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Chemical analyses and rock series classification of 102 tonalite samples for the Jurassic magmatic arc, Alaska-Aleutian Range batholith, Alaska

By

Bruce L. Reed, Marvin A. Lanphere, and Alfred T. Miesch

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature

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The purpose of this report is to make available major oxide chemical analyses and the corresponding CIPW norms of 102 tonalite samples from the Jurassic magmatic arc in the Alaska-Aleutian Range batholith. Discussion of chemical variations and the polarity of the Jurassic arc is given in Reed, Miesch, and Lanphere (1983).

More than 80 percent of the exposed plutonic rocks in this part of the Jurassic arc (figs. 1 and 2) comprise a compositionally continuous calc-alkaline suite that ranges from hornblendite through hornblende gabbro, hornblende-biotite diorite, hornblende-biotite quartz diorite, tonalite, to rare granodiorite and quartz mozonite. Tonalite and quartz diorite are the dominant rock types, and this suite of plutonic rocks is informally referred to as tonalite. Isolated bodies of high-Al_2O_3-type trondhjemite on the northwest side of the belt and quartz monzonite and granodiorite plutons present locally on the southeast margin of the belt are not included in this study.

The average and ranges of 64 modal analyses made on stained slabs are given in table 1. Forty-four of these samples contain less than 1 volume percent K-feldspar, and on a Q-A-P diagram most of the samples fall in the quartz diorite or tonalite field close to the quartz-plagioclase join (fig. 3A). Examination of thin sections of the remaining samples shows them to contain generally less than 3 volume percent K-feldspar. Ferromagnesian minerals comprise between 15 and 60 percent of each rock (fig. 3B) and consist chiefly of green hornblende, brown biotite, and, rarely, pyroxene.

Chemical analyses and the corresponding CIPW norms for the 102 samples are given in table 2. A statistical summary of these data and a few simple ratios are given in table 3.

On a ternary normative feldspar diagram (fig. 4A), all 102 samples fall in the tonalite field. All but one are classified as calcalkaline on an A-F-M plot (fig. 4B).

Figures 5A, 5B, and 6 show that, for this suite of plutonic rocks, use of commonly used x-y rock classification diagrams may result in samples being placed in different rock series. The grouping of samples on SiO_2-versus-Na_2O+K_2O plot (fig. 5A) is not distinct, and about half the samples lie in the tholeiitic field. The tonalite samples have a high alkali-lime index (≈ 66, fig. 5A), and their K_2O/Na_2O ratios are low, ranging from 0.08 in the mafic rocks to 0.73 in the more silicic rocks (table 3). The FeO*/MgO ratios relative to SiO_2 have a uniformly low rate of increase (fig. 6), range between 1.41 to 4.75, and

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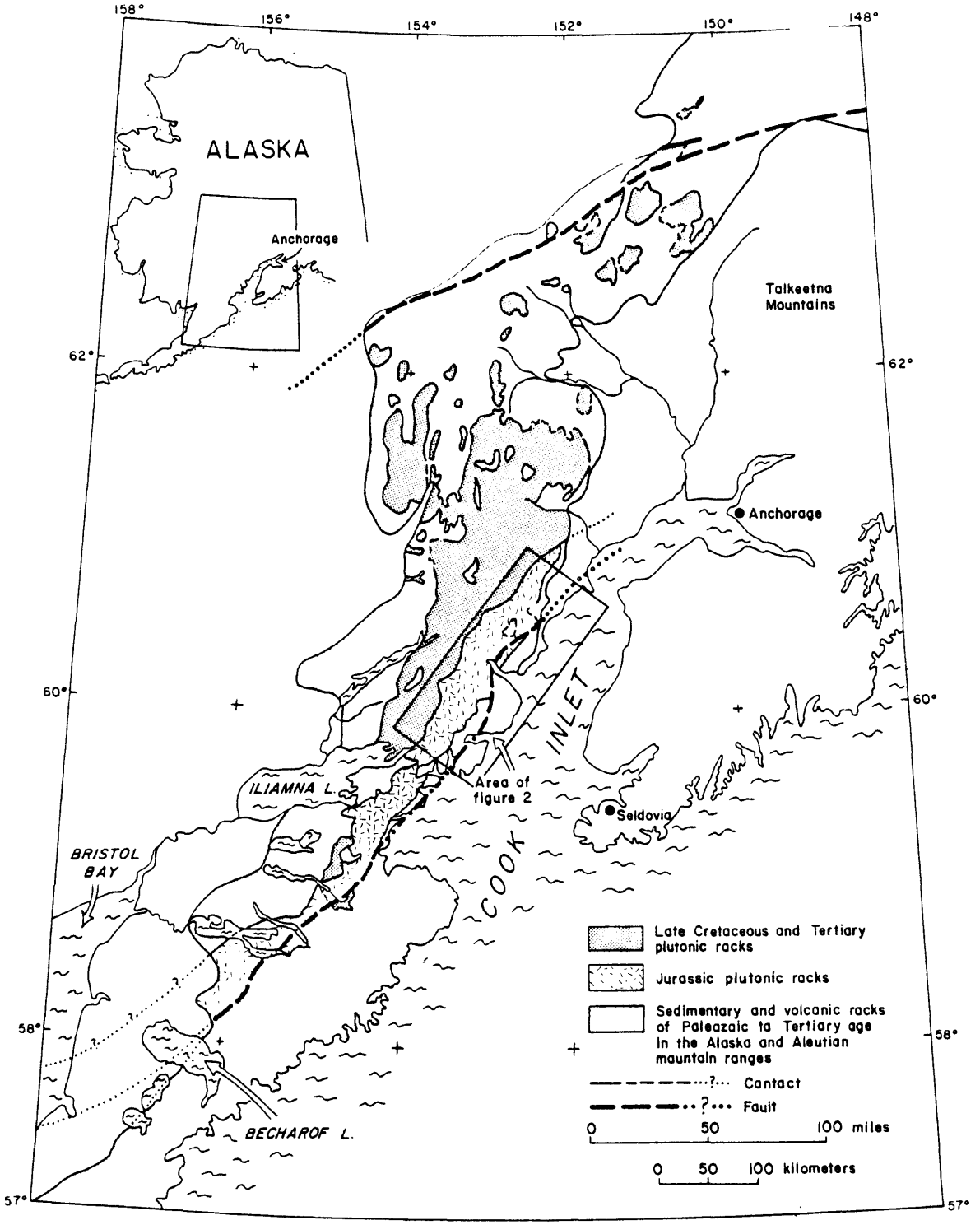
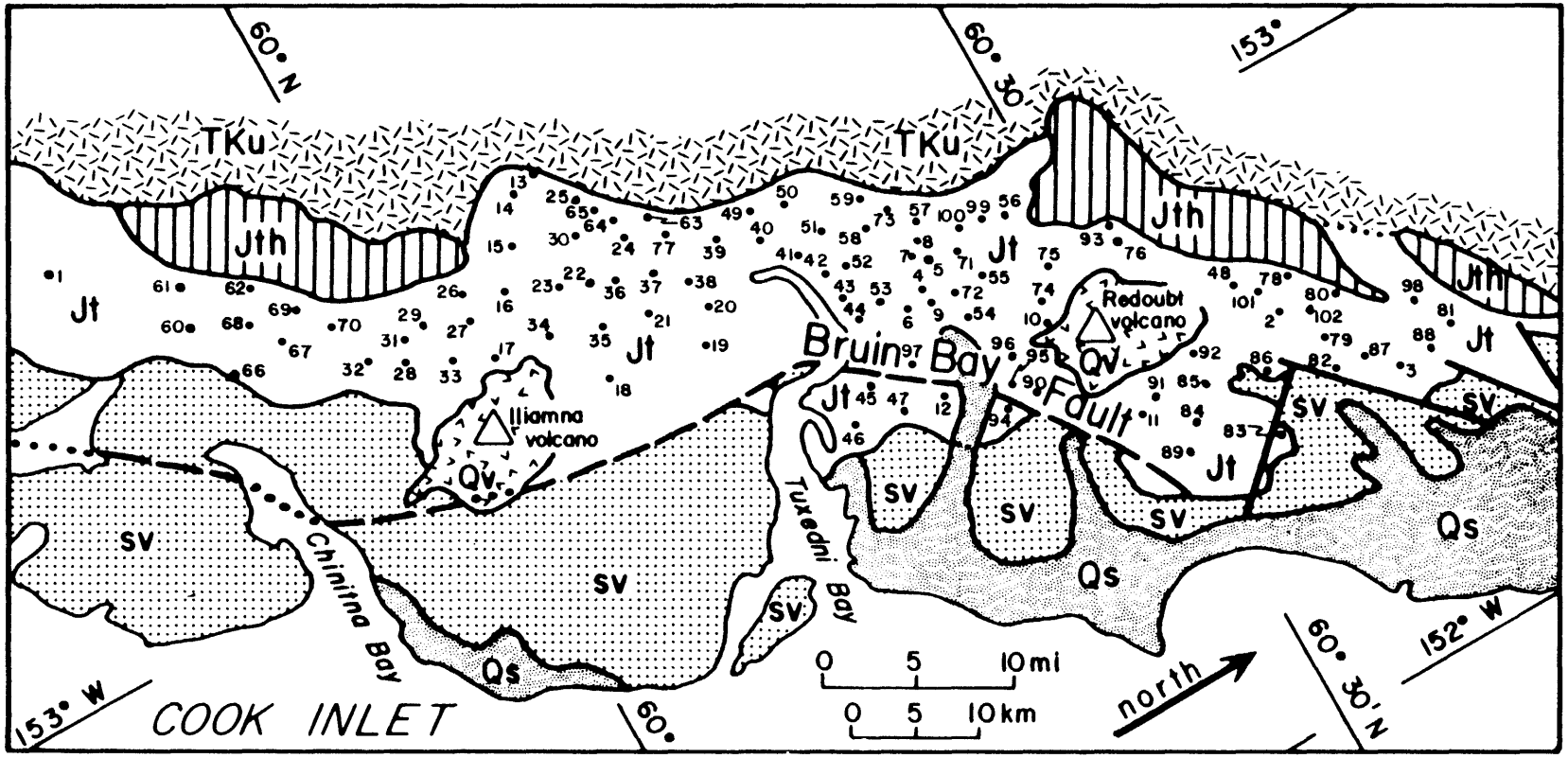


