

Data set to accompany "Aluminum in hornblende: an empirical igneous geobarometer" by Jane M. Hammarstrom and E-an Zen

Data tables are generated using a modified version of a FORTRAN program supplied by N.M.S. Rock (Rock and Leake, 1984, Mineralogical Magazine 48, 211-227). Total iron is treated as FeO; F and Cl are reported with the oxides but are set to zero for the formula calculation.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	52.19	49.42	52.10	49.09	49.16	49.47	49.63	51.74	51.01	48.93	49.57	48.87
Al2O3	3.75	4.73	4.22	6.58	5.63	6.14	6.01	5.07	5.68	5.92	5.89	6.33
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	11.75	11.97	10.61	12.10	11.52	11.91	12.48	11.92	12.73	12.04	12.18	12.02
MgO	16.15	15.43	15.88	14.07	14.29	14.08	14.39	15.10	14.59	14.18	14.41	14.17
CaO	12.52	12.60	12.21	12.49	12.21	12.30	11.70	11.96	11.89	12.39	12.45	12.28
Na2O	0.78	1.14	0.55	1.08	0.90	1.04	1.26	1.04	1.14	0.86	1.00	1.03
K2O	0.30	0.52	0.56	0.68	0.77	0.76	0.58	0.53	0.55	0.79	0.75	0.80
TiO2	0.32	0.73	0.73	1.17	1.13	1.09	1.14	0.85	0.96	1.02	1.12	1.21
MnO	0.67	0.83	0.59	0.57	0.50	0.50	0.54	0.71	0.46	0.58	0.65	0.51
Cl	0.04	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.11	0.00	0.00	0.00
F	0.50	0.65	0.51	0.49	0.54	0.57	0.00	0.00	0.00	0.52	0.57	0.75
Total	98.75	97.75	97.75	98.11	96.42	97.62	97.82	99.01	99.10	97.01	98.35	97.65

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.487	7.242	7.499	7.145	7.258	7.225	7.221	7.393	7.310	7.206	7.204	7.158
Al	0.635	0.818	0.717	1.130	0.980	1.058	1.031	0.855	0.960	1.028	1.010	1.094
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.409	1.466	1.277	1.472	1.422	1.454	1.518	1.424	1.525	1.482	1.480	1.472
Mg	3.455	3.372	3.409	3.054	3.146	3.067	3.122	3.218	3.118	3.114	3.123	3.095
Ca	1.924	1.978	1.883	1.948	1.931	1.924	1.824	1.831	1.825	1.955	1.938	1.927
Na	0.217	0.324	0.153	0.305	0.258	0.294	0.355	0.288	0.317	0.246	0.282	0.292
K	0.055	0.097	0.103	0.126	0.145	0.142	0.108	0.097	0.101	0.148	0.139	0.150
Ti	0.035	0.080	0.079	0.128	0.125	0.120	0.125	0.091	0.103	0.113	0.122	0.133
Mn	0.081	0.103	0.072	0.070	0.063	0.062	0.067	0.086	0.056	0.072	0.080	0.063
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.30	15.48	15.19	15.38	15.33	15.34	15.37	15.28	15.32	15.36	15.38	15.38

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.924	1.978	1.948	2.000	2.000	2.000	1.916	1.934	1.928	1.984	1.980	1.986
NaB	0.000	0.000	0.065	0.052	0.069	0.076	0.093	0.104	0.102	0.030	0.042	0.059
NaKA	0.272	0.421	0.192	0.379	0.334	0.360	0.370	0.281	0.315	0.364	0.379	0.383
AlVI	0.121	0.059	0.216	0.275	0.238	0.282	0.252	0.247	0.270	0.234	0.214	0.251
MgFe	0.710	0.697	0.728	0.675	0.689	0.678	0.673	0.693	0.672	0.678	0.679	0.678

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	13	14	15	16	17	18	19	20	21	22	23	24
SiO2	49.13	50.25	50.07	47.19	49.75	47.23	47.91	46.89	46.94	47.45	46.36	49.33
Al2O3	5.68	5.54	5.91	5.80	4.66	6.69	7.69	6.77	6.85	6.46	7.58	4.76
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	12.48	11.62	14.15	14.80	12.85	14.89	15.19	14.45	14.73	15.19	15.75	13.56
MgO	14.17	14.12	13.43	14.06	15.07	13.33	11.93	15.18	14.64	14.18	13.15	14.91
CaO	11.62	11.86	11.88	11.94	12.57	11.93	11.96	11.95	11.55	11.83	11.75	12.13
Na2O	1.23	1.23	1.02	1.11	0.88	1.13	1.18	1.33	1.35	1.24	1.46	1.02
K2O	0.60	0.42	0.58	0.53	0.33	0.52	0.65	0.72	0.81	0.61	0.99	0.60
TiO2	1.19	0.77	0.71	0.73	0.39	0.77	0.90	1.22	0.94	1.03	1.18	0.57
MnO	0.59	0.98	0.74	0.72	0.77	0.82	0.78	0.78	0.73	0.89	0.78	0.77
Cl	0.13	0.00	0.13	0.02	0.07	0.08	0.11	0.13	0.09	0.01	0.10	0.00
F	0.00	0.46	0.58	0.88	0.29	0.52	1.07	0.48	0.35	0.48	0.73	0.41
Total	96.79	97.06	98.93	97.41	97.49	97.67	98.89	99.67	98.81	99.17	99.50	97.89

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.235	7.351	7.278	7.053	7.301	7.023	7.050	6.846	6.904	6.963	6.836	7.248
Al	0.987	0.956	1.013	1.022	0.807	1.173	1.335	1.166	1.188	1.118	1.318	0.825
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.536	1.421	1.719	1.849	1.576	1.851	1.868	1.764	1.811	1.863	1.941	1.665
Mg	3.112	3.080	2.911	3.134	3.298	2.956	2.618	3.305	3.211	3.103	2.892	3.267
Ca	1.833	1.859	1.850	1.912	1.976	1.900	1.885	1.869	1.820	1.860	1.856	1.909
Na	0.351	0.349	0.287	0.322	0.250	0.326	0.337	0.376	0.385	0.353	0.417	0.291
K	0.113	0.078	0.108	0.101	0.062	0.099	0.122	0.134	0.152	0.114	0.186	0.112
Ti	0.132	0.085	0.078	0.082	0.043	0.086	0.100	0.134	0.104	0.114	0.131	0.063
Mn	0.074	0.122	0.091	0.091	0.096	0.103	0.097	0.097	0.091	0.111	0.097	0.096
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.37	15.30	15.34	15.57	15.41	15.52	15.41	15.69	15.67	15.60	15.68	15.48

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.925	1.986	1.910	1.912	1.976	1.900	1.932	1.869	1.820	1.860	1.856	1.909
NaB	0.092	0.127	0.060	0.000	0.000	0.000	0.046	0.000	0.000	0.000	0.000	0.000
NaKA	0.372	0.300	0.335	0.423	0.312	0.424	0.412	0.511	0.537	0.467	0.604	0.403
AlVI	0.221	0.307	0.291	0.075	0.107	0.196	0.385	0.012	0.092	0.081	0.154	0.073
MgFe	0.670	0.684	0.629	0.629	0.677	0.615	0.584	0.652	0.639	0.625	0.598	0.662

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
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 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	25	26	27	28	29	30	31	32	33	34	35	36
SiO2	50.81	45.87	49.46	47.82	48.03	46.73	48.08	48.60	50.77	49.75	48.08	50.36
Al2O3	4.94	7.86	5.80	6.23	6.36	6.63	6.33	6.23	4.63	5.65	5.86	4.65
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	13.40	15.61	14.11	14.85	15.14	15.06	15.08	15.11	13.62	14.63	14.85	13.80
MgO	15.08	13.21	14.61	12.98	12.44	14.12	13.08	12.91	14.04	13.99	13.83	14.65
CaO	11.98	11.79	11.88	12.08	11.88	11.76	11.89	11.80	11.84	11.86	11.92	12.12
Na2O	1.05	1.50	1.17	1.20	1.26	1.29	1.27	1.27	0.91	1.20	1.21	0.76
K2O	0.55	0.99	0.69	0.75	0.82	0.69	0.71	0.70	0.26	0.65	0.68	0.44
TiO2	0.86	1.43	1.05	0.88	0.94	0.95	0.89	0.76	0.49	0.72	1.00	0.65
MnO	0.75	0.73	0.85	0.79	0.81	0.76	0.77	0.77	0.90	0.92	0.91	0.84
Cl	0.00	0.12	0.12	0.14	0.16	0.04	0.08	0.04	0.00	0.06	0.09	0.12
F	0.51	0.51	0.34	0.51	0.45	0.52	0.38	0.23	0.08	0.32	0.46	0.32
Total	99.72	99.40	99.91	97.98	98.06	98.32	98.38	98.31	97.51	99.60	98.68	98.55

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.296	6.769	7.138	7.095	7.123	6.925	7.094	7.155	7.424	7.209	7.079	7.330
Al	0.837	1.368	0.987	1.090	1.113	1.159	1.102	1.082	0.799	0.966	1.018	0.798
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.608	1.925	1.702	1.842	1.877	1.866	1.860	1.860	1.665	1.772	1.828	1.679
Mg	3.229	2.906	3.144	2.872	2.751	3.121	2.878	2.835	3.062	3.023	3.037	3.180
Ca	1.843	1.863	1.837	1.920	1.887	1.867	1.879	1.861	1.855	1.841	1.880	1.890
Na	0.292	0.429	0.327	0.345	0.362	0.371	0.363	0.362	0.258	0.337	0.345	0.214
K	0.101	0.186	0.127	0.142	0.155	0.130	0.134	0.132	0.049	0.120	0.128	0.082
Ti	0.093	0.159	0.114	0.098	0.105	0.106	0.099	0.084	0.054	0.078	0.111	0.071
Mn	0.091	0.091	0.104	0.099	0.102	0.095	0.096	0.096	0.112	0.113	0.114	0.104
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.39	15.70	15.48	15.50	15.47	15.64	15.50	15.47	15.28	15.46	15.54	15.35

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.846	1.863	1.837	1.920	1.930	1.867	1.879	1.889	1.885	1.841	1.880	1.890
NaB	0.003	0.000	0.000	0.000	0.043	0.000	0.000	0.027	0.031	0.000	0.000	0.000
NaKA	0.390	0.615	0.454	0.487	0.475	0.501	0.497	0.467	0.276	0.457	0.473	0.296
AlVI	0.132	0.137	0.126	0.186	0.235	0.084	0.196	0.237	0.223	0.174	0.096	0.128
MgFe	0.668	0.602	0.649	0.609	0.594	0.626	0.607	0.604	0.648	0.630	0.624	0.654

GENERAL NOTES FOR THE ABOVE TABLE:

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 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	37	38	39	40	41	42	43	44	45	46	47	48
SiO2	49.90	50.36	50.68	50.48	50.58	47.98	47.49	45.03	48.46	48.84	49.75	48.69
Al2O3	4.54	5.28	4.70	4.79	4.65	6.11	6.59	8.20	7.15	6.73	5.48	6.38
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	14.07	14.75	13.94	13.92	13.59	14.69	14.54	15.59	5.73	14.08	14.18	14.80
MgO	14.61	14.42	14.62	14.48	14.85	13.09	13.17	12.31	2.64	13.58	14.09	13.85
CaO	12.04	11.85	11.79	12.17	12.03	11.76	12.19	11.85	12.04	11.88	12.03	12.02
Na2O	0.85	0.97	0.87	0.89	0.95	1.02	1.19	1.34	1.16	1.27	1.20	1.39
K2O	0.38	0.47	0.45	0.37	0.37	0.80	0.70	0.85	0.76	0.70	0.61	0.66
TiO2	0.68	0.63	0.45	0.71	0.52	0.91	0.98	1.18	0.98	0.89	0.86	0.95
MnO	0.86	0.98	0.91	0.83	0.91	0.80	0.64	0.82	0.86	0.68	0.68	0.59
Cl	0.00	0.02	0.00	0.03	0.01	0.17	0.09	0.13	0.12	0.08	0.14	0.14
F	0.65	0.50	0.26	0.54	0.52	0.30	0.70	0.49	0.55	0.14	0.67	0.72
Total	98.31	100.01	98.57	98.98	98.76	97.47	97.97	97.55	100.19	98.79	99.38	99.86

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.306	7.257	7.361	7.322	7.340	7.133	7.042	6.771	7.042	7.113	7.225	7.076
Al	0.784	0.897	0.805	0.820	0.796	1.071	1.153	1.454	1.226	1.156	0.939	1.094
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.722	1.777	1.692	1.688	1.648	1.825	1.802	1.959	1.911	1.714	1.721	1.798
Mg	3.190	3.099	3.167	3.132	3.214	2.902	2.912	2.760	2.739	2.949	3.052	3.002
Ca	1.888	1.829	1.835	1.891	1.870	1.873	1.936	1.909	1.874	1.854	1.872	1.871
Na	0.241	0.271	0.245	0.250	0.267	0.294	0.342	0.391	0.327	0.359	0.338	0.392
K	0.071	0.086	0.083	0.068	0.069	0.152	0.132	0.163	0.141	0.130	0.113	0.122
Ti	0.075	0.068	0.050	0.077	0.057	0.102	0.109	0.133	0.107	0.097	0.094	0.104
Mn	0.107	0.120	0.112	0.102	0.112	0.101	0.080	0.105	0.106	0.084	0.084	0.073
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.38	15.40	15.35	15.35	15.37	15.45	15.51	15.65	15.47	15.46	15.44	15.53

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.888	1.829	1.835	1.891	1.870	1.873	1.936	1.909	1.874	1.886	1.886	1.871
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.033	0.014	0.000
NaKA	0.312	0.357	0.328	0.319	0.336	0.446	0.475	0.554	0.468	0.456	0.437	0.514
AlVI	0.090	0.154	0.166	0.141	0.136	0.204	0.195	0.225	0.267	0.269	0.164	0.169
MgFe	0.649	0.636	0.652	0.650	0.661	0.614	0.618	0.585	0.589	0.632	0.639	0.625

GENERAL NOTES FOR THE ABOVE TABLE:

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Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	49	50	51	52	53	54	55	56	57	58	59	60
SiO2	50.82	48.85	46.65	48.82	50.11	51.13	52.82	50.38	52.73	49.60	46.67	51.42
Al2O3	5.14	5.86	6.69	5.71	5.81	5.89	4.06	4.78	3.43	4.70	7.41	4.24
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	12.93	14.49	15.74	14.11	13.76	14.79	9.25	12.02	9.69	12.18	13.06	12.02
MgO	14.89	13.50	12.74	14.31	14.39	13.56	17.74	15.22	18.22	16.70	14.06	15.58
CaO	12.48	12.07	11.68	12.13	12.39	12.04	11.76	12.43	12.29	11.73	11.66	12.50
Na2O	0.86	0.99	1.42	1.13	1.04	0.77	1.32	1.49	1.27	0.51	2.28	0.95
K2O	0.37	0.39	0.87	0.40	0.36	0.40	0.54	0.27	0.43	0.12	0.62	0.44
TiO2	0.54	0.39	1.14	0.70	0.70	0.61	0.78	1.02	0.59	0.23	1.96	0.68
MnO	0.82	0.82	0.90	0.80	0.85	0.93	0.56	0.20	0.37	0.38	0.22	0.64
Cl	0.00	0.00	0.03	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00
F	0.52	0.71	0.76	0.51	0.46	0.18	0.80	0.57	0.73	0.50	0.63	0.00
Total	99.15	97.77	98.29	98.42	99.69	100.26	99.29	98.14	99.44	96.44	98.30	98.47

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.319	7.215	6.957	7.154	7.215	7.310	7.459	7.306	7.455	7.294	6.856	7.402
Al	0.873	1.021	1.177	0.987	0.987	0.993	0.676	0.818	0.572	0.815	1.284	0.720
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.557	1.789	1.962	1.728	1.656	1.767	1.092	1.457	1.145	1.497	1.604	1.446
Mg	3.198	2.973	2.834	3.127	3.090	2.891	3.736	3.292	3.842	3.662	3.080	3.345
Ca	1.926	1.910	1.866	1.904	1.911	1.844	1.779	1.931	1.862	1.848	1.835	1.928
Na	0.240	0.283	0.411	0.321	0.290	0.213	0.361	0.419	0.348	0.145	0.649	0.265
K	0.068	0.073	0.166	0.075	0.066	0.073	0.097	0.050	0.078	0.023	0.116	0.081
Ti	0.059	0.043	0.128	0.077	0.076	0.066	0.083	0.111	0.063	0.025	0.217	0.074
Mn	0.100	0.103	0.114	0.099	0.104	0.113	0.067	0.025	0.044	0.047	0.027	0.078
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.34	15.41	15.61	15.47	15.39	15.27	15.35	15.41	15.41	15.36	15.67	15.34

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.926	1.910	1.866	1.904	1.911	1.860	1.888	1.992	1.879	1.848	1.932	1.936
NaB	0.000	0.000	0.000	0.000	0.000	0.016	0.109	0.061	0.017	0.000	0.097	0.008
NaKA	0.308	0.357	0.576	0.396	0.356	0.271	0.350	0.408	0.409	0.168	0.668	0.338
AlVI	0.193	0.235	0.134	0.141	0.201	0.303	0.135	0.124	0.027	0.109	0.140	0.122
MgFe	0.673	0.624	0.591	0.644	0.651	0.621	0.774	0.693	0.770	0.710	0.658	0.698

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	61	62	63	64	65	66	67	68	69	70	71	72
SiO2	51.62	52.46	50.74	50.97	50.36	49.96	50.40	49.75	50.71	52.16	51.36	51.51
Al2O3	4.64	4.35	4.46	5.01	4.96	5.12	4.63	5.16	5.07	3.50	4.17	4.89
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	12.05	11.20	11.65	11.82	11.72	12.32	11.98	12.13	11.78	11.99	12.01	10.87
MgO	15.61	15.74	16.66	16.17	16.11	15.84	15.98	15.62	16.00	16.91	16.04	15.96
CaO	12.20	11.75	11.68	11.58	11.56	12.38	11.54	11.58	11.85	11.92	11.44	11.90
Na2O	1.32	0.99	1.05	1.15	1.19	1.27	1.17	1.10	1.13	0.78	0.95	1.04
K2O	0.55	0.54	0.37	0.52	0.46	0.46	0.34	0.59	0.57	0.24	0.42	0.43
TiO2	0.77	0.62	0.94	1.14	1.04	0.97	1.34	0.81	0.86	0.19	0.40	0.67
MnO	0.60	0.79	0.63	0.50	0.72	0.59	0.52	0.60	0.57	0.54	0.51	0.51
Cl	0.00	0.19	0.00	0.00	0.00	0.23	0.15	0.00	0.00	0.00	0.00	0.00
F	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Cr2O3	0.00	0.00	0.05	0.08	0.00	0.00	0.00	0.08	0.13	0.11	0.09	0.00
Total	99.36	98.59	98.23	98.94	98.12	99.41	98.02	97.42	98.67	98.34	97.39	97.78

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.367	7.497	7.306	7.287	7.270	7.198	7.290	7.254	7.281	7.484	7.446	7.403
Al	0.781	0.733	0.758	0.845	0.845	0.870	0.790	0.888	0.859	0.592	0.713	0.829
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.437	1.338	1.402	1.412	1.414	1.484	1.448	1.478	1.414	1.438	1.455	1.306
Mg	3.322	3.354	3.578	3.447	3.468	3.403	3.447	3.397	3.426	3.618	3.468	3.421
Ca	1.865	1.799	1.802	1.774	1.788	1.911	1.788	1.809	1.823	1.832	1.777	1.832
Na	0.365	0.274	0.293	0.319	0.333	0.355	0.328	0.311	0.315	0.217	0.267	0.290
K	0.100	0.098	0.068	0.095	0.085	0.085	0.063	0.110	0.104	0.044	0.078	0.079
Ti	0.083	0.067	0.102	0.123	0.113	0.105	0.146	0.089	0.093	0.021	0.044	0.072
Mn	0.073	0.096	0.077	0.061	0.088	0.072	0.064	0.074	0.069	0.066	0.063	0.062
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.000	0.000	0.006	0.009	0.000	0.000	0.000	0.009	0.015	0.012	0.010	0.000
Total	15.39	15.26	15.39	15.37	15.40	15.48	15.36	15.42	15.40	15.32	15.32	15.29

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.938	1.915	1.802	1.816	1.802	1.911	1.815	1.811	1.843	1.832	1.801	1.907
NaB	0.072	0.116	0.000	0.043	0.014	0.000	0.026	0.002	0.020	0.000	0.024	0.074
NaKA	0.393	0.256	0.361	0.371	0.404	0.439	0.364	0.419	0.399	0.261	0.321	0.294
AlVI	0.148	0.230	0.064	0.131	0.115	0.068	0.080	0.142	0.140	0.076	0.159	0.232
MgFe	0.698	0.715	0.718	0.709	0.710	0.696	0.704	0.697	0.708	0.716	0.704	0.724

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	73	74	75	76	77	78	79	80	81	82	83	84
SiO2	52.27	48.44	50.72	51.19	52.07	52.46	50.40	48.24	46.71	48.60	46.39	52.19
Al2O3	4.08	7.88	4.60	5.21	4.83	4.35	4.63	4.94	5.54	4.95	6.21	2.35
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	10.56	10.91	10.89	11.96	11.38	11.19	11.97	13.93	14.64	13.88	15.44	13.45
MgO	16.27	15.81	15.55	14.92	15.39	15.74	15.91	14.57	13.97	14.61	13.31	15.34
CaO	11.80	11.75	12.18	12.29	12.13	11.75	11.54	11.75	11.60	11.72	11.82	12.64
Na2O	1.03	1.51	1.20	1.21	1.22	0.99	1.17	1.32	1.40	1.18	1.50	0.44
K2O	0.35	0.72	0.45	0.60	0.51	0.54	0.34	0.73	0.81	0.57	0.84	0.15
TiO2	0.93	0.78	0.91	0.78	0.93	0.62	1.31	0.91	1.10	0.70	1.42	0.12
MnO	0.67	0.44	0.60	0.52	0.96	0.79	0.52	0.45	0.43	0.42	0.45	0.40
Cl	0.00	0.00	0.00	0.00	0.00	0.19	0.16	0.16	0.23	0.17	0.20	0.05
F	0.00	0.00	0.50	0.42	0.57	0.00	0.00	0.90	0.90	0.90	1.02	0.54
Cr2O3	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.09

Total 97.96 98.33 97.39 98.92 99.75 98.58 97.91 97.49 96.92 97.28 98.13 97.52
 (Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.482	6.977	7.372	7.350	7.399	7.497	7.297	7.173	7.039	7.220	6.942	7.632
Al	0.689	1.339	0.789	0.882	0.810	0.733	0.791	0.866	0.985	0.867	1.096	0.405
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.264	1.314	1.323	1.435	1.352	1.337	1.449	1.731	1.844	1.724	1.931	1.644
Mg	3.473	3.396	3.370	3.195	3.261	3.355	3.435	3.231	3.140	3.237	2.970	3.345
Ca	1.810	1.813	1.896	1.891	1.846	1.799	1.790	1.872	1.873	1.865	1.895	1.980
Na	0.286	0.422	0.338	0.337	0.336	0.274	0.328	0.381	0.409	0.340	0.435	0.125
K	0.064	0.132	0.083	0.110	0.092	0.098	0.063	0.139	0.156	0.108	0.160	0.028
Ti	0.100	0.085	0.099	0.084	0.099	0.067	0.143	0.102	0.125	0.078	0.160	0.013
Mn	0.081	0.054	0.074	0.063	0.116	0.096	0.064	0.057	0.055	0.053	0.057	0.050
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.005
Total	15.25	15.54	15.35	15.35	15.31	15.26	15.36	15.55	15.63	15.49	15.65	15.23

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEG = 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.911	1.826	1.973	1.990	1.964	1.916	1.821	1.872	1.873	1.865	1.895	1.980
NaB	0.101	0.013	0.076	0.099	0.117	0.117	0.031	0.000	0.000	0.000	0.000	0.000
NaKA	0.248	0.541	0.345	0.348	0.311	0.256	0.360	0.519	0.566	0.448	0.596	0.158
AlVI	0.171	0.316	0.160	0.233	0.208	0.230	0.088	0.040	0.024	0.087	0.038	0.038
MgFe	0.733	0.721	0.718	0.690	0.707	0.715	0.703	0.651	0.630	0.653	0.606	0.670

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	85	86	87	88	89	90	91	92	93	94	95	96
SiO2	46.59	48.57	48.00	43.40	45.42	45.24	43.91	47.77	45.56	46.78	48.37	46.12
Al2O3	5.56	7.68	7.40	9.16	8.07	8.65	9.47	6.77	8.07	5.75	6.41	7.49
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	14.46	14.41	15.25	16.18	14.46	14.68	15.13	14.67	15.84	15.30	15.04	15.77
MgO	13.94	13.66	12.99	12.02	12.81	12.15	11.75	14.19	13.70	13.56	13.83	12.86
CaO	11.86	11.37	11.68	11.45	12.04	11.82	11.73	12.34	12.11	11.95	11.70	11.51
Na2O	1.40	1.48	1.63	1.72	1.41	1.53	1.76	1.58	1.71	1.66	1.50	1.72
K2O	0.82	0.68	0.80	0.81	0.75	0.86	0.93	0.62	0.69	0.70	0.58	0.73
TiO2	1.20	0.97	1.12	1.10	0.98	0.99	1.18	0.83	1.16	0.77	0.80	0.97
MnO	0.45	0.84	0.54	0.64	0.63	0.62	0.52	0.63	0.56	0.52	0.61	0.59
Cl	0.24	0.00	0.00	0.00	0.06	0.15	0.07	0.05	0.07	0.05	0.02	0.03
F	1.07	0.55	0.64	0.71	0.72	0.78	0.74	0.61	0.76	0.94	0.74	0.82
Cr2O3	0.00	0.05	0.01	0.00	0.00	0.00	0.01	0.00	0.08	0.08	0.01	0.00
BaO	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Total 97.18 100.03 99.79 96.89 97.03 97.11 96.87 99.79 99.97 97.65 99.29 98.26
 (Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.017	7.007	6.989	6.606	6.825	6.806	6.651	6.959	6.698	7.019	7.069	6.876
Al	0.988	1.307	1.271	1.645	1.430	1.535	1.692	1.163	1.399	1.018	1.105	1.317
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.821	1.738	1.856	2.059	1.816	1.846	1.916	1.786	1.946	1.919	1.837	1.965
Mg	3.131	2.939	2.821	2.728	2.871	2.726	2.654	3.083	3.003	3.034	3.014	2.859
Ca	1.914	1.757	1.822	1.867	1.938	1.905	1.903	1.926	1.907	1.921	1.832	1.838
Na	0.409	0.414	0.460	0.508	0.411	0.446	0.517	0.446	0.487	0.483	0.425	0.497
K	0.158	0.125	0.149	0.157	0.144	0.165	0.180	0.115	0.129	0.134	0.108	0.139
Ti	0.136	0.105	0.123	0.126	0.111	0.112	0.134	0.091	0.128	0.087	0.088	0.109
Mn	0.057	0.103	0.067	0.083	0.080	0.079	0.067	0.078	0.070	0.066	0.076	0.075
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.000	0.006	0.001	0.000	0.000	0.000	0.001	0.000	0.009	0.009	0.001	0.000
Ba	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Total 15.64 15.50 15.56 15.78 15.63 15.62 15.72 15.65 15.78 15.69 15.56 15.67
 CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS
 OXEG = 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.914	1.796	1.874	1.867	1.938	1.905	1.903	1.926	1.907	1.921	1.832	1.838
NaB	0.000	0.038	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.572	0.501	0.557	0.665	0.555	0.611	0.697	0.562	0.617	0.617	0.533	0.636
AlVI	0.005	0.314	0.260	0.251	0.256	0.341	0.343	0.123	0.097	0.036	0.175	0.193
MgFe	0.632	0.628	0.603	0.570	0.612	0.596	0.581	0.633	0.607	0.613	0.621	0.593

