U.S. DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

Chemical data for Tertiary volcanic and intrusive rocks of the Spirit Lake 15-minute quadrangle, southern Washington Cascade Range

by

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Prepared in cooperation with the Washington Department of Natural Resources, Division of Geology and Earth Resources

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CHEMICAL DATA FOR TERTIARY VOLCANIC AND INTRUSIVE ROCKS OF THE SPIRIT LAKE 15-MINUTE QUADRANGLE, SOUTHERN WASHINGTON CASCADE RANGE

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INTRODUCTION

This report presents major-element and selected trace-element analyses and CIPW norms for 131 samples of Oligocene and Miocene volcanic and hypabyssal intrusive rocks collected from the Spirit Lake 15-minute quadrangle in the Cascade Range of southwestern Washington (fig. 1). These data supplement new geologic maps of the four 7½-minute quadrangles that make up the Spirit Lake 15-minute quadrangle: Cowlitz Falls, Vanson Peak, Spirit Lake East, and Spirit Lake West (Evarts and Ashley, 1993a,b,c,d). The rocks selected for analysis were the least altered of approximately 2000 samples collected during mapping. They represent all of the rock types and rock units described by Evarts and Ashley (1993a,b,c,d) within the mapped area except for the large granitic complex of the Spirit Lake pluton (Evarts and others, 1987), analyses of which will be published elsewhere.

ANALYTICAL METHODS

All data reported herein were acquired in laboratories of the U.S. Geological Survey. Sample-preparation procedures are described by Taylor (1990). The major-element compositions of most rocks analyzed prior to 1982 (42 samples) were determined by the single-solution rapid-rock method (Shapiro, 1975) in Reston, Va. by J. Gillison and H. Smith. The remainder were analyzed by X-ray fluorescence (Taggart and others, 1987, 1990) in Lakewood, Colo. by J. Baker, A.J. Bartel, D. Fey, D. Siems, K. Stewart, J.E. Taggart, and J.S. Wahlberg. FeO, H_2O, and CO_2 were determined in Reston or Menlo Park, Calif. using methods described in Jackson and others (1987) by N. Elsheimer, E. Engelman, L. Espos, P. Klock, S. Neil, H. Neiman, and S. Pribble.

The major-element analyses presented herein (table 1) have been recalculated H_2O- and CO_2-free and normalized to 100 percent; the original data are included with the geologic maps of Evarts and Ashley (1993a,b,c,d). In table 1, FeO* designates total Fe calculated as FeO, mg-value is the atomic ratio $100(Mg/Mg+Fe_{total})$, and Mg# is the atomic ratio $100(Mg/Mg+Fe^{2+})$ after adjustment of the Fe_2O_3/FeO ratio as recommended by Middlemost (1989).

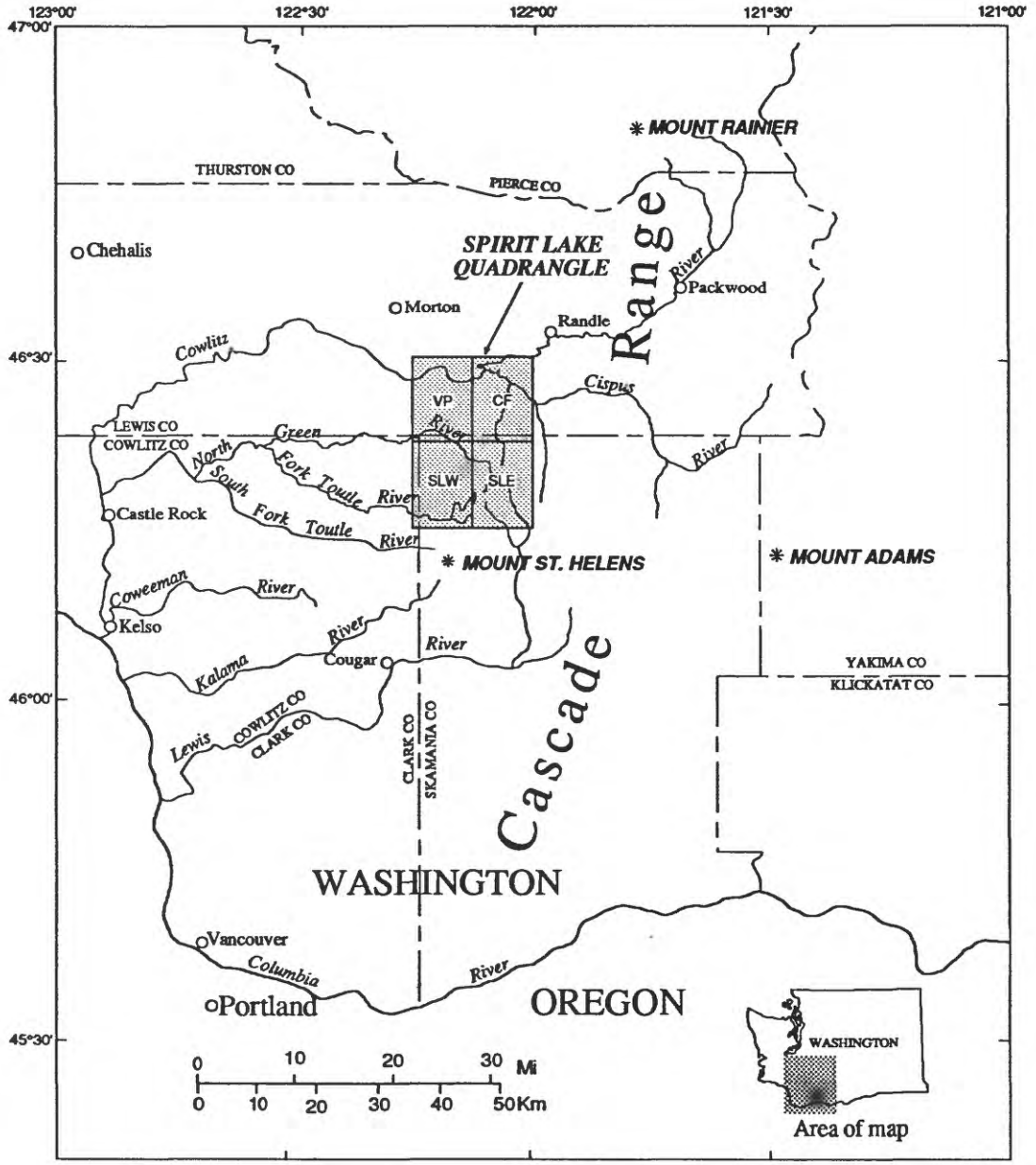

Figure 1. Index map southwestern Washington showing the location of the Spirit Lake 15-minute quadrangle and its constituent $7^1/_2$-minute quadrangles: Vanson Peak (VP), Cowlitz Falls (CF), Spirit Lake West (SLW), and Spirit Lake East (SLE).

CIPW norms were calculated using the PETCAL program of Bingler and others (1976) using the option of setting weight percent Fe_2O_3 = weight percent TiO_2 + 1.5 as suggested by Irvine and Baragar (1971).

Trace-element contents were determined using induction-coupled plasma-atomic emission spectroscopy (ICP-AES) and energy-dispersive X-Ray fluorescence (EDXRF). The ICP-AES analyses were performed in Lakewood by P.H. Briggs, D. Fey, D.B. Hatfield, and M. Malcolm, using methods detailed in Lichte and others (1987) and Briggs (1990). Table 1 includes the results for Co, Cr, Cu, Ga, Ni, Pb, Sc, Sr, V, Y, and Zn. The following elements were sought but were generally near or below the given detection limits (in ppm): Ag (2), As (10), Au (8), Be (1), Bi (10), Cd (2), Eu (2), Mo (2), Sn (4), Ta (40), Th (4), and U (100). La, Ce, Nd, Nb, and Yb typically are present at levels above detection limits but are not included here because comparison with superior spectrophotometric and neutron activation techniques indicates that the ICP-AES results are only semiquantitative for these elements. Ba results by ICP-AES are not reported but are typically virtually identical to the EDXRF results. Li results are not reported because this element is highly susceptible to remobilization during zeolite-facies metamorphism and weathering, which have affected all Tertiary rocks of the region to some extent.

Rb, Sr, Y, Zr, Nb, Ba, La, Ce, Cu, Ni, Zn, and Cr were determined by K. R. Bishop in Menlo Park using EDXRF equipment and procedures described by Johnson and King (1987) and King and Lindsley (1990); the Nb, La, and Ce data are not included here because, for most samples, the results were near or below the limits of determination (10 ppm for Nb; 30 ppm for La and Ce). Each sample was run at least twice and the results presented in table 1 are the averaged values. The precision and accuracy were evaluated by repeated determinations of standards JB-1 basalt and W-2 diabase (table 2).

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_____1993c, Geologic map of the Spirit Lake West quadrangle, Skamania and Cowlitz Counties, Washington: U.S. Geological Survey Geologic Quadrangle Map GQ-1681, scale 1:24,000.

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Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, Washington
[Major-element analyses recalculated volatile-free]

