Tables

Table 1 Classifications of landforms and geology in Nasuno-ga-hara proposed in previous studies.

Era	Sasaki *et al.* (1958)	Watanabe *et al.* (1960)	Koike (1961)	Akutsu (1962)	Oguchi **(the present study)**	Key Tephras (after Suzuki ,1993)
Holocene	Floodplain Deposits Forth Terrace Gravel	Recent River Gravel <Fujinita Volcanic Ash Soils Recent Terrace Gravel	Recent River Floodplain Post Volcani-Ash Soil Terraces	Recent River Deposits Kamikuroiso Gravel Sabui Gravel Okusawa Gravel	**Recent River Floodplain** **Recent River Gravel** Lower Terraces II	 Nt-I (12-13 ka)[1]
Pleistocene	< Brown Volcanic Ashes Third Terrace Gravel Second Terrace Gravel First Terrace Gravel	<Nasu Volcanic Ash Soils Nasu Alluvial-fan Gravel	< $L_{1\text{-}2}$ Volcanic Ash Soils Nasuno Surface (Lower Terraces I, II, III)	< Tahara and Takaragi Volcanic Ash Soils Nasuno Gravel	**Lower Terraces I (Main Alluvial-fan Surfaces)** **Nasuno Gravel**	AT (22-25 ka)[1] KP (31-32 ka)[2]
	Higher Terrace Gravel	<Torinome Volcanic Ash Soils Torinome Gravel	< $L_{2\text{-}2}$ Volcanic Ash Soils Middle Terraces < $L_{3\text{-}2}$ Volcanic Ash Soils Upper Terraces	< Hoshakuji Volcanic Ash Soils Kanemaruhara Gravel	Middle Terraces **Upper Terraces** **Torinome Gravel**	DKP (48 ka)[3] Mas (100 ka) Mzp 9,10 (135 ka)[4] Apm-U (300-350 ka)[5] MoP (>300 ka)
	Nasu Formation • Lava of Nasu-Volcano • Kuroiso Pyroclastic Rocks	Nasu Formation Kuroiso Volcanic mud-flow Nabekake Gravel	Nasu Hills	Kuroiso Volcanic Breccia/Nabekake Gravel menber	**Lower Hills** **Sakai-bayashi Gravel**	Kuroiso Dry Avalanche (≒500 ka) Nm-13 (500 ka)[5]
	Takahara Formation • Ohtawara Pumis Flow • Lava of Takahara-Volcano • Ainosawa Pyroclastic Rocks Yanagi-bayashi Gravel	Takahara Formation • Ohtawara Pumis-Flow • Ainosawa Pyroclastics • Yanagi-bayashi Gravel	Kitsuregawa Hills	Kawasaki Group • Wadayama Volcanic Breccia • Tatenokawa Tuff • Sakai-bayashi Gravel	**Upper Hills** **Yanagi-bayashi Gravel**	YG-HtB (830 ka)[6]

1) Machida and Arai (1992); 2) Suzuki (1976); 3) Machida and Arai (1979); 4)Suzuki (1992); 5) Suzuki and Hayakawa (1990); 6) Koike *et al.* (1985)

Table 2 List of rock samples

Samples	Sampling site	The longer diameter of rocks (cm)	Apparent thickness of weathering rind (mm)	Colour of groundmass
0-A1	**Loc. 1**	**6.3**	**-**	**gray**
0-A2	Loc. 1	5.9	-	brown
0-A3	Loc. 1	11.0	-	gray
0-A4	**Loc. 1**	**6.4**	**-**	**gray**
0-A5	Loc. 1	7.5	-	gray
0-A6	Loc. 1	12.5	-	brown
0-A7	Loc. 1	7.6	-	gray
0-A8	Loc. 1	6.0	-	gray
0-A9	Loc. 1	6.8	-	gray
0-A10	Loc. 1	7.6	-	gray
0-A11	Loc. 1	4.1	-	gray
0-A12	Loc. 1	7.5	-	gray
0-A13	Loc. 1	13.4	-	gray
0-A14	Loc. 1	6.0	-	gray
0-A15	Loc. 1	4.8	-	gray
0-A16	Loc. 1	14.0	-	gray
0-A17	Loc. 1	8.2	-	gray
0-A18	Loc. 1	7.8	-	gray
0-A19	Loc. 1	10.8	-	gray
0-B1	**Loc. 2**	**7.4**	**-**	**gray**
0-B2	Loc. 2	5.6	-	brown
0-B3	Loc. 2	6.6	-	gray
0-B4	Loc. 2	7.4	-	brown
0-B5	Loc. 2	11.4	-	brown
0-B6	Loc. 2	6.7	-	brown
0-B7	Loc. 2	10.8	-	green
0-B8	Loc. 2	6.5	-	gray
0-B9	Loc. 2	6.3	-	brown
0-B10	Loc. 2	20.2	-	gray
0-B11	Loc. 2	6.0	-	brown
0-B12	Loc. 2	9.0	-	gray
0-B13	Loc. 2	7.6	-	brown
0-B14	Loc. 2	6.6	-	gray
0-B15	Loc. 2	6.6	-	gray
0-B16	Loc. 2	6.4	-	green
0-B17	Loc. 2	9.1	-	gray
0-B18	Loc. 2	5.9	-	gray
0-B19	Loc. 2	7.9	-	gray
0-B20	Loc. 2	10.5	-	green
0-B21	Loc. 2	7.9	-	gray
0-B22	Loc. 2	6.0	-	gray
0-B23	Loc. 2	7.5	-	brown
0-B24	Loc. 2	10.4	-	gray
0-B25	Loc. 2	7.6	-	brown
0-B26	Loc. 2	6.7	-	brown
0-B27	Loc. 2	10.2	-	gray
0-B28	Loc. 2	9.3	-	gray
0-B29	Loc. 2	6.0	-	gray
0-B30	Loc. 2	8.0	-	gray
0-B31	Loc. 2	7.6	-	brown
0-B32	Loc. 2	5.6	-	gray
0-B33	Loc. 2	7.4	-	brown
0-B34	Loc. 2	11.2	-	brown
0-B35	Loc. 2	8.4	-	gray
0-B36	Loc. 2	8.0	-	gray
0-B37	**Loc. 2**	**7.5**	**-**	**gray**
20-A1	Loc. 3	9.6	-	gray
20-A2	Loc. 3	8.1	-	brown
20-A3	**Loc. 3**	**6.0**	**5.0**	**gray**
20-A4	Loc. 3	6.1	-	gray
20-A5	Loc. 3	5.0	6.0	gray
20-A6	Loc. 3	7.6	-	gray
20-A7	Loc. 3	10.0	-	gray
20-A8	Loc. 3	8.2	-	green
20-A9	Loc. 3	7.2	-	gray
20-A10	Loc. 3	4.7	5.0	gray
20-A11	Loc. 3	7.0	-	brown
20-A12	Loc. 3	7.2	-	gray
20-A13	Loc. 3	5.3	1.0	gray
20-A14	Loc. 3	8.2	1.0	gray
20-A15	Loc. 3	6.7	-	gray
20-A16	**Loc. 3**	**6.8**	**-**	**gray**
20-A17	Loc. 3	4.6	-	gray
20-A18	Loc. 3	7.0	-	gray
20-A19	Loc. 3	4.6	-	gray
20-A20	Loc. 3	6.4	6.0	gray
20-A21	Loc. 3	9.2	-	gray
20-B1	Loc. 4	8.2	-	brown
20-B2	Loc. 4	5.4	1.0	gray
20-B3	Loc. 4	8.0	-	gray
20-B4	Loc. 4	6.2	5.0	gray
20-B5	Loc. 4	7.3	-	gray
20-B6	Loc. 4	10.8	-	gray
20-B7	Loc. 4	10.3	-	gray
20-B8	Loc. 4	10.6	4.0	gray
20-B9	Loc. 4	8.8	-	brown
20-B10	Loc. 4	6.5	-	brown
20-B11	Loc. 4	6.0	0.5	gray
20-B12	Loc. 4	6.1	0.5	gray
20-B13	Loc. 4	8.5	0.5	gray
20-B14	Loc. 4	6.0	-	green
20-B15	Loc. 4	6.7	-	green
20-B16	Loc. 4	5.0	0.5	gray
20-B17	Loc. 4	16.0	-	brown
20-B18	Loc. 4	9.3	1.0	brown
20-B19	Loc. 4	6.5	-	brown
20-B20	Loc. 4	7.5	0.5	brown
20-B21	Loc. 4	4.5	0.3	gray
20-B22	Loc. 4	7.0	-	gray
20-B23	Loc. 4	7.9	-	gray
20-B24	Loc. 4	9.6	-	gray
20-B25	Loc. 4	9.9	-	brown
[illegible]	[illegible]	[illegible]	-	[illegible]

