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Preliminary Results

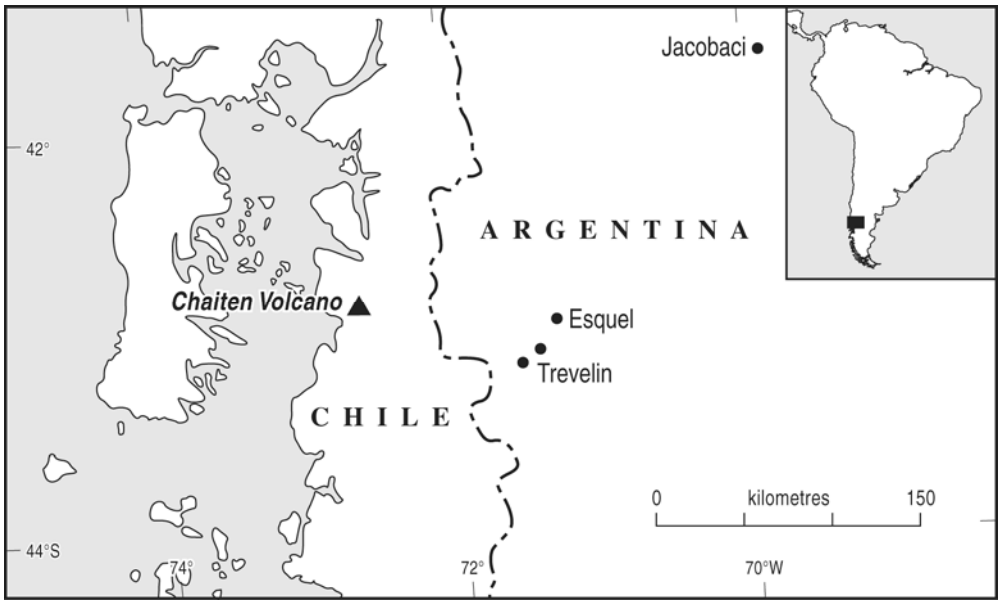
Grain size analysis of Chaitén ash

Sample information

Samples were sent to Durham University from SEGEMAR, Argentina. Information about the samples is as follows:

Sample No.	Eruption Date	Collection Date	Location	Grid ref.	Distance from volcano	Contamination /rain
Chai_0508_01	2/05/08	8/05/08	Esquel	42°54'51"S 71°19'8"W	103 km	no
Chai_0508_02	2/05/08	6/05/08	Jacobaci	41°33'31" S 69º52'87" W	307 km	no
Chai_0508_03	2/05/08	8/05/08	Trevelin	43°04'37"S 71°27'46"W	80 km	no
Chai_0508_04	2/05/08	8/05/08	Trevelin	43°08'21"S 71°34'03"W	80 km	no

Table 1. Information on samples



Sample preparation
Samples were dried in an oven at 80°C overnight (18 hours) then sieved through Endecott stainless steel sieves with 1mm and 2mm mesh size.

Sample analysis
The < 1mm fraction was analysed on a Malvern Mastersizer 2000 with Hydro MU attachment at the Department of Geography, Cambridge University, UK. Ultrasonics were used to disaggregate samples and the results below are from an average of three runs. Samples were measured with a refractive index of 1.63 and an absorption coefficient of 0.1 (after Horwell, 2007[*]). Table 2 gives information on the potential effects of each grain size fraction. Results in Table 3 are the cumulative volume % of grain size within the health-pertinent fractions.

Size	Potential Health Effect
< 4 μm	'Respirable' fraction – can enter the alveoli where chronic disease could occur with long-term exposure
< 10 μm	'Thoracic' fraction – can enter past the bronchus, where bronchitis, asthma and other acute diseases may be triggered in susceptible people.
< 15 μm	Can enter the throat, causing rhinitis, laryngitis and irritation

Table 2. Potential health effects.

Size	Chai_01	Chai_02	Chai_03	Chai_04
< 4 μm	9.71	10.73	11.93	8.73
< 10 μm	20.23	21.60	24.35	18.13
< 15 μm	27.33	28.91	32.57	24.37

Table 3. Grain-size results in cumulative volume %

Interpretation of results
Table 4. shows results published from other volcanoes. It can be seen that the Chaitén volcanic ash is fine-grained, with similar grain size characteristics to the Soufrière Hills volcano (Montserrat), Mt St Helens (USA) and Merapi (Indonesia). Please refer to Horwell et al. 2007 for further information on those eruptions. There does not appear to be a correlation in grain size with distance from the volcano.

