DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

Chemical Analyses of Volcanic Rocks from Monogenetic and Shield Volcanoes near Crater Lake, Oregon

by

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Open-File Report 89-562

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Introduction

This report contains chemical analyses of rocks from lava flows, cinder cones, and shallow intrusions associated with monogenetic and shield volcanoes near Crater Lake, Oregon. All analyzed samples of this type collected by C.R. Bacon and assistants (W.A. Bartling [1979, 1980], S.W. Novak [1981], M.H. Moench [1982], C.A. Michelsen [1983], M.M. Hirschman [1984, 1985], M.H. Price [1986, 1987], A.E. Gartner [1986, 1987], and M. Hanning [1988]) are included for completeness, although analyses of samples collected from 1979-1985 have been published previously (Bruggman, and others, 1987). This report is intended to supplement a paper by Bacon (in press) on the petrology and geochemistry of these rocks.

Analytical methods

Approximately 120 samples have been analyzed for major and trace elements. Chemical analyses are given in Table 1; sample number prefixes give the year of collection. Sample localities and phenocryst contents are presented in Table 2; phenocryst contents are estimates based on examination of thin sections. Samples were ground in an alumina shatterbox, except some powders for major element analyses that were made in a tungsten-carbide shatterbox. All chemical analyses were made in USGS laboratories.

Major elements were determined by wavelength-dispersive X-ray fluorescence spectrometry (WDXRF) in Lakewood, Colorado (Taggart and others, 1987). Na_2O and K_2O were measured by flame photometry on over half of the samples (Jackson and others, 1987). Ni, Rb, Sr, Y, Zr, and Ba were determined by energy-dispersive X-ray fluorescence spectrometry (Johnson and King, 1987). Nb analyses for most samples collected from 1979-1986 were made by spectrophotometry; 1987-1988 samples were analyzed by inductively coupled-plasma atomic emission spectrometry (ICP) following chemical separation. Emission spectrographic methods were used to determine Be, Cu, Ga, V, and a few low-level Rb concentrations (Golightly and others, 1987). Instrumental neutron activation analysis (INAA) was used to obtain concentrations of Co, Cr, Cs, Hf, Sb, Ta, Th, U, Zn, Sc, La, Ce, Nd, Sm, Eu, Tb, Yb, and Lu (Baedecker and McKown, 1987).

Precision and Accuracy

Precision was measured by repeated analysis of internal standards. Means and standard deviations for repeated determinations of concentrations in representative rock standards are given in Table 2 of Bruggman and others (1987). Precision of wet chemical and ICP determinations were not monitored by this method; for these techniques data are reported to a number of significant figures justified by experience with the particular technique employed and concentration range encountered.

Accuracy was addressed by Bruggman and others (1987). Trace element concentrations determined for USGS standards generally agree with accepted values to within limits of measured precision. Major element data compare favorably with analyses by other laboratories of the same rock powders or of samples collected from the same outcrops, suggesting that the analyses are probably accurate to within the measured precision. Na_2O is an exception in that WDXRF values prior to 1987 were consistently about 5% low relative to flame photometric values. To correct for this bias we have used flame photometric Na_2O and K_2O values where available and have multiplied remaining (WDXRF) Na_2O values obtained before 1987 by 1.05.

The data are available on floppy disk in ASCII, Lotus or Excel formats. Contact P. Bruggman (USGS, 345 Middlefield Rd. MS-910, Menlo Park, CA 94025 (415) 329-5234) to obtain a copy.

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TABLE 1

Sample No.	79C-120	79C-133	80C-354	80C-355	81C-533	81C-536	81C-543	81C-621	81C-664	81C-666	82C-674	82C-703	82C-730	82C-753
Major Elements														
weight %														
SiO_2	52.7	48.8	53.0	53.6	56.5	51.3	51.2	47.5	51.2	50.9	51.2	58.2	52.6	52.3
Al_2O_3	16.2	16.3	16.7	16.3	17.4	16.5	16.6	17.4	16.3	16.4	16.9	16.6	17.4	17.7
Fe_TO_3	7.91	8.37	7.66	7.76	6.80	8.48	8.38	10.80	8.31	8.32	8.69	6.18	8.94	7.90
MgO	7.73	7.99	7.21	8.10	4.77	8.06	7.58	9.74	8.17	8.03	7.30	4.62	6.23	4.14
CaO	9.25	9.53	8.52	7.96	7.39	9.92	9.82	11.1	9.66	9.69	8.13	7.21	8.51	7.28
Na_2O	3.78	3.38	3.70*	3.66*	4.24*	3.83*	3.69*	2.63	3.50*	3.47*	3.32	3.86	3.69	3.69
K_2O	1.08	0.760	1.22*	1.14*	1.36*	0.84*	0.89*	0.09	0.89*	0.87*	0.970	1.35	0.681	2.05
TiO_2	1.09	1.10	1.03	0.94	0.93	1.26	1.24	1.08	1.15	1.17	1.15	0.78	1.07	1.25
P_2O_5	0.36	0.39	0.42	0.31	0.31	0.41	0.42	0.11	0.40	0.41	0.36	0.18	0.25	0.62
MnO	0.12	0.13	0.11	0.11	0.10	0.13	0.13	0.19	0.13	0.13	0.13	0.09	0.14	0.11
LOI	0.25	0.86	0.33	<0.01	0.31	0.01	<0.01	0.49	0.51	0.34	1.16	0.64	<0.01	2.24
Total	100.47	97.61	99.90	99.88	100.11	100.74	99.95	101.13	100.22	99.73	99.31	99.71	99.51	99.28
Trace Elements														
ppm														
Ba	388	376	548	449	539	385	353	80	375	354	508	389	316	1010
Co	–	–	31.0	35.7	24.6	36.2	34.1	48.9	33.8	36.6	36.3	23.2	32.7	25.3
Cr	271	262	268	383	91	265	243	305	262	284	247	102	204	44.6
Cs	0.8	0.5	0.4	0.2	0.9	–	0.2	–	0.5	0.4	–	1.2	0.4	0.3
Cu	63	77	73	50	55	69	88	100	74	78	74	52	58	78
Ga	20	20	23	22	21	23	25	18	21	21	20	18	20	22
Hf	3.4	3.3	3.1	2.8	3.5	3.3	3.4	1.7	3.4	3.3	3.0	2.9	2.4	4.5
Nb	10*	11*	7.4*	6.4*	5.8	9.1	7.2	2.6	10*	8.9*	8.3*	3.9*	4.3*	10*
Ni	122	132	161	205	78	117	101	188	112	125	162	71	121	45
Rb	23	21	27	25	28	10*	12*	1*	24	21	15	26	8*	43
Sc	25.3	27.2	19.9	20.7	17.5	26.8	27.0	35.4	26.9	27.5	23.6	17.8	23.9	19.0
Sr	942	1000	1300	945	1020	1010	1020	315	986	964	888	742	502	1750
Ta	–	–	0.42	0.34	0.33	0.53	0.52	–	0.5	0.42	0.50	0.30	0.25	0.37
Th	2.8	2.7	2.7	2.4	3.1	2.7	2.7	–	2.8	2.4	2.2	2.6	1.0	4.0
U	1.1	1.0	0.8	0.7	0.8	0.5	0.7	–	0.6	0.8	0.6	1.1	–	–
V	160	170	160	160	140	190	190	210	190	170	170	130	160	110
Y	20	23	18	19	20	22	20	24	19	20	21	17	23	24
Zn	81	88	82	82	76	87	86	86	86	98	102	63	81	96
Zr	168	173	157	141	159	170	168	80	171	168	147	134	102	216
La	21	23	26	19	21	23	24	3.4	23	22	21	13	12	37
Ce	42	43	50	39	44	46	48	9.2	45	43	42	27	23	75
Nd	24	24	27	20	25	25	23	9	24	25	23	14	16	41
Sm	4.6	4.7	4.1	3.4	4.5	4.6	4.6	2.9	4.7	4.6	4.9	3.2	3.8	7.2
Eu	1.23	1.28	1.35	1.11	1.24	1.36	1.43	1.06	1.33	1.32	1.42	0.97	1.23	1.94
Tb	0.56	0.52	0.42	0.39	0.46	0.5	0.55	0.68	0.59	0.59	0.57	0.47	0.62	0.62
Yb	1.8	1.8	1.5	1.5	1.8	1.7	1.6	2.6	1.7	1.6	1.8	1.5	2.2	1.6
Lu	0.30	0.34	0.20	0.20	0.24	0.27	0.26	0.38	0.27	0.26	0.29	0.21	0.33	0.24

* indicates X-ray fluorescence Na_2O and K_2O, spectrophotometric Nb, or emission spectrographic Rb determination.