Samples	Sampling site	The longer diameter of rocks (cm)	Apparent thickness of weathering rind (mm)	Colour of groundmass
320-A1	Loc. 5	11.0	2.0	gray
320-A2	Loc. 5	11.0	1.2	gray
320-A3	Loc. 5	7.5	1.9	gray
320-A4	Loc. 5	9.2	1.9	gray
320-A5	Loc. 5	9.0	1.5	gray
320-A6	Loc. 5	9.5	1.4	gray
320-B1	Loc. 6	9.5	2.9	brown
320-B2	Loc. 6	7.6	1.6	brown
320-B3	Loc. 6	6.5	0.0	gray
320-B4	Loc. 6	6.5	4.5	gray
320-B5	**Loc. 6**	**7.0**	**4.0**	gray
320-B6	Loc. 6	9.2	3.8	gray
320-B7	Loc. 6	6.7	3.3	brown
320-B8	Loc. 6	7.4	4.2	gray
320-B9	Loc. 6	8.4	2.1	brown
320-B10	**Loc. 6**	**16.0**	**4.0**	gray
320-B11	Loc. 6	12.0	3.4	gray
320-B12	Loc. 6	8.0	12.6	green
320-B13	Loc. 6	11.5	2.4	gray
320-B14	Loc. 6	9.4	3.8	green
320-B15	Loc. 6	5.3	4.5	gray
320-B16	Loc. 6	6.4	1.8	brown
320-B17	Loc. 6	10.0	0.2	gray
320-B18	Loc. 6	4.4	3.0	gray
320-B19	Loc. 6	8.4	2.6	gray
320-B20	**Loc. 6**	**7.3**	**3.0**	gray
320-B21	Loc. 6	7.0	2.1	gray
320-B22	**Loc. 6**	**20.0**	**2.4**	gray
450-A1	Loc. 7	6.6	4.5	gray
450-A2	Loc. 7	4.0	3.3	gray
450-B1	**Loc. 8**	**5.5**	**3.3**	gray
450-B2	Loc. 8	9.5	2.0	gray
450-B3	Loc. 8	12.0	2.2	gray
450-B4	Loc. 8	5.5	5.6	gray
450-B5	Loc. 8	10.0	3.4	gray
450-B6	Loc. 8	9.0	1.9	gray
450-B7	Loc. 8	9.6	2.8	gray
450-B8	Loc. 8	0.1	3.2	gray
450-B9	Loc. 8	8.4	2.3	gray
450-B10	**Loc. 8**	**17.2**	**3.1**	gray
450-B11	Loc. 8	11.0	4.4	gray
450-B12	Loc. 8	7.3	4.4	gray
450-B13	Loc. 8	7.3	4.8	gray
450-B14	Loc. 8	9.5	3.9	gray
450-B15	Loc. 8	6.8	3.9	gray
450-B16	Loc. 8	14.0	6.4	gray
450-B17	Loc. 8	5.9	4.5	gray
450-B18	Loc. 8	7.0	11.9	gray
450-B19	Loc. 8	9.0	3.5	gray
450-B20	Loc. 8	16.0	1.1	gray
450-B21	Loc. 8	12.5	3.3	gray
450-B22	Loc. 8	9.8	3.6	gray
450-B23	Loc. 8	5.9	2.8	brown
450-B24	Loc. 8	8.3	5.6	gray
450-B25	Loc. 8	5.4	2.7	gray
450-B26	Loc. 8	5.0	2.6	gray
450-B27	Loc. 8	8.2	4.7	gray
450-B28	Loc. 8	7.1	5.5	gray
450-B29	Loc. 8	6.0	2.3	gray
450-B30	Loc. 8	13.4	2.2	brown
450-B31	Loc. 8	6.5	3.4	gray
450-B32	Loc. 8	9.5	4.2	gray
450-B33	Loc. 8	6.2	4.7	gray
450-B34	Loc. 8	6.7	2.3	gray
450-B35	Loc. 8	9.5	5.0	gray
450-B36	Loc. 8	9.0	3.4	gray
450-B37	Loc. 8	12.0	4.1	gray
450-B38	**Loc. 8**	**7.5**	**4.3**	gray
450-B39	**Loc. 8**	**6.7**	**3.6**	gray
450-B40	Loc. 8	13.0	2.5	gray
450-B41	Loc. 8	8.2	5.4	gray
450-B42	Loc. 8	7.5	3.3	gray
450-B43	Loc. 8	7.3	3.0	gray
450-B44	Loc. 8	8.9	4.1	gray
450-B45	Loc. 8	9.0	2.8	gray
450-B46	Loc. 8	6.5	5.0	gray
450-B47	Loc. 8	7.4	4.5	gray
450-B48	Loc. 8	10.5	3.9	gray
450-B49	Loc. 8	5.5	6.0	gray
450-B50	Loc. 8	7.0	2.7	gray
450-B51	Loc. 8	5.8	4.7	gray
450-B52	Loc. 8	7.2	3.3	gray
450-B53	Loc. 8	8.4	5.4	brown
450-B54	Loc. 8	4.0	2.3	gray
450-B55	Loc. 8	4.7	3.8	gray
450-B56	Loc. 8	8.4	2.3	gray
450-B57	Loc. 8	4.8	4.5	gray
450-B58	Loc. 8	5.1	3.4	gray
450-B59	Loc. 8	8.5	3.5	gray
450-B60	Loc. 8	6.7	3.3	gray
450-B61	Loc. 8	15.0	3.5	gray
450-B62	Loc. 8	28.0	3.7	gray
450-B63	Loc. 8	7.3	3.3	gray
450-B64	**Loc. 8**	**7.8**	**4.5**	gray
450-B65	Loc. 8	11.5	2.2	gray
450-C1	Loc. 9	21.2	2.0	gray
838-A1	**Loc. 10**	**12.9**	**5.8**	gray
Average	0-ka rocks	8.1	-	
Average	20-ka rocks	7.5	2.4	
Average	320-ka rocks	9.0	2.9	
Average	450-ka rocks	8.6	3.8	

Table 3 Results of X-ray diffraction.