Sample no.	0E68	3E64	0L28	8R132A	3E57	0E59	0E13B	6N42A
Quadrangle*	CF	VP	VP	VP	VP	VP	CF	VP
Latitude	46° 29' 42"	46° 27' 33"	46° 29' 56"	46° 26' 13"	46° 28' 08"	46° 26'57"	46° 28' 00"	46° 29' 08"
Longitude	122° 05' 35"	122° 11' 00"	122° 08' 16"	122° 11' 49"	122° 11' 36"	122° 08'49"	122° 06' 40"	122° 10' 53"
Map unit†	Tgc	Tgc	Tgc	Tgc	Tgc	Tgc	Tgc	Tgc
Rock type	Basalt	Basalt	Basalt	Basalt	Basalt	Basaltic andesite	Basaltic andesite	Basaltic andesite
SiO_2	50.20	50.91	51.66	51.66	51.87	52.37	52.81	52.87
TiO_2	1.42	1.09	1.02	1.23	1.39	1.15	1.03	1.54
Al_2O_3	20.83	17.81	17.39	18.49	17.59	18.26	16.98	18.27
Fe_2O_3	4.27	4.02	3.86	3.80	3.38	3.88	3.21	4.78
FeO	5.59	5.84	5.19	6.47	6.31	5.04	5.38	4.27
MnO	0.16	0.15	0.18	0.15	0.16	0.13	0.16	0.12
MgO	3.66	7.23	6.81	4.72	6.09	5.14	6.73	4.78
CaO	10.36	9.97	10.58	9.45	9.62	10.91	10.67	9.35
Na_2O	2.85	2.41	2.75	3.49	2.92	2.73	2.59	3.21
K_2O	0.51	0.42	0.41	0.25	0.45	0.18	0.27	0.56
P_2O_5	0.15	0.16	0.16	0.28	0.22	0.21	0.18	0.26
mg-value	40.5	57.3	57.9	45.6	53.3	51.4	58.7	49.5
FeO*	9.28	8.97	8.52	9.63	9.19	8.13	7.99	8.39
FeO*/MgO	2.58	1.31	1.27	2.09	1.53	1.66	1.23	1.79
Na_2O+K_2O	3.35	2.84	3.15	3.74	3.37	2.91	2.86	3.77
Mg#	45.3	62.8	62.7	50.7	58.2	58.8	65.5	54.4
				CIPW Norms				
q	2.548	1.933	1.789	1.942	3.247	5.466	4.823	5.376
c	--	--	--	--	--	--	--	--
or	3.006	2.495	2.407	1.458	2.645	1.055	1.592	3.323
ab	24.106	20.449	23.261	29.578	24.707	23.113	21.918	27.165
an	42.623	36.571	33.965	34.077	33.598	37.092	33.944	33.866
di	6.479	9.661	14.162	9.068	10.286	12.789	14.404	8.840
wo	3.284	4.979	7.309	4.608	5.298	6.573	7.454	4.562
en	1.705	3.095	4.608	2.463	3.277	3.973	4.822	2.877
fs	1.490	1.587	2.245	1.997	1.711	2.243	2.128	1.401
hy	13.902	22.591	18.416	16.868	18.118	13.843	17.225	13.444
en	7.418	14.935	12.382	9.316	11.902	8.848	11.951	9.040
fs	6.484	7.656	6.034	7.552	6.216	4.995	5.274	4.404
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	4.278	3.872	3.691	4.025	4.234	3.961	3.741	4.462
il	2.705	2.065	1.934	2.343	2.647	2.195	1.948	2.932
ap	0.353	0.367	0.377	0.643	0.518	0.487	0.408	0.592
Normative Plag.	61.12	64.14	59.35	53.53	57.62	61.61	59.08	55.49
DI	29.66	24.88	27.46	32.98	30.60	29.63	28.33	35.87
				Trace-element analyses by EDXRF				
Ba	111	115	130	122	119	93	108	166
Rb	12	<10	11	<10	<10	<10	<10	<10
Sr	360	270	306	295	281	315	324	303
Y	24	16	16	20	21	19	16	28
Zr	109	94	87	114	132	98	99	175
Ni	26	140	82	24	74	36	99	68
Cu	154	90	35	55	100	143	103	107
Zn	64	82	65	50	83	68	68	63
Cr	15	220	160	22	109	89	208	97
				Trace-element analyses by ICP-AES				
Co	44	48	61	41	39	50	57	33
Cr	35	290	410	17	140	140	330	140
Cu	310	98	100	110	150	240	190	160
Ga	41	20	35	21	21	37	32	23
Ni	34	120	150	32	75	49	160	120
Pb	18	<4	10	<4	<4	15	13	13
Sc	28	31	30	29	29	34	26	26
Sr	450	280	420	300	280	410	400	320
V	480	210	380	240	220	410	330	200
Y	22	16	14	21	20	16	14	34
Zn	90	72	100	81	79	80	80	100

*CF: Cowlitz Falls; VP: Vanson Peak; SLE: Spirit Lake East; SLW: Spirit Lake West
†See geologic maps (Evarts and Ashley, 1993a,b,c,d)

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	5E37	8R46	0E19B	5E74	8W21	0E38	1E05	2E106
Quadrangle	VP	VP	CF	VP	VP	CF	CF	CF
Latitude	46° 26' 51"	46° 26' 30"	46° 27' 46"	46° 27' 52"	46° 25' 54"	46° 28' 16"	46° 28' 00"	46° 28' 30"
Longitude	122° 09' 08"	122° 09' 40"	122° 05' 57"	122° 09' 56"	122° 08' 37"	122° 00' 57"	122° 01 '28"	122° 00' 09"
Map unit	Tgc	Tgc	Tgc	Tgc	Tgc	Thm	Thm	Thm
Rock type	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basalt	Basalt	Basalt
SiO_2	53.01	53.11	53.25	53.50	54.39	47.78	50.77	50.97
TiO_2	1.17	0.87	1.01	1.17	1.02	1.32	1.37	1.00
Al_2O_3	18.56	19.95	17.75	19.45	18.57	17.85	19.45	18.79
Fe_2O_3	2.83	3.76	2.97	3.61	3.27	3.90	4.94	4.00
FeO	5.56	3.47	5.82	4.84	5.20	7.07	4.83	5.30
MnO	0.13	0.11	0.14	0.15	0.15	0.18	0.15	0.17
MgO	5.06	4.81	5.36	4.17	4.49	8.48	3.68	6.10
CaO	10.25	10.54	10.53	9.78	8.88	10.75	10.30	9.70
Na_2O	2.87	2.88	2.64	3.02	3.27	2.21	3.47	3.10
K_2O	0.36	0.37	0.40	0.13	0.57	0.34	0.71	0.56
P_2O_5	0.19	0.14	0.13	0.17	0.18	0.11	0.34	0.32
mg-value	52.3	55.2	52.5	47.4	49.1	58.4	41.0	54.5
FeO*	7.90	6.69	8.23	7.99	7.98	10.43	8.83	8.90
FeO*/MgO	1.60	1.42	1.59	1.94	1.81	1.25	2.52	1.46
Na_2O+K_2O	3.23	3.24	3.04	3.15	3.84	2.56	4.18	3.66
Mg#	57.30	61.9	59.5	54.1	56.0	63.1	46.6	59.0
CIPW Norms								
q	5.818	5.535	6.058	7.548	6.566	--	0.640	0.067
c	--	--	--	--	--	--	--	--
or	2.121	2.180	2.379	0.779	3.379	2.040	4.232	3.312
ab	24.297	24.361	22.360	25.572	27.651	18.731	29.407	26.256
an	36.699	40.503	35.396	39.177	34.357	37.809	35.447	35.764
di	10.457	8.811	12.985	6.725	6.950	12.031	11.153	8.386
wo	5.388	4.557	6.665	3.445	3.557	6.205	5.660	4.306
en	3.345	2.934	3.978	2.012	2.061	3.886	2.974	2.582
fs	1.724	1.320	2.342	1.268	1.332	1.940	2.519	1.498
hy	14.013	13.134	14.879	13.689	15.032	13.649	11.466	19.946
en	9.247	9.059	9.365	8.395	9.130	9.105	6.207	12.625
fs	4.766	4.075	5.514	5.294	5.902	4.544	5.259	7.321
ol	--	--	--	--	--	8.854	--	--
fo	--	--	--	--	--	5.712	--	--
fa	--	--	--	--	--	3.142	--	--
mt	3.926	3.491	3.712	3.897	3.702	4.123	4.276	3.628
il	2.220	1.654	1.921	2.215	1.940	2.507	2.600	1.901
ap	0.451	0.332	0.311	0.399	0.426	0.259	0.780	0.742
Normative Plag.	60.17	62.44	58.86	60.51	55.41	64.54	51.31	54.74
DI	32.23	32.08	30.80	33.90	37.60	20.77	34.28	29.64
Trace-element analyses by EDXRF								
Ba	111	91	130	87	167	83	220	268
Rb	12	<10	<10	<10	13	<10	23	17
Sr	328	340	326	356	311	346	498	594
Y	20	11	13	17	18	21	26	22
Zr	130	96	84	108	109	75	134	129
Ni	29	47	25	26	32	91	25	30
Cu	67	110	43	102	82	122	130	80
Zn	79	65	70	79	64	77	65	71
Cr	64	86	78	39	27	114	32	42
Trace-element analyses by ICP-AES								
Co	30	28	33	28	36	60	30	39
Cr	94	93	92	38	54	150	32	42
Cu	70	120	50	120	130	160	130	95
Ga	21	20	20	22	31	24	23	23
Ni	33	46	18	22	36	150	25	39
Pb	<4	<4	6	5	10	23	4	5
Sc	29	23	33	24	25	37	26	24
Sr	330	330	330	370	340	360	500	610
V	190	160	210	190	270	300	200	210
Y	19	12	14	18	16	28	20	19
Zn	71	57	67	71	70	100	65	80

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	7E04	1R38	9R38	9R37	9E37C	2R14	88E08	6E18C
Quadrangle	CF	SLW	SLW	SLW	SLW	SLW	SLW	SLW
Latitude	46° 25' 45"	46° 15' 59"	46° 17' 07"	46° 17' 00"	46° 17' 34"	46° 16' 39"	46° 16' 57"	46° 16' 12"
Longitude	122° 01' 15"	122° 10' 14"	122° 10' 14"	122° 10' 13"	122° 12' 55"	122° 12' 50"	122° 14' 42"	122° 12' 04"
Map unit	Thm	Tcp	Tcp	Tcp	Tb_1	Tb_1	Tb_1	Tb_1
Rock type	Basalt	Basalt	Basaltic andesite	Basaltic andesite	Basalt	Basalt	Basalt	Basalt
SiO_2	51.85	51.33	53.92	56.27	50.02	51.61	51.71	51.78
TiO_2	1.17	1.24	1.50	1.63	1.85	2.24	1.27	1.67
Al_2O_3	18.41	19.19	17.67	15.83	16.64	16.24	16.90	17.60
Fe_2O_3	3.42	3.60	3.62	3.69	4.62	6.99	3.27	4.69
FeO	5.70	5.74	6.11	6.67	6.08	6.09	6.84	5.18
MnO	0.15	0.16	0.16	0.18	0.18	0.23	0.15	0.20
MgO	5.42	4.54	3.92	3.74	7.07	4.60	7.15	5.28
CaO	10.80	10.95	9.18	7.75	10.45	8.60	9.18	10.09
Na_2O	2.75	2.83	3.17	3.30	2.52	2.85	2.82	2.90
K_2O	0.17	0.29	0.54	0.70	0.37	0.21	0.52	0.36
P_2O_5	0.15	0.14	0.21	0.24	0.22	0.33	0.19	0.26
mg-value	52.0	47.0	42.3	39.6	54.8	39.4	56.2	49.5
FeO*	8.53	8.93	9.27	9.90	10.08	11.97	9.55	9.18
FeO*/MgO	1.62	1.98	2.39	2.67	1.45	2.69	1.37	1.78
Na_2O+K_2O	2.92	3.12	3.71	3.99	2.88	3.06	3.34	3.25
Mg#	57.2	51.6	48.8	46.0	59.5	44.6	61.1	54.7
CIPW Norms								
q	4.176	3.457	7.640	11.489	1.916	7.394	2.038	4.758
c	--	--	--	--	--	--	--	--
or	1.034	1.723	3.164	4.114	2.161	1.226	3.087	2.120
ab	23.256	23.989	26.844	27.917	21.315	24.232	23.837	24.540
an	37.424	38.808	32.424	26.358	33.067	30.983	31.933	34.019
di	12.346	11.971	9.642	8.653	14.019	7.930	10.034	11.707
wo	6.342	6.111	4.908	4.386	7.256	4.019	5.170	6.028
en	3.818	3.443	2.673	2.272	4.701	2.084	3.208	3.717
fs	2.186	2.417	2.061	1.995	2.062	1.827	1.656	1.962
hy	15.240	13.401	12.557	13.240	18.606	17.670	22.140	14.441
en	9.693	7.874	7.090	7.051	12.931	9.416	14.600	9.453
fs	5.547	5.527	5.467	6.189	5.675	8.254	7.540	4.988
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	3.940	3.980	4.380	4.565	4.890	5.522	4.070	4.651
il	2.229	2.349	2.859	3.105	3.511	4.277	2.413	3.173
ap	0.358	0.326	0.491	0.561	0.517	0.769	0.451	0.593
Normative Plag.	60.64	61.80	54.71	48.56	60.81	56.11	57.26	58.09
DI	28.47	29.17	37.65	43.52	25.39	32.85	28.96	31.42
Trace-element analyses by EDXRF								
Ba	84	80	132	168	144	115	142	132
Rb	<10	<10	<10	13	<10	<5	<10	<10
Sr	346	300	305	263	313	307	341	342
Y	15	16	20	28	23	28	17	27
Zr	79	99	138	165	141	179	127	164
Ni	43	26	19	15	120	34	97	59
Cu	74	82	99	80	149	186	158	37
Zn	66	66	77	93	85	102	71	82
Cr	68	64	42	33	249	28	132	78
Trace-element analyses by ICP-AES								
Co	35	30	27	28	40	38	46	37
Cr	92	77	35	18	370	16	210	130
Cu	92	83	120	110	180	240	240	37
Ga	22	22	21	22	20	23	21	23
Ni	37	22	14	9	130	18	100	50
Pb	<4	<4	<4	<4	<4	<4	4	<4
Sc	29	32	31	32	31	33	28	27
Sr	350	300	300	260	300	310	350	340
V	240	260	280	300	240	320	200	230
Y	15	19	23	29	23	28	19	22
Zn	76	72	83	94	83	100	73	91