Figure 1.--Map showing Alaska-Aleutian Range batholith and Jurassic magmatic arc (Jurassic plutonic rocks)



EXPLANATION

- Qs — Quaternary
- Qv — Quaternary volcanic rocks
- TKu — Tertiary and Cretaceous plutonic rocks, undivided
- Jth — Jurassic trondhjemite
- Jt — Jurassic tonalite. Includes hornblendite, hornblende–biotite quartz diorite, and rare granodiorite, quartz monzonite and granite.
- SV — Cenozoic and Mesozoic sedimentary and volcanic rocks. Chiefly Jurassic volcanic rocks, locally includes Mesozoic and Cenozoic sedimentary and volcanic rocks

Contact

27• Sample locality

Fault

Figure 2.--Generalized geologic map of part of the Jurassic magmatic arc (tonalite and trondhjemite) on the southeast margin of the Alaska-Aleutian Range batholith. Area shown is outlined on figure 1. Chemical analyses and CIPW norms of samples are given in table 2.

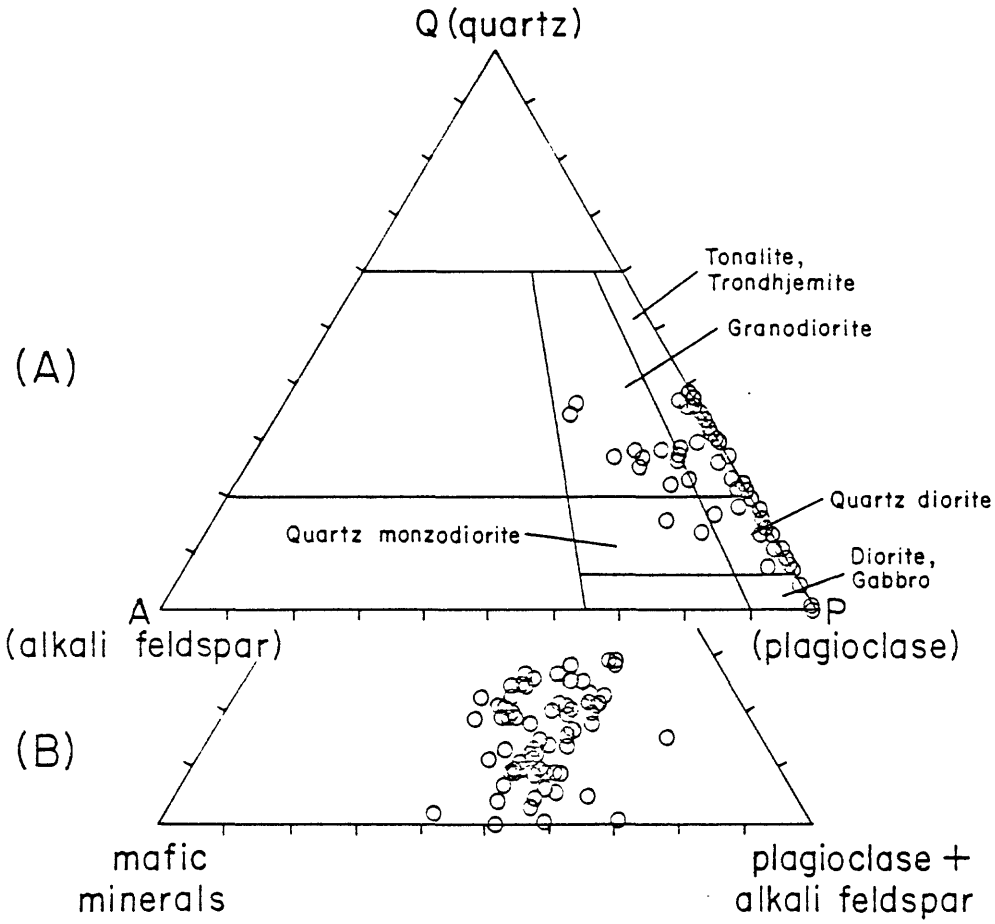
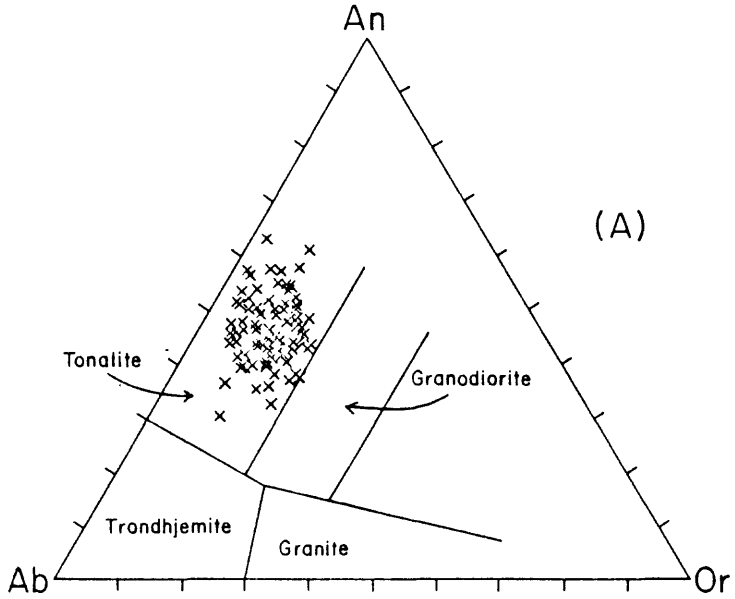


Figure 3.--Modal diagrams of 64 plutonic rocks from the Jurassic magmatic arc. (A), Q-A-P; (B) Quartz-mafic minerals-total feldspar.