Samples	Q	T	Pl	Px	Mgn	Z	K	S	Mgh	H
0-ka rocks										
0-A4, Inner part	△	○	◎	○	△	-	-	-	-	-
0-A6, Inner part	△	○	◎	○	△	-	-	-	-	-
0-B1, Inner part	△	○	◎	○	△	-	-	-	-	-
0-B7, Inner part	○	○	◎	○	△	-	-	-	-	-
20-ka rocks										
20-A1, Inner part	△	○	◎	○	△	◎	-	-	-	-
20-A3, Inner part	△	○	◎	○	△	-	-	-	-	-
20-A16, Inner part	○	○	◎	○	△	-	-	-	-	-
20-B2, Inner part	○	○	◎	○	△	-	-	-	-	-
20-B2, Brown layer (<0.1m	○	○	△	△	-	-	-	-	-	○
20-B6, Inner part	△	○	◎	○	△	-	-	-	-	-
320-ka rocks										
320-B5, Inner part	○	○	◎	○	△	-	△	-	-	-
320-B5, Brown layer	○	△	△	△	△	-	○	△	-	-
320-B10, Inner part	○	○	◎	○	△	-	-	-	-	-
320-B10, Brown layer	○	△	△	△	△	-	○	△	○	-
320-B20, Inner part	△	○	◎	○	△	-	-	-	-	-
320-B20, Brown layer	△	△	△	△	△	-	△	-	-	-
320-B22, Inner part	△	○	◎	○	△	-	-	-	-	-
320-B22, Brown layer	△	△	△	△	△	-	△	△	-	-
450-ka rocks										
450-B1, Inner part	○	○	◎	○	△	-	-	-	-	-
450-B1, Brown layer	○	△	△	△	△	-	△	-	-	-
450-B10, Inner part	△	△	◎	○	△	-	-	-	-	-
450-B10, Brown layer	△	△	△	△	△	-	△	△	-	-
450-B38, Inner part	○	○	◎	○	△	-	△	-	-	-
450-B38, Brown layer	○	△	△	△	△	-	○	-	-	-
450-B39, Inner part	△	△	◎	○	△	-	△	-	-	-
450-B39, Brown layer	△	△	△	△	△	-	○	-	-	-
450-B64, Inner part	○	○	◎	○	△	-	△	-	-	-
450-B64 Brown layer	○	△	△	△	△	-	△	△	-	-
830-ka rocks										
830-A1, Inner part	○	○	◎	○	△	-	-	-	-	-
830-A1, Brown layer	○	△	△	△	△	-	○	△	-	-

Q: Quartz, T: Trydimite, P: Plagioclase, Px: Pyroxene, Mgn: Magnetite, Z: Zeolite,
K: Kaolin minerals, S: Smectite, Mgh: Maghemite, H: Hematite

Table 4 Volume of pores with sub-range of pore diameter from the PSD measurement.

Samples	V_α, mm^3/g	V_β, $mm^3/$	V_γ, mm	V_δ, mm^3/g	V_t, mm^3g
0 ka (Inner parts)					
0-A1	2.1229	4.0405	3.8593	7.8794	17.9022
0-A4	1.1909	1.5448	2.7192	3.5060	8.9609
0-B1	1.0028	0.8030	3.0739	6.0431	10.9228
0-B37	1.3441	2.4220	6.7926	5.0267	15.5853
Average	***1.4152***	***2.2026***	***4.1112***	***5.6138***	***13.3428***
20 ka (Inner parts)					
20-A1	1.9549	3.2851	1.9432	8.1041	15.2872
20-A3	1.4592	1.3425	1.5807	9.5989	13.9813
20-A16	1.9396	4.5899	4.8062	2.4753	13.8111
20-B2	1.4235	1.2245	14.3528	2.8549	19.8556
20-B6	2.9854	6.6473	10.6682	7.2151	27.5161
Average	***2.2044***	***3.9359***	***12.5105***	***5.0350***	***23.6858***
320 ka (Inner parts)					
320-B5	2.9253	9.0869	7.8024	14.6627	34.4772
320-B10	1.0201	1.2343	1.4501	4.1155	7.8201
320-B20	5.9196	4.5359	6.8316	8.9727	26.2597
320-B22	1.3003	2.0807	2.3482	10.8780	16.6073
Average	***2.7913***	***4.2345***	***4.6081***	***9.6572***	***21.2911***
320 ka (Brown layers)					
320-B5	24.6117	39.3046	83.4741	18.4807	165.8711
320-B10	33.3253	39.5387	93.9595	39.3556	206.1791
320-B20	84.7236	241.7794	36.8317	0.0000	363.3346
320-B22	12.8463	53.8908	69.7220	47.9633	184.4224
Average	***38.8767***	***93.6284***	***70.9968***	***26.4499***	***229.9518***
450 ka (Inner parts)					
450-B1	0.7187	0.5920	0.7230	6.3707	8.4044
450-B10	0.8404	0.6765	0.6213	1.0213	3.1596
450-B12	3.3352	4.4481	3.3062	7.0926	18.1821
450-B37	1.5553	1.5189	1.3552	5.0760	9.5054
450-B38	1.6757	4.6596	3.1865	8.1426	17.6643
450-B39	4.3739	11.1324	9.5261	10.5162	35.5486
450-B64	3.6885	4.2367	4.5382	14.8128	27.2761
450-C1	1.5662	2.2424	2.4206	9.0700	15.2992
Average	***2.2192***	***3.6883***	***3.2096***	***7.7628***	***16.8800***
450 ka (White layers)					
450-B64	4.5587	9.7283	14.3134	13.7502	42.3506
450 ka (Brown layers)					
450-B1	12.0556	108.5896	212.7586	26.5769	359.9808
450-B10	63.6768	442.0637	105.6119	27.7545	639.1069
450-B12	24.7445	232.4982	80.3587	46.0986	383.7000
450-B38	32.8754	182.3437	60.1063	33.8372	309.1626
450-B39	35.7825	113.2424	89.9077	61.0800	300.0126
450-B64	17.8091	128.3461	84.1599	20.7235	251.0386
Average	***31.1573***	***201.1806***	***105.4838***	***36.0118***	***373.8336***
830 ka (Inner parts)					
830-A1	1.2217	1.5627	2.0727	4.1853	9.0424
830 ka (Brown layers)					
830-A1	40.9261	112.8092	69.1785	36.1935	259.1073