Sample No.	82C-754	82C-761	82C-814	82C-816	82C-845	82C-852	82C-853	82C-854	82C-893	82C-894	82C-930	83C-946	83C-947	83C-948
Major Elements														
weight %														
SiO_2	52.8	60.8	51.9	58.2	52.1	58.2	57.8	53.4	47.7	47.4	51.7	53.5	54.1	55.4
Al_2O_3	17.6	16.6	16.8	17.2	17.4	17.2	17.1	17.5	17.6	17.3	17.3	18.1	18.9	18.6
Fe_TO_3	8.31	5.38	8.00	6.72	8.19	6.59	6.67	8.73	10.1	10.1	8.79	8.77	7.44	7.63
MgO	5.38	3.15	6.86	4.05	6.34	4.07	4.08	5.99	9.38	9.51	7.00	4.51	4.38	4.11
CaO	8.56	5.61	9.58	6.94	9.47	6.94	6.91	7.96	11.3	11.3	8.94	8.02	8.12	7.89
Na_2O	3.69	4.19	3.57	4.09	3.45	4.01	3.91	3.94	2.85	2.82	3.60	4.05*	4.25	4.06*
K_2O	1.11	1.59	1.00	1.22	0.746	1.21	1.30	0.774	0.103	0.098	0.856	1.32*	1.21	0.92*
TiO_2	1.21	0.71	1.11	0.84	1.08	0.85	0.85	1.10	1.09	1.04	1.16	1.11	1.02	1.01
P_2O_5	0.36	0.16	0.37	0.22	0.24	0.30	0.3	0.25	0.11	0.1	0.34	0.52	0.37	0.27
MnO	0.12	0.08	0.12	0.11	0.13	0.10	0.11	0.14	0.16	0.16	0.13	0.14	0.11	0.11
LOI	0.78	0.59	0.31	<0.01	0.59	0.06	0.60	0.05	<0.01	<0.01	<0.01	<0.01	0.20	0.13
Total	99.92	98.86	99.62	99.59	99.736	99.53	99.63	99.834	100.393	99.828	99.816	100.04	100.10	100.13
Trace Elements														
ppm														
Ba	462	468	443	472	248	511	526	294	54	61	420	581	494	350
Co	28.1	17.1	32.7	22.0	31.0	22.2	22.7	33.0	45.7	47.6	34.6	–	24.0	–
Cr	94	50.5	206	82	186	99	102	197	250	253	192	–	29.7	–
Cs	–	1.2	0.5	0.6	0.4	0.5	0.8	0.4	–	–	–	–	0.3	–
Cu	36	28	100	51	52	39	60	35	83	91	60	–	–	–
Ga	21	20	20	20	19	20	21	21	21	19	23	–	–	–
Hf	3.1	3.6	3.2	3.2	2.5	3.6	3.7	2.8	1.6	1.6	2.8	–	3.0	–
Nb	8.4*	4.2*	7.4*	5.6*	4.5*	6.9	7.4	3.4*	2.9	2.5	7.1*	8.8	6.3	5.8
Ni	80	44	89	69	88	70	70	107	152	165	133	41	43	48
Rb	15*	35	21	17	12*	18	22	11*	<1*	<1*	7	19	30	9*
Sc	21.7	13.2	26.6	17.3	25.6	16.6	16.8	22.9	34.1	35.2	23.8	–	16.7	–
Sr	547	577	986	601	581	757	750	546	294	297	810	868	1350	823
Ta	0.40	0.34	0.34	0.36	0.27	0.48	0.51	0.20	–	–	0.42	–	0.31	–
Th	2.4	3.1	2.8	2.1	1.1	2.1	2.1	1.1	–	–	1.6	–	3.1	–
U	–	1.3	0.8	0.3	–	0.7	0.9	–	–	–	0.4	–	0.7	–
V	190	120	180	130	200	130	130	170	240	240	230	–	–	–
Y	21	18	22	19	21	19	23	21	22	25	20	26	22	19
Zn	83	65	85	72	81	78	79	85	69	76	90	–	81	–
Zr	118	153	158	156	122	170	177	118	78	73	135	160	153	132
La	22	14	22	17	11	21	20	11	2.6	2.5	17	–	22	–
Ce	43	26	44	31	23	39	42	25	7.9	8.6	35	–	43	–
Nd	28	18	26	18	15	20	23	18	5	7	21	–	25	–
Sm	4.6	3.4	4.7	3.8	3.5	4.5	4.6	4.1	2.6	2.5	4.5	–	4.5	–
Eu	1.35	0.87	1.34	1.08	1.09	1.25	1.27	1.27	0.95	1.00	1.34	–	1.28	–
Tb	0.48	0.43	0.54	0.48	0.59	0.57	0.54	0.67	0.58	0.61	0.54	–	0.48	–
Yb	1.9	1.6	1.8	1.7	1.8	2.0	1.9	2.3	2.6	2.6	1.7	–	1.3	–
Lu	0.28	0.24	0.27	0.26	0.30	0.29	0.30	0.34	0.39	0.36	0.27	–	0.24	–