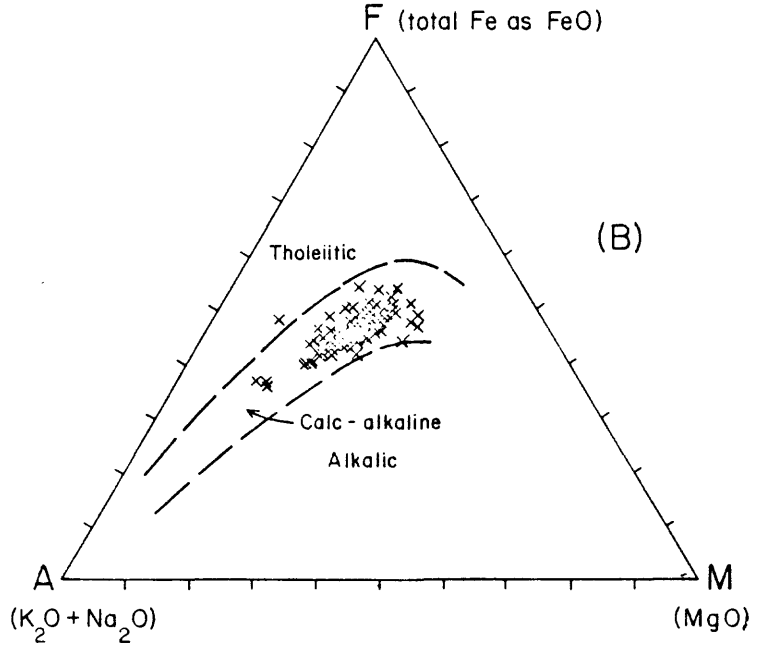


Figure 4A.--Normative plots of An-Ab-Or for Jurassic tonalite samples. Rock classification after O'Connor (1965) as modified by Barker (1979).

4B.--A-M-F diagram showing trend of Jurassic tonalite samples.

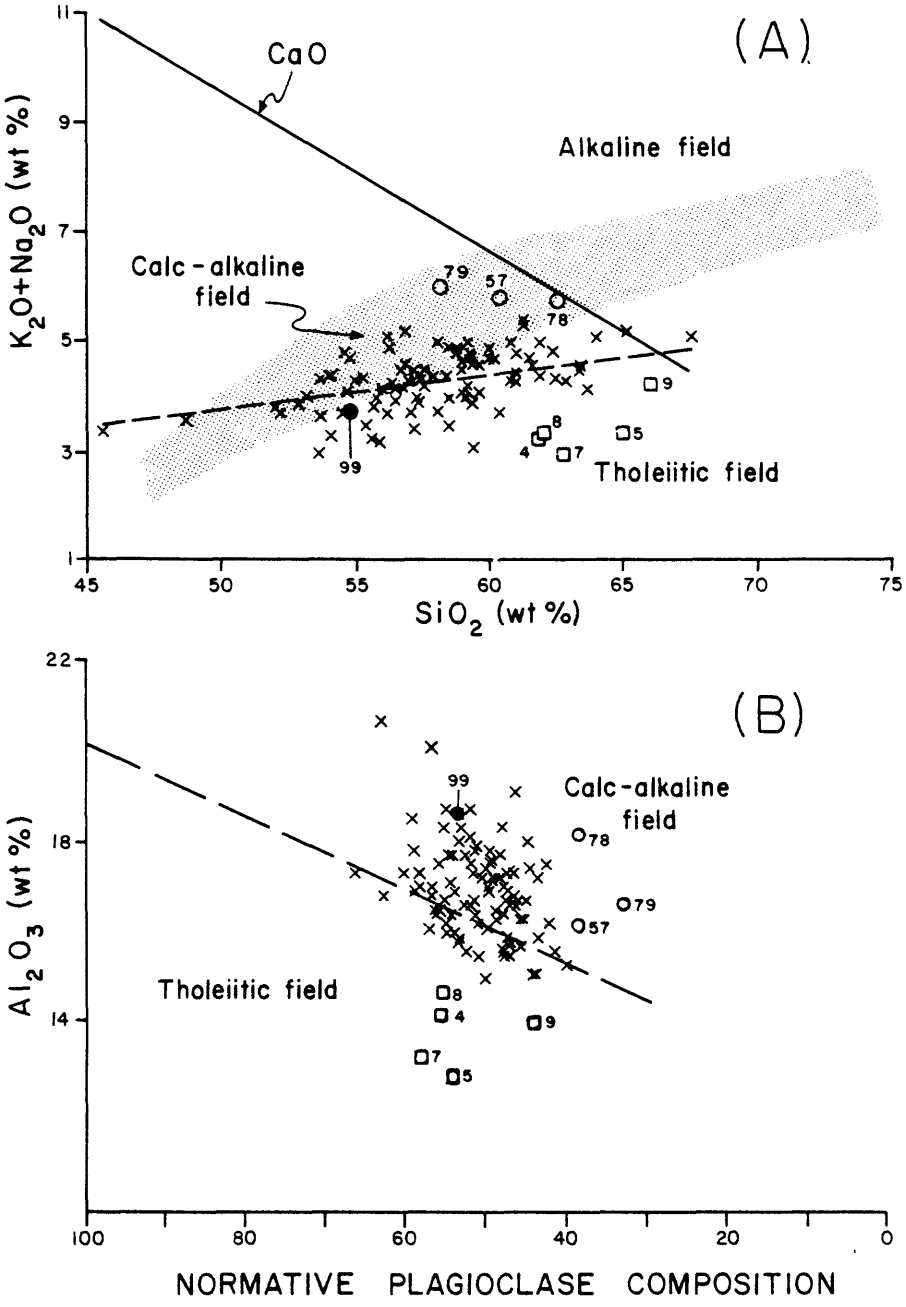


Figure 5A.--Plot of SiO_2 versus K_2O+Na_2O with least-squares fit line (dashed) for Jurassic tonalite samples. Solid line is least-squares fit for CaO. The alkali-line index (weight percent of SiO_2), where the K_2O+Na_2O line intersects the CaO line, for the Jurassic suite of rocks is about 66, defining the rocks as calcic (Peacock,1931). Alkaline, calc-alkaline, and tholeiitic fields from Barker and Arth (1976). See text for explanation of sample numbers and symbols.

5B.--Plot of normative plagioclase composition versus weight percent Al_2O_3. Dashed line separating calc-alkaline and tholeiitic fields from Irving and Baragar (1971).