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	97	98	99	100	101	102	103	104	105	106	107	108
SiO2	47.18	47.40	47.97	51.74	47.07	51.10	47.78	49.49	49.05	50.47	42.11	45.67
Al2O3	7.06	6.54	6.82	3.21	6.90	4.05	5.20	5.06	4.81	4.42	9.76	8.65
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	13.85	13.86	13.58	11.23	15.45	12.92	13.85	13.25	13.51	13.02	17.22	15.16
MgO	12.39	12.92	13.26	17.54	12.82	15.52	14.31	14.63	15.13	15.35	11.89	11.98
CaO	12.27	12.40	12.00	11.82	11.36	11.84	11.39	11.52	11.80	11.85	11.77	13.28
Na2O	1.20	1.13	1.35	0.97	1.27	0.77	1.09	1.00	0.96	0.93	1.52	1.01
K2O	0.97	0.92	0.84	0.27	0.66	0.45	0.90	0.79	0.46	0.46	1.45	0.89
TiO2	1.16	1.01	0.76	0.50	1.34	0.31	0.99	0.88	0.12	0.21	0.66	0.32
MnO	0.74	0.64	0.60	0.41	0.71	0.62	0.63	0.64	0.61	0.60	0.55	0.44
Cl	0.00	0.00	0.00	0.26	0.19	0.07	0.12	0.10	0.01	0.02	0.11	0.20
F	0.55	0.72	0.57	0.72	0.51	0.40	0.60	0.54	0.59	0.68	0.76	0.51
BaO	0.00	0.00	0.00	0.00	0.14	0.13	0.15	0.13	0.14	0.14	0.12	0.00
Total	97.14	97.24	97.51	98.31	98.16	98.00	96.73	97.78	96.94	97.86	97.58	97.85

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.037	7.068	7.096	7.457	6.990	7.435	7.155	7.271	7.274	7.379	6.451	6.829
Al	1.242	1.150	1.190	0.546	1.209	0.695	0.919	0.877	0.841	0.762	1.764	1.526
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.727	1.727	1.679	1.353	1.918	1.571	1.734	1.627	1.675	1.591	2.205	1.895
Mg	2.756	2.873	2.925	3.770	2.839	3.368	3.196	3.205	3.346	3.347	2.717	2.672
Ca	1.961	1.981	1.902	1.825	1.807	1.846	1.827	1.813	1.875	1.856	1.932	2.127
Na	0.347	0.327	0.387	0.271	0.366	0.217	0.316	0.285	0.276	0.264	0.451	0.293
K	0.185	0.175	0.159	0.050	0.125	0.084	0.172	0.148	0.087	0.086	0.283	0.170
Ti	0.130	0.113	0.085	0.054	0.150	0.034	0.112	0.097	0.013	0.023	0.076	0.036
Mn	0.094	0.081	0.075	0.050	0.089	0.076	0.080	0.080	0.077	0.074	0.071	0.056
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.000	0.000	0.000	0.008	0.007	0.009	0.007	0.008	0.008	0.007	0.000
Total	15.48	15.49	15.50	15.38	15.50	15.33	15.52	15.41	15.47	15.39	15.96	15.60

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	2.000	1.988	1.950	1.825	1.807	1.846	1.827	1.843	1.875	1.856	1.932	2.127
NaB	0.039	0.007	0.048	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000
NaKA	0.492	0.495	0.497	0.321	0.499	0.308	0.497	0.410	0.371	0.357	0.742	0.463
AlVI	0.279	0.218	0.286	0.003	0.199	0.130	0.073	0.147	0.116	0.142	0.215	0.355
MgFe	0.615	0.625	0.635	0.736	0.597	0.682	0.648	0.663	0.666	0.678	0.552	0.585

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	109	110	111	112	113	114	115	116	117	118	119	120
SiO2	47.25	51.78	46.75	47.08	47.18	42.24	46.09	47.37	45.91	44.26	45.45	46.99
Al2O3	6.77	3.60	6.90	7.07	6.90	10.93	8.20	7.32	7.42	10.04	7.64	6.80
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	14.92	12.46	13.94	13.79	13.78	14.52	13.94	13.49	14.94	16.14	14.98	14.20
MgO	13.00	16.17	12.96	12.72	13.11	10.95	12.64	12.73	12.41	11.85	12.24	14.23
CaO	1.30	12.38	11.86	12.04	12.04	11.83	11.74	11.95	11.82	11.57	11.50	11.67
Na2O	0.00	0.51	1.76	1.85	1.88	1.99	1.59	1.53	1.45	1.55	1.48	1.25
K2O	0.86	0.27	0.71	0.65	0.70	1.13	0.84	0.74	0.86	1.02	0.89	0.58
TiO2	0.21	0.20	0.89	0.94	1.04	2.57	1.31	1.26	1.29	1.59	1.17	0.80
MnO	0.43	0.46	0.49	0.77	0.62	0.52	0.72	0.42	0.62	0.53	0.62	0.60
Cl	0.15	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
F	0.53	0.48	0.79	0.87	0.72	0.44	0.45	0.70	0.54	0.20	0.55	0.67
BaO	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	97.22	98.23	96.72	97.41	97.67	96.93	97.33	97.22	97.03	98.67	96.29	97.52

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.066	7.485	7.014	7.016	7.006	6.395	6.865	7.031	6.900	6.575	6.886	6.977
Al	1.194	0.614	1.221	1.243	1.209	1.952	1.441	1.282	1.316	1.759	1.365	1.191
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.865	1.506	1.748	1.718	1.710	1.838	1.735	1.674	1.877	2.004	1.897	1.762
Mg	2.899	3.486	2.900	2.827	2.903	2.472	2.808	2.818	2.782	2.625	2.766	3.151
Ca	2.003	1.917	1.906	1.922	1.915	1.919	1.873	1.900	1.903	1.841	1.867	1.856
Na	0.249	0.143	0.512	0.534	0.541	0.584	0.459	0.440	0.423	0.446	0.435	0.360
K	0.164	0.050	0.136	0.124	0.133	0.218	0.160	0.140	0.165	0.193	0.172	0.110
Ti	0.024	0.022	0.100	0.105	0.116	0.293	0.147	0.141	0.146	0.178	0.133	0.089
Mn	0.055	0.056	0.062	0.097	0.078	0.067	0.091	0.053	0.079	0.067	0.080	0.076
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.52	15.28	15.60	15.59	15.61	15.74	15.58	15.48	15.59	15.69	15.60	15.57

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	2.003	1.917	1.955	1.994	1.978	1.984	1.914	2.000	1.903	1.841	1.872	1.856
NaB	0.000	0.000	0.049	0.072	0.063	0.065	0.041	0.100	0.000	0.000	0.006	0.000
NaKA	0.413	0.197	0.599	0.586	0.611	0.737	0.578	0.481	0.587	0.640	0.601	0.470
AlVI	0.261	0.099	0.235	0.259	0.214	0.347	0.305	0.312	0.216	0.334	0.252	0.168
MgFe	0.609	0.698	0.624	0.622	0.629	0.574	0.618	0.627	0.597	0.567	0.593	0.641

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Mt. Princeton hornblendes (altered compositions deleted) 4/14/86

	121	122	123
SiO2	46.88	46.50	46.25
Al2O3	7.60	7.88	7.66
Fe2O3	0.00	0.00	0.00
FeO	13.50	13.80	14.75
MgO	12.74	12.44	12.60
CaO	12.06	12.19	11.97
Na2O	1.65	1.47	1.47
K2O	1.06	1.05	0.97
TiO2	1.57	1.33	1.52
MnO	0.77	0.52	0.66
Cl	0.00	0.00	0.13
F	0.74	0.78	0.53

Total 98.26 97.63 98.26
(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00
Si	6.925	6.917	6.868
Al	1.324	1.383	1.342
Fe3	0.000	0.000	0.000
Fe2	1.667	1.716	1.831
Mg	2.807	2.760	2.790
Ca	1.909	1.943	1.904
Na	0.473	0.424	0.423
K	0.200	0.199	0.184
Ti	0.174	0.149	0.170
Mn	0.096	0.066	0.083
Cl	0.000	0.000	0.000
F	0.000	0.000	0.000
Total	15.57	15.55	15.59

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ = 23.00 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	2.000	2.000	1.916
NaB	0.091	0.057	0.012
NaKA	0.581	0.566	0.595
AlVI	0.249	0.299	0.210
MgFe	0.627	0.617	0.604

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Pioneer hornblendes (rims only) 4/14/86

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	45.32	45.91	44.49	46.24	46.04	45.76	45.55	44.30	44.23	46.29	46.16	44.01
Al2O3	8.92	8.42	8.36	8.34	9.05	9.49	8.46	9.02	8.77	9.00	8.55	10.18
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	15.08	14.89	17.73	14.55	16.78	14.26	17.89	17.32	17.68	13.04	14.83	15.89
MgO	12.98	13.14	11.21	13.30	10.66	12.53	11.06	10.00	10.47	13.09	13.29	11.35
CaO	11.51	11.46	12.40	11.58	12.25	11.73	10.72	11.96	12.13	11.48	12.02	10.52
Na2O	1.25	0.96	1.08	1.17	0.75	1.14	1.45	1.18	1.64	1.32	1.18	1.98
K2O	0.40	0.57	0.93	0.81	0.54	0.80	0.87	0.79	1.00	0.43	0.56	0.96
TiO2	0.98	0.87	1.20	1.66	0.32	1.89	1.62	1.28	1.40	1.21	1.13	2.90
MnO	0.35	0.36	0.54	0.46	0.38	0.50	0.64	0.35	0.61	0.37	0.24	0.47
Cl	0.03	0.06	0.03	0.10	0.00	0.00	0.15	0.00	0.00	0.10	0.08	0.00
F	0.00	0.06	0.27	0.00	0.00	0.00	0.26	0.00	0.00	0.16	0.00	0.00
BaO	0.00	0.09	0.00	0.21	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Total	96.81	96.75	98.12	98.40	96.77	98.10	98.63	96.20	97.93	96.40	98.02	98.26

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.771	6.858	6.710	6.806	6.920	6.731	6.804	6.764	6.683	6.873	6.808	6.539
Al	1.572	1.484	1.487	1.448	1.605	1.647	1.491	1.625	1.563	1.576	1.487	1.784
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.883	1.859	2.235	1.790	2.108	1.753	2.234	2.211	2.233	1.618	1.828	1.973
Mg	2.892	2.927	2.521	2.919	2.390	2.749	2.464	2.277	2.359	2.898	2.923	2.515
Ca	1.842	1.834	2.004	1.826	1.973	1.848	1.715	1.956	1.964	1.826	1.899	1.674
Na	0.362	0.278	0.316	0.334	0.219	0.325	0.420	0.349	0.480	0.380	0.337	0.570
K	0.076	0.109	0.179	0.152	0.104	0.150	0.166	0.154	0.193	0.081	0.105	0.182
Ti	0.110	0.098	0.136	0.184	0.036	0.209	0.182	0.147	0.159	0.135	0.125	0.324
Mn	0.044	0.046	0.069	0.057	0.048	0.062	0.081	0.045	0.078	0.047	0.030	0.059
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.005	0.000	0.012	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000
Total	15.55	15.50	15.66	15.53	15.40	15.47	15.56	15.53	15.71	15.43	15.54	15.62

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.842	1.834	2.004	1.826	1.973	1.849	1.745	1.956	1.964	1.853	1.899	1.806
NaB	0.000	0.000	0.000	0.000	0.000	0.001	0.030	0.000	0.000	0.027	0.000	0.131
NaKA	0.438	0.392	0.495	0.498	0.322	0.474	0.562	0.503	0.673	0.435	0.443	0.621
AlVI	0.343	0.341	0.197	0.254	0.525	0.377	0.294	0.389	0.246	0.449	0.296	0.323
MgFe	0.606	0.612	0.530	0.620	0.531	0.611	0.524	0.507	0.514	0.642	0.615	0.560

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Pioneer hornblendes (rims only) 4/14/86

	13	14	15	16	17	18	19	20	21	22	23	24
SiO2	45.99	46.71	46.66	46.91	46.10	45.59	49.45	47.27	49.55	46.82	48.01	47.54
Al2O3	7.35	6.85	7.79	6.54	7.62	7.48	5.14	6.99	5.07	7.38	6.72	7.21
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	17.51	15.48	15.85	15.31	15.91	16.22	12.76	13.77	13.09	14.50	14.95	14.62
MgO	11.29	13.04	12.11	13.15	12.12	12.08	15.30	14.28	15.36	14.02	12.72	13.00
CaO	11.11	12.36	12.52	12.48	12.51	12.44	11.55	11.69	11.56	11.52	12.43	11.71
Na2O	1.19	0.78	0.94	0.89	0.68	0.70	0.92	1.30	0.93	1.24	0.95	1.10
K2O	0.60	0.69	0.93	0.73	0.85	0.95	0.45	0.65	0.47	0.73	0.52	0.67
TiO2	0.60	0.83	1.29	0.88	1.09	1.16	0.89	1.28	0.84	1.23	0.68	0.88
MnO	0.66	0.80	0.79	0.83	0.74	0.49	0.83	0.91	0.92	0.84	0.96	0.85
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00
Total	96.30	97.54	98.88	97.72	97.62	97.11	97.29	98.14	97.79	98.28	98.02	97.58

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.988	6.963	6.882	6.982	6.888	6.864	7.241	6.942	7.234	6.890	7.088	7.030
Al	1.317	1.205	1.355	1.148	1.343	1.328	0.888	1.211	0.873	1.281	1.170	1.258
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.224	1.929	1.954	1.905	1.987	2.041	1.562	1.690	1.597	1.784	1.845	1.807
Mg	2.558	2.899	2.664	2.919	2.701	2.712	3.341	3.128	3.344	3.077	2.801	2.867
Ca	1.809	1.974	1.978	1.990	2.003	2.007	1.812	1.839	1.808	1.816	1.966	1.855
Na	0.351	0.225	0.269	0.257	0.197	0.204	0.261	0.370	0.263	0.354	0.272	0.315
K	0.116	0.131	0.175	0.139	0.162	0.183	0.084	0.122	0.088	0.137	0.098	0.126
Ti	0.069	0.093	0.143	0.099	0.123	0.131	0.098	0.141	0.092	0.136	0.076	0.098
Mn	0.085	0.101	0.099	0.105	0.094	0.053	0.103	0.113	0.114	0.105	0.120	0.107
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.52	15.52	15.52	15.54	15.50	15.53	15.39	15.56	15.41	15.58	15.44	15.46