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	6E18B	2R37	7E31	1R48A	2R18B	7E43	2E67	1E79
Quadrangle	SLW	SLW	SLW	SLW	SLW	SLW	SLW	SLW
Latitude	46° 16' 11"	46° 16' 50"	46° 16' 29"	46° 16'12"	46° 17'16"	46° 16'03"	46° 18'40"	46° 17' 22"
Longitude	122° 11' 56"	122° 14' 57"	122° 12' 06"	122° 13'44"	122° 12'47"	122° 14'22"	122° 14'42"	122° 14' 44"
Map unit	Tb_1	Tb_1	Tb_1	Tb_1	Tb_1	Tb_1	Tb_1	Tb_1
Rock type	Basalt	Basalt	Basalt	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite
SiO_2	51.83	51.93	51.95	52.09	52.30	52.34	52.48	52.87
TiO_2	2.17	1.30	2.27	0.96	1.60	1.56	1.38	1.40
Al_2O_3	16.22	17.72	15.92	15.98	16.93	17.85	19.16	18.77
Fe_2O_3	5.40	4.34	3.70	3.54	3.30	4.18	3.10	4.14
FeO	6.51	5.07	8.80	5.66	6.86	5.98	5.83	4.96
MnO	0.18	0.16	0.20	0.18	0.16	0.19	0.13	0.15
MgO	4.44	6.00	4.46	7.48	5.59	4.69	4.09	4.03
CaO	9.96	9.84	9.01	10.01	9.65	9.46	9.96	9.26
Na_2O	2.69	2.92	2.95	3.24	2.62	3.11	3.11	3.13
K_2O	0.21	0.55	0.39	0.57	0.80	0.41	0.60	1.14
P_2O_5	0.40	0.17	0.35	0.28	0.18	0.22	0.18	0.15
mg-value	40.7	53.9	39.2	59.6	49.9	45.7	45.4	44.8
FeO*	11.07	8.81	11.89	8.75	9.70	9.55	8.46	8.56
FeO*/MgO	2.56	1.50	2.72	1.18	1.76	2.08	2.11	2.16
Na_2O+K_2O	2.89	3.47	3.34	3.80	3.43	3.52	3.71	4.26
Mg#	45.7	58.8	44.0	65.9	56.5	52.6	52.2	51.5
				CIPW Norms				
q	8.027	2.878	6.790	--	4.997	4.981	4.708	4.293
c	--	--	--	--	--	--	--	--
or	1.215	3.254	2.292	3.350	4.732	2.414	3.553	6.724
ab	22.792	24.763	24.957	27.414	22.214	26.357	26.301	26.479
an	31.625	33.652	29.085	27.432	32.040	33.579	36.550	33.881
di	12.490	11.410	11.025	16.529	11.900	9.743	9.502	9.058
wo	6.359	5.881	5.588	8.536	6.113	4.978	4.863	4.632
en	3.476	3.662	2.898	5.418	3.680	2.827	2.814	2.657
fs	2.655	1.867	2.539	2.575	2.107	1.938	1.825	1.769
hy	13.424	17.054	15.403	18.307	16.128	14.954	12.138	12.308
en	7.611	11.296	8.210	12.409	10.255	8.873	7.364	7.389
fs	5.813	5.758	7.193	5.898	5.873	6.081	4.774	4.919
ol	--	--	--	0.890	--	--	--	--
fo	--	--	--	0.584	--	--	--	--
fa	--	--	--	0.306	--	--	--	--
mt	5.381	4.110	5.372	3.597	4.527	4.487	4.211	4.243
il	4.120	2.479	4.303	1.827	3.042	2.968	2.613	2.663
ap	0.928	0.401	0.804	0.656	0.422	0.520	0.425	0.353
Normative Plag.	58.12	57.61	53.82	37.60	59.06	56.02	58.15	56.13
DI	32.03	30.90	34.04	30.76	31.94	33.75	34.56	37.50
				Trace-element analyses by EDXRF				
Ba	125	121	191	150	200	115	123	147
Rb	<10	<10	<10	12	17	<10	10	15
Sr	341	355	295	628	380	374	378	367
Y	37	21	28	20	25	21	18	24
Zr	201	114	180	128	140	122	121	156
Ni	180	75	<20	80	53	29	28	62
Cu	96	38	174	91	43	74	109	209
Zn	74	75	93	70	76	79	72	70
Cr	74	146	18	178	86	48	39	67
				Trace-element analyses by ICP-AES				
Co	34	38	36	46	37	34	30	34
Cr	77	170	16	250	110	56	40	98
Cu	240	38	210	120	97	110	200	220
Ga	25	21	25	20	23	24	22	21
Ni	31	71	14	92	50	24	24	60
Pb	<4	<4	<4	4	<4	<4	<4	<4
Sc	30	29	33	31	30	29	26	26
Sr	340	350	300	660	370	380	380	350
V	310	240	350	230	280	260	230	210
Y	30	20	30	17	22	20	18	24
Zn	110	74	110	72	86	91	72	78

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	7E29	9E57	8M44	2R27	7N26	2E65A	5E10	1E17B
Quadrangle	SLW	SLW	VP	SLE	CF	SLE	VP	CF
Latitude	46° 16' 46"	46° 15' 47"	46° 26' 42"	46° 16' 39"	46° 28'23"	46° 15'52"	46° 23' 28"	46° 28' 42"
Longitude	122° 11' 21"	122° 08' 00"	122° 08' 41"	122° 02' 27"	122° 03'35"	122° 05'30"	122° 12' 22"	122° 02' 59"
Map unit	Tb_1	Tb_2	Tb_2	Tb	Tb	Tb	Tib	Tgb
Rock type	Basaltic andesite	Basalt	Basalt	Basalt	Basaltic andesite	Basaltic andesite	Basalt	Gabbro
SiO_2	54.56	49.91	51.96	51.91	52.13	52.30	51.06	49.94
TiO_2	1.52	1.03	0.99	1.18	0.98	1.38	1.43	1.44
Al_2O_3	18.26	20.33	16.18	18.88	18.46	18.16	18.74	17.20
Fe_2O_3	3.23	3.18	4.36	3.12	3.75	4.95	3.34	3.40
FeO	5.77	5.34	5.19	5.86	5.07	4.49	6.85	6.80
MnO	0.15	0.14	0.17	0.15	0.16	0.16	0.15	0.19
MgO	3.47	5.44	7.67	5.25	5.58	5.17	4.64	7.52
CaO	8.94	11.71	10.99	10.46	10.45	10.48	10.54	10.61
Na_2O	3.09	2.46	2.18	2.78	2.84	2.63	2.74	2.37
K_2O	0.77	0.28	0.16	0.22	0.43	0.11	0.33	0.38
P_2O_5	0.24	0.16	0.17	0.19	0.15	0.18	0.18	0.18
mg-value	41.2	53.8	59.6	51.5	53.6	50.3	45.3	57.2
FeO*	8.55	7.99	8.78	8.45	8.33	8.62	9.73	9.57
FeO*/MgO	2.50	1.51	1.19	1.65	1.51	1.73	2.12	1.31
Na_2O+K_2O	3.86	2.74	2.33	3.00	3.27	2.74	3.07	2.75
Mg#	46.0	58.8	64.7	56.6	60.2	57.5	50.0	62.2
CIPW Norms								
q	9.156	1.364	4.254	4.443	3.210	6.581	3.778	0.853
c	--	--	--	--	--	--	--	--
or	4.556	1.640	0.921	1.274	2.520	6.676	1.976	2.252
ab	26.178	20.868	18.462	23.532	24.058	22.258	23.153	20.046
an	33.656	43.628	33.972	38.403	36.405	37.258	37.888	35.177
di	7.436	10.883	15.831	9.959	11.776	10.915	10.828	13.179
wo	3.795	5.601	8.175	5.116	6.049	5.612	5.515	6.811
en	2.126	3.437	5.186	3.077	3.638	3.407	3.028	4.354
fs	1.515	1.845	2.470	1.766	2.089	1.896	2.285	2.014
hy	11.154	15.562	20.612	15.754	16.172	14.768	14.967	21.019
en	6.513	10.127	13.963	10.009	10.272	9.488	8.532	14.373
fs	4.641	5.435	6.649	5.745	5.900	5.280	6.435	6.646
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	4.412	3.725	3.691	3.943	3.637	4.266	4.276	4.331
il	2.890	1.952	1.875	2.241	1.871	2.626	2.714	2.739
ap	0.564	0.381	0.385	0.452	0.353	0.409	0.422	0.405
Normative Plag.	56.25	67.64	64.79	60.76	57.80	56.29	62.07	61.20
DI	39.89	23.87	23.64	29.25	29.79	29.51	28.91	23.15
Trace-element analyses by EDXRF								
Ba	172	120	113	103	110	166	96	75
Rb	13	<10	<10	<10	<10	13	<10	<10
Sr	291	350	344	470	312	387	296	354
Y	24	18	13	19	14	24	21	18
Zr	161	87	73	124	76	120	116	82
Ni	<20	37	87	52	34	58	34	89
Cu	100	104	62	77	45	132	158	122
Zn	76	67	69	87	69	81	79	64
Cr	20	58	289	86	80	93	57	199
Trace-element analyses by ICP-AES								
Co	25	32	57	32	48	34	34	60
Cr	20	65	460	83	150	97	55	350
Cu	120	110	130	67	100	140	170	210
Ga	23	21	29	17	30	18	20	31
Ni	9	36	130	42	57	52	29	160
Pb	<4	12	26	5	12	4	<4	14
Sc	26	39	38	24	33	30	33	31
Sr	290	350	440	430	370	370	300	430
V	240	240	390	170	320	230	270	510
Y	23	20	15	17	14	20	22	15
Zn	81	60	70	69	70	72	72	70