V_α: Volume of pores with 33-3 μ m diameter

V_β: Volume of pores with 3-0.3 μ m diameter

V_γ: Volume of pores with 0.3-0.03 μ m diameter

V_δ: Volume of pores with 0.03-0.003 μ m diameter

V_t: Volume of pores with 33-0.003 μ m diameter

Sampl	Th	U	V	Y	Zr	Ig. Loss (%)	Total (%)
0-ka rc							
0-A4 9	3.924	1.196	64.495	34.958	190.859	4.480	**95.520**
0-A6 7	2.509	-0.099	142.612	28.258	94.459	-	**100.105**
0-B1 6	4.360	1.459	283.969	39.086	139.818	0.306	**99.694**
0-B37 0	4.021	0.564	175.914	25.033	110.289	-	**100.162**
Averaβ	***4.191***	***1.012***	***229.942***	***32.060***	***125.054***	***0.306***	***99.928***
20-ka I							
20-A1 6	4.324	0.747	94.067	30.319	160.683	1.378	**98.622**
20-A3 4	3.702	0.490	188.939	32.869	115.409	1.064	**98.936**
20-A1t0	2.365	-0.006	215.815	21.764	75.338	-	**100.358**
20-B2 7	0.713	1.484	36.609	34.648	122.165	0.514	**99.486**
20-B6 9	3.837	1.170	215.303	23.886	98.117	-	**100.800**
Averaβ	***2.275***	***1.327***	***125.956***	***29.267***	***110.141***	***0.514***	***100.143***
320-ka							
320-B13	4.809	1.254	124.406	36.579	136.909	1.177	**98.823**
320-B15	5.108	1.033	106.284	38.903	152.483	2.036	**97.964**
320-B14	3.142	1.320	267.868	35.400	137.311	-	**101.197**
320-B19	5.000	1.188	182.552	29.695	97.047	-	**100.825**
Averaβ	***4.515***	***1.199***	***170.278***	***35.144***	***130.938***	***1.606***	***99.702***
320-ka							
320-B15	7.104	1.400	189.116	29.898	190.061	5.522	**94.478**
320-B12	6.682	0.974	170.961	37.805	200.034	-	**102.686**
320-B15	6.034	1.422	500.451	42.903	198.247	6.060	**93.940**
320-B14	4.349	0.499	479.594	32.312	122.312	8.663	**91.337**
Averaβ	***6.042***	***1.074***	***335.031***	***35.730***	***177.664***	***6.748***	***95.610***
450-ka							
450-B10	3.639	0.903	216.638	24.074	98.570	1.228	**98.772**
450-B11	1.844	0.267	230.349	22.657	56.763	-	**101.577**
450-B15	2.112	1.336	242.444	24.835	75.131	4.174	**95.826**
450-B16	1.992	0.432	242.726	21.005	49.011	0.988	**99.012**
450-B11	3.514	1.038	72.715	39.793	151.783	2.741	**97.259**
Averaβ	***2.620***	***0.795***	***200.974***	***26.473***	***86.252***	***2.283***	***98.489***
450-ka							
450-B12	3.366	0.393	81.137	33.180	160.235	1.090	**98.910**
450-ka							
450-B12	8.268	1.861	576.033	26.179	249.482	6.985	**93.015**
450-B16	1.465	0.745	694.055	29.206	110.738	6.773	**93.227**
450\-B9	2.466	0.532	378.684	23.094	108.726	10.630	**89.370**
450-B10	1.540	-0.127	233.483	19.962	49.127	11.439	**88.561**
450-B13	4.550	0.901	116.366	33.031	224.197	3.989	**96.011**
Averaβ	***3.658***	***0.782***	***399.724***	***26.294***	***148.454***	***7.963***	***92.037***
830-ka							
830-A12	2.397	1.141	168.660	28.451	98.997	-	**102.741**
830-ka							
830-A16	4.117	1.120	341.184	17.301	145.625	4.723	**95.277**

Table 6 Chemical compositions from XRF analysis.

	Major elements (wt %)										*Minor elements (ppm)*														
Samples	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Ba	Cu	Ga	Mo	Nb	Ni	Pb	Rb	Sr	Th	U	V	Y	Zr	lg. Loss (%)	Total (%)
0-ka rocks (Inner parts)																										
0-A4	65.909	0.631	13.732	4.547	0.097	1.095	4.251	3.391	1.602	0.154	474.727	11.895	18.711	2.479	6.032	3.209	10.160	53.718	238.469	3.924	1.196	64.495	34.958	190.859	4.480	**95.520**
0-A6	60.352	0.942	16.564	8.933	0.181	1.638	7.213	3.295	0.720	0.181	221.257	37.539	20.684	1.070	4.332	3.590	4.537	18.582	276.887	2.509	-0.099	142.612	28.258	94.459	-	**100.105**
0-B1	60.659	1.200	14.928	10.598	0.151	2.243	5.901	2.437	1.257	0.191	437.818	76.306	18.800	1.319	5.047	16.740	5.973	41.910	217.696	4.360	1.459	283.969	39.086	139.818	0.306	**99.694**
0-B37	60.614	0.728	16.349	7.987	0.126	3.086	7.116	2.809	1.109	0.139	335.501	23.537	19.233	1.598	4.238	20.351	3.771	32.390	235.300	4.021	0.564	175.914	25.033	110.289	-	**100.162**
Average	***60.637***	***0.964***	***15.639***	***9.293***	***0.139***	***2.665***	***6.509***	***2.623***	***1.183***	***0.165***	***386.660***	***49.922***	***19.017***	***1.459***	***4.643***	***18.546***	***4.872***	***37.150***	***226.498***	***4.191***	***1.012***	***229.942***	***32.060***	***125.054***	***0.306***	***99.928***
20-ka rocks (Inner parts)																										
20-A1	65.817	0.693	15.369	5.539	0.120	1.228	4.712	3.280	1.589	0.170	412.883	24.398	19.210	2.203	5.452	4.256	7.720	51.706	229.756	4.324	0.747	94.067	30.319	160.683	1.378	**98.622**
20-A3	59.638	0.817	15.994	8.300	0.112	3.358	6.907	2.501	1.046	0.153	403.690	24.412	19.183	1.371	4.483	16.850	6.456	32.670	253.294	3.702	0.490	188.939	32.869	115.409	1.064	**98.936**
20-A16	54.866	0.744	18.879	9.473	0.153	3.735	8.726	2.721	0.747	0.220	251.078	35.415	19.434	0.353	2.869	27.828	3.357	18.871	263.430	2.365	-0.006	215.815	21.764	75.338	-	**100.358**
20-B2	71.464	0.764	13.247	4.318	0.111	1.519	1.132	5.778	0.884	0.180	502.344	3.732	16.597	1.337	6.754	10.469	4.489	14.833	129.827	0.713	1.484	36.609	34.648	122.165	0.514	**99.486**
20-B6	58.243	0.775	17.939	9.340	0.169	3.198	7.390	2.516	0.988	0.138	314.761	29.905	21.140	1.001	4.232	20.373	4.852	26.448	273.199	3.837	1.170	215.303	23.886	98.117	-	**100.800**
Average	***64.854***	***0.770***	***15.593***	***6.829***	***0.140***	***2.359***	***4.261***	***4.147***	***0.936***	***0.159***	***408.553***	***16.819***	***18.869***	***1.169***	***5.493***	***15.421***	***4.671***	***20.641***	***201.513***	***2.275***	***1.327***	***125.956***	***29.267***	***110.141***	***0.514***	***100.143***
320-ka rocks (Inner parts)																										