Sample No.	83C-957	83C-980	83C-981	83C-982	83C-983	83C-984	83C-985	83C-987	83C-1006	83C-1007	83C-1008	83C-1009	83C-1010	83C-1029
Major Elements														
weight %														
SiO_2	55.8	55.9	54.2	53.5	54.2	53.5	53.2	53.3	56.6	57.5	57.0	57.1	57.1	57.2
Al_2O_3	17.8	17.6	17.7	18.2	17.9	18.2	18.0	18.2	18.8	18.7	18.7	18.7	18.7	17.1
Fe_TO_3	7.37	7.68	8.52	8.53	8.61	7.65	8.39	8.59	6.73	6.53	6.76	6.70	6.70	6.64
MgO	4.00	4.32	5.00	5.26	4.77	5.31	5.01	4.13	4.20	4.16	4.17	4.44	4.04	4.62
CaO	7.21	7.22	8.15	8.40	8.16	8.54	8.33	7.86	7.17	7.14	7.04	7.31	7.10	7.11
Na_2O	4.37	4.19	3.99	3.86	3.90	3.94*	3.87	4.14	4.11	4.22	4.12*	4.18	4.21	4.28
K_2O	1.59	1.32	0.862	0.839	0.944	0.87*	0.887	1.32	0.754	0.761	0.77*	0.766	0.787	1.43
TiO_2	1.11	1.02	1.17	1.13	1.24	0.95	1.14	1.09	0.70	0.67	0.72	0.71	0.69	0.89
P_2O_5	0.50	0.44	0.29	0.29	0.35	0.28	0.39	0.53	0.18	0.18	0.19	0.18	0.19	0.31
MnO	0.11	0.13	0.14	0.13	0.13	0.12	0.13	0.15	0.11	0.10	0.11	0.11	0.11	0.10
LOI	0.22	0.13	<0.01	0.18	0.15	0.18	0.42	0.33	0.58	0.17	0.64	0.04	0.46	0.04
Total	100.08	99.95	100.022	100.319	100.354	99.54	99.767	99.64	99.934	100.131	100.022	100.236	100.087	99.72
Trace Elements														
ppm														
Ba	683	636	392	324	391	356	339	577	263	292	285	286	271	541
Co	22.0	23.1	26.2	28.7	28.3	–	27.3	25.8	23.2	22.4	–	23.7	22.7	23.3
Cr	69	87	71	87	75	–	81	40.1	53.8	49.4	–	63	44.1	87
Cs	0.5	0.3	0.2	0.4	0.2	–	0.5	0.3	0.2	0.4	–	0.2	0.5	0.8
Cu	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hf	4.0	4.0	2.0	2.9	3.2	–	2.8	3.4	2.0	1.9	–	2.0	2.1	3.6
Nb	10	9.2*	5.4	6.8	6.4*	–	6.0*	9.6	2.1*	1.9*	–	2.3*	2.0*	6.0*
Ni	47	62	54	58	46	69	61	35	63	63	58	63	59	72
Rb	29	19	13	10*	16*	16	15	21	19	13	16	20	16	30
Sc	15.5	16.9	21.0	22.3	23.4	–	22.2	21.4	15.8	15.1	–	15.9	15.1	17.2
Sr	1370	917	688	701	676	879	700	811	807	777	776	784	790	980
Ta	0.57	0.53	0.26	0.34	0.41	–	0.39	0.46	0.15	0.12	–	0.19	0.16	0.36
Th	3.2	2.4	1.2	1.6	1.8	–	1.6	1.9	1.1	1.1	–	1.1	1.0	3.0
U	0.9	0.7	0.4	0.5	0.5	–	0.5	0.4	0.4	–	–	0.4	0.3	0.7
V	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y	22	22	21	19	20	19	20	24	19	16	17	18	16	22
Zn	85	93	81	93	95	–	86	97	78	68	–	77	74	80
Zr	203	193	105	128	144	122	131	164	99	98	103	107	103	164
La	30	27	13	14	16	–	14	23	9.0	9.0	–	9.5	8.9	21
Ce	60	52	25	30	34	–	30	47	18	18	–	18	19	40
Nd	32	30	16	19	23	–	19	27	12	12	–	11	11	23
Sm	5.8	5.8	3.8	4.3	4.9	–	4.2	5.8	2.8	2.7	–	2.8	2.9	4.5
Eu	1.55	1.47	1.31	1.26	1.35	–	1.22	1.57	0.94	0.93	–	0.94	0.96	1.16
Tb	0.53	0.60	0.55	0.57	0.67	–	0.59	0.68	0.38	0.36	–	0.41	0.40	0.48
Yb	1.8	2.1	1.9	1.9	2.2	–	2.1	2.1	1.2	1.2	–	1.3	1.3	1.6
Lu	0.30	0.33	0.32	0.33	0.37	–	0.35	0.35	0.23	0.23	–	0.22	0.23	0.30

Sample No.	83C-1054	83C-1059	83C-1074	83C-1087	83C-1089	84C-1107	84C-1141	84C-1142	84C-1143	85C-1181	85C-1185	85C-1186	85C-1187	85C-1193
Major Elements														
weight %														
SiO_2	56.7	52.5	56.4	53.7	51.4	51.2	53.2	53.8	48.7	52.9	53.1	53.5	53.8	52.4
Al_2O_3	18.1	17.6	17.4	18.2	18.3	16.3	16.8	17.0	17.0	17.1	17.2	16.9	17.4	16.9
Fe_TO_3	7.74	8.09	6.76	8.17	9.41	8.61	7.71	8.28	10.20	8.20	8.17	8.17	7.95	8.23
MgO	3.72	6.43	4.03	6.01	6.23	8.40	6.88	6.96	9.18	6.43	6.52	7.20	6.24	6.83
CaO	6.76	9.03	7.64	8.28	8.36	9.96	8.57	8.47	11.1	9.66	9.62	8.85	9.50	9.47
Na_2O	4.36	3.70	3.71	3.75	3.66	3.36	3.70	3.80	2.95	3.53	3.42	3.55	3.51	3.67
K_2O	1.05	1.04	1.44	0.650	0.563	0.84	0.94	0.74	0.25	1.01	0.904	1.04	0.916	0.968
TiO_2	0.99	1.08	0.96	0.95	1.23	1.19	1.02	0.99	1.17	1.12	1.09	1.03	1.07	1.18
P_2O_5	0.24	0.40	0.29	0.17	0.24	0.42	0.31	0.25	0.17	0.24	0.24	0.24	0.22	0.32
MnO	0.12	0.12	0.10	0.13	0.14	0.13	0.12	0.13	0.17	0.12	0.12	0.12	0.12	0.12
LOI	0.16	0.40	1.47	0.17	0.79	0.13	0.91	<0.01	<0.01	0.34	0.50	0.16	0.10	0.35
Total	99.94	100.39	100.20	100.18	100.32	100.54	100.16	100.42	100.89	100.65	100.88	100.76	100.83	100.44
Trace Elements														
ppm														
Ba	476	643	559	293	274	371	395	305	102	350	368	397	336	396
Co	24.2	31.4	21.4	31.4	36.0	37.3	32.5	34.1	46.9	29.7	–	–	29.5	32.2
Cr	29.1	173	34.4	176	147	278	251	276	326	153	–	–	152	198
Cs	0.4	0.4	1.2	0.6	–	0.3	0.3	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–	49	–	–	42	65
Ga	–	–	–	–	–	–	–	–	–	20	–	–	21	23
Hf	2.7	3.0	3.8	2.0	2.6	3.4	2.7	2.7	2.2	2.8	–	–	2.6	3.1
Nb	3.6*	6.2*	4.6*	2.3*	3.5*	8.3*	4.0	3.4*	2.7*	3.4*	4.0	4.2	3.4*	5.0
Ni	55	138	–	105	113	116	159	144	162	73	78	126	73	93
Rb	22	24	28	8*	7*	16	14	10*	3*	13	8*	15	14	20
Sc	16.8	22.7	19.6	21.3	23.4	27.8	20.7	22.7	38.9	25.2	–	–	24.8	25.6
Sr	610	1050	870	553	495	996	1130	717	366	888	896	809	857	887
Ta	0.25	0.36	0.32	0.18	0.24	0.50	0.24	0.23	0.19	0.22	–	–	0.19	0.28
Th	1.3	3.1	3.1	0.8	0.8	2.8	1.7	1.5	0.7	1.4	–	–	1.5	2.2
U	0.6	–	1.0	–	0.4	0.8	0.4	–	0.3	0.5	–	–	0.5	0.6
V	–	–	–	–	–	–	–	–	–	210	–	–	210	190
Y	21	21	17	19	22	19	16	19	24	20	17	20	18	24
Zn	82	96	77	77	85	86	80	71	79	76	–	–	71	87
Zr	119	150	164	97	119	158	134	115	94	136	135	134	129	158
La	12	29	19	8.0	9.8	22	16	12	6.3	14	–	–	13	17
Ce	25	56	39	17	20	46	35	27	16	31	–	–	27	37
Nd	16	21	25	12	17	22	18	13	9	18	–	–	16	19
Sm	3.6	4.6	4.7	3.2	4.1	4.8	4.0	3.8	3.5	4.0	–	–	3.8	4.5
Eu	1.15	1.60	1.25	0.93	1.18	1.42	1.28	1.21	1.21	1.23	–	–	1.13	1.34
Tb	0.51	0.53	0.52	0.46	0.66	0.58	0.50	0.55	0.70	0.54	–	–	0.52	0.57
Yb	1.7	1.4	1.6	1.9	2.4	1.6	1.7	1.8	2.9	1.7	–	–	1.9	1.7
Lu	0.30	0.29	0.28	0.29	0.40	0.26	0.23	0.28	0.45	0.26	–	–	0.25	0.28

