Sampling the Volcanic Ash from the Eyjafjallajökull Volcano, Iceland—A Personal Account

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The eruption of the Eyjafjallajökull volcano started on 20 March 2010. The first phase of the eruption was effusive, producing lava flows on the glacier-free part of the volcano, with insignificant volcanic ash fallout. In the early morning of 14 April 2010, the eruption entered an explosive phase, ejecting volcanic ash to heights in excess of 9 km (Fig. 1) and causing major disruption to European air travel. The explosive phase of the eruption took place within the summit caldera under a 200–300 m thick ice cover. The meltwater and steam at the glacier-covered eruption site chilled the magma, causing it to disintegrate explosively and producing fine-grained volcanic ash particles that were able to travel long distances. *Jökulhlaup*, floods of meltwater, reached the lowlands around the volcano at about noon on 14 April. The ash-loaded eruption plume was deflected to the east by westerly winds, and ash started to fall in southeastern Iceland on 14 April. The next day, the eruption plume reached mainland Europe (Fig. 2). Most of the erupted material was in the form of volcanic ash. The ash was sent into the southeasterly moving jet stream, which then carried the ash over Europe, into one of the busiest airspaces in the world.

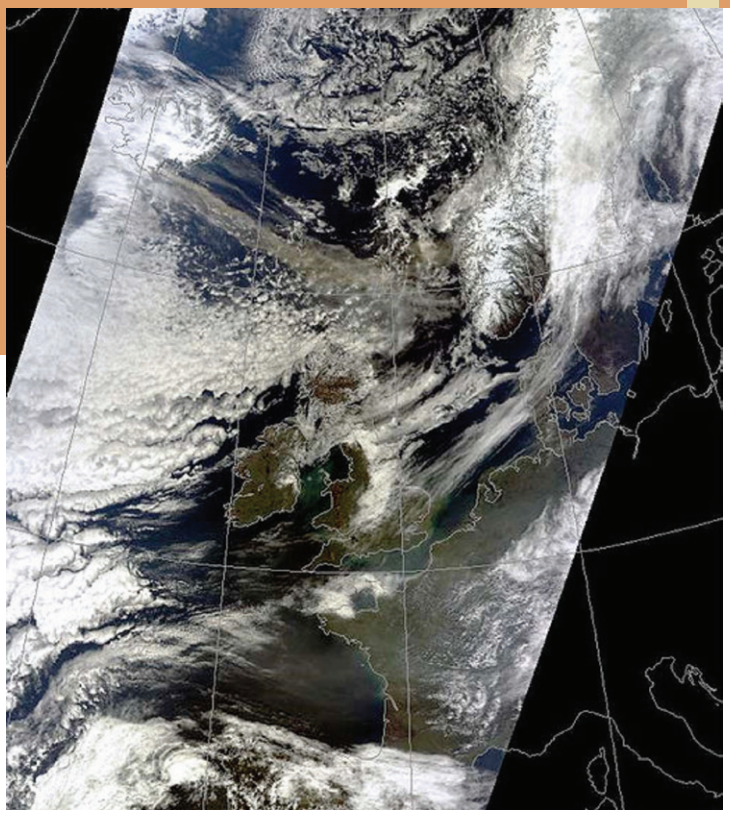

Figure 2 MODIS image of the ash cloud (darker grey than ordinary clouds) at 11:39 GMT on 15 April. Reproduced with permission from NEODAAS/University of Dundee

Figure 1 The plume from Eyjafjallajökull, 15:20 local time (= GMT), 14 April 2010. Photo Árni Sæberg

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Figure 3 Heading into the plume shortly after noon, April 15. Helgi is the driver of the first car. Photo courtesy of Ómar Óskarsson

Volcanic ash ingested by jet engines may lead to engine failure. Large amounts of air are sucked into jet engines during combustion. Very fine volcanic ash particles sucked into a jet engine melt at about 1100 °C, fusing onto the blades and other parts of the turbine, which operates at about 1400 °C[1]. Moreover, volcanic ash is highly abrasive, and therefore, forward-facing surfaces of an airplane (e.g. cockpit windows) are likely to be damaged. Some ash particles passing through the engines may enter the interior of the plane via the ventilation ductwork[1,2]. To prevent such damage, the controlled airspace of many European countries was closed to passenger flights, resulting in the largest air-traffic shutdown since World War II[3,4]. The closures caused millions of passengers to be stranded in Europe and across the world. After an initial continuous shutdown over much of northern Europe from 15 April to 23 April, airspace was closed occasionally in parts of Europe during the following weeks.