320-B10	63.764	0.661	15.680	6.300	0.099	2.058	5.581	2.995	1.424	0.154	386.817	38.125	19.111	1.796	4.568	7.995	20.546	46.216	242.963	4.809	1.254	124.406	36.579	136.909	1.177	**98.823**
320-B5	65.305	0.643	16.479	5.297	0.070	2.080	3.673	2.619	1.539	0.147	494.789	30.704	20.354	1.494	5.986	6.812	11.410	48.338	194.875	5.108	1.033	106.284	38.903	152.483	2.036	**97.964**
320-B20	62.297	1.144	14.733	9.483	0.148	2.247	6.712	2.875	1.252	0.182	358.460	89.821	19.307	2.164	4.093	35.668	5.658	39.615	239.744	3.142	1.320	267.868	35.400	137.311	-	**101.197**
320-B22	59.887	0.758	16.478	9.960	0.130	3.432	6.617	2.274	1.063	0.129	301.576	42.405	19.397	1.357	3.667	30.502	4.340	33.488	220.299	5.000	1.188	182.552	29.695	97.047	-	**100.825**
Average	***62.813***	***0.802***	***15.843***	***7.760***	***0.112***	***2.454***	***5.646***	***2.691***	***1.320***	***0.153***	***385.411***	***50.264***	***19.542***	***1.703***	***4.579***	***20.244***	***10.489***	***41.914***	***224.470***	***4.515***	***1.199***	***170.278***	***35.144***	***130.938***	***1.606***	***99.702***
320-ka rocks (Brown layers)																										
320-B10	63.604	0.825	17.043	9.451	0.072	0.620	0.352	0.619	1.681	0.139	-	31.438	23.152	2.482	6.122	35.303	16.279	58.279	126.235	7.104	1.400	189.116	29.898	190.061	5.522	**94.478**
320-B5	62.837	0.691	17.875	8.493	0.154	2.940	5.864	2.666	0.927	0.107	685.037	26.386	22.772	2.116	6.784	18.525	10.322	58.468	70.982	6.682	0.974	170.961	37.805	200.034	-	**102.686**
320-B20	54.057	1.592	13.854	21.246	0.066	0.743	0.563	0.447	0.978	0.250	432.841	94.243	27.536	2.181	7.497	47.770	12.920	24.900	38.045	6.034	1.422	500.451	42.903	198.247	6.060	**93.940**
320-B22	54.096	0.853	16.864	15.497	0.100	0.959	0.628	0.622	1.345	0.188	925.134	65.700	21.119	1.209	5.156	49.208	17.602	45.777	83.984	4.349	0.499	479.594	32.312	122.312	8.663	**91.337**
Average	***58.649***	***0.990***	***16.409***	***13.672***	***0.098***	***1.316***	***1.852***	***1.089***	***1.233***	***0.171***	***681.004***	***54.442***	***23.645***	***1.997***	***6.390***	***37.702***	***14.281***	***46.856***	***79.812***	***6.042***	***1.074***	***335.031***	***35.730***	***177.664***	***6.748***	***95.610***
450-ka rocks (Inner parts)																										
450-B1	56.854	0.762	17.799	9.490	0.151	2.939	7.282	2.313	0.943	0.138	303.422	56.283	19.619	1.089	3.976	15.802	18.825	25.234	225.810	3.639	0.903	216.638	24.074	98.570	1.228	**98.772**
450-B10	53.857	0.791	17.960	10.791	0.175	5.373	9.766	2.191	0.416	0.156	267.769	57.253	20.305	1.437	3.437	43.271	2.293	13.295	285.061	1.844	0.267	230.349	22.657	56.763	-	**101.577**
450-B38	55.000	0.791	17.056	10.081	0.169	3.264	6.480	2.171	0.602	0.120	251.961	42.490	18.532	0.754	3.445	21.326	3.978	19.426	207.745	2.112	1.336	242.444	24.835	75.131	4.174	**95.826**
450-B39	49.899	0.759	22.728	11.044	0.177	4.062	8.124	1.732	0.215	0.172	273.607	60.368	21.004	0.892	2.350	26.136	3.840	4.667	288.286	1.992	0.432	242.726	21.005	49.011	0.988	**99.012**
450-B64	65.990	0.804	14.657	6.611	0.104	1.000	3.336	3.142	1.341	0.180	388.383	20.073	19.417	2.111	5.078	6.673	5.852	40.324	182.511	3.514	1.038	72.715	39.793	151.783	2.741	**97.259**
Average	***56.320***	***0.781***	***18.040***	***9.603***	***0.155***	***3.328***	***6.998***	***2.310***	***0.703***	***0.153***	***297.028***	***47.293***	***19.775***	***1.257***	***3.657***	***22.642***	***6.958***	***20.589***	***237.883***	***2.620***	***0.795***	***200.974***	***26.473***	***86.252***	***2.283***	***98.489***
450-ka rocks (White layers)																										
450-B64	66.826	0.833	15.376	6.936	0.095	0.973	2.986	3.208	1.400	0.177	463.838	18.821	18.792	1.968	4.451	3.426	5.563	42.275	166.822	3.366	0.393	81.137	33.180	160.235	1.090	**98.910**
450-ka rocks (Brown layers)																										
450-B1	60.146	1.863	9.198	18.594	0.057	0.444	0.317	0.363	1.635	0.225	571.083	81.568	28.512	3.113	6.090	22.147	16.908	60.647	76.652	8.268	1.861	576.033	26.179	249.482	6.985	**93.015**
450-B10	52.992	1.120	18.413	15.281	0.200	1.382	2.098	0.706	0.680	0.158	654.928	196.676	32.287	1.437	4.591	187.436	3.432	18.845	33.216	1.465	0.745	694.055	29.206	110.738	6.773	**93.227**
450\-B38	44.477	1.774	13.790	25.864	0.164	1.938	0.492	0.118	0.429	0.171	733.993	86.447	25.603	1.118	4.515	29.619	7.737	23.966	102.479	2.466	0.532	378.684	23.094	108.726	10.630	**89.370**
450-B39	43.345	1.180	23.346	17.037	0.095	0.982	1.781	0.304	0.167	0.225	277.617	64.806	19.465	0.261	2.801	26.284	5.762	5.404	285.580	1.540	-0.127	233.483	19.962	49.127	11.439	**88.561**
450-B64	68.682	1.095	11.747	9.635	0.158	0.674	0.704	1.630	1.436	0.141	506.646	32.587	23.046	2.873	6.424	8.858	9.618	47.038	74.113	4.550	0.901	116.366	33.031	224.197	3.989	**96.011**
Average	***53.928***	***1.406***	***15.299***	***17.282***	***0.135***	***1.084***	***1.078***	***0.624***	***0.869***	***0.184***	***548.853***	***92.417***	***25.783***	***1.760***	***4.884***	***54.869***	***8.691***	***31.180***	***114.408***	***3.658***	***0.782***	***399.724***	***26.294***	***148.454***	***7.963***	***92.037***
830-ka rocks (Inner parts)																										
830-A1	62.877	0.692	17.909	8.502	0.153	2.935	5.872	2.671	0.928	0.107	362.523	19.809	19.567	1.806	3.127	28.266	4.365	28.529	184.342	2.397	1.141	168.660	28.451	98.997	-	**102.741**
830-ka rocks (Brown layers)																										
830-A1	62.654	0.939	17.235	12.169	0.053	0.425	0.140	0.437	0.946	0.132	786.116	42.431	21.534	1.969	4.346	29.345	8.525	32.616	36.826	4.117	1.120	341.184	17.301	145.625	4.723	**95.277**