Sample No.	85C-1198	85C-1210	85C-1211	85C-1216	85C-1217	85C-1222	85C-1229	85C-1230	85C-1231	85C-1234	85C-1236	85C-1241	85C-1267	86C-1294
Major Elements														
weight %														
SiO_2	53.9	52.4	57.1	53.3	56.9	53.6	58.5	62.2	60.7	51.9	53.9	52.7	55.4	52.5
Al_2O_3	16.3	18.0	18.1	17.4	17.3	17.9	17.8	16.5	16.6	17.5	17.5	17.1	18.6	17.2
Fe_TO_3	7.89	8.95	7.09	7.97	6.75	8.61	7.15	6.57	7.01	9.05	8.59	8.43	7.67	7.84
MgO	7.80	6.85	3.93	6.35	4.62	6.28	2.55	1.91	1.95	6.46	6.61	6.82	4.26	6.14
CaO	8.45	8.58	7.31	8.28	7.19	8.61	6.7	4.80	4.97	9.11	8.92	9.49	8.05	8.27
Na_2O	3.69	3.90	4.13	3.84	4.05	3.67	4.66	5.11	5.07	3.64	3.47*	3.69	3.63	4.15*
K_2O	1.11	0.564	1.07	1.26	1.55	0.663	1.18	1.49	1.41	0.841	0.68*	0.967	0.844	1.20*
TiO_2	1.00	1.07	0.89	1.03	0.90	0.98	1.06	1.03	1.24	1.23	0.84	1.21	0.93	1.04
P_2O_5	0.33	0.20	0.22	0.35	0.28	0.15	0.2	0.22	0.37	0.33	0.17	0.32	0.18	0.40
MnO	0.12	0.13	0.11	0.12	0.10	0.13	0.11	0.11	0.13	0.14	0.14	0.13	0.11	0.11
LOI	0.05	<0.01	0.54	0.55	0.98	0.75	0.10	0.64	0.86	0.70	<0.01	0.31	0.40	0.51
Total	100.64	100.64	100.49	100.45	100.62	101.34	100.01	100.58	100.31	100.90	100.82	101.17	100.07	99.36
Trace Elements														
ppm														
Ba	429	196	454	548	549	270	446	535	558	381	254	380	338	505
Co	–	35.4	–	30.9	–	33.4	15.8	–	–	33.3	32.6	32.6	25.4	31.0
Cr	–	145	–	134	–	174	11.6	–	–	161	210	192	66	162
Cs	–	0.3	–	0.6	–	0.6	0.6	–	–	–	0.6	0.6	0.5	0.5
Cu	–	57	–	57	–	69	43	–	–	67	30	69	44	65
Ga	–	21	–	23	–	21	21	–	–	23	19	22	22	24
Hf	–	2.2	–	3.1	–	1.9	2.8	–	–	3.0	2.0	3.5	2.3	3.1
Nb	6.3	2.4*	6.4	4.6*	5.6	1.9*	3.8*	6.6	5.8	6.3*	3.2	4.5*	2.8*	5.5
Ni	161	127	48	127	69	118	10	13	13	126	102	88	69	124
Rb	17	7*	16	22	24	9*	24	30	27	16	9*	13	19	11*
Sc	–	22.1	–	19.3	–	22.6	19.1	–	–	24.0	24.9	26.1	20.2	19.7
Sr	959	650	678	1150	982	539	609	520	535	636	537	871	679	1280
Ta	–	0.17	–	0.31	–	0.15	0.28	–	–	0.43	0.16	0.29	0.24	0.37
Th	–	0.8	–	2.4	–	0.8	1.9	–	–	1.4	0.8	2.3	1.2	2.5
U	–	–	–	0.7	–	0.4	0.8	–	–	–	–	0.8	0.5	0.7
V	–	200	–	170	–	180	190	–	–	170	190	200	170	170
Y	19	18	17	19	18	19	20	24	34	23	18	21	19	20
Zn	–	72	–	86	–	89	69	–	–	85	83	93	75	88
Zr	141	102	132	157	169	94	125	147	140	148	101	156	111	151
La	–	8.3	–	21	–	7.5	12	–	–	16	7.9	17	10	22
Ce	–	18	–	40	–	17	25	–	–	32	17	37	21	44
Nd	–	12	–	22	–	11	15	–	–	18	10	21	12	24
Sm	–	3.3	–	4.6	–	3.0	3.8	–	–	4.5	2.9	4.6	3.2	4.7
Eu	–	1.07	–	1.24	–	1.01	1.17	–	–	1.34	0.96	1.33	1.03	1.30
Tb	–	0.55	–	0.57	–	0.51	0.55	–	–	0.67	0.47	0.61	0.47	0.54
Yb	–	2.0	–	1.6	–	1.8	1.8	–	–	2.2	1.9	1.9	1.5	1.7
Lu	–	0.26	–	0.25	–	0.26	0.29	–	–	0.33	0.27	0.26	0.23	0.24

