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SEM analysis of tephra collected in rain in Copenhagen during the 2010 eruption of Eyafjallajökull

Chr. Bender Koch (1), Thomas Bjerring Kristensen (2), and Merete Bilde (2)

(1) Department of Basic Science and Environment, Faculty of Life Science, University of Copenhagen, Denmark (cbk@life.ku.dk), (2) Department of Chemistry, Faculty of Science, University of Copenhagen, Denmark

Volcanic eruptions are localized sources of reactive, fine-grained materials that spread into and modify the properties of the atmosphere. The tremendous variability in concentration and sizes of particles makes assessment of ash behavior a huge technical challenge. Rain accelerates leaching of the particles from the air column thus providing access to spatially confined information on some basic properties (particularly size) of the ash particles. We here report on the morphology and size of particles attributed to be of volcanic origin in rain collected in Copenhagen in April 2010 following the eruption of the Eyafjallajökull volcano. The particles exhibit angular morphology and are extremely variable in size, typically of dimensions between a few micrometers and approximately 50 micrometers.

Precipitation was collected using a glass funnel and a glass container on top of the HCØ building complex at Universitetsparken in Copenhagen (55.7°N, 12.6°E). Rain water was collected: From April 20th 14:30 to April 21st 10:00 local time 410 mL rain was collected. From April 21st 10:00 to April 21st 19:30 350 mL rain was collected.

The precipitate was filtered using a 0.45 my cellulose filter (D=4.0 cm) and prepared for SEM analysis by adhering small parts of the filter onto the supporting Al stub and coating with carbon by sputtering to minimize charging effects. A FEI Inspect instrument operated between 5 and 20 kV was used for imaging. Semi quantitative elemental analysis was obtained using an Oxford energy dispersive x-ray detector.

Admixed with the tephra particles of biological and technical origin were also identified.

The most abundant tephra observed was blocky shards dominated by angular edges and sharp protrusions. The surfaces of the particles appear mostly fresh and clean but often agglomerates of rounded particles of much smaller size are found adhering to the surface. These particles are interpreted as originating from physical fracturing of much larger particles. The particles appear dense indicating that gas-driven fracturing has been of minor importance.

We also observed several spheres ($\sim$20-30 μm) giving the impression of hollow structure with abundant (approximately ring shaped) opening to the exterior with flow lines on the surface. They are preliminary interpreted as remelted cellular particles.

In addition to that aggregates (with dimensions up to $\sim$20-40 μm) of mostly blocky micron-sized particles having angular to subangular edges, often showing muschled fractures were present. They appear to have been welded together either by mechanical impact or late stage heating from gas phase.

In conclusion this direct investigation shows that tephra particles can be both simple and composite. The contrasting morphologies will exhibit different fundamental physical properties for comparable sizes, rendering extraction of size information from scattering difficult. Our results document the occurrence of particles in the tephra of larger size than previous results derived from scattering