Table 7 The absolute weights in unit volume of chemical elements.

	Major elements (g/cm^3)										*Minor elements (mg/cm^3)*														
Samples	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Ba	Cu	Ga	Mo	Nb	Ni	Pb	Rb	Sr	Th	U	V	Y	Zr	Ig. Loss (g/cm^3)	Total(g/cm^3)
0-ka rocks (Inner parts)																										
0-A4	1.653	0.016	0.344	0.004	0.114	0.002	0.027	0.107	0.085	0.040	119.076	2.984	4.693	0.622	1.513	0.805	2.548	13.474	59.815	0.984	0.300	16.177	8.769	47.873	0.112	2.673
0-A6	1.537	0.024	0.422	0.005	0.228	0.005	0.042	0.184	0.084	0.018	56.365	9.563	5.269	0.273	1.104	0.915	1.156	4.734	70.536	0.639	-0.025	36.330	7.199	24.063	-	2.766
0-B1	1.601	0.032	0.394	0.005	0.280	0.004	0.059	0.156	0.064	0.033	115.565	20.142	4.962	0.348	1.332	4.419	1.577	11.062	57.462	1.151	0.385	74.956	10.317	36.906	0.008	2.969
0-B37	1.584	0.019	0.427	0.004	0.209	0.003	0.081	0.186	0.073	0.029	87.666	6.150	5.026	0.418	1.107	5.318	0.985	8.464	61.484	1.051	0.147	45.966	6.541	28.819	-	2.874
Average	*1.592*	*0.025*	*0.411*	*0.004*	*0.244*	*0.004*	*0.070*	*0.171*	*0.069*	*0.031*	*101.616*	*13.146*	*4.994*	*0.383*	*1.220*	*4.868*	*1.281*	*9.763*	*59.473*	*1.101*	*0.266*	*60.461*	*8.429*	*32.862*	*0.008*	2.921
20-ka rocks (Inner parts)																										
20-A1	1.624	0.017	0.379	0.004	0.137	0.003	0.030	0.116	0.081	0.039	101.902	6.022	4.741	0.544	1.346	1.050	1.905	12.761	56.705	1.067	0.184	23.216	7.483	39.657	0.034	2.690
20-A3	1.522	0.021	0.408	0.004	0.212	0.003	0.086	0.176	0.064	0.027	103.014	6.229	4.895	0.350	1.144	4.300	1.647	8.337	64.636	0.945	0.125	48.213	8.388	29.450	-	2.804
20-A16	1.481	0.020	0.509	0.006	0.256	0.004	0.101	0.235	0.073	0.020	67.751	9.556	5.244	0.095	0.774	7.509	0.906	5.092	71.084	0.638	-0.002	58.236	5.873	20.329	-	2.959
20-B2	1.764	0.019	0.327	0.004	0.107	0.003	0.037	0.028	0.143	0.022	123.996	0.921	4.097	0.330	1.667	2.584	1.108	3.661	32.046	0.176	0.366	9.036	8.552	30.155	0.013	2.672
20-B6	1.478	0.020	0.455	0.004	0.237	0.004	0.081	0.188	0.064	0.025	79.867	7.588	5.364	0.254	1.074	5.169	1.231	6.711	69.322	0.974	0.297	54.631	6.061	24.896	-	2.818
Average	*1.621*	*0.019*	*0.391*	*0.004*	*0.172*	*0.004*	*0.059*	*0.108*	*0.103*	*0.023*	*101.932*	*4.255*	*4.730*	*0.292*	*1.370*	*3.877*	*1.170*	*5.186*	*50.684*	*0.575*	*0.332*	*31.834*	*7.307*	*27.525*	*0.013*	2.745
320-ka rocks (Inner parts)																										
320-B10	1.641	0.017	0.404	0.004	0.162	0.003	0.053	0.144	0.077	0.037	99.572	9.814	4.919	0.462	1.176	2.058	5.289	11.897	62.542	1.238	0.323	32.024	9.416	35.242	0.030	2.817
320-B5	1.532	0.015	0.387	0.003	0.124	0.002	0.049	0.086	0.061	0.036	116.092	7.204	4.776	0.351	1.404	1.598	2.677	11.342	45.724	1.198	0.242	24.937	9.128	35.777	-	2.558
320-B20	1.542	0.028	0.365	0.005	0.235	0.004	0.056	0.166	0.071	0.031	88.730	22.233	4.779	0.536	1.013	8.829	1.401	9.806	59.344	0.778	0.327	66.305	8.763	33.989	-	2.809
320-B22	1.533	0.019	0.422	0.003	0.255	0.003	0.088	0.169	0.058	0.027	77.173	10.851	4.964	0.347	0.938	7.805	1.111	8.570	56.375	1.280	0.304	46.715	7.599	24.834	-	2.826
Average	*1.562*	*0.020*	*0.394*	*0.004*	*0.194*	*0.003*	*0.061*	*0.141*	*0.067*	*0.033*	*95.392*	*12.526*	*4.859*	*0.424*	*1.133*	*5.073*	*2.619*	*10.403*	*55.996*	*1.123*	*0.299*	*42.495*	*8.726*	*32.461*	*0.030*	2.753
320-ka rocks (Brown layers)																										
320-B10	1.016	0.013	0.272	0.002	0.151	0.001	0.010	0.006	0.010	0.027	-	5.021	3.698	0.396	0.978	5.639	2.600	9.308	20.162	1.135	0.224	30.206	4.775	30.357	0.088	1.622
320-B5	1.088	0.012	0.310	0.002	0.147	0.003	0.051	0.102	0.046	0.016	118.666	4.571	3.945	0.367	1.175	3.209	1.788	10.128	12.296	1.157	0.169	29.615	6.549	34.651	-	2.005
320-B20	0.591	0.017	0.151	0.003	0.232	0.001	0.008	0.006	0.005	0.011	47.320	10.303	3.010	0.238	0.820	5.222	1.412	2.722	4.159	0.660	0.155	54.712	4.690	21.673	-	1.183
320-B22	0.911	0.014	0.284	0.003	0.261	0.002	0.016	0.011	0.010	0.023	155.746	11.061	3.555	0.204	0.868	8.284	2.963	7.707	14.139	0.732	0.084	80.740	5.440	20.591	0.146	1.847
Average	*0.902*	*0.014*	*0.254*	*0.002*	*0.198*	*0.002*	*0.021*	*0.031*	*0.018*	*0.019*	*107.244*	*7.739*	*3.552*	*0.301*	*0.960*	*5.589*	*2.191*	*7.466*	*12.689*	*0.921*	*0.158*	*48.818*	*5.364*	*26.818*	*0.117*	1.691
450-ka rocks (Inner parts)																										
450-B1	1.506	0.020	0.471	0.004	0.251	0.004	0.078	0.193	0.061	0.025	80.373	14.909	5.197	0.288	1.053	4.186	4.987	6.684	59.815	0.964	0.239	57.385	6.377	26.110	0.033	2.882
450-B10	1.481	0.022	0.494	0.004	0.297	0.005	0.148	0.269	0.060	0.011	73.650	15.747	5.585	0.395	0.945	11.902	0.631	3.657	78.406	0.507	0.073	63.357	6.232	15.613	-	3.068
450-B38	1.431	0.021	0.444	0.003	0.262	0.004	0.085	0.169	0.056	0.016	65.540	11.052	4.821	0.196	0.896	5.547	1.035	5.053	54.039	0.549	0.348	63.065	6.460	19.543	-	2.728
450-B39	1.234	0.019	0.562	0.004	0.273	0.004	0.100	0.201	0.043	0.005	67.675	14.932	5.195	0.221	0.581	6.465	0.950	1.154	71.306	0.493	0.107	60.037	5.195	12.123	-	2.693
450-B64	1.605	0.020	0.356	0.004	0.161	0.003	0.024	0.081	0.076	0.033	94.461	4.882	4.723	0.513	1.235	1.623	1.423	9.807	44.389	0.855	0.252	17.685	9.678	36.916	0.067	2.592
Average	*1.451*	*0.020*	*0.466*	*0.004*	*0.249*	*0.004*	*0.087*	*0.182*	*0.059*	*0.018*	*76.340*	*12.305*	*5.104*	*0.323*	*0.942*	*5.944*	*1.805*	*5.271*	*61.591*	*0.674*	*0.204*	*52.306*	*6.789*	*22.061*	*0.050*	2.793
450-ka rocks (White layers)																										
450-B64	1.556	0.019	0.358	0.004	0.161	0.002	0.023	0.070	0.075	0.033	107.968	4.381	4.374	0.458	1.036	0.797	1.295	9.840	38.831	0.784	0.091	18.886	7.723	37.298	0.025	2.534
450-ka rocks (Brown layers)																										
450-B1	0.901	0.028	0.138	0.003	0.279	0.001	0.007	0.005	0.005	0.024	85.545	12.218	4.271	0.466	0.912	3.318	2.533	9.085	11.482	1.239	0.279	86.287	3.921	37.371	0.105	1.650
450-B10	0.484	0.010	0.168	0.001	0.140	0.002	0.013	0.019	0.006	0.006	59.877	17.981	2.952	0.131	0.420	17.136	0.314	1.723	3.037	0.134	0.068	63.454	2.670	10.124	-	1.031
450\-B38	0.610	0.024	0.189	0.002	0.355	0.002	0.027	0.007	0.002	0.006	100.741	11.865	3.514	0.153	0.620	4.065	1.062	3.289	14.065	0.338	0.073	51.974	3.170	14.923	-	1.434
450-B39	0.607	0.017	0.327	0.003	0.239	0.001	0.014	0.025	0.004	0.002	38.907	9.082	2.728	0.037	0.393	3.684	0.808	0.757	40.023	0.216	-0.018	32.721	2.798	6.885	-	1.379
450-B64	1.002	0.016	0.171	0.002	0.141	0.002	0.010	0.010	0.024	0.021	73.882	4.752	3.361	0.419	0.937	1.292	1.403	6.859	10.808	0.664	0.131	16.969	4.817	32.694	0.058	1.557
Average	*0.721*	*0.019*	*0.199*	*0.002*	*0.230*	*0.002*	*0.014*	*0.013*	*0.008*	*0.012*	*71.790*	*11.180*	*3.365*	*0.241*	*0.656*	*5.899*	*1.224*	*4.343*	*15.883*	*0.518*	*0.107*	*50.281*	*3.475*	*20.399*	*0.081*	1.410
830-ka rocks (Inner parts)																										
830-A1	1.644	0.018	0.468	0.003	0.222	0.004	0.077	0.154	0.070	0.024	94.798	5.180	5.117	0.472	0.818	7.391	1.141	7.460	48.205	0.627	0.298	44.104	7.440	25.887	-	2.933
830-ka rocks (Brown layers)																										
830-A1	0.917	0.014	0.252	0.002	0.178	0.001	0.006	0.002	0.006	0.014	115.040	6.209	3.151	0.288	0.636	4.294	1.248	4.773	5.389	0.602	0.164	49.929	2.532	21.311	0.069	1.608

Table 8 Chemical changes with depth analyzed by ICP method.