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	0E14	5E36	7N19	7N45	9I41A	7N162	7N144	8R107
Quadrangle	VP	VP	CF	CF	CF	CF	CF	VP
Latitude	46° 27' 52"	46° 26' 46"	46° 28' 31"	46° 28' 42"	46° 26' 04"	46° 25' 44"	46° 25' 32"	46° 25' 53"
Longitude	122° 07' 32"	122° 09' 34"	122° 01' 28"	122° 01' 21"	122° 06' 21"	122° 05' 08"	122° 05' 39"	122° 14' 26"
Map unit	Tgb	Tgb	Tgb	Tgb	Ttm	Ttm	Ttm	Ta_1
Rock type	Gabbro	Gabbro	Gabbro	Gabbro	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite
SiO_2	51.25	51.27	52.87	53.49	54.26	55.58	55.98	52.59
TiO_2	1.22	0.95	1.42	1.10	0.83	0.85	0.96	1.54
Al_2O_3	18.27	18.06	17.96	19.43	17.85	16.89	16.85	17.43
Fe_2O_3	3.88	3.04	3.35	2.70	2.97	3.38	3.60	3.90
FeO	5.82	5.47	6.60	5.61	5.13	4.71	4.73	5.74
MnO	0.16	0.11	0.16	0.14	0.16	0.14	0.17	0.13
MgO	5.92	7.76	4.57	3.81	5.13	5.12	5.03	4.10
CaO	9.90	10.38	9.03	9.82	9.85	8.60	8.53	9.84
Na_2O	2.96	2.50	3.35	3.21	2.97	3.58	2.98	3.38
K_2O	0.43	0.31	0.46	0.52	0.53	0.90	0.90	0.86
P_2O_5	0.18	0.13	0.23	0.17	0.31	0.26	0.28	0.49
mg-value	52.7	62.5	45.5	45.3	53.4	53.6	52.5	43.8
FeO*	9.12	7.91	9.47	8.03	7.61	7.57	7.75	9.02
FeO*/MgO	1.57	1.06	2.10	2.11	1.52	1.51	1.58	2.25
Na_2O+K_2O	3.39	2.81	3.81	3.73	3.51	4.48	3.88	4.24
Mg#	57.7	67.3	52.1	51.7	60.3	60.4	59.5	48.8
CIPW Norms								
q	1.700	1.609	4.665	5.882	6.504	5.650	9.232	4.003
c	--	--	--	--	--	--	--	--
or	2.536	1.841	2.700	3.078	3.154	5.328	5.347	5.093
ab	25.076	21.175	28.347	27.124	25.184	30.341	25.233	28.646
an	35.343	37.148	32.643	37.101	33.792	27.368	29.958	29.847
di	10.272	10.845	8.726	8.584	10.633	11.093	8.593	12.915
wo	5.275	5.631	4.449	4.380	5.460	5.701	4.414	6.596
en	3.164	3.760	2.472	2.455	3.276	3.449	2.657	3.735
fs	1.833	1.454	1.805	1.749	1.897	1.943	1.522	2.584
hy	18.318	21.613	15.412	12.033	15.006	14.553	15.556	10.972
en	11.598	15.585	8.906	7.026	9.504	9.309	9.892	6.485
fs	6.720	6.028	6.506	5.007	5.502	5.244	5.664	4.487
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	4.001	3.644	4.269	3.777	3.438	3.461	3.623	4.463
il	2.329	1.814	2.699	2.093	1.579	1.615	1.816	2.923
ap	0.426	0.313	0.541	0.394	0.713	0.593	0.643	1.140
Normative Plag.	58.50	63.69	51.25	55.13	54.39	43.42	49.49	51.03
DI	29.31	24.63	35.71	36.02	34.84	41.32	39.81	37.74
Trace-element analyses by EDXRF								
Ba	139	78	140	111	382	288	329	335
Rb	10	10	11	10	16	27	28	24
Sr	326	299	351	360	336	416	407	362
Y	19	16	19	15	15	20	20	33
Zr	98	70	96	78	107	134	144	246
Ni	45	79	23	<20	29	38	38	51
Cu	110	77	128	114	68	185	85	187
Zn	79	69	80	61	64	64	59	80
Cr	95	157	40	24	68	95	81	66
Trace-element analyses by ICP-AES								
Co	53	39	43	40	33	33	32	35
Cr	150	230	61	60	82	110	100	81
Cu	190	110	230	210	82	200	97	210
Ga	34	19	36	38	20	20	20	24
Ni	83	79	33	20	39	46	46	62
Pb	20	<4	13	<4	4	12	8	<4
Sc	25	29	28	26	29	27	27	24
Sr	370	300	390	460	340	410	390	350
V	360	210	430	420	200	210	200	210
Y	16	12	15	12	16	18	16	33
Zn	80	61	90	80	70	69	86	89

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	5E03B	2E18	7E42	5E08C	2E32	7E18B	2E34	0R22
Quadrangle	VP	VP	SLW	SLW	VP	VP	VP	SLW
Latitude	46° 27' 49"	46° 22' 33"	46° 15' 53"	46° 19' 58"	46° 23' 44"	46° 24' 04"	46° 23' 34"	46° 17' 42"
Longitude	122° 12' 26"	122° 14' 02"	122° 11' 11"	122° 14' 53"	122° 14' 21"	122° 13' 06"	122° 14' 03"	122° 12' 44"
Map unit	Ta_1	Ta_1	Ta_1	Ta_1	Ta_1	Ta_1	Ta_1	Ta_1
Rock type	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite
SiO_2	52.82	53.17	53.32	53.88	53.98	54.03	54.09	54.25
TiO_2	1.31	1.61	1.37	1.60	1.65	1.30	1.31	1.91
Al_2O_3	18.43	16.65	16.85	16.84	17.58	17.88	16.97	15.77
Fe_2O_3	4.44	3.46	3.68	4.58	2.93	3.11	3.46	5.32
FeO	4.09	6.53	5.99	5.57	6.14	6.18	5.71	6.23
MnO	0.14	0.18	0.17	0.14	0.14	0.18	0.14	0.20
MgO	4.24	4.96	5.36	4.38	3.88	4.12	5.18	3.82
CaO	10.40	9.61	9.88	8.54	9.14	9.72	9.38	7.94
Na_2O	3.26	2.77	2.64	3.16	3.36	2.91	3.05	3.42
K_2O	0.76	0.66	0.52	0.99	0.90	0.37	0.50	0.79
P_2O_5	0.10	0.40	0.22	0.31	0.29	0.20	0.21	0.35
mg-value	47.9	47.4	50.2	44.3	43.7	44.5	50.8	37.8
FeO*	7.85	9.28	9.10	9.55	8.39	8.83	8.57	10.97
FeO*/MgO	1.90	1.94	1.73	2.21	2.26	2.18	1.70	2.89
Na_2O+K_2O	4.03	3.42	3.16	4.15	4.26	3.28	3.56	4.21
Mg#	53.1	54.7	57.1	50.9	51.1	51.3	57.7	44.0
				CIPW Norms				
q	3.721	7.291	7.086	6.766	6.408	8.443	6.908	8.094
c	--	--	--	--	--	--	--	--
or	4.510	3.875	3.081	5.884	5.317	2.161	2.979	4.699
ab	27.661	23.424	22.315	26.737	28.416	24.670	25.858	28.956
an	33.441	31.074	32.644	28.897	30.227	34.620	31.120	25.409
di	14.259	11.442	12.145	9.396	10.794	10.067	11.447	9.694
wo	7.331	5.867	6.232	4.797	5.521	5.130	5.884	4.901
en	4.451	3.466	3.708	2.703	3.176	2.827	3.564	2.463
fs	2.477	2.109	2.205	1.896	2.097	2.110	1.999	2.330
hy	9.542	14.315	15.399	14.004	10.774	13.006	14.598	13.741
en	6.131	8.898	9.657	8.229	6.490	7.446	9.352	7.062
fs	3.411	5.417	5.742	5.775	4.284	5.560	5.246	6.679
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	4.142	4.603	4.209	4.538	4.248	4.095	4.133	4.962
il	2.488	3.064	2.602	3.049	3.140	2.470	2.482	3.632
ap	0.239	0.916	0.521	0.729	0.678	0.470	0.477	0.816
Normative Plag.	54.73	57.02	59.40	51.94	51.54	58.39	54.62	46.74
DI	35.89	34.59	32.48	39.39	40.14	35.27	35.75	41.75
				Trace-element analyses by EDXRF				
Ba	169	384	123	214	256	107	189	216
Rb	13	15	<10	21	<10	<10	<10	20
Sr	445	360	268	350	352	291	333	279
Y	16	36	22	32	28	22	21	32
Zr	119	260	149	217	213	136	156	202
Ni	41	72	45	34	52	25	54	<20
Cu	80	150	117	193	184	79	135	205
Zn	84	90	67	87	64	68	63	87
Cr	36	147	89	42	98	57	123	15
				Trace-element analyses by ICP-AES				
Co	33	35	35	33	29	29	35	32
Cr	31	170	120	56	110	78	150	2
Cu	97	150	230	190	190	110	150	260
Ga	21	21	22	21	22	23	21	26
Ni	41	74	41	33	63	22	57	16
Pb	<4	5	<4	<4	5	<4	<4	12
Sc	26	26	30	30	22	30	29	29
Sr	440	360	270	340	360	290	340	270
V	220	200	250	210	240	260	230	330
Y	17	33	24	32	27	23	20	26
Zn	77	91	82	92	74	85	76	90

