

Appendix 1. Representative compositions of plagioclase cores in volcanic rocks from Numazawa volcano.

Eruption age	110 ka		71 ka		53 ka		43 ka		24 ka				5.4 ka							
Eruption name	Shirofukitoge		Mukurezawa		Mizunuma		Sozan		Maeyama				Numazawako							
Rock type	Pumice		Lava		Pumice		Lava		Enclave		Lava		Enclave		Pumice		Black scoria		Gray scoria	
(wt.%)																				
SiO ₂	62.61	64.19	60.56	53.17	60.34	58.94	58.83	51.32	52.57	50.22	56.50	49.58	51.67	47.47	56.92	55.08	53.53	46.11	52.45	50.32
TiO ₂	0.01	0.00	0.00	0.03	0.04	0.02	0.00	0.00	0.04	0.11	0.00	0.00	0.02	0.00	0.05	0.00	0.04	0.07	0.03	0.00
Al ₂ O ₃	24.59	23.41	25.01	29.81	24.87	25.55	27.24	31.68	29.80	30.73	26.54	31.56	29.79	32.38	27.36	28.87	28.76	33.55	30.36	31.57
Cr ₂ O ₃	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.01
FeO	0.13	0.08	0.18	0.22	0.18	0.22	0.18	0.23	0.27	0.49	0.24	0.35	0.68	0.69	0.32	0.38	0.38	0.56	0.36	0.38
MnO	0.04	0.01	0.01	0.00	0.03	0.02	0.04	0.02	0.00	0.03	0.01	0.02	0.02	0.01	0.02	0.00	0.00	0.01	0.01	0.01
MgO	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.34	0.02	0.01	0.01	0.03	0.02	0.01	0.02	0.05	0.02	0.00
NiO	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.01	0.00	0.02
CaO	6.19	5.04	6.76	12.53	7.13	7.85	9.09	14.60	12.04	13.40	8.72	14.15	12.80	15.86	9.78	11.48	11.96	16.90	12.46	13.48
Na ₂ O	7.51	8.07	7.23	4.21	6.83	6.44	5.95	3.01	4.12	3.20	5.88	2.84	3.68	1.96	5.70	4.72	4.22	1.34	3.61	2.88
K ₂ O	0.37	0.52	0.38	0.13	0.44	0.42	0.32	0.09	0.16	0.32	0.47	0.16	0.25	0.08	0.16	0.12	0.16	0.02	0.12	0.10
Total	101.45	101.34	100.18	100.15	99.86	99.46	101.67	100.98	99.02	98.85	98.40	98.68	98.91	98.49	100.35	100.65	99.08	98.61	99.42	98.78
Obasis	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
Si	2.737	2.800	2.690	2.405	2.690	2.646	2.590	2.312	2.401	2.316	2.576	2.289	2.375	2.211	2.548	2.469	2.443	2.150	2.386	2.312
Ti	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.001	0.004	0.000	0.000	0.001	0.000	0.002	0.000	0.001	0.002	0.001	0.000
Al	1.267	1.203	1.309	1.589	1.307	1.352	1.413	1.682	1.604	1.670	1.426	1.717	1.613	1.777	1.443	1.525	1.546	1.843	1.627	1.709
Cr	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Fe	0.005	0.003	0.007	0.008	0.007	0.008	0.007	0.009	0.010	0.019	0.009	0.014	0.026	0.027	0.012	0.014	0.015	0.022	0.014	0.015
Mn	0.001	0.000	0.000	0.001	0.001	0.001	0.002	0.001	0.000	0.001	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Mg	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.024	0.001	0.001	0.001	0.002	0.001	0.003	0.001	0.000	0.000	0.000
Ni	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001
Ca	0.290	0.236	0.322	0.607	0.340	0.378	0.429	0.704	0.589	0.661	0.426	0.700	0.630	0.791	0.469	0.551	0.585	0.844	0.607	0.664
Na	0.636	0.682	0.623	0.369	0.590	0.561	0.508	0.263	0.365	0.286	0.520	0.254	0.328	0.177	0.495	0.410	0.373	0.121	0.318	0.257
K	0.020	0.029	0.021	0.008	0.025	0.024	0.018	0.005	0.009	0.019	0.027	0.009	0.015	0.005	0.009	0.007	0.009	0.001	0.007	0.006
Total	4.958	4.954	4.974	4.989	4.962	4.970	4.966	4.978	4.982	4.999	4.985	4.984	4.989	4.991	4.980	4.977	4.974	4.987	4.962	4.964
An(mol %)	30.6	24.9	33.3	61.7	35.6	39.2	44.9	72.4	61.2	68.5	43.8	72.7	64.8	81.3	48.2	57.0	60.5	87.4	65.1	71.7