		Major elements (%)									*Trace elements (ppm)*										
Samples	**depth, mm**	**Al_2O_3**	**TiO_2**	**$FeO+Fe_2O_3$**	**MnO**	**MgO**	**CaO**	**Na_2O**	**K_2O**	**P_2O_5**	**As**	**Ba**	**Co**	**Cr**	**Cu**	**Li**	**Ni**	**Pb**	**Sr**	**V**	**Zr**	**Zn**
20-B2	0～0.1	16.7240	0.0052	9.5086	0.1658	5.3420	9.6573	1.8047	0.3311	0.1479	0.9300	221.6600	51.7130	795.2500	77.7710	3.4614	440.1900	6.4699	2.3512	0.2303	1.2792	8.3799
	0.1～2	11.0550	0.6967	3.4366	0.0796	0.5223	0.4348	4.9213	0.8387	0.0281	0.4382	480.2000	21.2160	415.2700	24.8010	4.4614	450.7100	13.5820	104.6700	25.0750	125.7200	72.4840
	4～6	11.9790	0.6633	4.2414	0.0829	0.4946	0.9118	5.4621	0.7430	0.0458	0.4049	379.7400	33.4810	1495.9000	64.1200	3.8717	911.7800	3.2880	108.0400	24.2060	123.2800	77.3070
	9～11	11.9110	0.6599	3.8831	0.0775	0.4469	0.9381	5.4779	0.6611	0.0844	0.5574	413.7600	27.5410	1125.2000	48.8650	2.9486	844.2000	3.0021	110.9200	18.9010	118.7500	83.5080
	14～16	11.6470	0.7017	5.2228	0.0970	0.4391	0.9678	5.3905	0.7614	0.1135	0.4715	448.9400	55.1380	2862.8000	185.9900	2.8290	1918.5000	6.2903	113.1300	24.3280	118.4800	87.0910
20-B6	0～0.2	9.6740	1.2983	14.6540	0.2464	7.0961	3.2206	0.7353	1.0688	0.2311	0.7105	323.1100	46.8810	283.9800	45.8970	14.6540	137.7500	21.6810	42.4010	390.1600	168.1400	117.7000
	0.2～1	13.7120	0.9538	11.2670	0.1947	5.6628	4.6872	1.4309	0.9164	0.2480	0.7987	328.1000	40.5320	453.9400	42.3920	12.5780	317.6400	25.1670	126.0800	276.5600	131.8500	100.8100
	1～2	16.2630	0.7751	9.6512	0.1702	4.7497	6.7226	1.9730	0.3960	0.1730	0.8110	316.8600	34.5870	829.5200	118.0800	12.6040	333.7700	19.5550	215.1100	221.0300	108.0400	186.2100
	5～7	16.8710	0.7879	9.6356	0.1669	4.5303	7.7853	2.1172	0.8046	0.1875	0.8305	318.2000	31.8530	768.8900	52.3110	17.0160	424.6500	18.6200	259.8600	233.0000	105.2400	84.8260
	9～11	17.4560	0.6969	8.6840	0.1518	4.4064	8.0026	2.0984	0.8388	0.1440	0.7803	295.4400	32.6790	562.6300	50.8100	23.1830	487.1500	23.2960	279.3100	200.7800	98.7420	87.1580
	24～26	16.7170	0.7220	9.2896	0.1656	4.7241	7.1881	1.9912	0.9450	0.1500	0.8787	299.8600	39.9450	514.3200	53.3290	14.4340	402.7300	26.0170	291.1300	217.6600	112.2300	76.3480
	34～36	16.3600	0.7844	9.7798	0.1767	5.1594	7.2952	1.9013	0.7678	0.1484	0.8217	307.8900	36.5990	429.5300	37.2980	12.8630	265.3000	21.8290	283.9000	221.9800	103.7100	86.1570
450-B1	0.2～1	10.7130	1.9787	17.5550	0.0654	0.6304	0.4167	0.3118	1.3330	0.1238	0.5781	623.2600	41.2590	46.1880	64.7450	10.1750	39.0580	15.1780	92.7230	441.5900	280.6300	107.2300
	1～2	14.0680	1.0542	10.4540	0.1353	2.2790	5.9861	2.3384	1.0698	0.1416	0.6478	372.4000	38.9010	629.2400	63.1840	7.9713	645.9500	14.8970	227.0700	250.4800	138.4600	85.1890
	5～7	12.6840	0.9627	8.2145	0.1314	2.0161	5.3916	2.3334	1.0366	0.1521	0.5541	341.7700	35.1230	1509.6000	169.1700	7.5150	489.5200	16.1150	204.4000	209.7000	136.8200	153.9900
	14～16	14.3410	1.0616	9.3422	0.1532	2.4477	6.4895	2.5961	1.1425	0.1122	0.6969	366.0500	69.0780	1535.1000	134.7800	6.9899	2262.7000	8.6194	234.5300	248.6100	139.9900	92.4860
	26～28	14.2410	1.1076	9.7157	0.1549	2.4398	6.7190	2.7550	1.2369	0.0714	0.6705	361.0600	36.4040	747.8500	101.7900	7.6263	413.9500	13.7740	240.1900	267.5900	154.5100	85.2670
450-B10	0～2	8.7981	1.5558	22.0980	0.1411	4.7301	0.8743	0.1437	0.3495	0.1867	0.6378	272.7100	58.3560	241.1600	70.6630	6.8367	155.1200	20.4860	31.0420	523.1300	111.7000	112.1100
	2～4	16.5800	0.7568	11.5800	0.1869	5.9249	9.1714	1.7055	0.3540	0.1643	0.8497	254.4700	48.3240	670.2400	57.3920	4.9175	596.8000	17.1440	269.9100	255.4300	53.6600	80.0170
	8～10	18.0730	0.7123	9.5051	0.1605	5.3360	10.5370	1.8990	0.4239	0.1480	0.8170	167.8000	48.9770	694.7000	71.5720	3.8385	749.3800	19.0850	303.8400	243.0600	53.4730	74.6430
	14～16	17.0880	0.6811	9.3502	0.1571	5.0779	9.5550	1.8092	0.4388	0.1337	0.8159	139.0600	41.2170	1218.6000	75.9610	3.4670	801.0900	13.3700	291.5200	217.0600	47.8960	67.6260
	19～21	18.0030	0.6596	9.8528	0.1808	5.8905	10.4390	1.6263	0.4894	0.1674	0.8978	206.1600	44.8190	1100.8000	83.3970	4.2718	650.0800	15.8500	285.1200	220.4500	49.2590	76.5840
	24～26	8.4015	0.4833	15.9060	0.0460	0.2247	0.3304	3.2614	0.6714	0.0816	0.5144	299.5500	22.2160	73.7260	16.6150	3.9181	181.7600	14.8790	77.6130	79.1130	113.1500	64.9390
450-B12	0～4	13.5850	1.7941	16.4450	0.1512	0.6316	0.3353	0.4742	0.6554	0.0854	0.6458	573.2500	39.6560	31.9440	69.2330	6.7120	23.9100	23.4260	64.2040	399.5800	168.6700	151.5100
	5～6	13.2320	0.8087	7.7299	0.1616	1.4100	3.3936	1.5005	0.4762	0.0598	0.5744	274.8200	24.3080	525.6400	51.4260	6.6270	104.5900	13.9760	148.2800	170.9200	78.3310	78.3380
	9～11	16.0810	0.9499	9.2997	0.1292	0.9289	5.2944	2.4734	0.6764	0.0710	0.7079	276.8000	30.6960	770.5200	75.9530	4.4010	143.6300	20.7640	220.4300	218.5400	92.1300	98.4020
	23～25	15.7900	0.9368	9.3639	0.1284	1.8471	6.1028	2.5995	0.6752	0.0758	0.6261	253.0600	34.4060	1203.6000	73.8030	4.1461	434.9500	22.8940	225.0200	205.2900	92.6780	93.5340
450-B64	0～3	13.0290	1.1585	9.7112	0.3598	0.4212	0.2821	0.8221	0.9654	0.1021	0.5950	473.7400	43.6740	25.2940	44.0060	16.7260	53.8670	10.0070	70.3980	98.2430	241.1000	95.6350
	3～5	13.0010	0.9961	8.1672	0.1707	0.9095	1.8572	2.0728	1.1778	0.0708	0.5445	433.6700	31.2710	220.9000	41.8550	17.6060	176.2700	11.7230	118.6000	87.5440	198.5800	84.1970
	5～9	14.5280	0.9031	7.7714	0.1123	1.1775	2.8419	2.6322	1.1057	0.0462	0.5781	433.4200	22.1640	919.4400	54.0310	15.5810	144.7400	12.9290	155.8600	87.1120	157.5600	74.3170
	9～13	14.4640	0.8001	6.4174	0.0859	0.9506	2.8641	2.7365	1.1166	0.0860	0.5689	436.6300	16.8890	165.7200	28.8030	13.2650	125.3900	6.2771	163.0000	66.0230	154.8800	67.7640
	20～23	14.3340	0.8151	6.6917	0.0915	1.0522	3.5071	3.0000	1.2017	0.0787	0.5804	439.1600	22.2150	372.7000	37.7700	10.6480	284.3700	12.8360	178.5000	74.1050	155.3100	71.6360

