N	9.9	N	N <2	24	N	N	310	14	290	N	28	NA	97	150
82KAT-113C		19	23	N	N	N	660	N	7.1	N	9	20	N	47	430	N	400	N	27	NA	41	140
82KAT-113D		21	28	N	N	N	1300	N	9	11	6	28	N	39	440	4.8	320	N	26	NA	79	130
82KAT-113E		28	H	N	N	N	1500	N	15	H	N	H	N	H	240	N	340	N	H	NA	H	110
82KAT-113F		38	26	N	N	N	440	N	6.4	71	12	21	N	40	240	2.5	69	N	20	NA	53	190
82KAT-113G		30	16	N	N	N	970	N	11	10	N	22	N	N	260	N	300	N	16	NA	97	100
82KAT-113H		30	23	N	N	15	430	N	6.7	60	10	23	N	51	270	N	170	N	17	NA	300	130
82KAT-113I		12	N <10	N	N	N	300	N	4.2	45	N	N<10	N	N	150	N	51	N	21	NA	66	250
82KAT-113J		13	11	N	N	N	580	N	4.8	29	N	13	N	N	190	N	<100	N	19	NA	130	200
Site 122	Middle Knife Creek			SWR							SWR		SWR			SWR					SWR	
82KAT-122A		15	N <20	N <2	N <40	N <20	N <400	N <50	10	N <20	9.5	N <20	N <10	N <20	200	14	44	N <200	N <20	NA	7	160
82KAT-122B		9.6	N <10	N	N <20	N <10	350	N <25	2.5	N <10	N <2	27	N	N <10	120	N <2	250	N <100	N <10	NA	4	65
82KAT-122C		10	27	N	N	N	1000	N	7	N	N	22	N	N	130	N	81	N	25	NA	48	130
82KAT-122D		16	110	N	32	N	490	N	9.4	N	14	22	N	N	460	N	370	N	39	NA	27	180
82KAT-122E		46	H	N	21	N	600	N	11	N	13	H	N	N	540	8	210	H	H	NA	68	160
82KAT-122F		35	24	N	24	N	1600	N	14	30	8.2	26	N	14	360	5.4	350	N	41	NA	70	160
82KAT-122G		13	14	N	N	N	1000	N	5.5	11	14	24	N	19	390	N	390	N	24	NA	79	110
82KAT-122H		11	N	N	20	N	760	N	5.6	15	7.7	22	N	23	210	N	76	N	32	NA	88	170
82KAT-122I		22	18	N	18	N	1600	N	13	68	9.2	42	N	N	390	4.5	180	N	31	NA	98	110
82KAT-122J		20	21	N	20	N	1900	N	8.7	18	12	47	N	N	220	N	370	N	23	NA	88	89
82KAT-122K		14	36	N	N	N	330	N	4.3	N	17	29	N	N	120	19	230	N	14	NA	16	93

Table 2 continued

Sample	Description	Si(%)	Al(%)	Na(%)	K(%)	P(%)	Fe (%)	Mg (%)	Ca(%)	Ti(%)	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr
Site 127	warm, shoulder of Broken Mountain					SWR						SWR	SWR				SWR	SWR		
82KAT-127A1		23	11	0.35	0.66	0.054	4.1	0.58	0.92	0.2	N <1	<2	N <0.2	<10	180	N <1	N <0.2	N <0.08	7.5	35
82KAT-127A2		23	11	0.34	0.62	0.18	7.2	0.57	0.85	0.17	N	12	N	<10	170	N	N	N	7.1	43
82KAT-127B		21	9.1	0.28	0.71	0.052	7.2	0.3	0.54	0.11	N	7.6	N	<10	210	N	N	N	4.8	38
82KAT-127C		22	10	0.45	0.58	0.2	8	0.51	1	0.15	N	11	N	<10	160	N	N	N	6.6	47
82KAT-127D		20	8.5	1.3	0.67	0.073	>10	1.1	2	0.23	N	9.6	N	H	250	N	N	0.23	14	46
82KAT-127E		26	9.5	1.7	0.71	0.15	5.6	1.2	2.5	0.31	N	6.7	N	28	430	N	N	0.17	14	25
Site 183	Upper Knife Creek																			
79KAT-183	leached fallout	>10	5	1.5	0.7	0.05	1	0.1	1.5	0.3	N	200	N	100	300	N	N	N	N	N
Site 211	River Lethe, mid Valley					SWR						SWR	SWR				SWR	SWR		
87KAT211A	most leached	>15	7	5	3	0.0059	2	0.7	3	0.5	N<0.2	490	N <0.2	30	1000	0.7	N <0.2	H	50	7
87KAT211B		>15	7	5	2	0.013	2	0.7	2	0.5	N	180	N	30	1000	1	N	0.3	50	7
87KAT211C	least leached	>15	5	3	1.5	0.018	2	0.7	2	0.3	N	69	N	15	700	1	N	0.22	15	7
Site 212	River Lethe, mid Valley					SWR						SWR	SWR				SWR	SWR		
87KAT212A		>15	10	5	1	0.14	3	1	3	0.7	N<0.2	860	N <0.2	200	700	1	36	1.5	30	7
87KAT212B		>15	7	5	1	0.055	3	0.7	3	0.5	N	1500	N	200	700	1	35	2.4	50	15
87KAT212C		>15	7	3	0.7	0.037	5	1	5	0.7	N	880	N	100	500	1	59	3.4	30	10
87KAT212D		>15	7	3	0.7	0.053	7	1	5	0.5	N	240	N	20	500	1	28	2.8	50	10
87KAT212E		>15	5	3	1.5	0.053	3	0.7	2	0.5	N	1000	N	100	700	1	40	3.6	50	7
87KAT212F		>15	10	5	1	0.035	7	1	3	0.5	7	1000	N	70	500	N <0.7	24	4.6	50	15
87KAT212G		>15	7	3	1	0.058	3	1	5	0.5	N	870	N	150	700	1	14	4	50	7
87KAT212H		>15	10	5	1.5	0.06	3	1	5	0.5	N	580	N	100	1000	N	52	4	50	7
87KAT212J	most leached	>15	3	2	1	0.0045	1	0.5	1	0.7	N	134	N	100	700	0.7	N <0.2	N<0.05	50	5
87KAT212K		>15	7	5	2	0.0084	1.5	0.7	2	0.5	N	46	N	50	1000	0.7	N	N	50	7
87KAT212L		>15	10	5	3	0.019	2	0.7	5	0.5	N	22	N	50	1500	0.7	N	0.39	50	10
87KAT212M		>15	10	5	2	0.037	2	0.7	3	0.5	N	14	N	30	1000	0.7	N	0.44	30	10
87KAT212N		>15	7	5	2	0.026	5	1	3	0.5	N	N <2	N	20	1000	1	N	0.28	30	10
87KAT212O	least leached	>15	7	3	2	0.036	2	0.7	2	0.3	N	18	N	15	700	1	N	0.29	50	15

