

Table: Summary of previous works analysing volcanic-ash leachates, arranged by geographical region of the volcano.
Dashes indicate where sampling stages are known to have been omitted.

Reference	Region and Eruption	Purpose	Particle size fraction	Solute	Solute/ash ratio (ml g ⁻¹)	Agitation type	Agitation time	Resting time	Ions measured	Analysis method
CARIBBEAN										
Edmonds et al. (2003)	Soufrière Hills, 1996-2001	Comparison to plume gas measurements		deionised water	5	agitated	1 hr	6-8 hrs	Cl, SO ₄ ²⁻	Ion chromatography
Horwell et al. (2003)	Soufrière Hills, 1997-2001	Health impacts	<4 µm	distilled water, NaCl, 1% nitric acid and/or NaOH	400	-	-	4 weeks	Fe	ICP-AES
CENTRAL AMERICA										
Armienta et al. (1998)	Popocatepetl, 1994-1996	Plume proxy		deionised water	25	agitated then centrifuged	2 hrs then 15 min	-	Ca, Cd, Cl, Co, Cu, F, K, Mg, Mn, Na, Pb, SO ₄ ²⁻ , Sb, Ti, Tl, Zn	ICP-MS, potentiometry, flame emission and ion chromatography
Armienta et al. (1998)	Popocatepetl, 1994-1996	Plume proxy		deionised water	2	agitated	1 hr	6-8 hours then repeated	Ca, Cd, Cl, Co, Cu, F, K, Mg, Mn, Na, Pb, SO ₄ ²⁻ , Sb, Ti, Tl, Zn	ICP-MS, potentiometry, flame emission and ion chromatography
Armienta et al. (2002)	Popocatepetl, 1996-1998	Controls on materials on the ash		deionised water	25	agitated then centrifuged	2 hrs then 15 min	-	As, Cl, Co, Cr, Cu, F, Mg, Mn, Mo, Ni, Pb, SO ₄ ²⁻ , Se, Ti, Tl, V, Zn	ICP-MS, potentiometry and ion chromatography
Bornemisza and Morales (1969)	Irazu, 1963-1964	Environmental impacts (soil)		water	37.5 cm ³ to 1360g	-	-	column	Al, Ca, K, Mg, NH ₄ , NO ₃ , PO ₄ , SO ₄ ²⁻	Various chemical tests including vernese titration and flame photometry
Murata et al. (1966)	Irazu, 1963-1964	Study of constituents and impact on vegetation		distilled water	5				Cl, SO ₃ ⁻ , SO ₄ ²⁻	
Rose et al. (1973)	Cerro Negro, 1971 and Fuego, 1971	Calculation of emissions and also examination of adsorption process	-	water	2	agitated	1 hr	6-8 hrs then leach repeated	Ca, Cl, F, K, Mg, Na, SO ₄ ²⁻	Atomic absorption spectrophotometer, ion selective electrodes and turbidimetric method
Rose et al. (1978)	Fuego, 1974	Plume proxy		water					Ba, Ca, Cl, Cu, K, Mg, Mn, Na, S, Se, Zn	
Smith et al. (1982)	Fuego, 1973 and 1974; Pacaya, 1974; Santiaguito, 1967, 1975 and 1976	Environmental impacts	850-106 µm and <106 µm after crushing	distilled deionised water	4	rocker shaker	1 hr	overnight	Al, B, Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Li, ICP-OES, ion electrode, some others Mg, Mn, Mo, Na, Pb, Si, Sr, U, V, Zn	
Smith et al. (1982)	Fuego, 1973 and 1974; Pacaya, 1974; Santiaguito, 1967, 1975 and 1976	Environmental impacts	850-106 µm and <106 µm after crushing	HCl solution pH 3.5-4	4	rocker shaker	1 hr	overnight	Al, B, Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Li, ICP-OES, ion electrode, some others Mg, Mn, Mo, Na, Pb, Si, Sr, U, V, Zn	
Smith et al. (1982)	Fuego, 1973 and 1974; Pacaya, 1974; Santiaguito, 1967, 1975 and 1976	Environmental impacts	850-106 µm and <106 µm after crushing	carbonate-bicarbonate pH 9.9	4	in oven at 80°C	1 week		Al, B, Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Li, ICP-OES, ion electrode, some others Mg, Mn, Mo, Na, Pb, Si, Sr, U, V, Zn	
Taylor and Stoiber (1973)	Central American volcanoes 1963-1970	Origins of materials on the ash	several	water	2	agitated	1 hr	6-8 hours then repeated	Br, Ca, Cl, Co, Cr, Cu, F, K, Li, Mg, Mn, Na, Ni, SO ₄ ²⁻ , Zn	Atomic absorption, turbidometric method and ion exchange electrode
Varekamp et al. (1984)	El Chichon, 1982	Plume proxy		double-distilled water	2.5 and 143				As, Br, Ca, Ce, Cl, Cr, Co, Cu, F, Fe, K, Na, Sb, SO ₄ ²⁻ , Zn	INA and ion chromatography
EUROPE										
Cimino and Toscano (1998)	Etna, 1996	Impact of ash on atmospheric/rainwater composition	0.1-0.3 mm	distilled water	10, 33.3, 500, 2000	stirred	3 mins – 3 hours	-	Ca, Cu, Fe, K, Mg, Mn, Na, SO ₄ ²⁻ , Zn;	Atomic absorption spectrophotometer and ion chromatography