Sample No.	86C-1295	86C-1357	86C-1358	86C-1359	87C-1395	87C-1438	87C-1440	87C-1445	87C-1446	87C-1457	88C-1518	88C-1520	88C-1521	88C-1523
Major Elements														
weight %														
SiO_2	57.0	53.4	57.3	55.8	52.5	58.6	58.4	57.9	58.4	63.1	52.3	52.8	53.8	52.2
Al_2O_3	17.3	17.8	17.5	18.2	18.6	17.2	17.4	17.4	17.2	15.9	17.4	16.2	16.3	16.0
Fe_TO_3	6.83	9.17	7.20	7.53	8.59	6.62	6.67	6.66	6.61	5.60	8.64	8.05	8.23	8.17
MgO	4.70	5.10	3.93	3.79	5.77	4.01	4.13	4.14	4.17	1.64	7.10	7.67	8.27	8.23
CaO	7.31	8.25	7.03	7.74	8.40	6.88	7.01	6.96	7.02	4.17	9.36	8.87	8.37	8.94
Na_2O	4.33*	3.72*	4.32*	4.32*	3.72	3.93*	3.94*	3.77*	3.86	4.87	3.57	3.82	3.60	3.84
K_2O	1.39*	0.73*	1.27*	1.01*	0.463	1.26*	1.18*	1.20*	1.27	1.99	0.723	1.11	0.896	1.14
TiO_2	0.91	1.24	1.01	0.96	1.01	0.88	0.87	0.86	0.81	0.98	1.13	1.1	0.96	1.14
P_2O_5	0.32	0.24	0.23	0.17	0.22	0.32	0.29	0.29	0.28	0.29	0.26	0.48	0.3.0	0.52
MnO	0.1	0.14	0.11	0.11	0.14	0.10	0.10	0.10	0.10	0.09	0.13	0.11	0.12	0.12
LOI	0.16	0.45	0.61	0.68	0.73	0.28	0.10	0.70	0.41	1.14	<0.01	<0.01	<0.01	<0.01
Total	100.35	100.24	100.51	100.31	100.14	100.08	100.09	99.98	100.13	99.77	100.61	100.21	100.55	100.30
Trace Elements														
ppm														
Ba	549	256	362	299	333	535	505	500	523	695	271	469	335	492
Co	–	32.6	21.6	24.3	31.2	–	–	–	21.7	10.8	34.0	34.0	36.2	33.6
Cr	–	96	50.4	43.6	145	–	–	–	104	–	201	296	368	313
Cs	–	0.3	1.0	0.8	–	–	–	–	0.7	1.7	0.3	0.3	0.4	–
Cu	–	33	52	64	83	–	–	–	56	37	–	–	–	–
Ga	–	19	23	22	30	–	–	–	25	24	–	–	–	–
Hf	–	2.7	2.7	2.2	2.3	–	–	–	3.6	4.1	2.7	3.1	2.6	3.1
Nb	6.2	6.0	4.2	3.0	3.7	–	–	–	8.1	7.6	5.0	8.6	6.2	8.2
Ni	72	76	58	48	125	–	–	–	–	–	88	158	171	172
Rb	33	8*	23*	14*	8	28	20	25	23	42	19	29	22	31
Sc	–	24.0	19.0	20.8	22.4	–	–	–	16.5	13.7	25.0	22.9	22.0	21.5
Sr	1040	551	585	709	590	853	771	770	700	561	589	1110	717	1200
Ta	–	0.42	0.34	0.23	0.23	–	–	–	0.43	0.44	0.37	0.52	0.33	0.49
Th	–	1.5	2.8	1.9	1	–	–	–	2	3.7	1.2	3.2	2.1	3.2
U	–	0.6	0.9	–	0.5	–	–	–	0.8	1.3	0.5	0.8	0.7	0.9
V	–	210	190	210	170	–	–	–	140	150	–	–	–	–
Y	20	25	21	19	19	26	24	24	22	27	24	27	25	24
Zn	–	91	77	76	83	–	–	–	71	68	78	94	82	90
Zr	164	124	120	104	114	184	180	182	175	180	131	160	126	162
La	–	11	11	10	10.2	–	–	–	20	21	10.6	26	16	28
Ce	–	24	25	21	22	–	–	–	38	41	24	52	33	53
Nd	–	15	14	12	12	–	–	–	19	22	13	25	17	26
Sm	–	4.0	3.7	3.3	3.5	–	–	–	4.3	5.0	3.7	4.8	3.6	4.83
Eu	–	1.26	1.09	1.04	1.06	–	–	–	1.17	1.27	1.22	1.28	1.05	1.32
Tb	–	0.64	0.57	0.49	0.50	–	–	–	0.51	0.65	0.61	0.52	0.53	0.49
Yb	–	2.2	1.8	1.6	1.8	–	–	–	1.7	2.1	2.0	1.5	1.6	1.3
Lu	–	0.33	0.28	0.24	0.28	–	–	–	0.27	0.33	0.32	0.20	0.23	0.174

Sample No.	88C-1524	88C-1525	88C-1529	88C-1530	88C-1535	88C-1536	88C-1537	88C-1538	88C-1539	88C-1540	88C-1541	88C-1542	88C-1544	88C-1545
Major Elements														
weight %														
SiO_2	48.9	48.5	53.2	49.9	48.2	48.5	48.6	48.7	48.8	48.9	53.9	55.6	55.0	54.9
Al_2O_3	17.7	17.4	16.4	17.2	17.1	17.1	17.2	17.1	17.5	17.2	17.1	18.3	18.4	18.3
Fe_TO_3	10.1	9.93	7.86	9.60	10.2	10.1	10.1	10.2	9.83	10.1	8.00	7.22	7.44	7.50
MgO	8.53	9.16	7.84	8.43	9.33	9.22	9.46	9.20	8.99	9.05	6.60	5.18	5.45	5.49
CaO	11.3	11.2	8.72	10.0	11.1	11.2	11.2	11.2	10.8	10.9	8.29	8.14	8.39	8.43
Na_2O	3.01	2.91	3.66	3.32	2.71	2.88	2.88	2.89	2.97	2.97	3.87	3.88	3.83	3.81
K_2O	0.229	0.311	1.11	0.536	0.204	0.245	0.227	0.235	0.296	0.329	0.820	0.713	0.705	0.696
TiO_2	1.15	1.07	1.03	1.18	1.16	1.17	1.14	1.18	1.07	1.16	1.0	0.82	0.86	0.86
P_2O_5	0.17	0.18	0.38	0.28	0.16	0.17	0.16	0.16	0.17	0.19	0.26	0.19	0.20	0.20
MnO	0.17	0.16	0.11	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.12	0.11	0.11	0.11
LOI	<0.01	<0.01	0.05	<0.01	0.40	0.04	<0.01	<0.01	<0.01	<0.01	0.29	0.11	0.16	0.05
Total	101.26	100.82	100.36	100.60	100.72	100.79	101.13	101.03	100.59	100.96	100.25	100.26	100.55	100.35
Trace Elements														
ppm														
Ba	86	119	450	233	102	90	101	98	117	151	334	299	283	293
Co	41.5	43.6	31.8	39.6	44.6	45.3	45.0	45.6	45.8	46.3	32.1	26.9	27.8	27.4
Cr	217	239	301	274	325	327	331	330	287	278	253	127	107	105
Cs	–	–	0.5	–	–	–	–	<0.3	<0.2	<0.3	0.5	0.2	–	0.3
Cu	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hf	2.0	2.1	2.8	2.8	2.0	2.2	2.0	2.1	2.2	2.5	2.6	2.2	2.2	2.2
Nb	3.0	2.9	6.9	4.4	3.0	3.0	3.0	3.4	3.3	3.4	4.5	3.6	3.8	3.3
Ni	124	157	167	132	157	157	159	150	145	153	142	67	91	84
Rb	3	3	30	11	3	3	3	5	9	10	23	19	21	18
Sc	36.3	35.6	21.1	30.1	36.3	37.0	36.3	38.3	35.1	37.5	21.2	19.4	19.6	19.5
Sr	378	421	1030	562	353	369	364	356	420	415	769	752	750	727
Ta	–	0.16	0.37	0.25	0.16	0.19	0.19	0.26	0.20	0.21	0.27	0.19	0.23	0.18
Th	0.5	0.7	2.8	1.3	0.5	0.5	0.6	0.6	0.8	1.0	1.7	1.25	1.2	1.2
U	–	0.4	0.8	0.5	–	0.2	–	–	–	–	0.6	0.45	0.3	0.4
V	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y	29	27	23	30	28	29	30	31	28	30	29	23	24	26
Zn	77	78	86	81	73	82	145	89	81	95	76	72	70	71
Zr	93	100	153	131	93	101	99	95	101	113	127	108	116	110
La	5.4	6.6	21	12	5.5	5.8	5.5	5.6	6.9	7.9	13	10.8	10.5	10.8
Ce	13	16	42	27	13	14	14	15	17	19	28	21	22	22
Nd	10	9	19	14	9	10	11	10	11	12	15	12	13	11
Sm	3.3	3.2	4.2	3.9	3.2	3.4	3.3	3.3	3.2	3.5	3.7	3.1	3.2	3.2
Eu	1.10	1.08	1.19	1.27	1.11	1.17	1.11	1.16	1.13	1.21	1.11	1.04	1.06	1.02
Tb	0.67	0.60	0.45	0.67	0.63	0.67	0.63	0.67	0.63	0.65	0.52	0.47	0.46	0.43
Yb	2.8	2.4	1.4	2.5	2.8	2.8	2.7	2.8	2.5	2.9	1.8	1.4	1.7	1.6
Lu	0.42	0.37	0.21	0.33	0.37	0.39	0.37	0.40	0.38	0.40	0.26	0.21	0.23	0.23