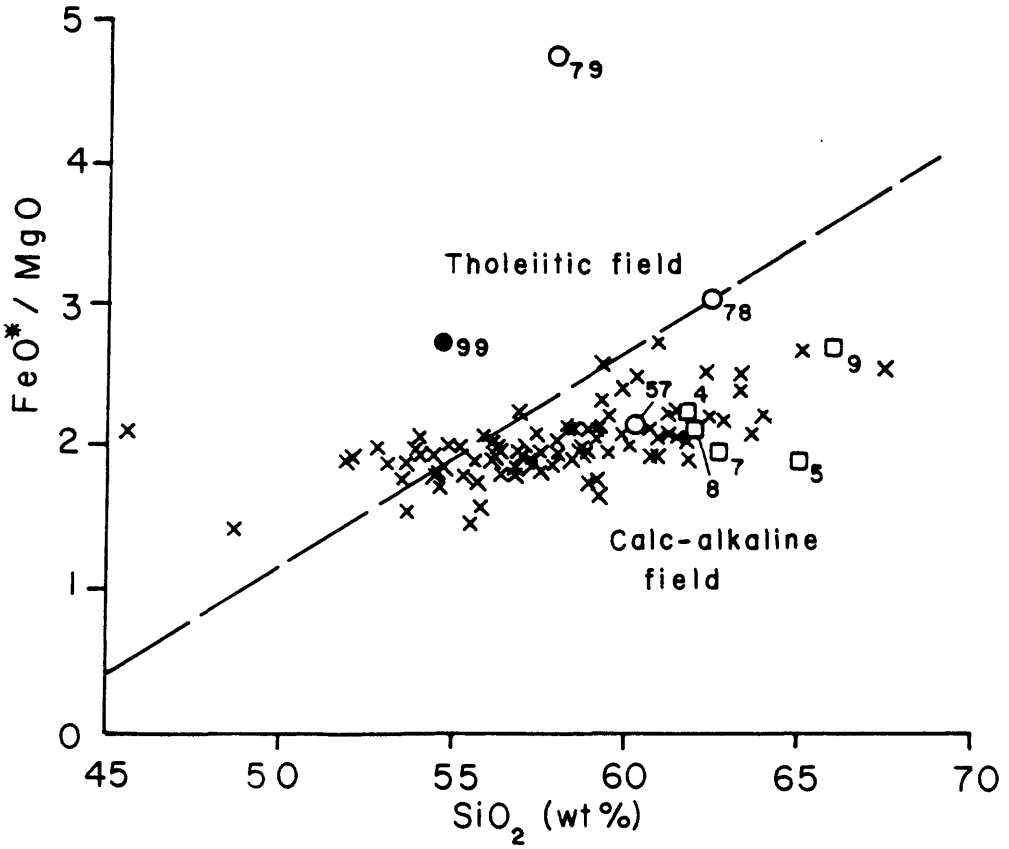


Figure 6.--Plot of SiO_2 versus FeO*/MgO. Dashed line that separates alkaline and tholeiitic fields from Gill (1981), following Miyashiro (1974). See text for explanation of sample numbers and symbols.

Table 1. Averages and ranges of modal analyses (volume percent) of 64 samples collectively referred to as tonalite from the Jurassic magmatic arc in the Alaska-Aleutian Range batholith.

	Average	Range	Standard Deviation
Quartz	15.4	0 - 29.6	8
Alkali feldspar	2.1	0 - 16.8	3.9
Plagioclase	49.1	31 - 69.3	7
Mafic minerals	33.0	14 - 57	8.3
Unknown	.4	0 - 4	--

Table 2.--Chemical analyses, norms, differentiation indices and location of 102 plutonic rocks collectively referred to as tonalite from the Jurassic magmatic arc in the Alaska-Aleutian Range batholith.

[Rapid chemical analyses of rocks by Lowell Artis, S. D. Botts, Gilson Chloe, P. L. D. Elmore, J. L. Glen, James Kelsey, Herbert Kirschenbaum and Hezekiah Smith. X-ray spectroscopic analyses and partial chemical analyses are indicated by a † symbol, and analyses were made by J. W. Barker, E. L. Brandt, E. E. Engleman, G. Manson, H. G. Neiman, F. Newman and J. N. Taggart.]

(Table 2 begins on page 11.)

Table 2.--Chemical analyses

Sample No:	1	2	3	4	5	6	7	8	9
Field No:	65AR-827	70AR-177	70AR-178	71AR-34	71AR-35	71AR-36	71AR-37	71AR-38	71AR-39
					Chemical Analyses				
SiO_2	53.2	57.2	63.4	61.9	65.1	59.1	62.8	62.1	66.1
Al_2O_3	18.9	17.2	15.8	14.4	13.1	16.1	13.5	14.9	14.3
Fe_2O_3	3.6	1.7	1.8	2.4	2.0	3.1	2.2	3.0	2.3
FeO	4.8	6.2	4.1	4.6	4.3	4.7	5.1	3.7	3.6
MgO	4.3	4.2	2.4	3.0	3.2	3.5	3.6	3.0	2.1
CaO	9.0	7.8	5.5	6.4	6.0	7.51	6.8	6.8	5.2
Na_2O	3.5	2.6	2.6	2.3	2.1	2.7	2.0	2.4	3.0
K_2O	.51	.83	1.9	1.0	1.3	1.3	1.0	1.0	1.3
H_2O+	.77	.91	1.3	2.6	1.3	.93	1.1	1.0	.81
TiO_2	.21	.64	.62	.76	.51	.61	.72	.70	.61
P_2O_5	.25	.14	.12	.28	.16	.27	.21	.24	.20
MnO	.18	.16	.12	.21	.18	.20	.19	.17	.17
CO_2	--	.06	.04	.05	.05	.05	.05	.05	.05
					CIPW norms[1/]				
Q	5.20	13.45	24.18	26.37	30.14	17.24	27.11	26.07	29.11
or	3.06	4.97	11.41	6.07	7.84	7.75	6.02	6.03	7.76
ab	30.08	22.28	22.36	20.00	18.13	23.04	17.24	20.71	25.66
an	34.89	33.23	26.25	26.73	22.94	28.21	25.37	27.46	21.95
wo	3.67	1.94	.18	1.54	2.52	3.03	3.04	2.10	1.04
en	10.88	10.59	6.07	7.68	8.13	8.79	9.13	7.62	5.29
fs	5.92	9.34	5.33	5.75	5.85	5.48	6.84	3.54	4.06
mt	5.30	2.50	2.65	3.58	2.96	4.53	3.25	4.44	3.37
il	.41	1.23	1.20	1.48	.99	1.17	1.39	1.36	1.17
ap	.60	.34	.29	.68	.39	.64	.51	.58	.48
cc	--	.14	.09	.12	.12	.11	.12	.12	.11
Diff. Index	38.34	40.70	57.94	52.44	56.11	48.02	50.36	52.80	62.53
					Latitude and Longitude				
Lat (N.)	59.773	60.615	60.675	60.378	60.393	60.361	60.383	60.396	60.377
Long (W.)	153.645	152.628	152.453	152.949	152.981	152.928	153.996	153.014	152.920

Table 2.--Chemical analyses (continued)

Sample No:	10	11	12	13	14	15	16	17	18
Field No:	72AR-46	72AR-47	72AR-48	72AR-50	72AR-52	72AR-53	72AR-54	72AR-55	72AR-56
					Chemical analyses				
SiO_2	59.0	64.0	57.3	48.7	54.6	54.8	57.6	59.6	58.5
Al_2O_3	16.8	15.9	17.7	20.2	19.3	18.2	18.3	17.4	16.2
Fe_2O_3	2.4	2.1	3.1	1.2	3.2	3.3	2.8	2.5	2.7
FeO	4.8	3.2	4.9	5.7	4.1	4.2	4.5	3.8	5.0
MgO	4.0	2.3	4.0	4.8	3.9	3.9	3.6	3.1	3.5
CaO	7.5	5.2	7.8	11.5	8.0	8.4	7.4	7.0	7.8
Na_2O	2.8	3.1	2.8	3.3	4.1	4.0	3.3	3.3	2.7
K_2O	1.7	2.0	1.2	.27	.71	.71	.91	1.3	.80
H_2O+	1.2	1.2	.94	.51	.98	1.1	.94	.83	.87
TiO_2	.65	.54	.62	1.00	.76	.75	.66	.53	.59
P_2O_5	.12	.13	.10	.25	.22	.22	.13	.11	.07
MnO	.07	.04	.07	.15	.07	.10	.11	.10	.12
CO_2	.02	.04	.04	.06	.02	.07	.04	.06	.06
					CIPW norms				
Q	13.64	23.29	12.87	—	5.38	6.31	12.64	15.58	17.44
or	10.06	11.99	7.12	1.64	4.24	4.25	5.41	7.77	4.82
ab	23.72	26.62	23.78	28.74	35.05	34.31	28.10	28.26	23.30
an	28.29	23.91	32.30	40.67	32.49	30.01	32.64	29.17	30.31
wo	3.36	.48	2.35	6.68	2.52	4.31	1.33	2.03	3.47
en	9.98	5.81	10.00	5.97	9.81	9.84	9.02	7.81	8.89
fs	5.90	3.37	5.56	4.05	3.80	3.99	5.10	4.27	6.32
mt	3.48	3.09	4.51	1.79	4.69	4.85	4.09	3.67	3.99
il	1.24	1.04	1.18	1.96	1.46	1.44	1.26	1.02	1.14
ap	.28	.31	.24	.61	.53	.53	.31	.26	.17
cc	.05	.09	.09	.14	.05	.16	.09	.14	.14
Diff. Index	47.43	61.89	43.77	30.39	44.67	44.87	46.15	51.62	45.56
					Latitude and longitude				
Lat (N.)	60.446	60.478	60.349	60.153	60.130	60.106	60.083	60.049	60.123
Long (W.)	152.790	152.593	152.776	153.413	153.399	153.331	153.271	153.184	153.068