Table 2 continued

Sample	Description	Cu	Ga	Hg	La	Mo	Mn	Nb	Ni	Pb	Sb	Sc	Se	Sn	Sr	Tl	V	W	Y	Yb	Zn	Zr
Site 127	warm, shoulder of Broken Mour			SWR									SWR			SWR					SWR	
82KAT-127A1		12	N <10	N <2	21	N <10	360	N <25	7.1	N <10	SWR N<2	26	N <10	N <10	120	N <2	240	N <100	N <10	NA	17	110
82KAT-127A2		8.9	11	N	N <20	N	320	N	7.7	N	N	25	N	N	110	N	300	N	11	NA	12	110
82KAT-127B		17	N	N	N	N	200	N	5.1	2.6	N	24	N	N	200	N	230	N	N	NA	14	81
82KAT-127C		10	31	N	N	N	320	N	11	N	N	24	N	N	120	N	190	N	11	NA	12	86
82KAT-127D		13	26	N	22	H	620	N	9	N	N	H	N	N	250	N	430	N	H	NA	24	110
82KAT-127E		15	32	N	24	N	630	N	7.9	N	N	27	N	N	380	N	150	N	22	NA	78	140
Site 183	Upper Knife Creek																					
79KAT-183	leached fallout	15	20	1.5	N	N	150	N	N	30	70	7	N	150	100	30	20	N	30	5	30	200
Site 211	River Lethe, mid Valley			SWR							SWR		SWR			SWR						
87KAT211A	most leached	30	20	N <2	N <7	3	700	N <10	3	50	N <2	10	N <10	N <2	500	N <2	15	150	30	5	50	150
87KAT211B		30	20	N	N	5	700	N	5	50	N	15	N	N	500	N	20	200	30	3	50	150
87KAT211C	least leached	15	20	N	N	N <2	700	N	3	50	N	15	N	3	300	N	70	N <10	30	3	50	200
Site 212	River Lethe, mid Valley			SWR							SWR		SWR			SWR						
87KAT212A	ht,gt-rich	500	20	N <2	N <7	N <2	500	N <10	2	200	12.5	20	N <10	70	500	150	150	N <10	70	7	100	500
87KAT212B		150	50	N	N	N	700	N	3	1500	11.9	20	N	500	700	150	200	N	50	5	100	200
87KAT212C		100	30	N	N	N	1500	N	7	1500	N <2	20	N	100	700	70	100	N	20	3	500	100
87KAT212D		70	30	N	N	5	2000	N	10	500	N	20	N	70	700	30	200	70	30	3	200	150
87KAT212E	mt-rich	70	30	N	N	3	1500	N	7	2000	N	15	N	500	500	39	100	70	50	5	500	500
87KAT212F		1000	30	N	N	150	2000	N	10	700	3	15	N	150	700	18	200	N	20	3	700	70
87KAT212G		70	30	N	N	N	1500	N	7	300	3.4	15	N	200	700	17	100	70	30	3	300	150
87KAT212H		200	50	N	N	N	1500	N	7	300	3.5	15	N	200	700	16	100	N	30	5	500	200
87KAT212J	most leached	50	15	N	N	5	500	N	5	N <7	17.5	10	N	30	200	N <2	20	N	30	3	30	700
87KAT212K		50	30	N	N	N	700	N	5	30	16.5	15	N	20	500	N	50	N	20	3	50	300
87KAT212L		50	30	N	N	2	700	N	7	50	4.7	20	N	10	700	N	70	70	30	3	50	300
87KAT212M		50	30	N	N	N	700	N	15	50	N	20	N	N <2	500	N	70	N	30	3	50	300
87KAT212N		50	50	N	N	N	1500	N	10	30	N	20	N	N	700	N	150	N	50	5	100	300
87KAT212O	least leached	30	20	N	N	N	1000	N	10	20	4.8	10	N	N	500	N	200	N	20	3	50	150