Sample No.	88C-1546	88C-1547	88C-1548	88C-1549	88C-1550	88C-1552	88C-1553	88C-1554	88C-1555	88C-1556	88C-1557	88C-1558	88C-1559	88C-1560
Major Elements														
weight %														
SiO_2	55.1	54.9	57.9	54.9	53.5	53.2	58.9	59.2	59.0	59.2	52.1	59.5	54.0	54.0
Al_2O_3	17.7	18.2	17.4	17.7	18.4	16.9	18.0	17.9	17.7	18.0	17.3	17.2	18.3	18.5
Fe_TO_3	7.95	8.07	7.58	7.67	8.33	8.27	6.33	6.24	6.31	6.24	8.73	6.27	8.57	8.52
MgO	4.24	5.25	3.40	4.53	4.61	6.96	3.41	3.46	3.71	3.38	7.59	3.83	5.14	5.09
CaO	7.45	7.88	6.76	7.51	7.35	8.63	6.96	6.93	7.15	6.95	9.42	6.75	8.30	8.30
Na_2O	4.24	4.06	4.59	4.32	4.14	3.63	4.06	4.01	3.82	4.10	3.57	3.77	3.92	3.90
K_2O	1.38	0.758	1.16	1.40	1.05	0.862	1.12	1.23	1.28	1.19	0.680	1.41	0.754	0.709
TiO_2	1.13	0.94	1.09	1.15	1.10	1.07	0.72	0.72	0.73	0.73	1.12	0.72	1.02	1.00
P_2O_5	0.53	0.28	0.28	0.48	0.46	0.25	0.18	0.20	0.20	0.19	0.26	0.22	0.24	0.24
MnO	0.13	0.13	0.12	0.11	0.14	0.13	0.09	0.09	0.10	0.09	0.14	0.10	0.13	0.13
LOI	0.13	<0.01	<0.01	0.25	1.00	<0.01	0.11	0.19	0.08	<0.01	<0.01	0.36	<0.01	0.15
Total	99.98	100.47	100.28	100.02	100.08	99.90	99.88	100.17	100.08	100.07	100.91	100.13	100.37	100.54
Trace Elements														
ppm														
Ba	614	380	414	627	686	313	469	532	512	494	262	615	337	338
Co	22.7	27.7	18.9	24.9	24.2	32.9	19.9	19.3	19.7	19.1	36.4	19.7	28.0	27.5
Cr	62	127	35.1	79	79	238	13.2	17.0	39.0	12.8	272	77	80	80
Cs	0.5	0.4	0.7	0.4	0.4	0.6	0.6	0.9	0.8	0.9	0.3	0.9	0.6	0.5
Cu	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hf	3.9	2.5	3.2	3.8	4.1	3.0	2.6	2.7	3.0	2.6	2.8	3.5	2.1	2.1
Nb	11.2	5.1	5.8	10.2	10.7	5.9	5.4	6.2	6.8	6.1	5.1	7.7	4.9	4.6
Ni	49	80	23	61	67	117	43	44	44	42	120	54	67	61
Rb	35	15	27	36	20	11	26	26	28	28	14	23	14	14
Sc	16.6	19.2	19.3	16.1	17.4	23.3	16.2	16.0	16.4	15.8	26.8	16.0	20.7	20.1
Sr	1040	618	557	1300	1000	547	626	591	577	599	546	521	608	590
Ta	0.63	0.25	0.28	0.55	0.53	0.32	0.31	0.34	0.34	0.33	0.28	0.43	0.20	0.22
Th	2.7	1.0	1.9	2.9	2.5	1.5	1.9	2.1	2.3	1.9	1.2	2.7	0.8	0.7
U	0.9	0.5	0.8	0.9	0.6	0.6	0.9	1.0	0.9	1.0	1.9	1.1	0.4	0.4
V	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y	30	23	29	26	31	25	24	24	24	22	27	24	20	23
Zn	86	81	71	89	92	76	68	65	64	63	80	70	84	82
Zr	203	115	154	190	215	142	126	136	146	131	129	165	102	101
La	29	12	13	27	27	12	13	14	16	14	11	19	9.6	9.5
Ce	59	26	27	55	57	26	26	28	31	26	25	36	21	21
Nd	30	14	16	29	26	16	13	14	15	13	14	17	13	13
Sm	6.2	3.9	4.3	5.4	5.63	3.9	3.1	3.3	3.5	3.2	3.8	3.9	3.6	3.5
Eu	1.63	1.19	1.2	1.53	1.59	1.14	0.94	0.94	1.00	0.94	1.21	1.03	1.18	1.17
Tb	0.69	0.55	0.59	0.58	0.67	0.59	0.47	0.44	0.49	0.42	0.60	0.55	0.55	0.52
Yb	2.1	1.8	2.2	1.6	1.9	2.1	1.4	1.5	1.6	1.4	2.1	1.9	1.8	1.8
Lu	0.31	0.25	0.30	0.24	0.28	0.29	0.21	0.21	0.24	0.19	0.31	0.25	0.26	0.26

Sample No.	88C-1561	88C-1562	88C-1563	88C-1564	88C-1565	88C-1566	88C-1567	88C-1568	88C-1569
Major Elements									
weight %									
SiO_2	53.9	54.2	55.5	52.9	54.8	54.5	58.7	47.9	57.2
Al_2O_3	18.3	18.3	18.8	18.5	17.6	17.9	17.1	17.7	18.5
Fe_TO_3	8.61	8.58	6.83	8.79	7.45	7.91	6.67	10.2	6.80
MgO	5.25	5.10	4.58	5.29	6.43	5.21	4.27	9.23	4.39
CaO	8.18	8.25	8.03	8.22	8.45	8.04	6.99	11.4	7.42
Na_2O	3.89	3.94	3.99	3.73	3.85	4.07	3.96	2.71	4.22
K_2O	0.721	0.740	0.748	0.627	0.990	1.04	1.28	0.104	0.761
TiO_2	1.01	1.03	0.76	1.03	0.87	1.01	0.83	1.02	0.71
P_2O_5	0.23	0.24	0.14	0.23	0.27	0.33	0.30	0.08	0.19
MnO	0.14	0.14	0.10	0.14	0.11	0.12	0.10	0.16	0.11
LOI	<0.01	<0.01	0.71	0.71	<0.01	0.04	0.02	0.31	0.03
Total	100.23	100.52	100.19	100.17	100.82	100.17	100.22	100.81	100.33
Trace Elements									
ppm									
Ba	327	346	241	312	425	457	516	66	283
Co	28.6	28.0	25.3	29.6	28.5	27.6	21.3	48.2	23.2
Cr	85	78	38.1	88	158	105	104	232	53.3
Cs	0.4	0.4	0.5	0.4	0.3	0.5	0.6	–	–
Cu	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Hf	2.1	2.1	1.9	2.1	2.4	2.9	3.5	1.6	1.9
Nb	4.8	5.1	3.6	4.6	4.9	7.1	8.9	2.2	3.7
Ni	82	63	62	80	110	87	65	165	58
Rb	11	8	19	11	25	22	27	–	18
Sc	20.4	20.6	16.8	21.0	19.3	18.4	15.8	37.6	15.5
Sr	575	592	847	575	942	863	689	267	748
Ta	0.23	0.22	0.12	0.23	0.21	0.37	0.45	–	0.12
Th	0.8	0.9	1.2	0.7	1.8	1.9	2.1	–	1.2
U	0.30	–	0.4	0.3	0.4	0.5	0.8	–	0.4
V	–	–	–	–	–	–	–	–	–
Y	24	23	22	22	24	24	26	26	19
Zn	83	78	67	85	67	79	73	81	66
Zr	99	106	102	101	127	146	175	69	102
La	9.2	9.6	8.8	8.9	14	18	19	2.2	8.2
Ce	20	21	19	20	29	38	39	6.7	18
Nd	13	15	10	13	16	20	19	6.1	11
Sm	3.5	3.6	2.7	3.5	3.4	4.4	4.3	2.4	2.7
Eu	1.16	1.14	0.88	1.20	1.06	1.28	1.21	0.91	0.92
Tb	0.49	0.50	0.35	0.56	0.38	0.54	0.55	0.57	0.40
Yb	1.8	1.8	1.1	1.7	1.3	1.7	1.9	2.4	1.3
Lu	0.24	0.25	0.14	0.26	0.19	0.26	0.26	0.34	0.19

