

Supporting Information

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Table S1. Bulk ash composition, averaged for two analyses: major oxides, expressed in relative mass % and relative element %, and minor elements, expressed as mg/kg

	Explosive ash		Typical ash	
	Mass %	Element %	Mass %	Element %
SiO ₂	57.98	27.1	56.73	26.5
Al ₂ O ₃	14.87	7.87	14.65	7.75
FeO	9.75	7.58	9.93	7.72
MnO	0.24	0.19	0.24	0.19
MgO	2.3	1.39	3.15	1.90
CaO	5.5	3.93	6.11	4.37
Na ₂ O	5.01	3.72	5.04	3.74
K ₂ O	1.79	1.49	1.64	1.36
TiO ₂	1.8	1.08	1.88	1.13
P ₂ O ₅	0.53	0.23	0.43	0.19
O		45.4		45.1
Ba	447		425	
Co	27		33	
Cr	25		97	
Cu	27		35	
Ni	15		41	
Sc	16		19	
Sr	330		328	
V	86		114	
Y	71		65	
Zn	144		137	
Zr	490		441	

Rock powder fluxed with Li-metaborate, dissolved in nitric, hydrochloric, oxalic acid mixture; analyzed with inductively coupled plasma optical emission spectroscopy simultaneous spectrograph (Spectro CIROS); standard reference material (SRM): USGS BHVO, USGS QLO-1.

Table S2. Time-resolved concentration in the leachate from fresh ash samples exposed to pure water for various times, determined by inductively coupled plasma optical emission spectroscopy

In water, min	Explosive ash				Typical ash				Typical ash, repeated			
	15	30	45	85	4	22	29	41	5	18	22	29
water: ash	1,000	1,000	1,000	1,000	625	597	713	680	997	1,002	1,003	1,006
T, °C	21.0	21.0	21.0	21.0	23.5	23.6	23.2	23.1	23.4	23.4	23.5	23.6
pH	7.96	8.09	8.01	8.54	5.17	5.29	5.22	5.14	5.01	5.33	5.02	5.02
Major elements, ppm												
SiO ₂	0.50	0.53	0.68	0.72	0.02	0.02	0.02	0.02	ND	ND	ND	ND
Na	0.90	0.66	0.83	0.73	0.30	0.41	0.29	0.37	0.29	0.23	0.29	0.27
K	0.20	0.06	0.11	0.07	0.10	0.14	0.08	0.11	0.13	0.09	0.10	0.12
Ca	1.24	1.16	1.37	1.41	0.67	0.91	0.63	0.79	0.43	0.53	0.42	0.39
Mg	0.05	0.04	0.05	0.05	0.10	0.15	0.12	0.17	0.09	0.09	0.11	0.11
CO ₂	1.59	1.68	2.08	2.29	0.85	0.71	0.71	0.72	NA	NA	NA	NA
SO ₄	1.76	1.25	1.33	1.21	1.49	1.51	1.47	1.52	0.99	0.90	0.98	0.93
Cl	1.18	0.87	0.89	0.86	2.83	3.14	2.76	2.95	1.95	1.58	1.84	1.76
F	0.22	0.11	0.16	0.12	0.42	0.59	0.54	0.79	0.33	0.52	0.56	0.54
Minor elements, ppb												
P	4.71	4.41	8.65	7.3	ND	ND	7.76	6.99	8.71	<3.44	<3.44	9.26
Al	24.56	22.16	29.68	33.18	116.37	175.29	159.44	248.09	96.59	86.86	148.1	152.6
Fe	23.63	18.87	19.91	16.81	158.77	73.65	118.00	180.91	79.74	6.02	87.94	70.07
B	1.91	0.09	ND	ND	ND	ND	ND	ND	<0.24	<0.23	ND	0.65
Mn	8.83	9.17	9.86	9.48	18.06	23.06	17.90	21.72	ND	ND	ND	ND
Sr	2.96	2.46	2.96	2.93	2.66	3.57	2.67	3.48	ND	ND	ND	ND
Ba	NA	NA	NA	NA	3.08	3.91	2.98	3.72	2.54	3.35	3.44	5.14
Mo	0.73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ti	4.49	3.26	3.95	3.12	0.99	0.73	1.11	1.97	ND	ND	ND	ND
Li	0.51	0.31	0.31	0.4	ND	ND	ND	ND	<0.04	<0.05	<0.11	<0.07
Br	ND	4.35	ND	ND	19.91	25.85	24.28	39.34	ND	ND	<1.2	ND

NA, not analyzed; ND, not detected.