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	7E15B	5E03A	8E211	5E05A	1E58	0E52	7E10	8E49A
Quadrangle	VP	VP	VP	VP	SLW	VP	VP	VP
Latitude	46° 25' 26"	46° 27' 49"	46° 26' 32"	46° 26' 22"	46° 16' 50"	46° 29' 55"	46° 27' 04"	46° 24' 45"
Longitude	122° 13' 59"	122° 12' 26"	122° 12' 53"	122° 13' 51"	122° 10' 50"	122° 14' 46"	122° 08' 17"	122° 09' 20"
Map unit	Ta_1	Ta_1	Ta_1	Ta_1	Ta_1	Ta_1	Ta_2	Ta_2
Rock type	Basaltic andesite	Basaltic andesite	Andesite	Andesite	Andesite	Andesite	Basaltic andesite	Basaltic andesite
SiO_2	54.96	55.26	57.75	59.33	60.25	61.26	55.84	56.98
TiO_2	1.18	1.57	1.14	1.88	1.64	1.03	1.22	1.13
Al_2O_3	19.54	16.92	17.00	15.76	15.37	17.06	16.22	17.08
Fe_2O_3	3.01	2.89	4.04	4.41	3.28	3.60	3.67	4.60
FeO	4.42	6.73	4.04	4.34	5.64	2.88	5.71	3.89
MnO	0.07	0.15	0.13	0.11	0.16	0.06	0.15	0.14
MgO	3.51	4.00	3.73	2.45	2.46	2.36	4.34	3.68
CaO	9.20	7.49	7.47	5.60	5.64	4.83	8.66	7.88
Na_2O	3.26	3.79	3.21	4.18	3.89	4.83	3.24	3.17
K_2O	0.66	0.90	1.14	1.52	1.23	1.54	0.80	1.23
P_2O_5	0.18	0.30	0.33	0.41	0.45	0.54	0.16	0.23
mg-value	46.5	42.9	46.0	34.2	33.4	40.6	45.8	44.6
FeO*	7.00	9.10	7.41	8.06	8.38	5.95	8.89	7.85
FeO*/MgO	2.03	2.33	2.06	3.39	3.49	2.59	2.08	2.18
Na_2O+K_2O	3.92	4.70	4.35	5.71	5.12	6.37	4.04	4.40
Mg#	53.1	49.8	54.2	41.6	40.8	48.3	52.4	51.4
CIPW Norms								
q	8.644	6.973	12.803	14.100	16.833	13.466	8.858	11.051
c	--	--	--	--	--	--	--	--
or	3.911	5.331	6.748	9.016	7.266	9.120	4.736	7.268
ab	27.566	32.096	27.232	35.416	32.946	40.917	27.466	26.883
an	36.759	26.465	28.639	19.745	20.829	20.339	27.349	28.808
di	6.244	7.195	5.114	4.390	3.451	0.074	11.936	7.259
wo	3.216	3.663	2.620	2.249	1.748	0.038	6.083	3.703
en	1.990	1.997	1.536	1.314	0.898	0.023	3.358	2.073
fs	1.038	1.535	0.958	0.827	0.805	0.013	2.495	1.483
hy	10.283	14.082	12.615	7.817	9.913	9.138	12.998	12.206
en	6.758	7.961	7.772	4.797	5.227	5.870	7.455	7.116
fs	3.525	6.121	4.843	3.020	4.686	3.268	5.543	5.090
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	3.927	4.192	3.914	4.978	4.606	3.730	3.971	3.864
il	2.243	2.979	2.169	3.583	3.114	1.954	2.312	2.141
ap	0.424	0.688	0.769	0.955	1.044	1.263	0.376	0.522
Normative Plag.	57.15	45.19	51.26	35.80	38.73	33.20	49.89	51.73
DI	40.12	44.40	46.78	58.53	57.05	63.50	41.06	45.20
Trace-element analyses by EDXRF								
Ba	165	233	367	337	278	480	182	255
Rb	15	18	33	41	30	36	23	31
Sr	343	337	362	287	290	350	299	308
Y	17	30	26	41	39	34	20	26
Zr	139	183	222	314	276	294	118	201
Ni	<20	21	40	<20	<20	<20	<20	<20
Cu	71	102	74	28	46	37	103	119
Zn	54	88	68	78	95	77	68	68
Cr	37	27	40	21	<10	<10	34	37
Trace-element analyses by ICP-AES								
Co	26	28	31	23	18	15	31	32
Cr	51	23	63	21	3	2	41	67
Cu	84	100	120	28	75	35	180	180
Ga	22	21	21	21	23	20	22	28
Ni	19	15	45	3	<2	2	12	32
Pb	<4	4	<4	4	12	5	6	20
Sc	23	29	25	24	23	14	31	25
Sr	340	340	360	290	280	310	300	340
V	210	200	180	170	130	85	250	250
Y	16	32	24	39	36	29	19	26
Zn	71	91	73	93	70	75	83	70

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	8M24	7E11	5E39	2E07	8W13	2E14	8R82	5E53
Quadrangle	VP	VP	VP	SLE	CF	SLE	SLE	CF
Latitude	46° 26' 58"	46° 27' 02"	46° 26' 45"	46° 17' 40"	46° 26' 50"	46° 15' 13"	46° 15' 36"	46° 26' 34"
Longitude	122° 08' 44"	122° 08' 18"	122° 08' 45"	122° 02' 06"	122° 07' 04"	122° 01' 12"	122° 00' 00"	122° 05' 20"
Map unit	Ta_2	Ta_2	Ta_2	Ta	Ta	Ta	Ta	Ta
Rock type	Andesite	Andesite	Andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite
SiO_2	57.78	58.13	58.32	54.86	54.87	54.89	55.27	55.41
TiO_2	1.16	1.25	1.14	0.95	1.23	1.24	1.23	1.13
Al_2O_3	16.44	15.90	16.14	18.08	18.19	17.27	17.23	17.79
Fe_2O_3	3.09	4.43	2.99	2.51	3.37	3.08	3.38	4.35
FeO	5.18	4.63	5.23	4.71	5.31	5.56	5.02	4.01
MnO	0.14	0.15	0.14	0.14	0.15	0.19	0.14	0.16
MgO	3.96	3.44	3.95	5.46	4.09	5.15	4.92	4.01
CaO	8.65	7.27	7.70	9.15	8.69	8.97	8.61	8.83
Na_2O	3.12	3.50	3.20	3.18	3.27	3.00	3.18	3.23
K_2O	0.30	1.12	1.00	0.79	0.62	0.43	0.77	0.90
P_2O_5	0.18	0.18	0.18	0.17	0.20	0.22	0.25	0.17
mg-value	46.6	41.2	46.6	57.8	46.2	51.9	51.7	46.9
FeO*	7.80	8.50	7.76	6.75	8.17	8.11	7.87	7.79
FeO*/MgO	2.01	2.50	2.00	1.28	2.04	1.62	1.64	1.98
Na_2O+K_2O	3.42	4.63	4.20	3.97	3.89	3.43	3.95	4.14
Mg#	54.4	48.7	54.4	64.6	53.0	58.9	58.5	53.7
				CIPW Norms				
q	14.249	12.277	13.381	6.162	8.141	8.760	8.228	8.274
c	--	--	--	--	--	--	--	--
or	1.750	6.653	5.916	4.640	3.686	2.552	4.547	5.356
ab	26.441	29.695	27.057	26.925	27.685	25.402	26.910	27.402
an	29.961	24.374	26.734	32.731	33.132	32.379	30.481	31.415
di	9.580	8.689	8.383	9.331	7.061	8.705	8.637	9.264
wo	4.906	4.411	4.292	4.844	3.611	4.484	4.453	4.742
en	2.856	2.328	2.496	3.228	2.074	2.774	2.780	2.753
fs	1.818	1.950	1.595	1.259	1.376	1.447	1.404	1.769
hy	11.475	11.506	12.049	14.400	13.491	15.302	14.274	11.890
en	7.012	6.261	7.351	10.358	8.112	10.055	9.485	7.240
fs	4.463	5.245	4.698	4.042	5.379	5.247	4.789	4.650
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	3.909	4.015	3.881	3.625	4.003	4.040	4.016	3.854
il	2.211	2.370	2.173	1.805	2.330	2.363	2.338	2.753
ap	0.426	0.423	0.426	0.383	0.474	0.500	0.570	0.401
Normative Plag.	53.12	45.08	49.70	50.91	51.37	53.67	49.21	48.95
DI	42.44	48.63	46.35	37.77	39.51	36.71	39.69	41.03
				Trace-element analyses by EDXRF				
Ba	241	239	242	172	194	197	250	245
Rb	19	32	24	18	29	21	14	24
Sr	484	283	331	340	360	381	326	433
Y	23	24	22	18	20	25	27	21
Zr	150	147	148	143	129	169	178	122
Ni	15	<20	14	69	23	47	52	15
Cu	67	98	51	65	112	105	97	289
Zn	93	83	74	65	79	88	77	60
Cr	59	20	48	110	36	99	94	28
				Trace-element analyses by ICP-AES				
Co	23	26	24	32	36	29	39	26
Cr	63	18	76	150	44	110	140	36
Cu	74	120	58	74	160	120	190	280
Ga	20	22	20	22	28	20	32	21
Ni	6	8	7	71	34	44	75	16
Pb	<4	7	4	6	16	6	16	8
Sc	28	27	30	25	23	26	25	30
Sr	490	290	340	340	370	370	380	420
V	200	240	200	160	300	180	280	210
Y	22	22	23	18	18	23	24	21
Zn	76	87	75	66	80	74	80	78

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	8W56	2E09	7R22	3E17	2E53	3E81B	8E181	5E71
Quadrangle	SLE	SLE	SLE	CF	SLE	SLE	SLE	CF
Latitude	46° 15' 24"	46° 16' 19"	46° 21' 40"	46° 27' 49"	46° 15' 51"	46° 15' 33"	46° 16' 16"	46° 27' 00"
Longitude	122° 04' 21"	122° 01' 46"	122° 00' 15"	122° 05' 03"	122° 05' 17"	122° 02' 35"	122° 06' 26"	122° 07' 27"
Map unit	Ta	Ta	Ta	Ta	Ta	Ta	Ta	Ta
Rock type	Basaltic andesite	Basaltic andesite	Basaltic andesite	Andesite	Andesite	Andesite	Andesite	Andesite
SiO_2	55.96	56.27	56.37	57.01	57.13	57.23	57.75	57.76
TiO_2	1.23	1.49	0.84	1.59	1.06	1.17	1.84	1.32
Al_2O_3	18.41	16.66	16.60	16.10	18.09	17.95	15.46	16.02
Fe_2O_3	4.50	3.71	3.64	3.76	3.62	1.71	5.12	3.27
FeO	4.09	5.16	4.45	5.71	4.17	6.11	5.43	5.84
MnO	0.14	0.12	0.13	0.17	0.13	0.14	0.16	0.18
MgO	3.17	3.85	5.16	3.64	3.90	3.88	3.07	3.13
CaO	7.57	8.30	8.60	7.28	7.45	8.18	6.35	8.56
Na_2O	3.79	2.82	3.14	3.55	3.63	2.91	3.79	3.19
K_2O	0.84	1.34	0.81	0.90	0.63	0.50	0.71	0.53
P_2O_5	0.30	0.27	0.25	0.29	0.18	0.21	0.32	0.19
mg-value	40.6	45.0	53.9	41.2	47.9	47.0	34.9	38.4
FeO*	7.96	8.27	7.64	8.87	7.27	7.46	9.80	8.60
FeO*/MgO	2.57	2.21	1.50	2.50	1.90	1.97	3.27	2.80
Na_2O+K_2O	4.62	4.16	3.95	4.45	4.26	3.42	4.50	3.72
Mg#	47.4	51.2	60.4	49.0	55.8	54.9	42.4	46.1
CIPW Norms								
q	8.795	11.611	8.979	11.609	10.743	12.967	13.787	14.293
c	--	--	--	--	--	--	--	--
or	4.966	7.908	4.790	5.335	3.748	2.970	4.182	3.137
ab	32.083	23.865	26.580	30.036	30.728	24.646	32.112	27.038
an	30.830	28.869	28.851	25.350	31.232	34.415	23.136	27.824
di	3.984	8.611	9.931	7.298	3.711	3.989	5.235	11.061
wo	2.025	4.415	5.105	3.721	1.905	2.024	2.646	5.596
en	1.086	2.603	3.092	2.063	1.139	1.066	1.324	2.837
fs	0.873	1.593	1.734	1.514	0.667	0.899	1.265	2.628
hy	12.309	11.259	15.264	12.151	13.625	15.837	12.398	9.570
en	6.826	6.985	9.779	7.008	8.594	8.590	6.340	4.969
fs	5.483	4.274	5.485	5.143	5.031	7.247	6.058	4.601
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	4.012	4.403	3.423	4.537	3.768	2.483	4.908	4.130
il	2.336	2.835	1.597	3.020	2.021	2.221	3.507	2.501
ap	0.688	0.620	0.585	0.665	0.426	0.475	0.736	0.449
Normative Plag.	45.42	47.61	47.91	41.75	47.53	55.48	38.93	47.97
DI	45.48	43.03	40.08	46.98	45.07	40.42	49.70	44.47
Trace-element analyses by EDXRF								
Ba	239	251	240	250	183	275	231	273
Rb	22	30	26	16	13	22	12	10
Sr	407	268	346	305	334	507	263	314
Y	23	33	21	26	20	24	30	22
Zr	181	224	165	169	141	171	186	140
Ni	26	33	55	<20	46	24	<20	<10
Cu	98	161	44	139	56	66	141	38
Zn	80	82	5	102	62	86	100	78
Cr	23	46	114	<20	48	45	<20	16
Trace-element analyses by ICP-AES								
Co	27	27	35	27	27	24	25	27
Cr	36	55	160	14	69	27	2	11
Cu	120	200	59	170	68	83	160	56
Ga	29	21	19	21	20	20	25	21
Ni	35	29	58	9	48	13	6	7
Pb	13	9	8	7	4	<4	14	5
Sc	18	26	28	28	20	23	29	32
Sr	390	260	340	310	330	380	250	330
V	220	210	190	210	140	140	270	230
Y	20	31	21	25	21	32	30	24
Zn	80	80	66	90	74	91	90	83