TABLE 2

Sample No.	Latitude	Longitude	% Phenocrysts[1]	Phases	Location
79C-120	42°57.22'	122°11.00'	30	ol pl aug	Inclusion in lava, Williams Crater
79C-133	42°57.27'	122°10.62'	30	ol pl aug	Bomb, Williams Crater
80C-354	42°59.89'	122°09.76'	<1	ol>>pl	Bomb, Red Cone
80C-355	42°59.70'	122°10.15'	2	ol>>pl	Lava, Red Cone
81C-533	42°51.02'	122°05.98'	2	ol pl aug ox	Bomb, Crater Peak
81C-536	42°57.42'	122°11.52'	30	ol pl aug	Inclusion in lava, Williams Crater
81C-543	42°57.43'	122°11.76'	25	ol pl aug	Lava west of Williams Crater
81C-621	42°53.64'	122°14.82'	2	ol	Lava, Castle Creek
81C-664	42°57.30'	122°10.67'	25	ol pl aug	Inclusion in lava-cored bomb, Williams Crater
81C-666	42°57.30'	122°10.67'	25	ol pl aug	Bomb, Williams Crater
82C-674	42°46.93'	121°59.06'	3	ol>>pl	Lava near west side of Sun Pass
82C-703	42°58.34'	121°55.17'	2	ol pl aug	Lava from cone southeast of Lookout Butte
82C-730	42°59.59'	121°56.66'	1	ol<pl	Lava, cone north of Lookout Butte
82C-753	43°05.38'	121°51.03'	<1	pl aug hb	Agglutinate, Buckeye Butte
82C-754	43°05.43'	121°58.42'	<1	ol<pl	Agglutinate, cone north of highway 138
82C-761	42°53.70'	121°59.92'	15	pl aug ox	Agglutinate, cone southeast of Mount Scott
82C-814	42°53.88'	122°14.40'	10-15	ol pl aug	Bomb, cone in north wall of Little Castle Creek
82C-816	42°54.40'	122°13.96'	1	pl aug opx	Bomb, cone 1 km north of Little Castle Creek
82C-845	42°58.58'	122°07.47'	15-20	ol pl aug	Bomb, caldera wall at Steel Bay
82C-852	43°02.64'	122°05.04'	<1	ol>>pl	Lava, west slope of Timber Crater
82C-853	43°02.50'	122°04.20'	<1	ol>>pl	Lava west of Timber Crater summit
82C-854	43°01.68'	122°09.65'	3	ol<pl	Lava, Desert Cone
82C-893	42°54.70'	122°26.34'	<1	ol	Lava, Rogue River at Farewell Bend
82C-894	42°56.04'	122°25.27'	<1	ol	Lava, Rogue River at Bybee Creek
82C-930	42°44.03'	121°58.47'	1	ol>pl	Lava, Kimball Park
83C-946	42°54.37'	122°15.72'	30[2]	ol pl microph	Lava north of Castle Creek, lowest flow
83C-947	42°54.44'	122°15.66'	5	ol<pl	Lava north of Castle Creek, cliff-forming flow
83C-948	42°54.21'	122°15.15'	<1	ol<<pl	Lava north of Castle Creek, top flow
83C-957	42°52.18'	122°10.22'	<1	ol pl	Lava, top flow in roadcut west of Annie Spring
83C-980	42°52.81'	122°11.15'	<1	ol>pl	Lava, east of Whitehorse Bluff
83C-981	42°53.14'	122°12.05'	<<1	ol pl	Dike south of highway 62
83C-982	42°53.14'	122°12.05'	<1	ol<pl	Dike south of highway 62
83C-983	42°53.16'	122°12.05'	na	na	Dike south of highway 62
83C-984	42°53.19'	122°12.06'	<1	ol pl aug	Dike south of highway 62
83C-985	42°53.17'	122°12.03'	<1	ol pl	East margin of dike south of highway 62
83C-987	42°53.04'	122°14.84'	<1	ol<pl	Lava, top flow north of Castle Point
83C-1006	42°51.17'	122°09.84'	1	ol pl opx	Intrusive rock, Arant Point
83C-1007	42°51.11'	122°09.78'	<<1	pl	Intrusive rock, Arant Point
83C-1008	42°51.11'	122°09.78'	<1	ol pl opx	Intrusive rock, Arant Point
83C-1009	42°51.18'	122°09.84'	<1	ol pl opx	Intrusive rock, Arant Point
83C-1010	42°51.41'	122°10.01'	<<1	ol pl opx	Chilled margin of intrusion, Arant Point
83C-1029	42°51.15'	122°05.22'	na	na	Lava, Crater Peak
83C-1054	42°50.64'	121°56.30'	2	pl opx	Intrusive rock, north of Sand Creek
83C-1059	42°48.47'	121°55.15'	2	ol pl aug	Agglutinate, Boundary Butte
83C-1074	42°53.82'	122°06.07'	7	pl aug opx ox	Dike south of Applegate Peak
83C-1087	42°47.93'	121°59.38'	<1	ol>pl	Agglutinate, Sand Ridge 2 km northwest of Sun Pass