Other recommended analyses
The silicic magma erupted by Chaitén makes it a strong candidate for the generation of crystalline silica. We have sent samples for x-ray diffraction and x-ray fluorescence analyses. These will tell us the quantity of crystalline silica in the ash and the type of silica (quartz, cristobalite or tridymite) and also the general composition of the sample (in oxide weight percent). Crystalline silica can cause the chronic lung disease silicosis, but silica-related disease is rare without heavy and prolonged exposure to dust containing elevated concentrations of this mineral.

Health message
This ash is fine enough to have the potential to trigger asthma attacks in susceptible people, and aggravate respiratory symptoms in people with chronic lung problems. All people should wear masks in situations where exposure to the resuspended ash is going to be high, e.g., dry, windy days and where heavy traffic or tasks such as ash removal create dust in the air.

[*] Horwell, C.J. Grain size analysis of volcanic ash for the rapid assessment of respiratory health hazard. *J. Environ. Monitor*. **9**, 1107 - 1115 (2007).

Further Information

Please refer to the IVHHN pamphlet on the health hazards of volcanic ash in order to learn more on the potential respiratory hazard posed by the Chaitén ash.

Table 4. from Horwell, 2007[†] (Table 2)

Volcano	Magma type/ Eruption style	VEI*	Grain- size distribution, Cumulative volume %					
			< 1 µm	< 2.5 µm	< 4 µm	< 10 µm	< 15 µm	< 63 µm
Pacaya, Guatemala 1994	Basaltic Stromb.-Vulc.	1	0.00	0.00	0.04	0.41	0.70	2.23
Pacaya, Guatemala 1992	Basaltic Stromb,-Vulc.	1	0.00	0.26	0.76	2.43	3.76	16.60
Fuego, Guatemala 1999	Basaltic Vulcanian	2	0.00	0.00	0.00	0.00	0.00	1.56
Ulawun, Papua New Guinea	Basaltic Strombolian	2	0.00	0.02	0.27	0.88	1.63	4.14
Cerro Negro, Nicaragua	Basaltic Stromb.-Vulc.	2	0.00	0.22	0.64	2.55	4.17	14.64
Tungurahua, Ecuador	Andesitic Stromb.-Vulc.	2	0.65	2.49	4.11	10.49	15.46	41.80
Langila, Papua New Guinea	Bas.-And. Vulcanian	2	0.87	3.29	5.63	13.95	19.83	52.71
Merapi, Indonesia	Bas.-And. Dome collapse	2	1.95	8.02	12.66	27.24	38.11	83.06
Vesuvius, Italy AD79-472	Tephr.-Phon. Stromb.-Vulc.	2-3	0.72	2.09	3.24	7.13	10.14	33.99
Sakurajima, Japan	Andesitic Vulcanian	3	0.00	0.50	0.86	1.95	2.87	14.74
Etna, Italy	Basaltic Strombolian	3	0.27	1.09	1.83	4.59	6.75	22.17
Ruapehu, New Zealand	Andesitic Sub-plinian	3	0.51	2.44	4.14	9.43	13.37	32.19
Soufrière Hills, Montserrat 1997	Andesitic Vulc. explosion	3	1.00	3.60	5.90	13.40	18.50	44.08
Soufrière Hills, Montserrat 1999	Andesitic Dome collapse	3	1.94	6.74	10.70	23.10	31.90	76.88
Soufrière Hills, Montserrat 2003	Andesitic Dome collapse	3	2.70	7.87	11.47	22.49	30.75	74.63
Fuego, Guatemala 1974	Basaltic Subplinian	4	0.88	2.43	3.66	7.99	12.04	46.64
El Reventador, Ecuador	Andesitic Vulcanian	4	0.90	3.21	4.88	10.16	15.12	72.93
Mt St Helens, USA	Dacitic Plinian	5	1.69	7.39	11.74	24.50	33.15	78.76
Vesuvius, Italy AD79	Tephr.-Phon. Plinian	5	4.81	11.62	16.93	32.83	43.39	83.70
Pinatubo, Philippines 3/6/91	Dacitic Plinian	6	1.07	5.49	8.97	17.88	23.12	54.05
Pinatubo, Philippines 4/7/91	Dacitic Sub-plinian	6	1.33	6.18	9.82	18.93	24.34	60.69

Amount of material for health-pertinent fractions found in selected samples of volcanic ash. The table is ordered by increasing VEI (volcanic explosivity index). Grain-size distributions measured on Malvern Mastersizer 2000 with Hydro MU

[†] Horwell, C.J. Grain size analysis of volcanic ash for the rapid assessment of respiratory health hazard. *J. Environ. Monitor*. **9**, 1107 - 1115 (2007).