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	6E22	8M75B	7E23	3E53C	8E15	8W11	3E30A	9E116
Quadrangle	SLE	SLE	CF	SLE	CF	CF	CF	CF
Latitude	46° 15' 50"	46° 16' 26"	46° 26' 42"	46° 15' 57"	46° 26' 36"	46° 26' 51"	46° 27' 29"	46° 26' 42"
Longitude	122° 06' 49"	122° 04' 04"	122° 06' 33"	122° 04' 17"	122° 05' 34"	122° 06' 53"	122° 06' 51"	122° 06' 56"
Map unit	Ta	Ta	Ta	Ta	Ta	Ta	Ta	Ta
Rock type	Andesite	Andesite	Andesite	Andesite	Andesite	Andesite	Andesite	Andesite
SiO_2	57.82	58.45	58.49	58.58	58.79	60.78	60.87	61.98
TiO_2	1.93	1.49	1.16	1.94	1.03	1.55	1.44	1.23
Al_2O_3	15.17	16.73	16.92	15.26	18.29	15.58	15.60	16.13
Fe_2O_3	3.54	3.28	5.38	3.48	4.44	2.99	4.05	3.78
FeO	6.88	5.08	2.88	6.44	2.48	4.95	4.20	3.27
MnO	0.18	0.17	0.13	0.18	0.14	0.15	0.13	0.12
MgO	3.00	2.87	3.08	2.78	2.27	2.48	2.44	2.25
CaO	7.47	6.74	7.09	6.82	7.75	6.09	6.03	5.21
Na_2O	3.33	3.79	3.36	3.66	3.62	4.13	3.81	4.08
K_2O	0.39	1.01	1.27	0.58	0.98	0.93	1.18	1.63
P_2O_5	0.29	0.38	0.22	0.29	0.21	0.36	0.25	0.33
mg-value	34.3	38.4	41.1	33.8	38.0	36.1	35.3	37.1
FeO*	9.81	7.88	7.58	9.27	6.27	7.41	7.64	6.53
FeO*/MgO	3.35	2.80	2.51	3.43	2.85	3.09	3.21	2.97
Na_2O+K_2O	3.72	4.80	4.64	4.24	4.60	5.06	4.99	5.72
Mg#	41.8	46.1	48.8	41.3	46.0	44.0	42.9	44.7
CIPW Norms								
q	16.201	13.682	13.670	16.188	14.137	16.944	17.490	17.372
c	--	--	--	--	--	--	--	--
or	2.302	5.969	7.548	3.413	5.811	5.488	6.983	9.663
ab	28.191	32.116	28.531	30.979	30.653	34.927	32.257	34.592
an	25.294	25.638	27.374	23.509	30.824	21.247	22.016	20.882
di	8.181	4.383	5.280	6.940	5.185	5.399	5.174	2.318
wo	4.137	2.236	2.688	3.518	2.646	2.756	2.630	1.186
en	2.082	1.249	1.470	1.825	1.480	1.549	1.408	0.687
fs	1.962	0.898	1.122	1.597	1.059	1.094	1.136	0.445
hy	10.484	10.130	10.955	9.583	7.194	7.880	8.458	8.086
en	5.398	5.892	6.215	5.110	4.191	4.619	4.682	4.912
fs	5.086	4.238	4.740	4.473	3.003	3.261	3.776	3.174
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	5.024	4.379	3.911	5.039	3.752	4.339	4.321	4.001
il	3.661	2.829	2.212	3.683	1.966	2.940	2.732	2.329
ap	0.665	0.874	0.521	0.669	0.479	0.836	0.571	0.757
Normative Plag.	45.34	40.23	43.14	40.60	45.81	34.46	35.94	32.06
DI	46.42	51.26	49.75	50.29	50.60	57.36	56.73	61.63
Trace-element analyses by EDXRF								
Ba	257	275	271	268	270	345	309	335
Rb	30	22	41	41	26	45	27	51
Sr	291	276	321	279	366	300	283	272
Y	34	32	32	33	25	35	30	35
Zr	192	197	203	197	151	234	197	242
Ni	<20	19	<20	<10	<20	<20	16	<10
Cu	150	39	125	119	137	72	34	63
Zn	88	93	54	110	74	95	94	68
Cr	13	23	21	<10	18	<10	<10	<10
Trace-element analyses by ICP-AES								
Co	25	22	21	24	22	16	20	15
Cr	2	27	31	2	17	1	8	12
Cu	160	39	130	140	160	67	26	71
Ga	22	20	21	22	23	21	20	22
Ni	4	12	13	<2	15	4	5	5
Pb	<4	5	8	7	12	16	8	15
Sc	32	25	23	30	21	24	24	19
Sr	280	280	290	280	340	280	280	260
V	280	160	260	180	200	170	170	110
Y	33	34	23	32	23	34	29	33
Zn	100	88	85	100	60	70	82	60

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	1E70	5E55B	8E167A	9E125	9E133	8R128	3E52	5E02
Quadrangle	SLE	VP	SLE	VP	VP	VP	SLE	VP
Latitude	46° 15' 44"	46° 25'38"	46° 16' 06"	46° 24' 16"	46° 24' 35"	46° 26' 18"	46° 16' 15"	46° 29' 39"
Longitude	122° 01' 10"	122° 09'05"	122° 03' 55"	122° 13' 56"	122° 14' 46"	122° 12' 45"	122° 04' 20"	122° 12' 53"
Map unit	Ta	Tia	Tia	Tia	Tia	Tia	Tia	Tia
Rock type	Andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Basaltic andesite	Andesite	Andesite
SiO_2	62.45	52.09	53.56	54.19	55.59	55.91	57.43	57.53
TiO_2	1.03	0.80	1.56	1.34	1.02	1.53	2.02	1.45
Al_2O_3	16.85	16.75	17.72	16.86	17.58	16.15	14.72	17.30
Fe_2O_3	3.10	3.62	2.98	3.29	2.96	3.37	4.73	3.08
FeO	3.00	4.95	6.49	7.71	5.42	6.23	6.48	5.05
MnO	0.13	0.12	0.17	0.20	0.16	0.19	0.20	0.13
MgO	1.86	7.40	4.28	4.01	4.29	3.37	3.20	3.21
CaO	4.65	11.81	9.57	8.64	8.89	7.56	7.28	7.50
Na_2O	4.76	2.12	3.10	2.98	3.37	3.58	3.20	3.76
K_2O	1.86	0.21	0.33	0.47	0.39	1.53	0.35	0.71
P_2O_5	0.29	0.14	0.25	0.31	0.33	0.56	0.38	0.27
mg-value	35.9	61.3	44.9	39.7	48.1	38.9	34.3	41.9
FeO*	5.60	7.99	9.01	10.38	7.91	9.07	10.35	7.64
FeO*/MgO	3.11	1.11	2.14	2.66	1.88	2.75	3.35	2.43
Na_2O+K_2O	6.62	2.32	3.42	3.46	3.76	5.11	3.56	4.46
Mg#	43.8	67.6	51.7	46.6	55.1	45.6	42.1	49.7
CIPW Norms								
q	14.931	4.113	7.532	8.664	9.042	8.528	16.512	12.239
c	--	--	--	--	--	--	--	--
or	11.004	1.216	1.925	2.796	2.293	9.062	2.085	4.175
ab	40.266	17.929	26.191	25.242	28.515	30.277	27.136	31.793
an	19.151	35.630	33.485	31.244	31.655	23.485	24.776	28.259
di	1.670	17.845	10.076	7.966	8.401	8.543	7.328	5.887
wo	0.857	9.233	5.150	4.012	4.296	4.333	3.700	3.020
en	0.509	5.966	2.940	1.917	2.463	2.260	1.826	1.793
fs	0.304	2.646	1.986	2.037	1.642	1.950	1.802	1.074
hy	6.593	18.011	12.919	16.659	13.699	11.445	12.240	9.937
en	4.128	12.478	7.711	8.075	8.219	6.143	6.161	6.214
fs	2.465	5.533	5.208	8.584	5.480	5.302	6.079	3.723
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	3.750	3.401	4.326	4.176	3.702	4.447	5.192	4.335
il	1.965	1.524	2.959	2.540	1.940	2.913	3.844	2.761
ap	0.671	0.333	0.589	0.715	0.757	1.302	0.889	0.616
Normative Plag.	27.20	66.52	54.36	55.31	52.61	43.68	45.88	47.06
DI	65.81	23.26	35.65	36.70	39.85	47.87	45.24	48.21
Trace-element analyses by EDXRF								
Ba	447	114	152	235	930	263	317	260
Rb	48	<10	<10	18	23	25	17	27
Sr	266	426	404	315	369	280	340	464
Y	35	13	31	27	25	34	35	24
Zr	224	81	181	144	179	185	197	203
Ni	<20	99	<20	<20	24	<20	<20	15
Cu	47	96	81	123	105	112	136	125
Zn	70	73	93	94	69	91	117	81
Cr	<10	295	77	35	41	21	16	23
Trace-element analyses by ICP-AES								
Co	11	43	28	36	32	29	29	22
Cr	6	320	71	34	56	19	11	20
Cu	44	110	76	130	120	120	160	150
Ga	22	18	20	23	21	22	22	21
Ni	5	110	15	14	31	18	17	15
Pb	12	4	4	4	6	7	6	<4
Sc	19	34	32	36	24	31	32	22
Sr	250	450	390	320	410	290	340	460
V	100	200	220	310	190	230	280	220
Y	33	12	29	26	25	34	34	21
Zn	60	70	81	94	82	99	110	78