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.809	1.974	1.978	1.990	2.003	2.007	1.812	1.839	1.808	1.816	1.966	1.855
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.467	0.357	0.444	0.395	0.359	0.387	0.345	0.492	0.351	0.491	0.370	0.442
AlVI	0.306	0.168	0.237	0.130	0.231	0.193	0.129	0.153	0.107	0.171	0.259	0.288
MgFe	0.535	0.600	0.577	0.605	0.576	0.571	0.681	0.649	0.677	0.633	0.603	0.613

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Pioneer hornblendes (rims only) 4/14/86

	25	26	27	28	29	30	31	32	33	34	35	36
SiO2	43.79	45.39	44.37	46.51	47.21	47.15	46.63	43.86	45.76	45.78	46.41	47.82
Al2O3	8.75	7.24	9.01	7.09	6.60	6.79	7.05	9.07	7.94	7.43	7.63	6.98
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	15.61	15.54	16.92	15.13	15.15	15.12	15.10	16.63	16.29	14.88	15.01	15.20
MgO	11.54	13.14	11.80	13.33	13.48	13.54	13.36	11.63	12.60	12.42	13.21	13.05
CaO	12.20	11.56	11.62	11.89	11.61	11.53	11.58	11.69	11.99	12.09	12.29	11.61
Na2O	1.24	1.11	1.34	1.14	1.10	1.05	1.01	1.24	1.09	1.18	1.14	1.13
K2O	1.19	0.60	0.94	0.56	0.54	0.65	0.66	0.90	0.69	0.52	0.64	0.80
TiO2	0.91	1.00	1.11	0.87	0.77	0.78	0.81	1.03	0.97	1.23	0.90	0.90
MnO	0.87	0.82	0.82	0.79	0.91	0.79	0.77	0.78	0.79	0.90	0.83	0.75
Cl	0.00	0.07	0.05	0.03	0.04	0.03	0.03	0.11	0.08	0.09	0.18	0.00
F	0.22	0.07	0.20	0.11	0.02	0.00	0.09	0.16	0.13	0.25	1.37	0.00
BaO	0.00	0.16	0.16	0.06	0.14	0.10	0.17	0.16	0.08	0.00	0.00	0.00
Total	96.23	96.65	98.24	97.46	97.55	97.52	97.22	97.17	98.34	96.64	98.99	98.24

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.694	6.856	6.661	6.933	7.019	7.005	6.963	6.655	6.813	6.895	6.873	7.042
Al	1.578	1.290	1.596	1.247	1.157	1.190	1.242	1.623	1.394	1.320	1.333	1.212
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.995	1.962	2.123	1.885	1.883	1.878	1.885	2.109	2.027	1.873	1.858	1.871
Mg	2.631	2.960	2.642	2.963	2.989	3.000	2.975	2.632	2.798	2.790	2.918	2.866
Ca	1.998	1.870	1.869	1.899	1.849	1.835	1.853	1.900	1.912	1.951	1.950	1.832
Na	0.367	0.325	0.390	0.329	0.317	0.302	0.292	0.365	0.315	0.345	0.327	0.323
K	0.232	0.116	0.180	0.107	0.102	0.123	0.126	0.174	0.131	0.100	0.121	0.150
Ti	0.105	0.114	0.125	0.098	0.086	0.087	0.091	0.118	0.109	0.139	0.100	0.100
Mn	0.113	0.105	0.104	0.100	0.115	0.099	0.097	0.100	0.100	0.115	0.104	0.094
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.009	0.009	0.004	0.008	0.006	0.010	0.010	0.005	0.000	0.000	0.000
Total	15.71	15.61	15.70	15.56	15.53	15.53	15.53	15.69	15.60	15.53	15.58	15.49

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.998	1.870	1.869	1.899	1.849	1.835	1.853	1.900	1.912	1.951	1.950	1.832
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.600	0.450	0.580	0.439	0.428	0.431	0.428	0.549	0.450	0.444	0.448	0.473
AlVI	0.272	0.145	0.257	0.180	0.177	0.195	0.205	0.278	0.208	0.215	0.206	0.254
MgFe	0.569	0.601	0.554	0.611	0.614	0.615	0.612	0.555	0.580	0.598	0.611	0.605

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.

No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Pioneer hornblendes (rims only) 4/14/86

	37	38	39	40	41	42	43	44	45
SiO2	46.55	46.52	46.01	45.64	48.00	45.51	44.67	46.03	46.85
Al2O3	7.95	7.75	7.74	7.74	6.07	8.10	8.74	7.07	8.33
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	16.48	16.01	16.25	14.98	14.15	16.26	15.87	15.16	16.40
MgO	11.93	12.41	12.66	13.05	14.32	10.79	11.18	12.05	11.06
CaO	11.66	11.49	11.86	11.94	11.50	12.34	12.26	12.30	11.78
Na2O	1.18	1.26	1.29	1.05	0.81	1.22	1.48	1.29	1.16
K2O	0.77	0.77	0.76	0.62	0.39	1.04	0.80	0.74	0.84
TiO2	1.12	0.96	0.94	1.09	0.50	1.18	1.34	1.10	0.77
MnO	0.99	0.88	1.00	0.66	0.62	0.68	0.75	0.69	0.68
Cl	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00
F	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.18
BaO	0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.00	0.00
Total	98.63	98.05	98.51	96.97	96.93	97.12	97.09	96.43	97.97

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.890	6.909	6.833	6.842	7.121	6.866	6.738	6.949	6.967
Al	1.388	1.358	1.356	1.369	1.062	1.441	1.555	1.259	1.461
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.039	1.988	2.017	1.877	1.755	2.051	2.001	1.913	2.039
Mg	2.633	2.749	2.804	2.918	3.168	2.428	2.515	2.713	2.453
Ca	1.849	1.828	1.887	1.918	1.891	1.994	1.981	1.989	1.877
Na	0.339	0.363	0.371	0.305	0.233	0.357	0.433	0.378	0.334
K	0.145	0.146	0.144	0.119	0.074	0.200	0.154	0.143	0.159
Ti	0.125	0.107	0.105	0.123	0.056	0.134	0.152	0.125	0.086
Mn	0.124	0.111	0.126	0.084	0.078	0.087	0.096	0.088	0.086
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000
Total	15.53	15.56	15.64	15.56	15.45	15.56	15.63	15.56	15.46

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.849	1.828	1.887	1.918	1.891	1.994	1.981	1.989	1.908
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031
NaKA	0.484	0.509	0.515	0.433	0.315	0.557	0.587	0.520	0.463
AlVI	0.278	0.267	0.188	0.211	0.183	0.307	0.293	0.208	0.429
MgFe	0.564	0.580	0.582	0.608	0.644	0.542	0.557	0.586	0.546

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from rocks of the Riggins area, ID

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	40.78	40.64	40.95	41.51	40.73	40.84	42.23	41.67	41.59	40.98	40.06	41.11
Al2O3	14.14	13.95	13.14	12.79	14.01	13.93	13.19	13.78	13.39	14.13	13.90	14.33
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	19.45	19.46	18.94	19.06	19.78	19.54	19.81	19.99	19.84	20.32	20.10	20.38
MgO	7.58	7.53	8.32	8.34	7.64	8.02	7.43	7.31	7.51	7.70	7.67	7.46
CaO	11.63	11.70	11.60	11.82	11.32	11.67	12.30	12.06	12.21	11.25	11.30	11.21
Na2O	1.55	1.57	1.58	1.56	1.74	1.66	1.66	1.84	1.52	1.65	1.68	1.71
K2O	1.43	1.41	1.31	1.25	1.24	1.17	1.23	1.32	1.48	1.58	1.55	1.44
TiO2	1.03	1.00	0.79	0.87	1.02	0.94	0.97	1.10	0.69	0.76	0.70	0.77
MnO	0.57	0.58	0.60	0.54	0.65	0.62	0.74	0.67	0.47	0.60	0.60	0.57
Cl	0.04	0.03	0.03	0.02	0.07	0.03	0.04	0.00	0.00	0.07	0.06	0.09
F	0.33	0.23	0.19	0.23	0.16	0.25	0.00	0.00	0.05	0.05	0.02	0.03
Cr2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.12	0.08	0.00	0.00	0.00
BaO	0.15	0.11	0.15	0.14	0.19	0.13	0.00	0.00	0.00	0.04	0.04	0.04
Total	98.53	98.11	97.51	98.03	98.47	98.69	99.60	99.86	98.81	99.09	97.66	99.11

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.207	6.213	6.282	6.331	6.206	6.201	6.344	6.254	6.306	6.211	6.173	6.221
Al	2.539	2.516	2.378	2.301	2.518	2.495	2.337	2.440	2.395	2.526	2.527	2.558
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.475	2.487	2.428	2.430	2.519	2.480	2.488	2.508	2.515	2.574	2.589	2.578
Mg	1.721	1.717	1.903	1.897	1.736	1.816	1.665	1.636	1.698	1.740	1.763	1.684
Ca	1.896	1.916	1.906	1.931	1.848	1.898	1.979	1.939	1.983	1.827	1.865	1.817
Na	0.457	0.465	0.470	0.461	0.514	0.489	0.483	0.535	0.447	0.485	0.502	0.502
K	0.278	0.275	0.256	0.243	0.241	0.227	0.236	0.253	0.286	0.306	0.305	0.278
Ti	0.118	0.115	0.091	0.100	0.117	0.107	0.110	0.124	0.079	0.087	0.081	0.088
Mn	0.074	0.075	0.078	0.070	0.084	0.080	0.094	0.085	0.060	0.077	0.078	0.073
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.014	0.010	0.000	0.000	0.000
Ba	0.009	0.007	0.009	0.008	0.011	0.008	0.000	0.000	0.000	0.002	0.002	0.002
Total	15.77	15.78	15.80	15.77	15.80	15.80	15.74	15.79	15.78	15.83	15.89	15.80

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEG =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.896	1.916	1.906	1.931	1.848	1.898	1.979	1.939	1.983	1.827	1.865	1.817
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.744	0.747	0.735	0.713	0.766	0.723	0.719	0.788	0.733	0.793	0.809	0.782
AlVI	0.746	0.728	0.659	0.631	0.725	0.696	0.681	0.694	0.701	0.737	0.700	0.780
MgFe	0.410	0.408	0.439	0.438	0.408	0.423	0.401	0.395	0.403	0.403	0.405	0.395

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from rocks of the Riggins area, ID

	13	14	15	16
SiO2	40.08	40.80	40.31	41.47
Al2O3	13.49	14.03	13.70	12.61
Fe2O3	0.00	0.00	0.00	0.00
FeO	19.93	19.90	20.07	19.66
MgO	7.98	7.88	8.12	8.69
CaO	11.36	11.39	11.20	11.33
Na2O	1.83	1.78	1.87	1.83
K2O	1.11	1.09	1.08	0.55
TiO2	0.88	0.80	0.98	0.92
MnO	0.54	0.54	0.56	0.55
Cl	0.00	0.02	0.02	0.00
F	0.21	0.20	0.15	0.17
BaO	0.07	0.09	0.15	0.11

Total 97.39 98.43 98.14 97.82
(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00
Si	6.185	6.209	6.170	6.325
Al	2.455	2.519	2.474	2.269
Fe3	0.000	0.000	0.000	0.000
Fe2	2.571	2.531	2.568	2.506
Mg	1.836	1.788	1.854	1.977
Ca	1.878	1.857	1.837	1.851
Na	0.547	0.525	0.555	0.541
K	0.219	0.212	0.211	0.107
Ti	0.102	0.092	0.113	0.106
Mn	0.071	0.070	0.073	0.071
Cl	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000
Ba	0.004	0.005	0.009	0.007
Total	15.87	15.81	15.86	15.76

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ = 23.00 23.00 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.878	1.857	1.837	1.851
NaB	0.000	0.000	0.000	0.000
NaKA	0.770	0.742	0.775	0.655
AlVI	0.640	0.728	0.644	0.594
MgFe	0.417	0.414	0.419	0.441

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.

No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from a pluton at Moth Bay, Alaska

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	43.24	43.12	41.48	42.14	42.07	41.52	42.50	41.58	41.88	41.82	41.91	41.95
Al2O3	11.22	10.16	11.88	11.48	12.64	12.04	12.23	12.08	12.41	11.36	11.46	11.49
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	17.81	18.46	21.65	20.97	20.57	20.83	19.47	20.04	19.43	19.20	19.40	19.68
MgO	9.20	9.00	6.88	7.21	7.40	7.03	7.95	7.67	8.54	8.95	8.87	8.67
CaO	11.57	11.64	11.44	11.10	11.19	10.89	11.61	11.54	10.67	10.74	10.85	10.76
Na2O	1.94	1.94	2.02	2.12	1.96	1.86	1.84	2.03	1.90	1.98	2.03	2.05
K2O	1.22	1.16	1.39	1.18	1.76	1.56	1.66	1.35	1.67	1.47	1.60	1.56
TiO2	0.68	1.02	0.87	1.05	0.68	0.71	0.56	1.09	0.93	1.19	1.27	1.21
MnO	0.79	1.05	0.76	0.86	0.83	0.95	0.81	1.00	0.84	0.87	0.87	0.82
Cl	0.14	0.24	0.31	0.23	0.07	0.19	0.20	0.19	0.31	0.25	0.19	0.21
F	0.43	0.20	0.07	0.10	0.15	0.25	0.00	0.20	0.16	0.12	0.26	0.24
Cr2O3	0.00	0.15	0.06	0.11	0.01	0.11	0.12	0.11	0.00	0.02	0.00	0.00
Total	98.03	98.00	98.71	98.46	99.25	97.79	98.90	98.75	98.64	97.86	98.56	98.49

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.556	6.578	6.383	6.461	6.388	6.422	6.443	6.353	6.372	6.410	6.392	6.405
Al	2.007	1.828	2.156	2.076	2.264	2.197	2.187	2.177	2.227	2.054	2.062	2.069
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.257	2.354	2.785	2.687	2.611	2.693	2.467	2.559	2.471	2.460	2.473	2.512
Mg	2.080	2.048	1.579	1.649	1.676	1.622	1.797	1.748	1.938	2.046	2.018	1.974
Ca	1.879	1.902	1.886	1.823	1.820	1.804	1.885	1.889	1.742	1.764	1.773	1.760
Na	0.570	0.574	0.603	0.630	0.577	0.558	0.541	0.601	0.560	0.588	0.600	0.607
K	0.236	0.226	0.273	0.231	0.341	0.308	0.321	0.263	0.328	0.288	0.311	0.304
Ti	0.078	0.117	0.101	0.121	0.078	0.083	0.064	0.125	0.106	0.137	0.146	0.139
Mn	0.102	0.136	0.099	0.112	0.107	0.125	0.104	0.130	0.108	0.113	0.112	0.106
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.000	0.018	0.007	0.013	0.001	0.013	0.014	0.013	0.000	0.002	0.000	0.000
Total	15.77	15.78	15.87	15.80	15.86	15.82	15.82	15.86	15.85	15.86	15.89	15.88

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

DXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.920	1.921	1.889	1.881	1.877	1.847	1.924	1.895	1.778	1.777	1.797	1.794
NaB	0.041	0.018	0.004	0.057	0.057	0.042	0.038	0.006	0.036	0.014	0.024	0.034
NaKA	0.766	0.781	0.872	0.804	0.861	0.823	0.824	0.859	0.853	0.862	0.887	0.876
AlVI	0.563	0.407	0.540	0.537	0.651	0.618	0.630	0.530	0.599	0.464	0.454	0.475
MgFe	0.480	0.465	0.362	0.380	0.391	0.376	0.421	0.406	0.440	0.454	0.449	0.440

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.