$$\text{An} = 100 \times \text{Ca}/(\text{Ca} + \text{Na} + \text{K}).$$

Appendix 2. Representative core compositions of hornblende and cummingtonite in volcanic rocks from Numazawa volcano.

Eruption age	110 ka				71 ka				53 ka				43 ka				24 ka				5.4 ka					
	Shirofukitoge				Mukurezawa		Mizunuma				Sozan				Maeyama				Numazawako							
Rock type	Pumice				Lava				Pumice				Lava				Enclave		Lava		Pumice		Black scoria		Gray scoria	
Mineral type	Hbl	Hbl	Cmt	Cmt	Hbl	Hbl	Hbl	Hbl	Cmt	Cmt	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	Hbl	
(wt. %)																										
SiO ₂	43.94	47.05	54.36	54.66	49.40	50.14	48.83	47.39	54.35	55.25	49.93	50.19	48.22	48.32	48.99	48.03	49.56	46.84	43.26	43.74	48.95	49.12				
TiO ₂	2.35	1.86	0.33	0.39	0.72	0.64	1.11	0.83	0.30	0.29	0.87	0.91	0.93	1.01	1.20	1.07	1.24	1.77	2.29	2.26	1.35	1.43				
Al ₂ O ₃	11.49	9.60	3.18	3.27	6.76	6.46	7.82	6.05	2.39	1.91	7.34	7.25	7.20	7.78	6.59	6.75	7.26	9.14	12.29	11.88	6.98	6.48				
FeO	15.42	12.75	16.43	16.14	13.01	12.80	13.99	12.75	17.37	17.76	13.66	13.57	13.34	14.06	13.19	13.05	12.05	12.68	13.34	13.14	13.47	13.16				
MnO	0.42	0.66	2.14	1.96	1.72	1.66	0.97	1.05	1.72	1.71	0.97	1.36	0.96	0.92	0.57	0.67	0.46	0.46	0.29	0.26	0.50	0.47				
MgO	12.48	14.70	20.09	19.78	15.68	16.08	15.34	15.10	20.52	21.20	15.87	15.62	15.76	15.17	15.70	15.53	15.22	14.26	13.98	14.27	15.32	15.46				
CaO	10.60	10.42	2.19	2.83	9.43	9.72	9.42	9.02	1.91	1.56	9.94	9.77	9.53	9.74	10.82	10.31	10.96	10.54	10.28	10.32	10.50	10.62				
Na ₂ O	2.05	1.74	0.50	0.52	1.29	1.15	1.32	1.04	0.42	0.32	1.33	1.26	2.43	1.38	1.21	1.28	1.38	1.88	2.23	2.23	1.26	1.24				
K ₂ O	0.34	0.26	0.00	0.04	0.25	0.22	0.32	0.22	0.02	0.02	0.28	0.26	0.30	0.32	0.27	0.28	0.20	0.18	0.19	0.19	0.33	0.25				