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	2E70	2E63	7E14	8R124	8M88A	2R35C	3E72A	8E168A
Quadrangle	SLE	SLE	VP	VP	SLE	SLW	SLE	SLE
Latitude	46° 15' 40"	46° 15' 11"	46° 27' 11"	46° 27' 09"	46° 15' 06"	46° 16' 36"	46° 15' 55"	46° 16' 06"
Longitude	122° 04' 44"	122° 06' 05"	122° 14' 06"	122° 14' 58"	122° 02' 54"	122° 14' 22"	122° 03' 43"	122° 02' 50"
Map unit	Tia	Tia	Tia	Tia	Tia	Tia	Tia	Tia
Rock type	Andesite	Andesite	Andesite	Andesite	Andesite	Andesite	Andesite	Andesite
SiO_2	58.18	58.23	58.54	58.62	59.25	59.45	59.80	59.98
TiO_2	1.92	1.46	1.55	1.11	1.44	1.75	1.68	1.30
Al_2O_3	15.19	16.84	16.68	16.40	16.25	15.30	15.18	16.64
Fe_2O_3	3.31	2.85	4.87	3.85	3.29	2.32	3.00	1.97
FeO	6.81	5.59	3.75	3.44	5.76	6.94	6.41	5.57
MnO	0.17	0.14	0.13	0.13	0.15	0.16	0.18	0.12
MgO	2.98	2.92	2.58	4.25	2.16	2.64	2.35	2.67
CaO	6.74	7.36	6.55	6.68	6.07	6.50	5.96	6.69
Na_2O	3.82	3.96	3.67	3.64	4.11	3.90	4.14	3.70
K_2O	0.53	0.42	1.36	1.62	1.13	0.67	0.85	1.02
P_2O_5	0.34	0.23	0.32	0.25	0.37	0.37	0.45	0.35
mg-value	34.7	38.5	35.6	51.8	30.3	33.9	31.1	38.9
FeO*	9.55	7.94	7.85	6.82	8.48	8.79	8.75	7.15
FeO*/MgO	3.29	2.80	3.15	1.62	4.04	3.42	3.87	2.75
Na_2O+K_2O	4.35	4.38	5.02	5.26	5.25	4.57	4.99	4.71
Mg#	42.2	46.3	43.5	59.4	37.4	41.3	38.6	46.7
CIPW Norms								
q	14.695	13.209	13.984	10.921	13.954	15.264	15.702	15.325
c	--	--	--	--	--	--	--	--
or	3.153	2.488	8.034	9.583	6.689	3.944	5.040	6.008
ab	32.299	33.539	31.087	30.874	34.827	33.014	35.024	31.283
an	22.729	26.916	25.087	23.635	22.544	22.260	20.333	25.798
di	7.023	6.680	4.390	6.368	4.294	6.312	5.249	4.212
wo	3.552	3.397	2.235	3.297	2.153	3.161	2.635	2.125
en	1.794	1.831	1.221	2.147	0.967	1.397	1.206	1.042
fs	1.677	1.452	0.934	0.924	1.174	1.754	1.408	1.045
hy	10.870	9.739	9.203	12.096	9.775	11.672	10.076	11.231
en	5.618	5.432	5.215	8.455	4.415	5.175	4.648	5.608
fs	5.252	4.307	3.988	3.641	5.360	6.497	5.428	5.623
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	4.806	4.139	4.515	3.821	4.327	3.365	4.343	2.859
il	3.645	2.769	2.957	2.118	2.736	3.315	3.200	2.477
ap	0.784	0.523	0.745	0.587	0.858	0.856	1.036	0.809
Normative Plag.	39.07	42.76	44.66	43.36	35.19	40.27	33.67	40.89
DI	49.77	49.02	53.11	51.38	54.92	52.22	55.15	52.10
Trace-element analyses by EDXRF								
Ba	279	391	268	286	393	310	299	358
Rb	33	31	32	34	48	48	27	41
Sr	276	367	289	431	318	301	252	311
Y	37	33	37	27	36	35	40	35
Zr	201	213	285	215	230	266	236	258
Ni	<20	<20	<20	40	<20	<20	<20	<20
Cu	132	120	171	88	55	101	124	121
Zn	102	84	61	56	105	97	111	80
Cr	11	23	<10	51	<20	<10	<10	33
Trace-element analyses by ICP-AES								
Co	26	22	22	26	17	24	25	26
Cr	1	14	2	76	6	2	27	42
Cu	130	120	190	120	62	110	84	130
Ga	20	20	22	23	25	22	21	19
Ni	5	9	6	59	<2	<2	12	30
Pb	6	7	4	9	15	5	6	30
Sc	30	25	22	14	24	27	24	20
Sr	270	340	290	390	300	310	380	320
V	240	220	200	180	190	170	140	120
Y	35	27	36	17	35	37	32	47
Zn	100	82	91	50	80	100	94	100

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	2E35B	88E07	1E77A	5E66A	2E69	8E117B	9C35B	5E21A
Quadrangle	VP	SLW	SLW	SLE	SLW	SLE	SLE	SLE
Latitude	46° 23' 31"	46° 16' 59"	46° 17' 14"	46° 16' 16"	46° 18' 32"	46° 17' 09"	46° 17' 48"	46° 21' 34"
Longitude	122° 14' 25"	122° 14' 30"	122° 14' 52"	122° 02' 26"	122° 14' 13"	122° 04' 50"	122° 05' 15"	122° 01' 33"
Map unit	Tia	Tia	Tia	Tdi	Tdi	Tdi	Tdi	Tdi
Rock type	Andesite	Andesite	Andesite	Diorite	Diorite	Diorite	Diorite	Diorite
SiO_2	60.09	60.54	61.11	52.87	53.22	53.96	54.64	55.71
TiO_2	1.71	1.35	1.23	1.40	1.35	1.14	1.02	1.21
Al_2O_3	15.86	16.72	15.13	18.77	17.91	17.57	18.38	17.28
Fe_2O_3	2.58	2.47	2.66	4.15	3.10	2.70	4.16	3.01
FeO	5.90	5.08	5.62	4.95	6.23	5.82	4.27	5.46
MnO	0.15	0.16	0.15	0.15	0.16	0.15	0.15	0.14
MgO	2.48	2.21	2.45	4.03	4.45	5.72	4.47	4.36
CaO	6.03	5.79	5.83	9.26	9.86	8.94	9.04	8.84
Na_2O	3.95	4.71	4.29	3.13	2.97	3.22	3.15	2.86
K_2O	0.81	0.66	0.94	1.14	0.58	0.57	0.55	0.95
P_2O_5	0.43	0.32	0.59	0.15	0.17	0.20	0.18	0.18
mg-value	34.5	34.6	34.9	44.8	46.4	54.8	49.4	48.3
FeO*	7.83	7.16	7.84	8.56	8.91	7.94	7.89	8.03
FeO*/MgO	3.32	3.30	3.27	2.16	2.03	1.44	1.79	1.87
Na_2O+K_2O	4.76	5.37	5.23	4.26	3.55	3.79	3.70	3.80
Mg#	42.6	42.0	42.3	51.5	53.0	61.9	56.1	55.1
				CIPW Norms				
q	16.669	14.262	16.431	4.294	6.027	5.223	7.525	9.997
c	--	--	--	--	--	--	--	--
or	4.780	3.915	5.556	6.725	3.409	3.379	3.246	5.588
ab	33.421	39.843	36.318	26.479	25.176	27.271	26.680	24.176
an	23.164	22.517	19.227	33.881	33.819	31.787	34.459	31.548
di	3.258	3.423	4.808	9.058	11.406	9.123	7.545	9.069
wo	1.645	1.729	2.423	4.632	5.829	4.710	3.865	4.653
en	0.808	0.858	1.166	2.657	3.319	2.981	2.256	2.765
fs	0.805	0.836	1.219	1.769	2.258	1.432	1.424	1.651
hy	10.712	9.178	10.109	12.306	13.057	16.669	14.503	12.935
en	5.366	4.650	4.942	7.389	7.771	11.260	8.890	8.099
fs	5.346	4.528	5.167	4.917	5.286	5.409	5.613	4.836
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	3.747	3.576	3.853	4.243	4.153	3.920	3.687	3.966
il	3.252	2.555	2.329	2.663	2.557	2.172	1.932	2.298
ap	0.997	0.732	1.373	0.353	0.398	0.457	0.424	0.424
Normative Plag.	40.94	36.11	34.62	50.50	57.33	50.91	53.52	51.45
DI	54.87	58.02	58.30	37.50	34.61	35.87	37.45	39.68
				Trace-element analyses by EDXRF				
Ba	784	323	413	250	124	196	195	236
Rb	57	58	42	28	<10	11	<10	30
Sr	905	350	294	503	362	339	350	353
Y	50	31	45	25	19	15	17	26
Zr	364	216	399	119	118	116	122	160
Ni	<20	<20	<20	18	26	45	<20	<20
Cu	56	50	123	121	64	83	111	123
Zn	103	86	82	65	87	66	73	74
Cr	13	<10	13	25	31	78	28	52
				Trace-element analyses by ICP-AES				
Co	21	15	22	28	32	44	37	28
Cr	2	3	12	20	36	120	39	68
Cu	59	51	140	140	110	130	160	140
Ga	22	22	21	23	21	29	29	20
Ni	<2	<2	11	20	17	71	26	26
Pb	4	4	9	4	<4	19	11	6
Sc	18	21	20	24	29	23	25	29
Sr	920	350	290	480	350	370	380	340
V	130	83	160	250	240	330	280	200
Y	42	31	43	24	17	15	13	24
Zn	94	91	88	77	76	70	70	74