No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from a pluton at Moth Bay, Alaska

	13	14	15	16	17	18	19	20	21	22	23	24
SiO2	41.91	42.80	42.32	42.49	42.28	42.21	42.53	42.17	42.47	43.13	41.48	42.68
Al2O3	11.59	10.79	11.00	10.89	10.96	10.94	11.02	11.04	10.86	10.86	11.48	12.66
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	19.71	19.17	19.09	19.53	19.38	19.42	19.22	18.78	19.40	19.45	19.57	18.91
MgO	8.77	9.27	8.96	9.13	9.14	9.08	9.13	8.50	9.12	9.23	8.79	7.97
CaO	10.75	10.82	10.55	10.73	10.92	10.71	10.82	10.49	10.80	10.81	10.74	10.37
Na2O	2.05	2.03	1.98	2.03	2.07	2.04	2.05	1.85	1.98	1.85	1.89	1.81
K2O	1.58	1.36	1.47	1.51	1.60	1.42	1.42	1.42	1.50	1.56	1.76	1.98
TiO2	1.30	1.16	1.11	1.30	1.14	1.14	1.21	1.21	1.24	1.00	1.06	0.73
MnO	0.85	0.83	0.83	0.87	0.85	0.84	0.82	0.83	0.84	0.83	0.88	0.79
Cl	0.24	0.14	0.25	0.24	0.26	0.29	0.22	0.26	0.25	0.22	0.35	0.39
F	0.29	0.27	0.17	0.17	0.07	0.23	0.27	0.13	0.13	0.05	0.26	0.17
Cr2O3	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.01	0.02	0.00	0.00	0.00
Total	98.86	98.49	97.60	98.76	98.59	98.21	98.55	96.58	98.50	98.92	98.07	98.30

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.381	6.501	6.491	6.459	6.442	6.455	6.468	6.522	6.468	6.523	6.380	6.486
Al	2.081	1.933	1.990	1.953	1.970	1.974	1.977	2.014	1.951	1.937	2.083	2.269
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.508	2.434	2.447	2.481	2.468	2.483	2.443	2.428	2.470	2.459	2.516	2.402
Mg	1.991	2.100	2.049	2.070	2.077	2.071	2.071	1.960	2.071	2.082	2.016	1.806
Ca	1.753	1.761	1.734	1.747	1.782	1.755	1.763	1.738	1.762	1.751	1.770	1.688
Na	0.605	0.598	0.589	0.598	0.611	0.605	0.604	0.555	0.585	0.542	0.564	0.533
K	0.307	0.264	0.288	0.293	0.311	0.277	0.276	0.280	0.291	0.301	0.345	0.384
Ti	0.149	0.133	0.128	0.149	0.131	0.131	0.138	0.141	0.142	0.114	0.123	0.083
Mn	0.110	0.107	0.108	0.112	0.110	0.109	0.106	0.109	0.108	0.106	0.115	0.102
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.000	0.000	0.000	0.000	0.001	0.006	0.000	0.001	0.002	0.000	0.000	0.000
Total	15.87	15.83	15.82	15.86	15.90	15.86	15.85	15.75	15.85	15.82	15.91	15.75

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.780	1.792	1.786	1.777	1.802	1.772	1.797	1.825	1.787	1.779	1.770	1.851
NaB	0.026	0.031	0.052	0.029	0.019	0.017	0.035	0.087	0.025	0.027	0.000	0.163
NaKA	0.886	0.830	0.824	0.862	0.903	0.865	0.845	0.747	0.851	0.816	0.909	0.754
AlVI	0.462	0.435	0.481	0.411	0.412	0.429	0.445	0.536	0.419	0.460	0.463	0.755
MgFe	0.443	0.463	0.456	0.455	0.457	0.455	0.459	0.447	0.456	0.458	0.445	0.429

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.

No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from a pluton at Moth Bay, Alaska

	25	26	27	28	29	30	31	32	33	34	35	36
SiO2	41.35	41.76	41.65	41.86	42.07	42.08	42.88	42.97	43.06	41.18	41.75	41.38
Al2O3	12.94	11.93	11.78	11.65	11.39	11.45	10.68	10.45	10.61	12.46	12.70	11.88
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	19.23	19.55	19.67	19.77	19.31	19.54	18.99	18.86	19.07	18.98	18.83	19.15
MgO	8.47	8.68	8.70	8.66	8.77	8.92	9.40	9.53	9.45	9.17	8.96	9.23
CaO	10.62	10.82	10.77	10.99	10.77	10.80	10.97	10.86	10.83	10.70	10.72	11.07
Na2O	1.97	2.02	2.11	1.99	2.08	2.01	1.97	2.01	2.03	1.67	1.64	1.68
K2O	1.87	1.69	1.46	1.61	1.48	1.47	1.26	1.31	1.26	1.59	1.66	1.49
TiO2	0.97	1.16	1.27	1.28	1.23	1.21	1.19	1.20	1.13	0.79	0.78	0.77
MnO	0.83	0.86	0.82	0.86	0.84	0.85	0.85	0.86	0.84	0.73	0.76	0.74
Cl	0.19	0.22	0.22	0.37	0.26	0.23	0.25	0.16	0.16	0.13	0.13	0.17
F	0.11	0.28	0.13	0.13	0.15	0.25	0.29	0.21	0.14	0.18	0.19	0.11
Cr2O3	0.03	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.08	0.04
Total	98.49	98.84	98.48	99.03	98.23	98.65	98.55	98.30	98.49	97.58	98.09	97.63

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.299	6.358	6.358	6.369	6.426	6.407	6.509	6.530	6.528	6.319	6.357	6.354
Al	2.325	2.143	2.121	2.091	2.052	2.057	1.912	1.873	1.997	2.255	2.281	2.152
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.449	2.488	2.510	2.514	2.466	2.487	2.409	2.396	2.417	2.434	2.397	2.458
Mg	1.924	1.971	1.980	1.965	1.998	2.026	1.928	2.160	2.137	2.098	2.035	2.114
Ca	1.733	1.765	1.761	1.791	1.762	1.762	1.784	1.768	1.759	1.759	1.749	1.821
Na	0.582	0.596	0.624	0.587	0.616	0.593	0.580	0.592	0.597	0.497	0.484	0.500
K	0.364	0.328	0.284	0.313	0.288	0.286	0.244	0.254	0.244	0.311	0.323	0.292
Ti	0.111	0.133	0.146	0.146	0.141	0.139	0.136	0.137	0.129	0.091	0.089	0.089
Mn	0.107	0.111	0.106	0.111	0.109	0.110	0.109	0.111	0.108	0.095	0.098	0.096
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.004	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.005	0.002
Total	15.90	15.90	15.89	15.89	15.86	15.87	15.81	15.82	15.81	15.87	15.82	15.88

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

DXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.781	1.792	1.779	1.803	1.808	1.775	1.796	1.794	1.785	1.759	1.749	1.821
NaB	0.047	0.027	0.018	0.011	0.046	0.014	0.013	0.026	0.026	0.000	0.000	0.000
NaKA	0.898	0.898	0.891	0.888	0.859	0.865	0.811	0.820	0.815	0.815	0.811	0.794
AlVI	0.624	0.501	0.479	0.460	0.478	0.464	0.421	0.403	0.425	0.574	0.63	0.505
MgFe	0.440	0.442	0.441	0.439	0.448	0.449	0.469	0.474	0.469	0.463	0.459	0.462

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from a pluton at Moth Bay, Alaska

	37	38	39	40	41	42	43	44	45	46	47	48
SiO2	40.98	40.90	41.11	40.70	41.00	40.98	40.66	42.61	41.09	40.80	42.06	41.69
Al2O3	12.83	12.50	12.34	13.04	12.16	12.12	12.67	11.37	12.62	12.62	10.97	11.27
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	18.23	18.84	18.75	18.39	19.93	19.67	18.96	18.99	20.35	20.70	20.34	20.69
MgO	9.09	8.83	9.02	8.61	8.47	8.59	8.68	9.53	7.92	7.95	8.94	8.61
CaO	10.75	11.03	10.79	10.86	10.99	10.91	11.10	10.88	10.87	11.07	10.95	10.66
Na2O	1.66	1.88	1.90	1.87	1.83	1.86	1.89	1.82	1.93	1.94	1.93	2.01
K2O	1.50	1.40	1.50	1.46	1.47	1.42	1.31	1.27	1.64	1.69	1.40	1.54
TiO2	0.85	0.76	0.89	0.71	0.88	1.01	0.92	1.04	0.86	1.34	1.26	1.18
MnO	0.74	0.73	0.68	0.65	0.71	0.67	0.67	0.73	0.65	0.65	0.70	0.68
Cl	0.14	0.12	0.09	0.11	0.10	0.10	0.13	0.10	0.16	0.16	0.15	0.14
F	0.20	0.08	0.07	0.22	0.19	0.26	0.16	0.18	0.09	0.12	0.08	0.09
BaO	0.00	0.04	0.06	0.03	0.07	0.00	0.00	0.08	0.00	0.00	0.02	0.00
Total	96.85	97.05	97.15	96.53	97.70	97.46	97.05	98.50	98.11	98.95	98.73	98.49

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.307	6.307	6.326	6.295	6.318	6.320	6.275	6.453	6.311	6.236	6.413	6.386
Al	2.329	2.274	2.240	2.379	2.211	2.205	2.306	2.031	2.287	2.275	1.973	2.036
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.345	2.429	2.412	2.378	2.567	2.536	2.446	2.404	2.613	2.645	2.592	2.649
Mg	2.086	2.031	2.070	1.986	1.947	1.976	1.998	2.152	1.814	1.812	2.033	1.967
Ca	1.772	1.822	1.779	1.800	1.814	1.802	1.835	1.765	1.789	1.813	1.789	1.749
Na	0.495	0.562	0.567	0.561	0.547	0.556	0.565	0.534	0.575	0.575	0.570	0.597
K	0.295	0.275	0.295	0.288	0.289	0.279	0.258	0.245	0.321	0.330	0.272	0.301
Ti	0.098	0.088	0.103	0.083	0.102	0.117	0.107	0.118	0.099	0.154	0.144	0.136
Mn	0.097	0.095	0.089	0.085	0.093	0.088	0.088	0.094	0.085	0.084	0.090	0.088
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.002	0.004	0.002	0.004	0.000	0.000	0.005	0.000	0.000	0.001	0.000
Total	15.82	15.89	15.88	15.86	15.89	15.88	15.88	15.80	15.89	15.92	15.88	15.91

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEG =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.772	1.822	1.779	1.800	1.814	1.802	1.835	1.765	1.791	1.813	1.789	1.749
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
NaKA	0.790	0.840	0.865	0.851	0.840	0.836	0.823	0.785	0.894	0.905	0.844	0.898
AlVI	0.636	0.581	0.565	0.675	0.529	0.525	0.581	0.484	0.598	0.512	0.385	0.422
MgFe	0.471	0.455	0.462	0.455	0.431	0.438	0.450	0.472	0.410	0.407	0.440	0.426

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from a pluton at Moth Bay, Alaska

	49	50	51	52	53	54	55	56	57	58	59	60
SiO2	41.32	40.68	39.49	40.17	40.13	41.11	40.18	41.64	43.49	42.66	41.71	42.29
Al2O3	11.56	12.63	14.66	14.26	13.43	12.18	13.64	11.29	10.09	10.40	10.83	10.34
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	20.87	21.07	21.17	20.83	21.49	20.83	20.82	21.15	18.82	18.99	20.36	18.25
MgO	8.17	7.64	7.26	7.46	7.57	8.08	7.37	8.39	9.55	9.38	8.13	9.75
CaO	10.63	10.88	10.71	11.02	11.05	10.83	10.75	10.86	10.90	10.73	10.61	11.20
Na2O	2.03	2.00	1.94	1.97	1.95	2.00	1.96	1.98	1.95	1.96	2.04	2.04
K2O	1.63	1.82	2.00	2.01	2.02	1.73	1.87	1.47	1.06	1.17	1.31	1.24
TiO2	1.02	1.17	0.34	0.64	0.79	1.20	0.82	1.11	1.04	1.15	1.16	1.16
MnO	0.70	0.69	0.70	0.65	0.59	0.67	0.65	0.70	0.70	0.72	0.67	0.64
Cl	0.15	0.14	0.27	0.15	0.16	0.15	0.19	0.15	0.20	0.15	0.12	0.14
F	0.12	0.15	0.18	0.21	0.07	0.02	0.08	0.13	0.07	0.23	0.00	0.00
BaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.11
Total	98.12	98.78	98.58	99.25	99.18	98.76	98.25	98.78	97.80	97.41	97.01	97.13