PERSONAL EXPERIENCE

I received a phone call around 6 AM on 14 April informing me that the eruption was in an explosive phase and that floods were expected in the vicinity of the volcano. I packed gear for sampling water and ash, and a few hours later, headed for the volcano with Helgi Alfredsson, one of my PhD students. It was a race against time, because floods were on the way and we needed to get east of the rivers before their arrival. We were the last ones to pass over the bridge before the road was washed away by the flood. We collected several samples from 3 floods on 14 April. Around midnight we learned that the eruption would close European air space, and we were asked to sample the fallout from the ash plume in eastern Iceland. Information about the volcanic ash was badly needed, and helicopters could not come close enough to the eruption. We had to drive into the ash plume. The information needed included mineralogical and chemical composition, the identity of metal-salt and acid-salt coatings on the ash, and grain-size distribution. These parameters would be fed into volcanic plume distribution models. In the morning of 15 April, we drove east into the plume, followed by two cars carrying local police and journalists (Fig. 3). We sampled the southern edge of the plume 50–60 km east of the summit crater. These samples were immediately driven back out of the plume by Helgi and the local police to a helicopter that brought them to the laboratories in Reykjavík for chemical analysis, grain-size analysis, and dry storage (ash is hygroscopic, that is, it takes up water from the air, causing alteration).

I headed farther into the plume followed by a journalist. It was absolutely dark in the middle of the fallout zone at 12:45 PM (Fig. 4). Once I got out of the car, I was expecting to sense fallout on my helmet, but nothing could be heard. It was perfectly quiet, and there was neither wind nor rain. When I was in front of the car, I could see in the light column from the headlights that the air was saturated with very fine-grained ash, floating like greyish flour in the air. This fine-grained ash prevented light from reaching the ground. It turned out that about 7 wt% of the ash was less than or equal to 2.6 micrometers (μm) in diameter and that more than 20% of the mass of the ash was less than or equal to 10 μm in diameter. This ash was able to travel long distances—all the way to Europe. I sampled the ash, drove on until we started to see light again, and sampled the northeastern edge of the plume. On the way back through the ash, the wind speed increased, blowing most of the ash off the road, and once I was out of the fallout zone, it started to rain. We were lucky to have collected pristine, dry ash samples across the plume.

On Friday morning, 16 April, when I returned to my laboratory at the university in Reykjavík, I was amazed – journalists were there from all over the world, the phone never stopped ringing, and all my colleagues were doing their best to answer questions about the eruption: When will it be over? Why is there so much ash? Is the ash harmful to health? I was very flattered in the beginning; you fight for attention for your research for years, and then all of a sudden you have too much of it. There were several pictures of us sampling the ash in the Icelandic morning paper, and over the weekend, we saw them on the covers of some of the major newspapers of the world. I read in *Der Spiegel* that I was 52 years old and that I was scared to death going into the plume[5]. After the first days of too much attention, I gave up, unplugged the phones, and ignored my e-mails for a while. I worked with my group on the ash, determined the composition of the floodwaters and the pollutants carried by the first rain on the ash in the vicinity of the volcano, started controlled laboratory experiments on the water/ash, and seawater/ash interactions, and began to explore chemical reactivity. And for a more thorough characterization of the nanoparticles and their surface coatings, we sent samples to Susan Stipp at the NanoGeoScience Centre in Copenhagen.

Figure 4 Sampling in the middle of the plume at 12:45 PM, 15 April, using the headlights of the car. The photographer pointed the lens out of the plume. I am mostly covered to avoid getting ash on my skin. Some ash has metal-salt and acid-salt coatings, which may be toxic. I wore a skimobile helmet that fits tightly and has a filter over the nose and mouth to prevent breathing the submicrometer-sized particles. Photo courtesy of Ómar Óskarsson

REFERENCES

1 USGS June 2010. http://volcanoes.usgs.gov/hazards/tephra/ashandaircraft.phpUSGS

2 Durant AJ, Bonadonna C, Horwell CJ (2010) Atmospheric and environmental impacts of volcanic particulates. Elements 6: 235-240

3 BBC: Row grows over airspace shutdown costs, 22 April 2010. http://news.bbc.co.uk/2/hi/uk_news/8636461.stm

4 *The Sydney Morning Herald*. 18 April 2010. Qantas cancels flights for a third day" http://www.smh.com.au/travel/travel-news/qantas-cancels-flights-for-a-third-day-20100418-slv5.html. Retrieved 18 April 2010. http://www.smh.com.au/travel/travel-news/qantas-cancels-flights-until-tuesday-afternoon-20100418-slv5.html

5 *Der Spiegel*. 19 April 2010, "Müder alter Mann" 16/2010, page 110-112