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	2E125B	2E42A	2E31	87R08B	0E62	8M74	4E09	6E02
Quadrangle	SLE	SLE	SLE	CF	CF	SLE	SLW	VP
Latitude	46° 17' 09"	46° 16' 23"	46° 16' 28"	46° 26' 27"	46° 26' 59"	46° 15' 27"	46° 15' 42"	46° 26' 34"
Longitude	122° 06' 40"	122° 03' 11"	122° 03' 40"	122° 03' 40"	122° 03' 14"	122° 05' 22"	122° 07' 53"	122° 07' 54"
Map unit	Tqd	Tqd	Tqd	Tqqd	Tqqd	Tsc	Twr	Td_2
Rock type	Quartz diorite	Quartz diorite	Quartz diorite	Quartz diorite	Diorite	Diorite	Granodiorite	Andesite
SiO_2	57.39	58.68	58.73	57.39	57.98	54.65	58.63	62.37
TiO_2	1.09	1.17	1.23	1.11	0.97	1.25	1.16	1.27
Al_2O_3	17.82	18.21	16.94	17.09	17.36	18.25	17.47	15.21
Fe_2O_3	2.67	4.04	4.09	3.85	3.51	4.48	1.55	2.23
FeO	5.00	3.24	3.79	4.06	4.03	4.17	5.92	5.31
MnO	0.12	0.14	0.12	0.14	0.13	0.17	0.12	0.14
MgO	3.65	2.24	3.16	4.07	3.93	4.17	3.33	2.12
CaO	7.91	6.84	6.75	7.23	7.55	8.76	6.60	5.61
Na_2O	3.04	4.41	4.12	3.41	3.41	3.02	3.59	3.60
K_2O	1.13	0.81	0.83	1.44	0.93	0.83	1.42	1.78
P_2O_5	0.18	0.22	0.23	0.20	0.19	0.23	0.20	0.36
mg-value	46.4	36.3	42.6	48.6	48.8	47.0	44.4	33.6
FeO*	7.18	6.79	7.36	7.39	6.96	7.87	7.17	7.12
FeO*/MgO	2.03	3.07	2.36	1.85	1.83	1.97	2.20	3.46
Na_2O+K_2O	4.17	5.22	4.95	4.85	4.34	3.86	5.01	5.37
Mg#	53.4	42.6	49.2	56.4	57.0	54.5	52.1	41.1
CIPW Norms								
q	12.381	11.714	12.213	10.068	12.040	8.425	11.092	18.886
c	--	--	--	--	--	--	--	--
or	6.697	4.789	4.922	8.548	5.502	4.939	8.390	10.504
ab	25.717	37.374	34.894	28.876	28.888	25.634	30.336	30.429
an	31.645	27.537	25.314	27.107	29.351	33.817	27.373	20.102
di	5.264	4.086	5.442	6.089	5.609	6.691	3.327	4.475
wo	2.700	2.080	2.785	3.129	2.881	3.431	1.682	2.247
en	1.600	1.135	1.612	1.893	1.734	2.025	0.843	1.035
fs	0.964	0.871	1.045	1.067	0.994	1.235	0.802	1.193
hy	11.994	7.846	10.350	12.907	12.672	13.492	14.548	9.120
en	7.484	4.441	6.281	8.256	8.057	8.382	7.450	4.237
fs	4.510	3.405	4.069	4.651	4.615	5.110	7.098	4.883
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	3.824	3.907	3.991	3.826	3.660	4.090	2.251	3.233
il	2.074	2.232	2.334	2.109	1.847	2.381	2.212	2.420
ap	0.406	0.516	0.541	0.472	0.431	0.532	0.473	0.833
Normative Plag.	49.40	39.51	38.87	42.01	46.05	52.52	47.43	39.78
DI	44.61	53.66	51.77	47.49	46.43	39.00	49.81	59.82
Trace-element analyses by EDXRF								
Ba	319	275	282	286	274	228	349	381
Rb	44	25	27	50	27	27	45	74
Sr	394	374	338	321	322	371	368	259
Y	27	32	30	26	19	24	25	40
Zr	184	154	178	186	162	147	191	273
Ni	<20	<20	<20	<20	26	29	18	18
Cu	48	41	76	37	154	65	55	65
Zn	69	63	57	104	64	64	85	99
Cr	26	<10	14	37	15	47	37	<10
Trace-element analyses by ICP-AES								
Co	24	15	23	26	23	37	22	16
Cr	24	1	24	47	36	67	46	8
Cu	58	42	68	38	95	100	62	61
Ga	19	19	20	21	22	32	21	19
Ni	17	3	17	15	21	40	16	3
Pb	5	5	<4	10	24	15	6	12
Sc	20	21	23	23	28	22	20	21
Sr	360	340	320	310	310	450	370	260
V	150	120	180	190	190	250	160	97
Y	22	23	25	21	20	21	25	40
Zn	67	63	59	100	70	90	86	89

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	2E12A	8R35	5E72	9M20A	8M70A	9I17B	1E68	2E90B
Quadrangle	SLE	CF	CF	VP	SLE	SLE	SLE	SLW
Latitude	46° 15' 05"	46° 26' 31"	46° 26' 47"	46° 29' 48"	46° 15' 56"	46° 15' 42"	46° 15' 55"	46° 17'51"
Longitude	122° 00' 39"	122° 07' 02"	122° 07' 25"	122° 12' 19"	122° 05' 10"	122° 06' 58"	122° 01' 31"	122° 07'55"
Map unit	Td	Td	Td	Td_1	Td	Td	Td	Tid
Rock type	Dacite	Dacite	Dacite	Dacite	Dacite	Dacite	Dacite	Rhyolite
SiO_2	65.15	66.01	68.12	69.96	68.46	68.76	68.90	75.29
TiO_2	0.94	0.85	0.83	0.63	0.74	0.73	0.54	0.23
Al_2O_3	16.03	15.34	14.73	14.43	14.41	14.30	15.28	12.96
Fe_2O_3	1.96	5.15	3.00	1.80	1.69	1.93	1.87	1.57
FeO	3.47	1.03	2.09	3.06	4.13	3.82	2.49	1.41
MnO	0.13	0.11	0.07	0.11	0.16	0.16	0.14	0.04
MgO	1.53	1.13	1.16	0.79	0.91	0.94	0.75	0.12
CaO	4.55	3.50	3.75	2.37	4.77	4.27	2.81	0.69
Na_2O	4.64	4.53	3.86	4.64	3.58	3.64	4.78	4.02
K_2O	1.32	2.06	2.20	2.07	0.94	1.25	2.29	3.66
P_2O_5	0.26	0.28	0.20	0.15	0.20	0.19	0.16	0.04
mg-value	33.7	25.9	29.8	22.7	21.9	22.7	23.6	7.1
FeO*	5.07	5.50	4.68	4.51	5.33	5.25	4.02	2.77
FeO*/MgO	3.43	5.00	4.14	5.93	6.20	5.90	5.58	23.05
Na_2O+K_2O	5.97	6.59	6.06	6.71	4.53	4.89	7.07	7.68
Mg#	42.4	33.5	37.6	30.0	29.5	30.5	31.3	10.3
CIPW Norms								
q	20.615	21.971	27.530	27.728	31.017	30.911	24.572	35.884
c	--	--	--	0.604	--	--	0.209	1.216
or	7.822	12.204	13.003	12.206	5.573	7.387	13.511	21.633
ab	39.287	38.443	32.647	39.258	30.308	30.836	40.450	33.996
an	18.985	15.488	16.395	10.792	20.462	18.974	12.903	3.174
di	1.567	0.091	0.734	--	1.601	0.813	--	--
wo	0.793	0.046	0.377	--	0.786	0.401	--	--
en	0.406	0.021	0.225	--	0.245	0.141	--	--
fs	0.368	0.024	0.132	--	0.570	0.271	--	--
hy	6.491	6.043	4.216	5.270	6.722	6.454	4.257	1.280
en	3.406	2.808	2.655	1.965	2.024	2.207	1.864	0.305
fs	3.085	3.235	1.561	3.305	4.698	4.247	2.393	0.975
ol	--	--	--	--	--	--	--	--
fo	--	--	--	--	--	--	--	--
fa	--	--	--	--	--	--	--	--
mt	2.849	3.488	3.428	2.604	2.443	2.796	2.712	2.277
il	1.787	1.628	1.574	1.203	1.409	1.388	1.026	0.445
ap	0.599	0.646	0.474	0.336	0.466	0.442	0.361	0.094
Normative Plag.	28.72	23.42	26.42	21.56	36.32	33.17	19.30	61.11
DI	67.43	72.62	73.18	79.19	66.80	69.07	78.45	91.51
Trace-element analyses by EDXRF								
Ba	437	459	588	437	537	428	541	670
Rb	52	61	63	49	29	48	63	103
Sr	272	220	240	140	436	200	243	72
Y	35	43	43	44	50	52	43	63
Zr	256	316	352	365	326	323	308	436
Ni	<10	<20	<20	<20	<20	<20	<10	<10
Cu	22	27	26	33	26	23	24	31
Zn	79	86	66	85	107	101	75	101
Cr	<10	<10	<10	<10	<10	<10	<10	<10
Trace-element analyses by ICP-AES								
Co	9	8	9	6	5	5	4	1
Cr	5	4	5	2	1	1	2	3
Cu	23	33	23	33	18	22	20	26
Ga	21	22	18	19	20	21	21	21
Ni	<2	<2	3	<2	<2	<2	2	<2
Pb	7	16	10	13	7	10	11	13
Sc	15	17	15	13	15	15	12	7
Sr	270	210	230	140	420	200	230	74
V	56	39	39	4	5	6	11	2
Y	35	42	36	52	49	48	35	54
Zn	71	80	71	110	96	99	70	89

Table 1. Chemical analyses and norms for volcanic and hypabyssal intrusive rocks from the Spirit Lake 15-minute quadrangle, continued

Sample no.	8E199A	7R49	7N04D
Quadrangle	SLE	CF	CF
Latitude	46° 15' 24"	46° 26'52"	46° 27'31"
Longitude	122° 03' 43"	122° 06'12"	122° 01'38"
Map unit	Tt	Tt	Tgr
Rock type	Dacite tuff	Rhyolite tuff	Granite
SiO_2	68.35	74.02	70.27
TiO_2	0.66	0.58	0.55
Al_2O_3	14.46	13.81	14.13
Fe_2O_3	3.40	1.15	1.93
FeO	2.73	2.15	2.80
MnO	0.17	0.07	0.08
MgO	0.70	0.91	0.60
CaO	5.40	2.05	2.36
Na_2O	3.44	3.36	4.30
K_2O	0.54	1.78	2.88
P_2O_5	0.15	0.11	0.10
mg-value	17.2	33.3	18.9
FeO*	5.40	3.07	4.42
FeO*/MgO	8.31	3.49	7.49
Na_2O+K_2O	3.97	5.14	7.18
Mg#	23.9	43.5	26.1
		CIPW Norms	
q	32.957	41.256	27.360
c	--	2.908	--
or	3.169	10.491	17.008
ab	29.131	28.461	36.399
an	22.470	9.401	10.758
di	2.868	--	0.220
wo	1.405	--	0.109
en	0.426	--	0.039
fs	1.037	--	0.072
hy	4.499	4.445	4.177
en	1.310	2.275	1.466
fs	3.189	2.170	2.711
ol	--	--	--
fo	--	--	--
fa	--	--	--
mt	3.297	1.671	2.792
il	1.263	1.104	1.050
ap	0.348	0.264	0.237
Normative Plag.	41.03	19.44	16.77
DI	65.19	80.21	80.77
		Trace-element analyses by EDXRF	
Ba	434	379	539
Rb	21	70	92
Sr	497	159	156
Y	48	37	46
Zr	309	337	374
Ni	<20	<20	<10
Cu	24	36	35
Zn	108	50	63
Cr	<10	<10	<10
		Trace-element analyses by ICP-AES	
Co	5	7	6
Cr	2	4	4
Cu	28	40	31
Ga	22	15	19
Ni	<2	2	<2
Pb	13	23	11
Sc	16	9	12
Sr	530	160	160
V	11	24	17
Y	61	44	42
Zn	140	60	66

Table 2 -- Analytical results for EDXRF determinations of selected trace elements in standards JB-1 and W-2.

Element	JB-1 Basalt			W-2 Diabase		
	Average[1]	Standard Deviation	Reported Value[2]	Average[1]	Standard Deviation	Reported Value[2]
Ba	491 (27)	16.5	490	175 (21)	6.9	173.6
Rb	41 (38)	4.5	41.2	22 (28)	4.6	20.9
Sr	440 (39)	10.4	435.2	197 (29)	6.6	192.0
Y	24 (39)	4.6	25.5	20 (29)	3.4	23.0
Zr	145 (39)	6.3	153	94 (29)	5.0	100.0
Ni	127 (41)	6.0	135	70 (32)	6.5	70.4
Cu	57 (41)	3.8	55.7	99 (32)	6.0	106.2
Zn	83 (41)	4.9	84	75 (32)	5.6	79.6
Cr	356 (27)	3.2	405	89 (29)	8.5	91.5

[1] Number of determinations in paratheses.
[2] Sources: JB-1, Ando and others, 1974; W-2: Flanagan, 1984