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.368	6.245	6.089	6.134	6.154	6.293	6.191	6.376	6.615	6.538	6.471	6.494
Al	2.101	2.287	2.666	2.569	2.429	2.199	2.479	2.039	1.810	1.880	1.982	1.873
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.688	2.704	2.728	2.659	2.755	2.665	2.681	2.707	2.393	2.433	2.640	2.343
Mg	1.878	1.749	1.669	1.699	1.731	1.845	1.693	1.916	2.166	2.144	1.881	2.233
Ca	1.755	1.789	1.769	1.803	1.815	1.776	1.774	1.782	1.776	1.762	1.763	1.843
Na	0.607	0.595	0.580	0.583	0.580	0.594	0.585	0.588	0.575	0.582	0.614	0.607
K	0.321	0.357	0.393	0.392	0.395	0.338	0.368	0.287	0.206	0.229	0.259	0.243
Ti	0.118	0.135	0.039	0.074	0.091	0.138	0.095	0.128	0.119	0.133	0.135	0.134
Mn	0.091	0.090	0.091	0.084	0.077	0.087	0.085	0.091	0.090	0.094	0.088	0.083
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.007
Total	15.93	15.95	16.03	16.00	16.03	15.93	15.95	15.91	15.75	15.79	15.84	15.86

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.755	1.789	1.769	1.803	1.815	1.776	1.776	1.782	1.806	1.778	1.803	1.843
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.030	0.017	0.040	0.000
NaKA	0.927	0.952	0.973	0.975	0.975	0.931	0.952	0.875	0.751	0.795	0.839	0.857
AlVI	0.469	0.533	0.755	0.703	0.583	0.492	0.669	0.415	0.426	0.419	0.453	0.368
MgFe	0.411	0.393	0.380	0.390	0.386	0.409	0.387	0.414	0.475	0.468	0.416	0.488

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from a pluton at Moth Bay, Alaska

	61	62	63	64	65	66	67
SiO2	41.40	44.95	44.62	42.41	40.94	40.48	40.47
Al2O3	10.68	10.19	10.26	11.96	12.94	12.29	13.07
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	19.63	16.67	16.51	17.04	19.09	21.87	21.67
MgO	8.77	10.94	11.21	10.17	8.01	7.05	6.96
CaO	10.97	11.51	11.21	11.30	11.25	10.99	10.97
Na2O	2.00	1.86	1.82	1.93	1.83	1.99	2.00
K2O	1.40	1.17	1.19	1.49	1.80	1.71	1.83
TiO2	1.37	1.07	1.07	1.17	1.08	1.17	0.94
MnO	0.65	0.60	0.61	0.61	0.66	0.66	0.68
Cl	0.12	0.09	0.11	0.15	0.10	0.15	0.16
BaO	0.09	0.00	0.00	0.03	0.09	0.07	0.02
Total	97.05	99.03	98.59	98.23	97.77	98.40	98.73

(Analysis totals are corrected for O=Cl.F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.416	6.662	6.639	6.392	6.283	6.264	6.230
Al	1.952	1.782	1.801	2.126	2.342	2.243	2.373
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.543	2.065	2.053	2.147	2.449	2.829	2.788
Mg	2.027	2.418	2.488	2.286	1.833	1.627	1.598
Ca	1.821	1.828	1.787	1.824	1.850	1.822	1.809
Na	0.601	0.534	0.525	0.564	0.544	0.597	0.597
K	0.277	0.221	0.226	0.287	0.352	0.338	0.359
Ti	0.160	0.119	0.120	0.133	0.125	0.136	0.109
Mn	0.085	0.075	0.077	0.078	0.086	0.087	0.089
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.005	0.000	0.000	0.002	0.005	0.004	0.001
Total	15.89	15.71	15.72	15.84	15.87	15.95	15.95

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEG =	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.821	1.878	1.822	1.839	1.882	1.822	1.814
NaB	0.000	0.050	0.035	0.014	0.033	0.000	0.004
NaKA	0.883	0.705	0.716	0.838	0.870	0.939	0.953
AlVI	0.368	0.444	0.440	0.518	0.625	0.507	0.603
MgFe	0.444	0.539	0.548	0.516	0.428	0.365	0.364

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Ecstall pluton, British Columbia 4/14/86

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	41.48	42.05	41.99	41.38	40.96	41.41	41.49	41.56	41.80	41.93	41.78	41.86
Al2O3	12.33	12.21	12.52	12.18	12.55	11.97	12.62	12.33	12.54	12.21	12.52	12.27
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	18.15	17.72	17.42	17.88	17.91	17.83	18.03	17.94	18.22	17.73	18.39	18.56
MgO	9.48	9.42	9.75	9.40	9.49	9.67	9.67	9.66	9.50	9.71	9.55	9.52
CaO	12.01	12.18	12.27	12.16	11.15	11.13	11.28	11.37	11.19	11.30	11.28	11.24
Na2O	1.82	1.86	1.90	1.86	1.82	1.79	1.90	1.85	1.80	1.83	1.88	1.88
K2O	1.66	1.68	1.72	1.72	1.64	1.56	1.67	1.69	1.67	1.64	1.76	1.73
TiO2	0.75	1.02	1.01	1.02	0.84	0.83	0.96	0.83	0.88	0.80	0.82	0.98
MnO	0.48	0.53	0.46	0.48	0.54	0.53	0.57	0.57	0.54	0.56	0.61	0.56
Cl	0.22	0.15	0.17	0.20	0.20	0.19	0.17	0.20	0.23	0.23	0.23	0.21
F	0.06	0.00	0.00	0.04	0.31	0.07	0.14	0.24	0.37	0.27	0.13	0.06
Cr2O3	0.12	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BaO	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.03	0.13	0.00	0.09	0.09
Total	98.49	98.79	99.17	98.44	97.27	96.91	98.40	98.12	98.66	98.04	98.93	98.89

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.299	6.343	6.303	6.288	6.291	6.363	6.290	6.325	6.333	6.371	6.316	6.330
Al	2.209	2.173	2.217	2.183	2.274	2.170	2.257	2.213	2.241	2.188	2.233	2.189
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.304	2.234	2.186	2.271	2.299	2.290	2.285	2.282	2.307	2.252	2.324	2.346
Mg	2.147	2.119	2.183	2.130	2.174	2.216	2.186	2.192	2.146	2.200	2.153	2.147
Ca	1.954	1.968	1.973	1.980	1.835	1.832	1.832	1.854	1.816	1.839	1.827	1.821
Na	0.536	0.544	0.553	0.548	0.542	0.533	0.558	0.546	0.529	0.539	0.551	0.551
K	0.322	0.323	0.329	0.334	0.321	0.306	0.323	0.328	0.323	0.318	0.340	0.334
Ti	0.086	0.116	0.114	0.117	0.097	0.096	0.109	0.095	0.100	0.091	0.093	0.111
Mn	0.062	0.068	0.059	0.062	0.070	0.069	0.073	0.074	0.069	0.072	0.078	0.072
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr	0.014	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.002	0.008	0.000	0.005	0.005
Total	15.93	15.89	15.92	15.93	15.91	15.88	15.91	15.91	15.87	15.87	15.92	15.91

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.954	1.968	1.973	1.980	1.835	1.832	1.832	1.854	1.816	1.839	1.827	1.821
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.858	0.867	0.882	0.881	0.866	0.839	0.881	0.876	0.859	0.857	0.896	0.890
AlVI	0.508	0.516	0.520	0.471	0.565	0.533	0.546	0.538	0.574	0.560	0.549	0.519
MgFe	0.482	0.487	0.500	0.484	0.486	0.492	0.487	0.490	0.482	0.494	0.487	0.478

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Ecstall pluton, British Columbia 4/14/86

	13	14	15	16	17	18	19	20	21
SiO2	41.31	41.24	41.21	42.05	42.51	41.34	41.72	41.24	41.93
Al2O3	12.69	12.76	12.54	12.45	12.31	12.65	12.61	12.69	12.53
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	18.62	18.31	18.45	18.49	18.32	18.18	18.44	18.25	18.19
MgO	9.57	9.60	9.51	9.71	9.92	9.54	9.58	9.76	9.56
CaO	11.07	11.15	11.18	11.25	11.12	11.08	11.41	11.36	11.15
Na2O	1.90	1.88	1.86	1.85	1.89	1.90	1.79	1.82	1.86
K2O	1.68	1.76	1.66	1.66	1.62	1.71	1.64	1.62	1.58
TiO2	0.89	1.01	0.83	0.88	0.92	0.89	0.84	0.89	0.88
MnO	0.56	0.52	0.55	0.59	0.57	0.54	0.56	0.58	0.55
Cl	0.24	0.22	0.18	0.20	0.16	0.24	0.22	0.18	0.25
F	0.11	0.03	0.05	0.12	0.11	0.00	0.06	0.13	0.05
BaO	0.06	0.00	0.07	0.00	0.09	0.00	0.12	0.00	0.09
Total	98.60	98.42	98.03	99.15	99.46	98.02	98.92	98.42	98.54

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.271	6.260	6.286	6.330	6.366	6.293	6.303	6.259	6.342
Al	2.272	2.285	2.256	2.211	2.174	2.272	2.247	2.272	2.235
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.363	2.323	2.352	2.327	2.293	2.313	2.329	2.315	2.300
Mg	2.166	2.173	2.163	2.180	2.215	2.166	2.158	2.209	2.156
Ca	1.800	1.813	1.827	1.814	1.784	1.807	1.847	1.847	1.807
Na	0.559	0.553	0.550	0.540	0.549	0.561	0.524	0.536	0.545
K	0.325	0.341	0.323	0.319	0.310	0.332	0.316	0.314	0.305
Ti	0.102	0.115	0.095	0.100	0.104	0.102	0.095	0.102	0.100
Mn	0.072	0.067	0.071	0.075	0.072	0.070	0.072	0.075	0.071
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ba	0.004	0.000	0.004	0.000	0.005	0.000	0.007	0.000	0.005
Total	15.93	15.93	15.93	15.89	15.87	15.92	15.90	15.93	15.87

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.800	1.813	1.827	1.814	1.784	1.807	1.847	1.847	1.807
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.888	0.894	0.877	0.859	0.864	0.893	0.848	0.849	0.856
AlVI	0.543	0.544	0.542	0.540	0.540	0.565	0.550	0.531	0.577
MgFe	0.478	0.483	0.479	0.484	0.491	0.484	0.481	0.488	0.484

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from the Finnmarka complex, Norway (Czamanske&Wones, 1973)

	1	2	3	4	5	6	7	8
SiO2	44.10	45.20	45.10	45.20	50.10	50.20	51.10	51.40
Al2O3	7.17	6.61	6.29	6.07	4.71	4.33	4.11	3.80
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	22.50	22.30	22.01	22.40	11.50	11.40	11.40	11.50
MgO	8.92	9.16	9.26	8.90	15.30	15.20	15.20	15.80
CaO	10.20	10.20	10.10	10.00	10.70	10.80	10.80	11.30
Na2O	1.74	1.45	1.69	1.52	1.66	1.32	1.36	1.20
K2O	0.78	0.67	0.86	0.87	0.67	0.49	0.52	0.40
TiO2	1.78	1.55	1.55	1.55	1.00	0.73	0.82	0.50
MnO	0.65	0.65	0.55	0.58	1.46	1.87	1.54	1.97
F	0.30	0.30	0.30	0.30	0.60	0.60	0.60	0.60
Total	98.01	97.96	97.58	97.26	97.45	96.69	97.20	98.22

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.792	6.929	6.946	6.991	7.330	7.396	7.466	7.452
Al	1.303	1.195	1.143	1.107	0.813	0.753	0.708	0.650
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.897	2.857	2.833	2.896	1.406	1.404	1.392	1.394
Mg	2.049	2.094	2.127	2.053	3.338	3.340	3.312	3.416
Ca	1.683	1.675	1.666	1.657	1.677	1.705	1.690	1.755
Na	0.520	0.431	0.505	0.456	0.471	0.377	0.385	0.337
K	0.153	0.131	0.169	0.172	0.125	0.092	0.097	0.074
Ti	0.206	0.179	0.180	0.180	0.110	0.081	0.090	0.055
Mn	0.085	0.084	0.072	0.076	0.181	0.234	0.191	0.242
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.69	15.58	15.64	15.59	15.45	15.38	15.33	15.37

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.683	1.675	1.700	1.696	1.821	1.793	1.841	1.792
NaB	0.000	0.000	0.034	0.039	0.144	0.088	0.151	0.037
NaKA	0.673	0.562	0.640	0.588	0.452	0.381	0.331	0.374
AlVI	0.095	0.124	0.088	0.099	0.143	0.149	0.174	0.102
MgFe	0.414	0.423	0.429	0.415	0.704	0.704	0.704	0.710

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-601]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from the Pliny complex, NH (Czamaske et al., 1977)

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	41.90	42.10	49.20	46.50	41.80	41.00	39.60	39.80	40.60	48.40	48.40	41.70
Al2O3	10.60	10.10	5.22	6.57	10.70	8.94	8.91	7.80	6.77	5.92	5.87	6.94
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	20.02	19.88	12.79	17.51	15.82	25.19	28.49	32.10	32.20	13.59	14.10	28.66
MgO	9.01	9.63	14.80	12.00	10.80	5.39	3.96	0.87	1.86	13.70	13.90	3.53
CaO	11.50	11.40	11.50	10.70	11.20	10.60	11.00	10.20	9.71	11.70	11.90	9.88
Na2O	1.69	1.93	1.86	1.66	2.37	2.10	1.66	2.25	2.36	1.56	1.21	2.28
K2O	1.31	1.34	0.66	0.62	1.08	1.30	2.03	1.27	1.22	0.76	0.76	1.14
TiO2	0.42	0.35	0.97	1.83	3.89	2.68	0.59	1.71	1.37	0.97	1.08	1.56
MnO	0.61	0.97	0.90	0.41	0.31	0.83	0.72	1.11	0.95	1.10	0.62	1.62
Cl	0.07	0.07	0.10	0.10	0.00	0.24	2.44	0.47	0.39	0.10	0.11	0.34
F	1.00	0.90	1.20	0.30	0.00	0.50	0.30	0.70	1.00	0.60	0.40	1.00
Total	97.69	98.28	98.67	98.05	97.97	98.51	99.02	97.88	97.92	98.12	98.16	98.15