[1]Estimated
[2]Microphenocrysts

Sample No.	Latitude	Longitude	% Phenocrysts[1]	Phases	Location
83C-1089	42°48.04'	121°56.37'	1	ol<pl	Agglutinate, cone southwest of Boundary Butte
84C-1107	42°57.37'	122°12.95'	25	ol pl aug	Lava, flow west of Williams Crater
84C-1141	43°02.53'	122°13.67'	<1	ol>>pl	Bomb, Bald Crater
84C-1142	43°02.33'	122°13.38'	1	ol pl	Lava, Bald Crater
84C-1143	43°02.75'	122°12.32'	<1	ol>>pl	Lava east of Bald Crater
85C-1181	43°01.25'	122°14.47'	3	ol pl aug	Intrusive rock, Oasis Butte
85C-1185	43°00.93'	122°14.65'	<3	ol pl aug	Lava south-southwest of Oasis Butte
85C-1186	43°01.06'	122°14.58'	5-7	ol pl aug ox	Lava south-southwest of Oasis Butte
85C-1187	43°00.85'	122°14.42'	5	ol pl aug	Lava, cone south of Oasis Butte
85C-1193	42°58.36'	122°13.43'	40	ol pl aug	Lava from cone 4 km southwest of Red Cone
85C-1198	43°01.07'	122°12.66'	3-5	ol pl aug	Lava from vent 1.5 km north of Red Cone
85C-1210	42°49.14'	122°06.00'	1-2	ol	Lava east of Annie Creek
85C-1211	42°49.55'	122°06.43'	7-10	ol pl aug	Lava east of Annie Creek
85C-1216	42°50.27'	122°05.82'	5	ol pl aug	Bomb, vent 1.3 km south of Crater Peak
85C-1217	42°50.29'	122°05.38'	10	ol pl aug opx ox	Lava, Crater Peak
85C-1222	42°49.97'	122°00.94'	<10	ol pl	Agglutinate, Maklaks Crater
85C-1229	42°49.79'	121°56.99'	10	ol pl aug ox	Lava, upper flow in quarry south of Sand Creek
85C-1230	42°49.79'	121°56.99'	5	pl aug opx ox	Lava, lower flow in quarry south of Sand Creek
85C-1231	42°48.87'	121°57.83'	2	pl aug	Agglutinate, vent 3.5 km west-northwest of Boundary Butte
85C-1234	42°48.66'	122°00.14'	<5	pl ol	Agglutinate, northeast Sand Ridge
85C-1236	42°47.70'	121°58.70'	2-3	ol	Bomb, northwest of Sun Pass
85C-1241	42°58.08'	122°11.26'	25	ol pl aug	Lava, cone 4 km southest of Red Cone
85C-1267	42°51.15'	121°53.83'	7-10	ol pl	Bomb, cone east of Sand Creek
86C-1294	42°52.41'	122°06.26'	4	ol	Agglutinate, cone 2 km north of Crater Peak
86C-1295	42°51.29'	122°06.79'	7	ol pl aug ox	Lava, Crater Peak
86C-1357	43°06.91'	121°47.74'	>10	ol<pl	Bomb, cone 5 km north-northeast of junction of highways138&97
86C-1358	43°06.69'	121°53.11'	3	ol pl	Bomb, Welch Butte
86C-1359	43°06.31'	121°54.42'	5-7	ol<pl	Bomb, cone west of Welch Butte
87C-1395	42°51.90'	121°58.87'	5-10	ol pl aug	Bomb, cone east of Cavern Creek
87C-1438	43°01.84'	122°02.77'	25[2]	ol pl aug microph	Lava, Timber Crater
87C-1440	43°02.78'	122°02.90'	3	ol pl	Lava, Timber Ctater
87C-1445	43°03.18'	122°01.12'	3	ol pl	Lava, Timber Crater
87C-1446	43°03.44'	122°01.93'	2	ol pl	Lava, Timber Crater
87C-1457	42°53.18'	122°02.87'	3	pl aug opx ox	Lava, West side of Kerr Valley
88C-1518	43°01.10'	122°09.82'	10	ol pl aug	Lava, vent south of Desert Cone
88C-1520	43°00.95'	122°10.15'	10	ol pl aug	Lava from vent 1.5 km north of Red Cone
88C-1521	43°00.87'	122°10.17'	7	ol pl aug ox	Lava from vent 1.5 km north of Red Cone
88C-1523	43°01.32'	122°11.57'	7-10	ol pl aug	Lava from vent 1.5 km north of Red Cone
88C-1524	43°01.70'	122°11.91'	2	ol pl	Lava southeast of Bald Crater
88C-1525	43°01.90'	122°12.12'	5	ol pl	Lava southeast of Bald Crater
88C-1529	43°02.27'	122°12.00'	7	ol pl aug	Lava from vent 1.5 km north of Red Cone
88C-1530	43°02.12'	122°12.10'	5	ol pl ox	Agglutinate, cone 1.5 km southeast of Bald Crater
88C-1535	43°02.60'	122°12.40'	2	ol pl	Lava east of Bald Crater, top of 3 flows
88C-1536	43°02.60'	122°12.40'	2	ol pl	Lava east of Bald Crater, middle of 3 flows
88C-1537	43°02.60'	122°12.40'	2	ol pl	Lava east of Bald Crater , bottom of 3 flows
88C-1538	43°02.60'	122°12.12'	2	ol pl	Lava east of Bald Crater, top flow
88C-1539	43°02.75'	122°12.17'	3	ol pl	Lava east of Bald Crater, top flow
88C-1540	43°02.74'	122°12.15'	3	ol pl	Lava east of Bald Crater , flow below 1539
88C-1541	43°03.00'	122°13.40'	2	ol pl	Agglutinate, vent north of Bald Crater
88C-1542	42°49.77'	122°13.20'	1	ol	Intrusive rock, Union Peak

Sample No.	Latitude	Longitude	% Phenocrysts[1]	Phases	Location
88C-1544	42°49.95'	122°12.86'	2	ol pl	Lava, Union Peak, upper of 2 flows
88C-1545	42°49.94'	122°12.85'	2	ol>pl	Lava, Union Peak, lower of 2 flows
88C-1546	42°49.35'	122°11.12'	2	ol>pl	Intrusive rock 3 km east-southeast of Union Peak
88C-1547	42°49.02'	122°10.70'	2	ol pl	Lava west of Pumice Flat
88C-1548	42°49.58'	122°09.78'	7	ol pl aug	Lava north of Pumice Flat
88C-1549	42°51.10'	122°10.95'	1	ol	Agglutinate, hill 6712, 2 km west of Arant Point
88C-1550	42°52.00'	122°11.27'	<1	ol	Agglutinate, hill 6428, 2 km northwest of Arant Point
88C-1552	43°02.77'	122°09.50'	2	ol pl	Lava, Klamath Ridge
88C-1553	43°03.32'	122°09.60'	40[2]	ol<<pl aug opx microph	Bomb (erratic?), hill 6366, southwest of Desert Ridge
88C-1554	43°03.70'	122°09.02'	40[2]	ol<pl aug opx microph	Lava, summit of Desert Ridge
88C-1555	43°03.80'	122°08.53'	<2	ol pl	Lava or intrusive rock, Gaywas Peak
88C-1556	43°04.80'	122°09.35'	40[2]	pl aug opx	Lava, northwest summit of Desert Ridge
88C-1557	43°04.65'	122°09.48'	2-3	ol>pl	Lava, hill 6062, north of Desert Ridge
88C-1558	43°04.42'	122°08.15'	30[2]	pl microph>>opx	Bomb, hill 6589, north of Gaywas Peak
88C-1559	43°05.10'	122°09.50'	2	ol pl	Lava (float), hill 6509, north of Desert Ridge"
88C-1560	43°04.60'	122°08.10'	1	ol>pl	Lava, hill north-northwest of hill 6589, north of Gaywas Peak
88C-1561	43°05.17'	122°08.24'	1-2	ol>pl	Bomb, hill 6256, north of Gaywas Peak
88C-1562	43°04.62'	122°08.02'	2	ol>pl	Lava, hill northeast of hill 6589, north of Gaywas Peak
88C-1563	43°05.40'	122°08.10'	5	ol>pl aug opx	Agglutinate, hill north-northeast of hill 6256, north of Gayway Peak
88C-1564	43°05.50'	122°08.22'	<2	ol	Bomb, hill 5955, north of Gaywas Peak
88C-1565	42°49.05'	122°06.75'	25	pl aug ox	Lava, Annie Falls
88C-1566	43°05.27'	122°03.70'	1	ol	Agglutinate, small cone north of Timber Crater
88C-1567	43°05.10'	122°03.78'	2	ol pl opx	Lava from north-northwest vent of Timber Crater
88C-1568	42°44.76'	122°29.69'	1	ol<pl	Lava west of Prospect
88C-1569	42°50.65'	122°08.58'	1	ol	Lava or intrusive rock, quarry south of Quillwort Pond