Total	99.09	99.02	99.20	99.59	98.25	98.87	99.12	93.45	98.99	100.02	100.19	100.17	98.67	98.70	98.54	96.95	98.31	97.74	98.15	98.29	98.66	98.23				
O basis	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	
Si	6.552	7.034	7.663	7.671	7.144	7.189	7.013	7.190	7.697	7.738	7.082	7.118	6.984	6.988	7.074	7.051	7.117	6.820	6.328	6.379	7.060	7.104				
Ti	0.260	0.092	0.034	0.041	0.078	0.069	0.120	0.095	0.032	0.031	0.093	0.097	0.101	0.110	0.130	0.118	0.134	0.193	0.252	0.248	0.146	0.155				
Al	1.801	1.365	0.528	0.541	1.153	1.092	1.324	1.083	0.399	0.315	1.227	1.211	1.228	1.326	1.121	1.168	1.228	1.568	2.119	2.043	1.186	1.104				
Fe	1.532	1.586	1.937	1.894	1.573	1.534	1.681	1.618	2.058	2.080	1.620	1.609	1.616	1.700	1.593	1.601	1.447	1.544	1.632	1.603	1.625	1.592				
Mn	0.054	0.138	0.256	0.233	0.210	0.201	0.118	0.135	0.206	0.203	0.117	0.164	0.118	0.112	0.070	0.083	0.056	0.057	0.036	0.032	0.061	0.058				
Mg	3.109	3.314	4.222	4.139	3.379	3.437	3.285	3.415	4.332	4.427	3.355	3.301	3.403	3.269	3.379	3.398	3.257	3.095	3.048	3.102	3.294	3.334				
Ca	1.673	1.463	0.330	0.426	1.461	1.494	1.450	1.467	0.290	0.234	1.510	1.484	1.479	1.509	1.674	1.621	1.687	1.644	1.611	1.613	1.622	1.645				
Na	0.558	0.366	0.136	0.141	0.361	0.319	0.367	0.305	0.114	0.088	0.366	0.346	0.683	0.387	0.339	0.363	0.385	0.530	0.632	0.629	0.352	0.349				
K	0.053	0.035	0.000	0.007	0.047	0.040	0.058	0.042	0.003	0.004	0.051	0.048	0.056	0.059	0.050	0.052	0.036	0.033	0.035	0.036	0.061	0.046				
Total	15.593	15.392	15.106	15.092	15.405	15.375	15.417	15.348	15.130	15.119	15.421	15.377	15.670	15.462	15.430	15.455	15.346	15.485	15.693	15.685	15.407	15.386				
Mg#	75.8	76.0	70.4	70.1	76.6	77.4	74.3	74.8	70.2	70.1	76.1	74.8	77.1	75.4	77.6	78.5	76.0	74.5	77.9	78.2	75.0	75.6				