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.482	6.484	7.200	6.957	6.285	6.465	6.465	6.587	6.708	7.136	7.124	6.747
Al	1.934	1.835	0.901	1.160	1.898	1.663	1.716	1.523	1.319	1.030	1.019	1.325
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.589	2.559	1.565	2.190	1.988	3.320	3.888	4.441	4.447	1.675	1.735	3.876
Mg	2.079	2.212	3.230	2.678	2.422	1.267	0.964	0.215	0.458	3.012	3.051	0.852
Ca	1.906	1.881	1.803	1.715	1.804	1.791	1.924	1.809	1.719	1.848	1.876	1.713
Na	0.507	0.576	0.528	0.482	0.691	0.642	0.525	0.722	0.756	0.446	0.345	0.715
K	0.259	0.263	0.123	0.118	0.207	0.262	0.423	0.268	0.257	0.143	0.143	0.235
Ti	0.049	0.041	0.107	0.206	0.440	0.318	0.072	0.213	0.170	0.108	0.120	0.190
Mn	0.080	0.127	0.112	0.052	0.040	0.111	0.100	0.156	0.133	0.137	0.077	0.222
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.88	15.98	15.57	15.56	15.77	15.84	16.08	15.93	15.97	15.54	15.49	15.88

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.906	1.881	1.886	1.758	1.927	1.856	1.924	1.865	1.764	1.901	1.876	1.783
NaB	0.000	0.000	0.083	0.043	0.123	0.066	0.000	0.057	0.045	0.053	0.000	0.075
NaKA	0.765	0.840	0.568	0.557	0.775	0.838	0.948	0.933	0.968	0.536	0.488	0.876
AlVI	0.417	0.319	0.101	0.117	0.183	0.128	0.181	0.110	0.028	0.166	0.143	0.072
MgFe	0.445	0.464	0.674	0.550	0.549	0.276	0.199	0.046	0.093	0.643	0.638	0.180

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from the Pliny complex, NH (Czamanske et al., 1977)

	13	14	15	16	17
SiO2	41.10	39.80	40.80	40.40	39.40
Al2O3	7.79	7.92	6.61	7.67	7.95
Fe2O3	0.00	0.00	0.00	0.00	0.00
FeO	27.65	29.36	32.97	29.88	31.13
MgO	3.79	2.97	1.36	2.68	2.00
CaO	9.89	10.50	9.77	9.64	10.20
Na2O	2.46	1.76	2.13	2.26	2.06
K2O	1.00	1.60	1.19	1.08	1.38
TiO2	1.84	0.51	1.60	1.80	1.27
MnO	1.70	1.85	0.86	1.37	1.34
Cl	0.25	0.96	0.39	0.37	0.58
F	0.70	0.50	0.60	0.60	0.70

Total 97.82 97.30 97.94 97.41 97.58
 (Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00
Si	6.630	6.591	6.736	6.617	6.533
Al	1.482	1.547	1.287	1.482	1.555
Fe3	0.000	0.000	0.000	0.000	0.000
Fe2	3.728	4.064	4.550	4.091	4.314
Mg	0.912	0.733	0.335	0.655	0.495
Ca	1.709	1.863	1.728	1.692	1.812
Na	0.769	0.565	0.682	0.718	0.662
K	0.206	0.338	0.251	0.226	0.292
Ti	0.223	0.064	0.199	0.222	0.158
Mn	0.232	0.260	0.120	0.190	0.188
Cl	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000

Total 15.89 16.02 15.89 15.89 16.01

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ = 23.00 23.00 23.00 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.791	1.863	1.773	1.743	1.812
NaB	0.082	0.000	0.045	0.052	0.000
NaKA	0.893	0.903	0.888	0.892	0.954
AlVI	0.113	0.138	0.023	0.099	0.087
MgFe	0.196	0.153	0.069	0.138	0.103

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Dinkey Creek hornblendes, Sierra Nevada, CA (Guy, 1980)

	1	2	3	4	5	6
SiO2	46.40	45.40	46.59	44.96	40.64	47.95
Al2O3	7.76	8.05	7.71	8.19	9.20	6.64
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00
FeO	16.59	18.59	16.63	17.28	28.46	16.16
MgO	11.14	9.82	11.57	10.78	2.78	11.22
CaO	12.27	11.77	11.53	11.75	10.66	11.49
Na2O	1.06	1.21	1.05	1.10	1.72	0.98
K2O	0.79	0.95	0.69	0.85	1.45	0.54
TiO2	1.49	1.41	1.34	1.21	0.97	0.78
MnO	0.52	0.68	0.53	0.49	1.21	0.44
Cl	0.09	0.11	0.09	0.09	0.10	0.10
F	0.10	0.25	0.15	0.18	0.20	0.21

Total 98.15 98.11 97.80 96.78 97.28 96.40
 (Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

D =	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.913	6.856	6.947	6.832	6.583	7.206
Al	1.364	1.434	1.356	1.468	1.758	1.177
Fe3	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.066	2.346	2.073	2.195	3.853	2.030
Mg	2.475	2.211	2.573	2.443	0.672	2.515
Ca	1.958	1.904	1.842	1.913	1.850	1.850
Na	0.306	0.354	0.304	0.324	0.540	0.286
K	0.150	0.183	0.131	0.165	0.300	0.104
Ti	0.167	0.160	0.150	0.138	0.118	0.088
Mn	0.066	0.087	0.067	0.063	0.166	0.056
Cl	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000

Total 15.47 15.54 15.44 15.54 15.84 15.31

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEG = 23.00 23.00 23.00 23.00 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.958	1.905	1.842	1.913	1.850	1.928
NaB	0.000	0.001	0.000	0.000	0.000	0.078
NaKA	0.456	0.536	0.435	0.489	0.840	0.311
AlVI	0.277	0.290	0.303	0.300	0.341	0.383
MgFe	0.545	0.485	0.554	0.527	0.148	0.553

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Teutonia batholith, CA (Beckerman et al., 1982)

	1	2	3	4	5	6
SiO2	45.44	47.41	47.97	44.71	45.75	49.83
Al2O3	9.10	5.57	6.87	7.92	8.25	4.85
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00
FeO	14.92	14.53	15.05	16.36	16.92	14.47
MgO	12.99	13.04	13.11	11.65	11.56	14.32
CaO	11.73	11.39	11.26	11.96	11.64	11.73
Na2O	1.18	1.55	1.13	1.26	1.05	1.13
K2O	0.75	0.63	0.80	1.09	1.04	0.54
TiO2	1.73	0.95	0.81	1.57	1.20	0.54
MnO	0.31	1.71	0.63	0.54	0.66	0.83
Cl	0.09	0.04	0.04	0.16	0.15	0.01
F	0.03	0.63	0.02	0.02	0.13	0.51
Total	98.24	97.18	97.67	97.20	98.26	98.54

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.705	7.115	7.088	6.764	6.833	7.290
Al	1.584	0.986	1.197	1.413	1.453	0.837
Fe3	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	1.840	1.823	1.859	2.069	2.112	1.769
Mg	2.858	2.919	2.889	2.628	2.575	3.124
Ca	1.854	1.831	1.783	1.938	1.862	1.838
Na	0.338	0.451	0.324	0.370	0.304	0.320
K	0.141	0.121	0.151	0.210	0.198	0.101
Ti	0.192	0.107	0.090	0.179	0.135	0.059
Mn	0.039	0.218	0.079	0.069	0.084	0.103
Cl	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.55	15.57	15.46	15.64	15.56	15.44

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.854	1.833	1.797	1.938	1.862	1.838
NaB	0.000	0.001	0.015	0.000	0.000	0.000
NaKA	0.479	0.570	0.460	0.580	0.502	0.421
AlVI	0.289	0.101	0.286	0.177	0.286	0.127
MgFe	0.608	0.616	0.608	0.560	0.549	0.638

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from SW Japan batholith (Czamanske et al., 1981)

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	43.90	48.30	48.80	50.40	47.80	44.10	43.10	44.20	44.90	42.10	45.00	41.70
Al2O3	9.82	6.08	5.65	3.47	6.10	7.85	8.63	9.95	8.84	10.30	8.20	11.40
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	16.54	14.10	12.50	22.50	15.93	25.08	24.67	17.07	21.43	20.52	18.43	16.54
MgO	11.20	13.80	15.00	9.84	13.30	6.15	5.92	10.90	7.50	8.05	10.10	10.20
CaO	11.50	11.50	11.30	10.70	10.70	10.20	10.30	11.10	11.40	11.10	11.20	10.90
Na2O	1.45	1.07	1.19	0.39	1.54	1.69	1.85	1.33	1.05	1.61	1.60	2.58
K2O	0.52	0.49	0.48	0.17	0.53	0.83	1.05	0.74	1.13	0.91	0.97	0.65
TiO2	2.43	1.28	1.10	0.08	1.26	1.07	1.28	2.49	1.16	1.86	1.71	2.76
MnO	0.60	0.51	0.78	0.50	0.26	1.53	1.22	0.30	0.64	0.92	0.50	0.67
Cl	0.02	0.04	0.09	0.00	0.06	0.07	0.10	0.02	0.03	0.14	0.08	0.03
F	0.09	0.16	0.26	0.10	0.45	0.49	0.58	0.11	0.23	0.34	0.24	0.53
Total	98.03	97.25	97.02	98.11	97.73	98.84	98.43	98.16	98.21	97.68	97.91	97.73

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.560	7.133	7.181	7.581	7.095	6.843	6.726	6.593	6.849	6.490	6.803	6.313
Al	1.731	1.059	0.981	0.616	1.068	1.437	1.589	1.751	1.591	1.873	1.462	2.036
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.066	1.740	1.538	2.829	1.976	3.253	3.218	2.128	2.732	2.644	2.329	2.093
Mg	2.496	3.039	3.292	2.207	2.944	1.423	1.378	2.425	1.706	1.851	2.277	2.303
Ca	1.841	1.819	1.781	1.724	1.701	1.696	1.722	1.774	1.863	1.833	1.814	1.768
Na	0.420	0.306	0.339	0.114	0.443	0.508	0.560	0.385	0.311	0.481	0.469	0.757
K	0.099	0.092	0.090	0.033	0.100	0.164	0.209	0.141	0.220	0.179	0.187	0.126
Ti	0.273	0.142	0.122	0.009	0.141	0.125	0.150	0.279	0.133	0.216	0.194	0.314
Mn	0.076	0.064	0.097	0.064	0.033	0.201	0.161	0.038	0.083	0.120	0.064	0.086
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.56	15.40	15.42	15.18	15.50	15.65	15.71	15.51	15.49	15.69	15.60	15.80

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

Oxeg =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.841	1.823	1.790	1.724	1.743	1.718	1.777	1.785	1.906	1.833	1.870	1.855
NaB	0.000	0.004	0.008	0.000	0.042	0.023	0.055	0.011	0.043	0.000	0.056	0.087
NaKA	0.519	0.395	0.421	0.146	0.502	0.650	0.714	0.514	0.488	0.660	0.600	0.796
AlVI	0.291	0.192	0.162	0.196	0.163	0.280	0.315	0.344	0.440	0.363	0.265	0.349
MgFe	0.547	0.636	0.682	0.438	0.598	0.304	0.300	0.533	0.384	0.412	0.494	0.524

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from SW Japan batholith (Czamanske et al., 1981)

	13	14	15	16	17	18	19	20
SiO2	47.20	45.30	45.50	42.40	44.90	46.70	43.40	44.80
Al2O3	6.32	7.74	7.91	9.06	9.61	7.56	9.94	9.41
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	22.20	21.36	21.36	24.13	21.98	18.85	23.03	21.40
MgO	8.15	7.86	7.92	5.08	7.22	9.34	5.85	7.11
CaO	9.96	10.70	10.70	10.70	10.70	11.20	11.10	11.20
Na2O	1.09	1.42	1.31	1.85	1.24	1.10	1.30	1.09
K2O	0.57	0.88	0.80	1.14	0.61	0.76	1.27	1.11
TiO2	0.60	1.29	1.59	1.37	1.26	1.51	1.40	1.10
MnO	0.65	1.08	0.74	1.50	0.51	0.51	0.60	0.65
Cl	0.10	0.19	0.08	0.13	0.04	0.06	0.10	0.06
F	0.41	0.45	0.28	0.80	0.14	0.19	0.38	0.23
Total	97.05	98.04	97.95	97.79	98.14	97.69	98.19	98.05

(Analysis totals are corrected for O=Cl,F)

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	7.245	6.940	6.938	6.684	6.824	7.033	6.702	6.837
Al	1.144	1.399	1.423	1.685	1.723	1.343	1.811	1.694
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.848	2.735	2.710	3.180	2.792	2.373	2.973	2.730
Mg	1.866	1.796	1.801	1.194	1.637	2.098	1.347	1.618
Ca	1.638	1.756	1.748	1.807	1.742	1.807	1.836	1.831
Na	0.324	0.422	0.387	0.565	0.365	0.321	0.389	0.322
K	0.112	0.172	0.156	0.229	0.118	0.146	0.250	0.216
Ti	0.069	0.149	0.182	0.162	0.144	0.171	0.163	0.126
Mn	0.085	0.140	0.096	0.200	0.066	0.065	0.079	0.084
Cl	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	15.33	15.51	15.44	15.71	15.41	15.36	15.55	15.46

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.743	1.841	1.851	1.894	1.814	1.917	1.926	1.911
NaB	0.105	0.085	0.103	0.087	0.072	0.110	0.090	0.080
NaKA	0.331	0.509	0.440	0.708	0.412	0.358	0.550	0.459
AlVI	0.390	0.339	0.361	0.369	0.547	0.376	0.513	0.531
MgFe	0.396	0.396	0.399	0.273	0.370	0.469	0.312	0.372

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Hardwick pluton, MA (Shearer, 1983)