Table 2.--Chemical analyses (continued)

Sample No:	19	20	21	22	23	24	25	26	27
Field No:	72AR-61	72AR-62	72AR-63	72AR-64	72AR-65	72AR-66	72AR-67	72AR-97	72AR-98
Chemical analyses									
SiO_2	61.9	57.6	61.0	65.2	55.3	56.3	56.7	54.5	54.7
Al_2O_3	15.3	16.8	15.3	15.8	16.9	17.6	16.1	18.5	17.9
Fe_2O_3	2.1	3.0	2.6	1.9	3.3	3.0	3.2	3.2	2.8
FeO	4.2	4.2	3.4	2.3	4.6	4.0	4.2	4.8	4.8
MgO	3.0	3.8	2.8	1.5	3.8	3.3	3.9	4.0	4.3
CaO	7.5	7.4	6.9	5.0	7.9	7.6	8.0	8.0	8.3
Na_2O	3.1	3.4	3.2	3.5	3.6	3.8	3.6	3.1	3.0
K_2O	1.9	1.1	1.6	1.7	.75	1.1	.90	.60	1.1
H_2O+	1.0	1.2	.93	1.3	1.7	1.1	1.0	1.3	1.1
TiO_2	.55	.65	.55	.34	.69	.76	.77	.73	.69
P_2O_5	.06	.10	.09	.09	.12	.18	.17	.13	.13
MnO	.09	.12	.09	.09	.12	.10	.11	.12	.11
CO_2	.03	.06	.07	.08	.08	.05	.04	.03	.06
CIPW norms									
Q	17.08	12.57	18.95	25.76	9.74	9.75	11.24	10.22	8.71
or	11.26	6.62	9.69	10.30	4.56	6.65	5.44	3.63	6.64
ab	26.30	29.29	27.74	30.37	31.35	32.88	31.18	26.84	25.93
an	22.28	27.82	23.21	22.95	28.55	28.34	25.70	35.60	32.82
wo	6.03	3.55	4.51	.57	4.37	3.63	5.65	1.65	3.34
en	7.49	9.63	7.14	3.83	9.74	8.40	9.94	10.19	10.94
fs	5.25	4.46	3.44	2.32	4.94	3.88	4.10	5.31	5.69
mt	3.05	4.43	3.86	2.83	4.92	4.45	4.75	4.75	4.15
il	1.05	1.26	1.07	.66	1.35	1.48	1.50	1.42	1.34
ap	.14	.24	.22	.22	.29	.44	.41	.32	.31
cc	.07	.14	.16	.19	.19	.12	.09	.07	.14
Diff. index	54.64	48.47	56.38	66.44	45.65	49.27	47.86	40.69	41.28
Latitude and longitude									
Lat (N.)	60.202	60.221	60.180	60.148	60.122	60.190	60.170	60.055	60.047
Long (W.)	153.039	153.092	153.131	153.215	153.232	153.257	153.340	153.301	153.256

Table 2.--Chemical analyses (continued)

Sample No:	28	29	30	31	32	33	34	35	36
Field No:	72AR-99	72AR-100	72AR-107	72AR-113	72AR-114	72AR-115	72AR-116	72AR-117	72AR-118
Chemical analyses									
SiO_2	58.8	62.9	56.2	59.2	57.2	54.1	56.9	59.4	55.8
Al_2O_3	16.6	15.9	17.4	15.2	17.3	18.7	18.0	17.2	17.9
Fe_2O_3	2.2	2.5	3.5	2.5	2.2	3.9	3.1	2.7	1.2
FeO	4.4	3.2	3.4	4.6	4.9	4.7	4.6	3.9	5.7
MgO	3.2	2.5	3.4	3.9	3.6	4.0	3.8	3.0	3.9
CaO	6.8	5.9	7.8	7.7	7.2	7.4	7.3	6.5	8.0
Na_2O	2.8	3.2	3.8	2.8	2.8	2.7	3.4	3.4	3.2
K_2O	2.0	1.1	1.3	1.2	1.5	.60	1.20	1.2	.80
H_2O+	1.2	.85	1.5	.96	1.0	1.9	.68	1.1	.80
TiO_2	.66	.54	.72	.69	.78	.86	.72	.66	.88
P_2O_5	.10	.08	.17	.10	.10	.16	.15	.13	.16
MnO	.09	.09	.10	.10	.10	.11	.14	.13	.16
CO_2	.08	.08	.06	.08	.07	.07	.03	.07	.04
CIPW norms									
Q	15.17	23.76	9.41	16.88	13.34	13.37	10.56	16.22	9.51
or	12.09	6.63	7.85	7.23	9.07	3.64	7.14	7.21	4.84
ab	24.24	27.63	32.86	24.16	24.24	23.48	28.96	29.27	27.70
an	27.44	26.30	27.16	25.86	30.90	36.20	30.51	28.61	32.85
wo	2.46	1.05	4.53	4.97	1.89	--	1.99	1.20	2.68
en	8.15	6.35	8.65	9.90	9.17	10.24	9.53	7.60	9.94
fs	5.46	3.15	2.40	5.53	6.22	4.31	4.99	4.15	8.51
mt	3.26	3.70	5.19	3.70	3.26	5.81	4.52	3.98	1.78
il	1.28	1.05	1.40	1.34	1.52	1.68	1.38	1.28	1.71
ap	.24	.19	.41	.24	.24	.39	.36	.31	.39
cc	.19	.19	.14	.19	.16	.16	.07	.16	.09
Diff. index	51.51	58.02	50.12	48.27	46.64	40.49	46.66	52.70	42.05
Latitude and longitude									
Lat (N.)	59.987	60.015	60.157	59.995	59.962	60.023	60.098	60.135	60.167
Long (W.)	153.248	153.287	153.296	153.281	153.282	153.215	153.174	153.154	153.201

Table 2.--Chemical analyses (continued)