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ICELAND										
Frogner et al. (2001)	Hekla, 2000	Ocean fertilising potential	44-74 µm	deionised water; artificial and natural seawater		-	-	flow-through reactor	Cl, Co, Cu, Fe, F, Mn, Ni, PO ₄ , SO ₄ ²⁻ , Si, Zn	ICP, spectrophotometry and ion chromatography
Oskarsson (1980)	Hekla, 1970	Time to leach all F and its quantity		distilled water	50	shaken	0-300 min	-	Ca, Cl, F, Na	
Oskarsson (1980)	Hekla, 1970	Time to leach all F and its quantity		distilled water	50	shaken	1 hr	-	Ca, Cl, F, K, Mg, Na, SO ₄ ²⁻	
Oskarsson (1980)	Hekla, 1970	Time to leach all F and its quantity		distilled water	4	shaken	1 hr	-	Al, Ca, Cl, F, H, K, Mg, Na, SiO ₂ , SO ₄ ²⁻	
INDONESIA										
de Hoog et al. (2001)	Galunggung, 1982	Controls on materials and plume proxy		deionised water	80	shaken	4 hrs	-	Al, Ca, Cl, F, Fe, Mg, Mn, Na, S, Si,	ICP-AES and ion-selective electrode
de Hoog et al. (2001)	Galunggung, 1982	Controls on materials and plume proxy		0.01 M nitric acid	80	shaken	4 hrs	-	Al, Ba, Ca, Cl, Cu, F, Fe, K, Mg, Mn, Na, P, S, Si, Y, Zn	ICP-AES and ion-selective electrode
JAPAN										
Kawaratani and Fujita (1990)	Sakurajima, 1985-1986			distilled water		-	-	24 hr	Al, Ca, Cl, F, Fe, K, Mg, NH ₄ , NO ₃ , Na, SO ₄ ²⁻ , Si,	ICP, atomic absorption spectrometry, indophenol method and ion chromatography
Nogami et al. (2000)	Akita-Yakeyama, 1997	Plume proxy		pure water	14				Cl, S	Ion chromatography
KAMCHATKA										
Ivanov et al. (1996)	Avacha, 1991	Plume proxy		twice distilled water					Cl, F, S	
Tovarova (1958)	Bezymianny, 1955-1956	Transportation of mineral matter on surface	<1 mm	water	4			48 hr	CO ₂ , Ca, Cl, H ₂ S, HCO ₃ , K, Mg, NH ₃ , Na, R ₂ O ₃ , SO ₄ , SiO ₂	
MELANESIA										
Cronin and Sharp (2002)	Yasur and Ambrym, 1999	Health impacts		water	20	shaking	16 hrs	-	Al, As, B, Cd, Cl, Co, Cr, Cu, F, Fe, Li, Mn, Mo, Ni, Pb, SO ₄ ²⁻ , Sb, Sn, V, Zn	ICP-MS and ion chromatography
NEW ZEALAND										
Christenson (2000)	Ruapehu, 1995-1996	Adsorbed material and sulphur budget		distilled-deionised water, then heated to 60°C	~10	ultrasonic bath	15 min	overnight	Al, Br, Ca, Cl, F, Fe, K, Li, Mg, Na, NO ₃ , SO ₄ ²⁻	Ion chromatography, ICP-AES
Cronin et al. (1998)	Ruapehu, 1995 and 1996	Effects on soil fertility		water	40	shaken	24 hrs	-	Al, As, B, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sn, Sr, Zn	ICP-AAS