	1	2	3	4	5	6	7	8	9	10	11	12
SiO2	43.37	42.99	42.97	43.56	43.50	43.46	43.48	43.09	42.97	43.47	43.49	43.46
Al2O3	11.45	11.18	11.27	11.54	11.36	11.44	11.28	11.54	11.36	10.75	10.80	11.04
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	17.27	16.87	17.23	17.52	16.57	16.95	17.14	17.05	17.23	17.87	17.70	17.43
MgO	10.41	10.68	10.51	10.41	10.79	10.62	10.54	10.38	10.37	9.45	9.61	9.56
CaO	11.66	11.53	11.35	11.45	11.44	11.36	11.59	11.51	11.46	11.31	11.13	11.11
Na2O	1.67	1.60	1.52	1.48	1.50	1.51	1.67	1.46	1.56	1.60	1.53	1.54
K2O	0.88	0.98	0.88	0.93	0.90	0.83	0.82	0.92	0.86	1.30	1.31	1.28
TiO2	1.00	1.19	0.95	0.96	0.99	0.95	0.98	0.99	0.90	1.26	1.23	1.14
MnO	0.53	0.60	0.53	0.51	0.61	0.51	0.52	0.53	0.53	1.07	1.05	1.00
Total	98.24	97.62	97.21	98.36	97.66	97.63	98.02	97.47	97.24	98.08	97.85	97.56

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.495	6.479	6.501	6.511	6.525	6.525	6.518	6.494	6.500	6.565	6.572	6.574
Al	2.023	1.987	2.011	2.035	2.010	2.026	1.995	2.052	2.027	1.915	1.925	1.970
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.162	2.125	2.179	2.189	2.078	2.127	2.148	2.148	2.179	2.256	2.236	2.204
Mg	2.325	2.400	2.371	2.320	2.414	2.378	2.356	2.333	2.339	2.128	2.166	2.157
Ca	1.871	1.862	1.840	1.833	1.838	1.827	1.861	1.858	1.857	1.830	1.802	1.800
Na	0.485	0.467	0.446	0.429	0.436	0.440	0.485	0.427	0.457	0.468	0.448	0.452
K	0.168	0.188	0.170	0.177	0.172	0.159	0.157	0.177	0.166	0.251	0.253	0.247
Ti	0.113	0.135	0.108	0.108	0.112	0.107	0.110	0.112	0.102	0.143	0.140	0.130
Mn	0.067	0.077	0.068	0.065	0.078	0.065	0.066	0.068	0.068	0.137	0.135	0.128
Total	15.71	15.72	15.69	15.67	15.66	15.65	15.70	15.67	15.70	15.69	15.68	15.66

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.871	1.862	1.840	1.833	1.838	1.827	1.861	1.858	1.857	1.855	1.827	1.838
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.025	0.038
NaKA	0.653	0.656	0.616	0.606	0.608	0.599	0.642	0.604	0.623	0.694	0.676	0.661
AlVI	0.517	0.466	0.512	0.545	0.535	0.551	0.512	0.546	0.527	0.480	0.497	0.544
MgFe	0.518	0.530	0.521	0.515	0.537	0.528	0.523	0.521	0.518	0.485	0.492	0.495

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recal, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Hardwick pluton, MA (Shearer, 1983)

	13	14	15	16	17	18	19	20	21	22	23	24
SiO2	43.20	43.52	43.67	42.75	42.19	42.63	42.07	42.99	41.85	42.23	42.27	42.10
Al2O3	11.03	11.04	10.47	10.69	10.87	10.76	10.72	10.74	10.96	10.65	10.60	10.93
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	17.48	17.82	17.95	18.91	18.83	18.87	18.54	18.61	18.91	18.95	19.06	19.14
MgO	9.21	9.06	9.42	9.78	9.70	9.85	9.78	9.80	9.46	9.87	9.90	9.62
CaO	11.19	11.07	11.14	11.51	11.53	11.28	11.51	11.61	11.58	11.68	11.63	11.61
Na2O	1.51	1.54	1.49	1.63	1.51	1.64	1.72	1.74	1.83	1.78	1.79	1.61
K2O	1.28	1.21	1.26	1.26	1.19	1.23	1.26	1.20	1.29	1.25	1.28	1.17
TiO2	1.42	1.01	1.23	1.08	0.88	1.02	1.03	1.12	0.95	1.02	1.03	0.86
MnO	1.04	1.04	1.05	0.67	0.71	0.64	0.68	0.62	0.59	0.62	0.59	0.59
Total	97.36	97.31	97.68	98.28	97.41	97.92	97.31	98.43	97.42	98.05	98.15	97.63

CATIONS PER FORMULA UNIT

D =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.556	6.607	6.615	6.481	6.455	6.481	6.446	6.494	6.420	6.434	6.436	6.437
Al	1.975	1.977	1.871	1.912	1.962	1.929	1.937	1.914	1.983	1.914	1.904	1.971
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.217	2.261	2.273	2.396	2.408	2.398	2.374	2.350	2.425	2.413	2.426	2.446
Mg	2.085	2.051	2.128	2.211	2.213	2.233	2.235	2.208	2.164	2.243	2.248	2.194
Ca	1.819	1.800	1.808	1.869	1.890	1.837	1.889	1.879	1.903	1.906	1.897	1.902
Na	0.444	0.453	0.438	0.479	0.448	0.483	0.511	0.510	0.544	0.526	0.528	0.477
K	0.248	0.234	0.244	0.244	0.232	0.239	0.246	0.231	0.252	0.243	0.249	0.228
Ti	0.162	0.115	0.140	0.123	0.101	0.117	0.119	0.127	0.110	0.117	0.118	0.099
Mn	0.134	0.134	0.135	0.086	0.092	0.082	0.088	0.079	0.077	0.080	0.076	0.076
Total	15.64	15.63	15.65	15.80	15.80	15.80	15.85	15.79	15.88	15.88	15.88	15.83

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.871	1.855	1.839	1.869	1.890	1.837	1.889	1.879	1.903	1.906	1.897	1.902
NaB	0.052	0.054	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.640	0.633	0.650	0.723	0.680	0.722	0.757	0.741	0.797	0.769	0.777	0.706
AlVI	0.531	0.584	0.486	0.393	0.417	0.410	0.383	0.408	0.403	0.348	0.340	0.409
MgFe	0.485	0.476	0.484	0.480	0.479	0.482	0.485	0.484	0.472	0.482	0.481	0.473

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 523-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Hardwick pluton, MA (Shearer, 1983)

	25	26	27	28	29	30	31	32	33	34	35	36
SiO2	43.27	42.27	42.76	42.53	42.60	42.17	42.92	43.05	42.90	42.39	42.70	42.36
Al2O3	11.19	11.45	11.37	11.67	10.86	11.94	11.22	10.59	10.99	11.37	11.65	11.35
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	17.48	17.06	17.00	17.31	16.85	17.45	17.03	16.49	17.05	17.03	16.82	17.06
MgO	10.05	10.64	11.26	10.71	11.16	10.56	11.11	11.59	11.04	11.10	11.00	10.87
CaO	11.56	11.00	11.63	11.89	11.76	11.73	11.75	11.83	11.84	11.72	11.53	11.79
Na2O	1.76	1.59	1.51	1.63	1.69	1.44	1.62	1.45	1.53	1.48	1.66	1.67
K2O	1.24	1.50	0.85	0.85	0.71	0.88	0.75	0.75	0.84	0.78	0.77	0.82
TiO2	1.37	1.49	0.60	0.38	0.52	0.57	0.54	0.57	0.48	0.48	0.56	0.53
MnO	0.61	0.83	0.59	0.61	0.56	0.61	0.59	0.56	0.51	0.56	0.50	0.50
Total	98.55	97.83	97.57	97.58	96.71	97.35	97.53	96.88	97.16	96.91	97.19	96.95

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.489	6.390	6.449	6.431	6.485	6.394	6.476	6.523	6.499	6.441	6.453	6.441
Al	1.979	2.042	2.023	2.082	1.950	2.135	1.997	1.893	1.964	2.038	2.077	2.036
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.190	2.156	2.143	2.188	2.144	2.211	2.148	2.089	2.159	2.163	2.125	2.168
Mg	2.247	2.399	2.532	2.415	2.534	2.388	2.500	2.619	2.494	2.515	2.479	2.465
Ca	1.856	1.781	1.879	1.926	1.918	1.905	1.899	1.920	1.922	1.908	1.867	1.920
Na	0.511	0.466	0.441	0.478	0.499	0.423	0.474	0.426	0.449	0.436	0.486	0.492
K	0.237	0.289	0.164	0.164	0.138	0.170	0.144	0.145	0.162	0.151	0.148	0.159
Ti	0.154	0.169	0.068	0.043	0.060	0.065	0.061	0.065	0.055	0.055	0.064	0.061
Mn	0.078	0.106	0.075	0.078	0.072	0.078	0.075	0.072	0.065	0.072	0.064	0.064
Total	15.74	15.80	15.77	15.81	15.80	15.77	15.77	15.75	15.77	15.78	15.76	15.81

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.864	1.781	1.879	1.926	1.918	1.905	1.899	1.920	1.922	1.908	1.867	1.920
NaB	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.741	0.755	0.605	0.642	0.637	0.594	0.618	0.571	0.612	0.587	0.635	0.651
AlVI	0.468	0.431	0.471	0.513	0.435	0.529	0.472	0.416	0.463	0.479	0.530	0.476
MgFe	0.506	0.527	0.542	0.525	0.542	0.519	0.538	0.556	0.536	0.538	0.538	0.532

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.

No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
 Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Hardwick pluton, MA (Shearer, 1983)

	37	38	39	40	41	42	43	44	45	46	47	48
SiO2	43.63	43.48	43.50	43.89	43.97	43.90	43.90	43.64	44.27	43.59	43.85	44.53
Al2O3	10.60	9.99	10.02	10.29	10.45	10.30	10.32	10.05	10.92	11.80	11.13	10.76
Fe2O3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	16.26	16.67	16.55	16.47	16.33	16.08	16.38	16.21	16.94	17.26	17.03	16.80
MgO	11.59	11.64	11.70	11.67	11.91	11.86	11.62	11.83	10.03	10.03	10.40	10.48
CaO	11.74	11.67	11.77	11.64	11.73	11.71	11.76	11.86	11.74	11.67	11.64	11.85
Na2O	1.41	1.41	1.55	1.46	1.42	1.47	1.43	1.49	1.23	1.32	1.28	1.18
K2O	0.70	0.88	0.78	0.80	0.75	0.76	0.81	0.69	1.03	1.04	1.07	0.98
TiO2	0.54	0.94	0.68	0.73	0.72	0.76	0.75	0.57	0.78	0.64	0.84	0.83
MnO	0.59	0.50	0.52	0.59	0.57	0.50	0.53	0.55	0.77	0.73	0.73	0.72
Total	97.06	97.18	97.07	97.54	97.85	97.34	97.50	96.89	97.71	98.08	97.97	98.13

CATIONS PER FORMULA UNIT

O =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Si	6.576	6.571	6.579	6.591	6.574	6.592	6.592	6.596	6.645	6.533	6.574	6.647
Al	1.885	1.781	1.787	1.823	1.843	1.824	1.828	1.792	1.933	2.086	1.968	1.894
Fe3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2	2.049	2.106	2.092	2.068	2.041	2.018	2.056	2.048	2.125	2.162	2.134	2.096
Mg	2.605	2.623	2.639	2.614	2.656	2.656	2.602	2.657	2.245	2.242	2.325	2.333
Ca	1.896	1.889	1.907	1.873	1.879	1.884	1.892	1.920	1.888	1.874	1.870	1.895
Na	0.412	0.413	0.454	0.425	0.412	0.428	0.416	0.437	0.358	0.384	0.372	0.341
K	0.135	0.170	0.151	0.153	0.143	0.146	0.155	0.133	0.197	0.199	0.205	0.187
Ti	0.061	0.107	0.077	0.082	0.081	0.086	0.085	0.065	0.088	0.072	0.095	0.093
Mn	0.075	0.064	0.067	0.075	0.072	0.064	0.067	0.070	0.098	0.093	0.093	0.091
Total	15.69	15.72	15.75	15.70	15.70	15.70	15.69	15.73	15.58	15.64	15.64	15.58

CHECK ON OXYGEN(+CL, F) EQUIVALENCE OF ABOVE CATIONS

OXEQ =	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
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IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.896	1.889	1.907	1.873	1.879	1.884	1.892	1.920	1.888	1.874	1.870	1.895
NaB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaKA	0.547	0.583	0.605	0.578	0.555	0.574	0.572	0.570	0.555	0.582	0.577	0.528
AlVI	0.461	0.351	0.366	0.414	0.417	0.416	0.421	0.388	0.578	0.619	0.542	0.541
MgFe	0.560	0.555	0.558	0.558	0.565	0.568	0.559	0.566	0.514	0.509	0.521	0.527

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
 No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.

Program by NMS Rock to classify amphiboles using IMA (1978) scheme [Mineral. Mag. 42, 533-631]
Options Selected (mode, idtype, cal, ap, recalc, fe, noox): 5 0 0 0 0 0 23.00

Hornblendes from Hardwick pluton, MA (Shearer, 1983)

	49	50
SiO2	44.55	44.24
Al2O3	10.38	10.59
Fe2O3	0.00	0.00
FeO	16.98	16.86
MgO	10.61	10.55
CaO	11.71	11.74
Na2O	1.32	1.26
K2O	1.03	1.04
TiO2	0.85	0.88
MnO	0.63	0.71
Total	98.06	97.87

CATIONS PER FORMULA UNIT

O =	23.00	23.00
Si	6.663	6.632
Al	1.831	1.873
Fe3	0.000	0.000
Fe2	2.123	2.113
Mg	2.367	2.358
Ca	1.876	1.885
Na	0.383	0.366
K	0.197	0.199
Ti	0.096	0.099
Mn	0.080	0.090
Total	15.62	15.62

CHECK ON OXYGEN(+CL,F) EQUIVALENCE OF ABOVE CATIONS

OXEQ = 23.00 23.00

IMA (1978) CLASSIFICATION PARAMETERS

CaNa	1.876	1.885
NaB	0.000	0.000
NaKA	0.579	0.565
AlVI	0.495	0.504
MgFe	0.527	0.527

GENERAL NOTES FOR THE ABOVE TABLE:

Results have not been checked or adjusted for low water/high cation totals.
No attempt has been made to reallocate Fe between Fe3 and Fe2, where only total Fe is quoted.