Sample No:	37	38	39	40	41	42	43	44	45
Field No:	72AR-119	72AR-120	72AR-121	72AR-122	72AR-123	72AR-124	72AR-125	72AR-126	72AR-127
Chemical analyses									
SiO_2	60.0	58.8	58.5	60.8	61.3	59.2	59.3	61.3	61.6
Al_2O_3	16.6	17.2	17.4	17.1	16.5	16.9	16.7	16.5	16.5
Fe_2O_3	2.2	2.7	1.9	2.6	2.5	2.8	3.2	2.5	2.2
FeO	4.5	4.0	4.0	3.4	3.1	3.8	3.5	3.2	4.0
MgO	2.7	3.3	3.0	2.7	2.4	3.0	3.0	2.6	2.9
CaO	6.6	6.6	6.0	6.0	5.7	6.7	5.6	5.3	6.2
Na_2O	3.2	3.1	3.3	3.3	3.2	3.5	3.1	3.2	3.1
K_2O	1.5	1.8	1.6	1.7	2.2	1.5	1.7	2.1	1.5
H_2O+	1.0	.80	1.7	.76	1.5	1.3	2.0	1.5	.80
TiO_2	.77	.74	.67	.59	.60	.59	.74	.61	.56
P_2O_5	.12	.11	.14	.12	.11	.11	.11	.09	.10
MnO	.14	.13	.13	.12	.11	.13	.10	.11	.12
CO_2	.05	.06	.07	.05	.05	.07	.42	.08	.08
CIPW norms									
Q	16.86	14.47	14.79	17.84	18.71	14.55	18.98	19.14	19.37
or	9.01	10.79	9.78	10.20	13.30	9.02	10.31	12.72	8.97
ab	27.52	26.62	28.87	28.35	27.69	30.13	26.91	27.74	26.53
an	26.93	28.11	28.89	27.24	24.71	26.42	25.04	25.06	26.98
wo	2.18	1.67	.20	.78	1.32	2.59	--	.32	1.23
en	6.83	8.34	7.73	6.83	6.11	7.60	7.66	6.63	7.31
fs	5.52	4.20	5.08	3.40	2.91	4.00	2.82	3.08	4.88
mt	3.24	3.97	2.85	3.83	3.71	4.13	4.76	3.71	3.23
il	1.49	1.43	1.32	1.14	1.17	1.14	1.44	1.19	1.08
ap	.29	.26	.34	.29	.27	.27	.27	.22	.24
cc	.12	.14	.16	.12	.12	.16	.98	.19	.18
Diff. index	53.39	51.88	53.44	56.39	59.70	53.69	56.19	59.60	54.87
Latitude and longitude									
Lat (N.)	60.197	60.216	60.254	60.284	60.305	60.315	60.317	60.323	60.303
Long (W.)	153.182	153.140	153.180	153.147	153.094	153.044	152.996	152.948	152.849

Table 2.--Chemical analyses (continued)

Sample No:	46	47	48	49	50	51	52	53	54
Field No:	72AR-128	72AR-131	72AR-148	72AR-155	72AR-156	72AR-158	72AR-159	72AR-160	72AR-161
Chemical Analyses									
SiO_2	67.6	61.9	56.2	52.0	55.0	57.9	57.0	60.0	59.3
Al_2O_3	15.5	16.3	17.5	18.9	18.2	17.4	17.9	17.0	16.9
Fe_2O_3	1.9	2.2	2.6	3.9	3.2	2.8	3.5	2.5	2.5
FeO	2.1	4.1	5.4	4.4	4.5	4.0	3.8	3.8	4.0
MgO	1.5	3.2	4.1	4.2	3.7	3.5	3.1	2.9	3.8
CaO	4.4	6.5	7.6	9.0	7.7	6.6	6.8	5.8	5.9
Na_2O	3.6	3.0	2.6	3.2	3.1	3.2	2.9	3.4	2.9
K_2O	1.5	1.4	1.1	.60	1.2	1.2	1.4	1.5	1.8
H_2O+	1.1	.85	1.3	2.4	1.6	1.8	2.1	1.9	1.9
TiO_2	.46	.56	.71	.98	.80	.77	.67	.60	.63
P_2O_5	.02	.08	.14	.22	.14	.11	.13	.11	.09
MnO	.04	.11	.15	.14	.15	.16	.14	.11	.17
CO_2	.06	.05	.05	.06	.05	.06	.07	.08	.07
CIPW Norms									
Q	29.13	19.58	12.90	6.49	10.06	14.75	15.22	16.94	16.02
or	8.98	8.32	6.62	3.63	7.25	7.26	8.49	9.06	10.85
ab	30.87	25.54	22.41	27.74	26.84	27.71	25.19	29.41	25.02
an	21.60	27.04	33.45	36.30	32.94	30.26	32.53	27.29	28.33
wo	--	1.90	1.55	3.16	2.04	.89	.32	.37	.20
en	3.79	8.02	10.40	10.72	9.43	8.92	7.93	7.38	9.65
fs	1.62	5.02	7.00	3.59	4.68	4.15	3.33	4.22	4.65
mt	2.79	3.21	3.84	5.79	4.75	4.15	5.21	3.71	3.70
il	.89	1.07	1.37	1.91	1.55	1.50	1.31	1.17	1.22
ap	.05	.19	.34	.53	.34	.27	.32	.27	.22
cc	.14	.11	.12	.14	.12	.14	.16	.19	.16
Diff. index	68.98	53.44	41.93	37.86	44.15	49.72	48.90	55.42	51.88
Latitude and Longitude									
Lat (N.)	60.276	60.314	60.595	60.289	60.312	60.331	60.332	60.342	60.396
Long (W.)	152.805	152.787	152.701	153.195	153.182	153.105	153.039	152.963	152.869

Table 2.--Chemical analyses (continued)

Sample No:	55	56	57	58	59	60	61	62	63
Field No:	72AR-162	72AR-163	72AR-164	72AR-165	72AR-166	72AR-191	72AR-192	72AR-214	72AR-226
Chemical analyses									
SiO_2	57.2	59.4	60.4	58.1	56.9	60.4	57.1	54.1	55.7
Al_2O_3	17.4	18.1	16.3	17.5	17.7	16.8	17.7	17.7	18.0
Fe_2O_3	3.0	2.9	2.7	2.6	3.3	2.8	3.2	3.3	3.0
FeO	4.4	4.1	3.6	4.0	4.0	4.2	4.5	4.7	4.7
MgO	3.7	2.6	2.8	3.1	3.9	2.7	3.9	4.0	3.9
CaO	6.4	6.4	5.8	5.9	7.4	6.9	8.8	7.9	8.4
Na_2O	3.3	3.2	3.8	3.4	4.0	3.1	3.3	3.4	3.4
K_2O	1.2	.70	2.0	1.6	1.2	.62	.43	1.0	.44
H_2O+	2.0	1.7	1.8	2.7	1.3	.36	.50	1.6	.76
TiO_2	.78	.69	.73	.78	.72	.60	.80	.85	.85
P_2O_5	.11	.21	.14	.14	.15	.24	.39	.45	.46
MnO	.16	.18	.13	.12	.14	.12	.12	.11	.11
CO_2	.02	.02	.06	.33	.02	.01	.04	.16	.02
CIPW norms									
Q	13.14	19.48	14.56	14.71	8.12	20.63	12.57	8.48	10.93
or	7.26	4.20	12.00	9.69	7.13	3.72	2.53	6.05	2.63
ab	28.59	27.49	32.65	29.48	34.04	26.63	27.84	29.45	29.06
an	29.81	30.71	21.85	26.92	26.95	30.55	32.12	30.79	32.88
wo	.76	--	2.53	--	3.70	1.06	3.60	2.21	2.53
en	9.43	6.57	7.08	7.91	9.77	6.83	9.68	10.20	9.81
fs	4.72	4.39	3.47	4.23	3.71	4.70	4.51	4.82	5.00
mt	4.45	4.27	3.98	3.86	4.81	4.12	4.63	4.90	4.39
il	1.52	1.33	1.41	1.52	1.38	1.16	1.51	1.65	1.63
ap	.27	.50	.34	.34	.36	.58	.92	1.09	1.10
cc	.05	.05	.14	.77	.05	.02	.09	.37	.05
Diff. index	48.99	51.17	59.21	53.88	49.28	50.98	42.94	43.98	42.61
Latitude and longitude									
Lat (N.)	60.423	60.467	60.400	60.360	60.367	59.850	59.863	59.909	60.216
Long (W.)	152.916	152.990	153.053	153.077	153.125	153.465	153.526	153.475	153.270

Table 2.--Chemical analyses (continued)