Mg# = 100 × Mg/(Mg + Fet), where Fet represents total Fe as Fe²⁺.

Appendix 3. Representative core compositions of orthopyroxene in volcanic rocks from Numazawa volcano.

Eruption age	43 ka				24 ka			5.4 ka				
Eruption name	Sozan				Maeyama		Numazawako					
Rock type	Lava		Enclave		Lava		Pumice		Black scoria		Gray scoria	
(wt. %)												
SiO ₂	54.11	53.75	53.77	53.40	53.06	53.25	54.35	54.07	54.12	53.09	54.19	53.61
TiO ₂	0.07	0.18	0.16	0.15	0.09	0.12	0.14	0.13	0.13	0.23	0.13	0.20
Al ₂ O ₃	0.54	1.53	0.42	0.67	0.59	0.97	0.45	0.58	0.68	1.42	0.62	0.85
Cr ₂ O ₃	0.00	0.02	0.01	0.00	0.00	0.01	0.04	0.00	0.00	0.01	0.00	0.02
FeO	21.43	19.80	15.58	17.08	20.60	20.86	21.35	20.22	22.28	22.09	22.62	21.02
MnO	1.88	0.92	2.12	2.40	1.65	1.80	1.60	1.38	1.51	1.15	1.67	1.32
MgO	23.90	24.88	23.38	19.75	22.07	22.36	23.19	23.53	23.14	22.35	23.11	24.03
NiO	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	0.56	1.33	2.19	2.92	0.74	0.63	0.68	0.91	0.91	1.60	0.76	0.66
Na ₂ O	0.00	0.01	0.19	0.60	0.02	0.01	0.02	0.01	0.05	0.04	0.02	0.06
Total	102.49	102.41	97.89	97.06	98.85	100.01	101.82	100.85	102.81	102.01	103.14	101.76
O basis	6	6	6	6	6	6	6	6	6	6	6	6
Si	0.901	0.895	0.895	0.889	0.883	0.887	0.905	0.900	0.901	0.884	0.902	0.893
Ti	0.001	0.002	0.002	0.002	0.001	0.001	0.002	0.002	0.002	0.003	0.002	0.002
Al	0.005	0.015	0.004	0.007	0.006	0.010	0.004	0.006	0.007	0.014	0.006	0.008
Cr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe	0.298	0.276	0.217	0.238	0.287	0.290	0.297	0.281	0.310	0.308	0.315	0.293
Mn	0.026	0.013	0.030	0.034	0.023	0.025	0.023	0.019	0.021	0.016	0.024	0.019
Mg	0.593	0.617	0.580	0.490	0.547	0.555	0.575	0.583	0.574	0.554	0.573	0.596
Ni	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ca	0.010	0.024	0.039	0.052	0.013	0.011	0.012	0.016	0.016	0.028	0.014	0.012
Na	0.000	0.000	0.003	0.010	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001
Total	2.009	2.011	1.994	1.987	1.996	1.998	2.000	2.000	2.008	2.008	2.008	2.010
Mg#	66.5	69.1	72.8	67.3	65.6	65.6	65.9	67.5	64.9	64.3	64.5	67.1

Mg# = 100 × Mg/(Mg + Fet), where Fet represents total Fe as Fe²⁺.

Appendix 4. Compositions of coexisting Fe–Ti oxides in selected volcanic rocks from Numazawa volcano.

Eruption age	110 ka		53 ka		5.4 ka	
Eruption name	Shirofukitoge		Mizunuma		Numazawako	
Rock type	Pumice		Pumice		Pumice	
Mgt/IIm	Mgt	IIm	Mgt	IIm	Mgt	IIm
(wt. %)						
SiO ₂	0.02	0.11	0.09	0.07	0.07	0.01
TiO ₂	4.68	36.75	4.95	37.22	5.94	37.39
Al ₂ O ₃	2.34	0.29	1.98	0.25	1.84	0.19
Cr ₂ O ₃	0.04	0.00	0.04	0.00	0.01	0.00
FeO	87.19	58.08	87.51	57.59	85.47	55.78
MnO	1.13	1.22	0.86	1.05	0.81	0.92
MgO	1.16	1.77	1.17	1.92	1.25	2.07
CaO	0.00	0.00	0.00	0.00	0.00	0.04
Total	96.56	98.21	96.61	98.11	95.38	96.39
FeO*	33.7	28.8	34.2	29.1	34.6	29.0
Fe ₂ O ₃ *	59.5	32.5	59.2	31.7	56.6	29.8
Recalculated total	102.5	101.5	102.5	101.3	101.1	99.4
X _{Usp} *	0.132		0.140		0.169	
X _{IIm} *		0.678		0.687		0.700
T (°C)**	747.5		755.1		794.6	
log ₁₀ f _{O₂} (ΔNNO)	1.57		1.52		1.39	

Mgt = magnetite; IIm = ilmenite; X_{Usp} = mole fraction of ulvöspinel; X_{IIm} = mole fraction of ilmenite.

* Calculated using the method of Stormer (1983).

** Calculated using the method of Holland and Blundy (1994).