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Cronin et al. (1997)	Ruapehu, 1995	Effects on soil fertility		water	40	shaken	24 hrs	-	Al, As, B, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sn, Sr, Zn	ICP-AAS and ICP-MS
Cronin et al. (2003)	Ruapehu, 1995 and 1996	Impacts on cattle		water	20	shaken	24 hrs	-	F	Ion chromatography or ion selective electrode
SOUTH AMERICA										
Giggenbach, (Smithsonian Institution, 1989)	Lonquimay, 1989	Plume proxy		distilled water					Al, Br, Ca, Cl, F, Li, K, Mg, NO ₃ , SO ₄ ²⁻ , Si and trace constituents	
Risacher and Alonso (2001)	Lascar, 1993	Origins of materials on the ash		near neutral deionised water	10	shaken	15,30,60,120, 300,600 min		B, Br, Ca, Cl, F, I, K, Li, Mg, Na, NO ₃ , PO ₄ , Si, SO ₄ ²⁻	Atomic absorption spectrometry, colorimetry and ion chromatography
Risacher and Alonso (2001)	Lascar, 1993	Origins of materials on the ash		near neutral deionised water	10	stirred	15,30,60,120, 240,480 min		B, Br, Ca, Cl, F, I, K, Li, Mg, Na, NO ₃ , PO ₄ , Si, SO ₄ ²⁻	Atomic absorption spectrometry, colorimetry and ion chromatography
Viramonte (Smithsonian Institution, 1987)	Lascar, 1986			distilled water	10	stirred	5 min		Ca, Cl, K, Mg, Na, SO ₄ ²⁻	
Viramonte (Smithsonian Institution, 1987)	Lascar, 1986			0.1M HCl	10	stirred	15 min		Ca, Cl, K, Mg, Na, SO ₄ ²⁻	
Williams et al. (1986)	Nevado del Ruiz, 1985	Plume proxy		deionised distilled water			1 hr		Cl, SO ₄ ²⁻	Ion chromatography
WESTERN USA										
Dahlgren et al. (1999)	Mt. St. Helens, 1980	Chemical weathering of tephra				-	long period study	-	Al, Ca, Cl, Fe, K, Mg, Na, NO ₃ , PO ₄ , Si, SO ₄ ²⁻	ICP and ion chromatography
Fruchter et al. (1980)	Mt. St. Helens, 1980	Potential health impact	all, <75 µm and >75 µm	water	1	stirred	10 mins	1 hr	Cl, NO ₃ , SO ₄ ²⁻	
Fruchter et al. (1980)	Mt. St. Helens, 1980	Potential health impact	all, <75 µm and >75 µm	water	10	stirred	10 mins	1 hr	Al, As, B, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Hg, K, Li, Mg, Mn, Ni, Mo, NH ₄ , NO ₃ , Na, Pb, SO ₄ ²⁻ , Si, V, Zn	Ion chromatography and plasma emission spectroscopy
Gough et al. (1981)	Mt. St. Helens, 1980	Effects on crops	<2 mm						Ca, Cl, K, Mg, Na, SO ₄ ²⁻	ICP-OES
Hinkley et al. (1980) (methods in Dethier <i>et al.</i> , 1981)	Mt. St. Helens, 1980	Leach composition and comparison to soils		water	~0.6 initially	-	-	4 hrs in column (repeated)	B, Ba, Co, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, V, Zn	
McKnight et al. (1981a)	Mt. St. Helens, 1980	Impact on algae		simulated lake water		-	-	9 hrs in column	Ba, Ca, Cd, Co, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Sr, Zn,	ICP-ES
McKnight et al. (1981b)	Mt. St. Helens, 1980	Impact on algae		WC medium	1.25	-	-	14 hrs in column	Ba, Ca, Cd, Cl, Co, Cu, F, Fe, K, Li, Mg, Mn, Mo, N, Na, P, SO ₄ ²⁻ , Sr, Zn	ICP-ES
McKnight et al. (1981b)	Mt. St. Helens, 1980	Impact on algae		WC medium	0.87	-	-	12 hrs in column	Ba, Ca, Cd, Cl, Co, Cu, F, Fe, K, Li, Mg, Mn, Mo, N, Na, P, SO ₄ ²⁻ , Sr, Zn	ICP-ES

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Nehring and Johnston (1981)	Mt. St. Helens, 1980	Plume proxy		triply distilled water	2.5	stirred	1 hr	briefly	Al, As, B, Ba, Be, Bi, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Rb, SO ₄ , Sb, Se, Si, Sr, Ti, Tl, V, Zn, Zr	Spectrophotometer, specific ion electrode
Smith et al. (1983)	Mt. St. Helens, 1980	Environmental impacts		distilled deionised water	4	rocker-shaker	1 hr	overnight	Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Li, Mg, Mn, Mo, Na, Pb, SiO ₂ , SO ₄ ²⁻ , Sr, U, V, Zn	ICP-OES, ion chromatography and fissure track
Smith et al. (1983)	Mt. St. Helens, 1980	Environmental impacts		HCl pH 3.5-4	4	rocker-shaker	1 hr	overnight	Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Li, Mg, Mn, Mo, Na, Pb, SiO ₂ , SO ₄ ²⁻ , Sr, V, Zn	ICP-OES, ion chromatography and fissure track
Smith et al. (1983)	Mt. St. Helens, 1980	Environmental impacts		carbonate-bicarbonate pH 9.9	4	in oven at 80°C	1 week		Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Li, Mg, Mn, Mo, Na, Pb, SiO ₂ , Sr, U, V, Zn	ICP-OES, ion electrodes and fissure track
Taylor and Lichte (1980)	Mt. St. Helens, 1980	Environmental impacts		deionised water	~0.6 initially	-	-	4 hrs in column (repeated 3 times)	As, B, Ba, Be, Ca, Cd, Cl, Co, Cu, F, Fe, Hg, K, Li, Mg, Mn, Mo, NH ₄ , NO ₃ , Na, Pb, SO ₄ ²⁻ , Se, SiO ₂ , Sr, V, Zn	ICP-ES, atomic absorption spectrometry, ion chromatography, ultraviolet absorption spectrometry and ion selective electrode
OTHER										
Delmelle et al. (2000)	Various unknown	Comparison of leached to unleached ash	<100 µm	water					Ca, Cl, F, K, Mg, Na, S,	Ion chromatography, atomic emission spectroscopy