Sample No:	64	65	66	67	68	69	70	71	72
Field No:	72AR-227	72AR-228	72AR-239	72AR-245	72AR-246	72AR-247	72AR-248	78AR-154	78AR-155
Chemical analyses									
SiO_2	57.5	53.7	54.0	63.7	59.4	56.0	59.6	60.2	60.8
Al_2O_3	17.5	18.5	17.9	16.8	17.2	17.8	16.9	16.1	16.0
Fe_2O_3	3.2	3.0	3.3	2.1	3.5	3.5	3.4	1.9	2.4
FeO	3.8	4.4	5.1	2.7	4.3	4.9	4.0	4.9	4.6
MgO	3.2	3.8	4.1	2.2	3.2	3.9	3.2	3.3	3.5
CaO	8.1	8.9	9.1	6.9	7.1	8.2	7.5	6.4	6.5
Na_2O	3.7	3.8	3.6	3.6	2.8	3.5	3.5	3.1	2.6
K_2O	.64	.53	.78	.55	.31	.67	.60	1.6	1.7
H_2O+	.95	.91	.87	.69	1.1	.89	.86	1.8	1.9
TiO_2	.97	.78	.73	.36	.56	.68	.56	.61	.72
P_2O_5	.19	.46	.27	.26	.31	.36	.33	.12	.12
MnO	.09	.12	.16	.06	.10	.12	.09	.18	.15
CO_2	.02	.02	.02	.02	.02	.02	.04	.03	.01
CIPW norms									
Q	12.88	6.22	5.50	23.24	21.18	10.01	16.80	16.19	18.99
or	3.82	3.19	4.65	3.27	1.85	3.97	3.55	9.60	10.14
ab	31.65	32.80	30.75	30.69	23.98	29.71	29.69	26.64	22.20
an	29.57	32.49	30.66	28.26	33.47	30.98	28.71	25.69	27.21
wo	4.04	3.90	5.43	1.83	--	3.07	2.58	2.33	1.87
en	8.06	9.65	10.31	5.52	8.07	9.75	7.99	8.35	8.80
fs	2.93	4.63	5.78	2.76	4.32	5.22	3.79	6.86	5.60
mt	4.69	4.44	4.83	3.07	5.14	5.09	4.94	2.80	3.51
il	1.86	1.51	1.40	.69	1.08	1.30	1.07	1.18	1.38
ap	.45	1.11	.65	.62	.74	.86	.78	.29	.29
cc	.05	.05	.05	.05	.05	.05	.09	.07	.02
Diff. index	48.35	42.22	40.90	57.20	47.01	43.69	50.05	52.44	51.32
Latitude and Longitude									
Lat (N.)	60.187	60.179	59.857	59.912	59.893	59.930	59.948	60.416	60.398
Long (W.)	153.288	153.319	153.360	153.375	153.422	153.409	153.360	152.976	152.915

Table 2.--Chemical analyses (continued)

Sample No:	73	74	75	76	77	78	79	80	81
Field No:	78AR-156	78AR-157	78AR-158	78AR-160	78AR-206	78AR-283	78AR-284	78AR-285	78AR-295
Chemical analyses									
SiO_2	57.2	59.2	55.6	55.9	45.6	62.6	58.2	53.6	52.9
Al_2O_3	17.1	16.6	17.5	17.0	20.8	18.3	16.8	17.5	18.5
Fe_2O_3	3.3	3.2	3.9	3.4	4.7	2.5	2.7	2.6	3.8
FeO	4.2	4.4	4.3	5.4	5.2	2.0	4.7	5.9	4.9
MgO	3.6	3.6	5.4	5.4	4.5	1.4	1.5	4.7	4.2
CaO	7.1	7.1	7.5	7.4	10.6	5.8	8.0	8.9	9.2
Na_2O	3.2	2.7	2.5	2.2	3.1	4.6	4.7	2.0	3.3
K_2O	1.3	1.4	.76	1.0	.27	1.1	1.3	1.0	.57
H_2O+	1.8	1.8	1.3	1.7	2.2	.45	1.4	1.7	.63
TiO_2	.72	.71	.78	.80	.91	.45	.57	.68	.80
P_2O_5	.14	.13	.15	.16	.28	.19	.17	.17	.24
MnO	.15	.18	.14	.17	.17	.13	.14	.17	.15
CO_2	.02	.01	.05	.02	.02	.02	.07	.04	.02
CIPW norms									
Q	13.12	17.13	13.47	13.68	—	17.66	8.39	10.87	6.33
or	7.84	8.34	4.56	5.98	1.66	6.56	7.77	6.08	3.42
ab	27.62	23.02	21.46	18.83	27.28	39.28	40.23	17.40	28.32
an	29.02	29.26	34.77	33.94	43.72	26.27	21.14	36.82	34.47
wo	2.44	2.22	.69	.84	3.73	.58	7.28	2.99	4.22
en	9.15	9.03	13.64	13.60	5.72	3.52	3.78	12.03	10.61
fs	4.16	4.63	3.70	6.17	2.29	1.12	5.79	8.10	4.89
mt	4.88	4.68	5.74	4.99	7.09	3.66	3.96	3.88	5.59
il	1.39	1.36	1.50	1.54	1.80	.86	1.10	1.33	1.54
ap	.34	.31	.36	.38	.69	.45	.41	.41	.58
cc	.05	.02	.12	.05	.05	.05	.16	.09	.05
Diff. index	48.57	48.48	39.48	38.49	28.94	63.50	56.39	34.34	38.07
Latitude and longitude									
Lat (N.)	60.385	60.455	60.472	60.534	60.218	60.634	60.636	60.661	60.727
Long (W.)	153.088	152.834	152.877	152.856	153.225	152.676	152.552	152.604	152.476

Table 2.--Chemical analyses (continued)

Sample No:	82	83	84	85	86	87	88	89	90
Field No:	81AR-4†	81AR-8†	81AR-10†	81AR-12†	81AR-14†	81AR-16†	81AR-21†	81AR-24†	81AR-28†
Chemical analyses									
SiO_2	59.0	62.4	55.4	61.0	63.4	56.8	56.5	61.5	59.0
Al_2O_3	16.4	16.4	17.1	16.0	15.7	16.9	16.6	15.7	16.4
Fe_2O_3	2.16	2.60	2.42	4.68	1.84	2.38	2.56	2.13	2.24
FeO	4.84	3.23	5.80	2.47	3.84	5.28	5.18	4.33	5.00
MgO	3.47	2.21	4.47	2.45	2.19	3.98	3.82	2.78	3.31
CaO	7.33	5.89	8.95	5.98	5.75	7.79	7.36	6.21	7.36
Na_2O	2.84	3.75	2.51	3.16	2.99	2.67	2.50	3.02	2.60
K_2O	1.79	1.08	.99	1.28	1.59	1.51	1.67	1.70	1.49
H_2O+	.72	.65	.82	.43	.50	.46	1.72	.71	.67
TiO_2	.70	.67	.75	.80	.51	.69	.68	.72	.63
P_2O_5	.13	.17	.13	.14	.09	.12	.11	.13	.11
MnO	.13	.10	.15	.13	.12	.14	.14	.11	.14
CO_2	<.01	<.01	.01	<.01	.02	<.01	.05	<.01	<.01
CIPW norms									
Q	14.39	20.77	10.58	22.75	23.54	12.08	13.32	19.54	16.63
or	10.71	6.48	5.93	7.71	9.58	9.08	10.15	10.21	8.96
ab	24.32	32.21	21.52	27.25	25.80	22.99	21.77	25.98	22.38
an	27.04	25.10	32.90	26.19	25.21	30.19	29.99	24.67	29.17
wo	3.69	1.41	4.66	1.28	1.32	3.45	2.72	2.39	3.00
en	8.75	5.59	11.28	6.22	5.56	10.09	9.79	7.04	8.39
fs	6.26	2.91	7.79	--	5.01	6.97	6.72	5.30	6.66
mt	3.17	3.83	3.56	6.18	2.72	3.51	3.82	3.14	3.31
il	1.35	1.29	1.44	1.55	.99	1.33	1.33	1.39	1.22
ap	.31	.41	.31	.34	.22	.29	.27	.31	.27
cc	.02	.02	.02	.02	.05	.02	.12	.02	.02
Diff. index	49.41	59.45	38.03	57.72	58.92	44.14	45.24	55.74	47.97
Latitude and longitude									
Lat (N.)	60.634	60.567	60.505	60.542	60.583	60.661	60.707	60.491	60.416
Long (W.)	152.482	152.443	152.504	152.574	152.541	152.489	152.439	152.477	152.697