Table 9 Agerage VHN values of Zones I to III.

Samples	Zone I Brown layer	Zone II	Zone III Inner part
0-ka rocks			
0-A1	-	-	539
0-A4	-	-	399
0-B1	-	-	602
0-B37	-	-	540
Average	-	-	520
20-ka rocks			
20-A1	-	295	451
20-A3	-	230	467
20-A16	-	523	546
20-B2	-	233	508
20-B6	-	372	546
Average	-	331	504
320-ka rocks			
320-B5	31	361	-
320-B10	86	323	545
320-B22	23	248	517
Average	47	311	531
450-ka rocks			
450-B1	12	287	477
450-B38	17	290	-
450-B64	19	281	-
450-B10	25	227	560
450-B37	34	386	531
450-C1	65	297	442
450-B39	34	255	-
Average	29	289	503
830-ka rock			
830-A1	79	433	485

Table 10 Weathering indices calculated from chemical composition.

Samples	SiO_2/Al_2O_3	$SiO_2/TiOl_2$	WPI	PI	CIA
0-ka rocks, Inner part					
0-B1	4.063	50.549	11.633	70.382	60.873
0-B37	3.708	83.261	14.316	71.353	59.705
0-A6	3.644	64.068	13.053	70.300	59.600
0-A4	4.800	104.452	6.081	78.288	59.767
Average	***4.054***	***75.582***	***11.271***	***72.581***	***59.986***
20-ka rocks, Inner part					
20-B2	5.395	93.539	8.857	80.270	62.958
20-B6	3.247	75.152	14.845	68.103	62.217
20-A16	2.906	73.745	16.332	65.930	60.757
20-A3	3.729	72.996	12.930	71.055	60.473
20-A1	4.282	94.974	9.562	75.892	61.599
Average	***3.912***	***82.081***	***12.505***	***72.250***	***61.601***
320-ka rocks, Inner part					
320-B10	4.067	96.466	11.016	74.366	61.059
320-B5	3.963	101.563	8.004	74.993	67.787
320-B20	4.228	54.455	14.216	72.009	57.614
320-B22	3.634	79.007	14.155	69.374	62.341
Average	***3.973***	***82.873***	***11.848***	***72.685***	***62.200***
320-ka rocks, Brown layer					
320-B10	3.732	77.096	-2.487	70.594	86.535
320-B5	3.515	90.936	14.715	70.441	65.400
320-B20	3.902	33.955	-3.780	60.631	87.451
320-B22	3.208	63.419	-5.882	62.570	86.664
Average	***3.589***	***66.352***	***0.642***	***66.059***	***81.512***
450-ka rocks, Inner part					
450-B1	3.194	74.612	12.444	67.568	62.812
450-B10	2.999	68.087	19.154	65.196	59.209
450-B38	3.225	69.532	8.717	66.961	64.830
450-B39	2.195	65.743	13.338	59.637	69.295
450-B64	4.502	82.077	6.228	75.626	65.212
Average	***3.223***	***72.010***	***11.976***	***66.998***	***64.271***
450-ka rocks, White layer					
450-B64	4.346	80.223	7.550	74.969	66.939
450-ka rocks, Brown layer					
450-B1	6.539	32.284	-4.850	68.396	79.892
450-B10	2.878	47.314	-2.298	61.131	84.089
450-B38	3.225	25.072	-8.961	52.866	92.993
450-B39	1.857	36.733	-9.549	51.769	91.202
450-B64	5.847	62.723	0.366	76.259	75.704
Average	***4.069***	***40.825***	***-5.059***	***62.084***	***84.776***
830-ka rocks, Inner part					
830-A1	3.511	90.862	14.801	70.420	65.409
830-ka rocks, Brown layer					
830-A1	3.635	66.724	-3.108	68.059	91.881

Table 11 Thicknesses of Zone A and Zone A+B determined by VHN measurement.

	Porosity, %	Thickness, mm		Diffusion Coefficient, mm^2/1000yrs.	
Samples	*n*	L_A	L_{A+B}	D_A	D_{A+B}
20-ka Rocks					
20-A1	3.62	<0.10	2.88	0.001	0.413
20-A3	3.25	<0.10	3.03	0.001	0.459
20-A16	3.57	<0.10	1.88	0.001	0.176
20-B2	4.76	<0.10	2.00	0.001	0.200
20-B6	6.73	<0.10	3.00	0.001	0.450
320-ka Rocks					
320-B5	7.95	3.00	>20.00	0.028	1.250
320-B10	1.96	3.30	5.60	0.034	0.098
320-B20	6.15	2.00	>12.00	0.013	0.450
320-B22	4.14	2.00	5.04	0.013	0.079
450-ka Rocks					
450-B1	1.72	2.42	2.79	0.013	0.017
450-B10	0.85	1.87	4.26	0.008	0.040
450-B37	2.48	3.00	6.50	0.020	0.094
450-B38	4.49	3.25	10.20	0.023	0.231
450-B39	8.59	3.03	>21.00	0.020	0.980
450-B64	6.54	3.10	>15.00	0.021	0.500
450-C1	3.91	3.16	8.42	0.022	0.158
830-ka Rock					
830-A1	2.20	4.00	6.00	0.019	0.043