Table 2.--Chemical analyses (continued)

Sample No:	91	92	93	94	95	96	97	98	99
Fielde No:	81AR-29†	81AR-31†	81AR-33†	81AR-38†	81AR-39†	81AR-40†	81AR-42†	81AR-54†	81AR-102†
Chemical analyses									
SiO_2	62.5	61.0	53.7	58.1	59.2	58.5	57.4	56.4	54.8
Al_2O_3	15.7	15.8	17.5	16.3	16.2	16.7	16.7	17.6	18.8
Fe_2O_3	2.01	2.39	2.87	2.07	2.08	2.45	2.40	2.70	3.54
FeO	4.30	4.23	5.89	5.46	4.98	4.92	5.17	4.79	4.88
MgO	2.77	3.31	5.53	3.76	3.30	3.38	3.83	3.66	2.95
CaO	6.25	6.59	8.64	7.13	7.11	7.49	7.60	8.09	8.02
Na_2O	2.75	3.10	3.30	2.46	2.61	2.63	2.57	3.35	3.36
K_2O	1.59	1.19	.36	1.29	1.60	1.36	1.36	.91	.37
H_2O+	.79	.97	.82	1.84	.89	.86	1.46	.88	1.15
TiO_2	.57	.61	1.00	.56	.63	.68	.66	.81	.69
P_2O_5	.10	.10	.19	.08	.11	.10	.11	.19	.24
MnO	.12	.12	.17	.14	.13	.13	.14	.14	.21
CO_2	<.01	<.01	<.01	.02	.01	<.01	.02	<.01	<.01
CIPW norms									
Q	21.96	19.04	5.84	16.30	16.86	16.14	14.35	10.69	11.45
or	9.52	7.14	2.15	7.83	9.65	8.17	8.20	5.45	2.23
ab	23.58	26.64	28.16	21.38	22.54	22.63	22.20	28.73	29.05
an	26.14	26.08	32.14	30.42	28.34	30.24	30.64	30.71	35.88
wo	1.90	2.67	4.08	2.19	2.87	2.84	2.92	3.61	1.29
en	6.99	8.37	13.89	9.62	8.39	8.56	9.74	9.24	7.51
fs	5.59	5.09	7.17	7.86	6.77	6.23	6.82	5.57	5.41
mt	2.96	3.52	4.20	3.09	3.07	3.61	3.56	3.96	5.24
il	1.10	1.18	1.91	1.09	1.22	1.31	1.28	1.56	1.34
ap	.24	.24	.45	.19	.27	.24	.27	.46	.58
cc	.02	.02	.02	.05	.02	.02	.05	.02	.02
Diff. index	55.06	52.83	36.14	45.50	49.05	46.94	44.74	44.87	42.73
Latitude and longitude									
Lat (N.)	60.491	60.541	60.541	60.394	60.408	60.418	60.339	60.721	60.452
Long (W.)	152.602	152.625	152.886	152.708	152.737	152.772	152.842	152.519	153.012

Table 2.--Chemical analyses (continued)

Sample No:	100	101	102
Field No:	81AR-175†	81AR-193†	81AR-196†
Chemical analyses			
SiO_2	58.4	56.5	52.2
Al_2O_3	17.1	17.0	18.0
Fe_2O_3	2.93	2.15	2.77
FeO	3.65	5.52	6.38
MgO	2.96	4.15	4.63
CaO	6.47	8.28	9.41
Na_2O	2.79	2.59	2.61
K_2O	1.61	1.36	1.11
H_2O+	1.97	1.00	1.45
TiO_2	.62	.59	.82
P_2O_5	.14	.12	.14
MnO	.12	.14	.17
CO_2	<.01	.04	.09
CIPW norms			
0	17.51	11.45	5.00
or	9.83	8.16	6.67
ab	24.39	22.26	22.46
an	30.35	31.23	34.70
wo	.75	3.94	4.70
en	7.61	10.50	11.73
fs	3.59	7.77	8.53
mt	4.39	3.16	4.08
il	1.22	1.14	1.58
ap	.34	.29	.34
cc	.02	.09	.21
Diff. index	51.72	41.88	34.13
Latitude and longitude			
Lat (N.)	60.432	60.609	60.641
Long (W.)	153.007	152.671	152.595

1/ Six samples contain normative C (nos. 33 = .72, 43 = .84, 46 = .14, 56 = 1.01, 58 = .56, 68 = .14); 2 samples contain normative fo (nos. 13 = 4.44, 77 = 4.16); 2 samples contain normative fa (nos. 13 = 3.32, 77 = 1.83); 1 sample contains normative hm (no. 85 = 1.55).

Table 3.-- Statistical summary of major oxides and CIPW normative minerals

Variable	Mean	Range	Standard Deviation
Chemical variables			
SiO_2	58.29	45.6 - 67.6	3.56
Al_2O_3	16.98	13.1 - 20.8	1.21
Fe_2O_3	2.73	1.2 - 4.70	0.63
FeO	4.36	2.0 - 6.38	0.83
MgO	3.41	1.4 - 5.53	0.80
CaO	7.21	4.4 - 11.50	1.18
Na_2O	3.11	2.0 - 4.70	0.49
K_2O	1.19	0.27 - 2.20	0.46
H_2O+	1.20	0.36 - 2.70	0.50
TiO_2	0.68	0.21 - 1.00	0.13
P_2O_5	0.16	0.02 - 0.46	0.08
MnO	0.13	0.04 - 0.21	0.03
CO_2	0.05	0.01 - 0.42	0.06
Na_2O+K_2O	4.30	3.00 - 6.00	0.61
K_2O/Na_2O	0.39	0.08 - 0.73	0.17
Na_2O/SiO_2	0.05	0.03 - 0.08	0.009
K_2O/SiO_2	0.02	0.01 - 0.04	0.007
FeO*	6.82	3.81 - 9.43	0.98
FeO*/MgO	2.06	1.41 - 4.75	0.38
Atomic $Mg/Mg+Fe^{2+}$	0.58	0.36 - 0.69	0.04
Atomic $Mg/Mg+\Sigma Fe$	0.47	0.27 - 0.56	0.04
Normative variables			
Q	14.98	0 - 30.14	6.08
or	7.14	1.64 - 13.30	2.77
ab	26.78	17.23 - 40.23	4.21
an	29.27	21.14 - 43.72	4.05
wo	2.40	0 - 7.28	1.57
en	8.52	3.52 - 13.89	1.99
fs	4.89	0 - 9.34	1.62
mt	4.02	1.78 - 7.09	0.91
il	1.31	0.41 - 1.96	0.25
ap	0.39	0.05 - 1.11	0.20
cc	0.11	0 - 0.98	0.13
DI[1/]	48.91	28.94 - 68.98	7.54
CI[2/]	21.28	9.09 - 31.25	4.30
An plagioclase [3/]	50.80	33.13 - 66.61	5.58

1/ DI, Differentiation index = normative Q+or+ab

2/ CI, Color index = normative wo+en+fs+fo+fa+mt+hm+il

3/ Normative plagioclase composition = 100(an/278)/(an/278 + ab/262)