Evolution in phase composition and morphology of volcanic aerosols during transport: the Eyjafjallajoekull plume 2010

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To assess the impacts of volcanic aerosol on the environment and anthropogenic activity, the physico-chemical properties of the particles have to be known. Such information is usually drawn from samples taken on the ground or indirectly from remote sensing. Ground samples reflect only a deposited fraction of the aerosol. Remote sensing allows to extract grain size distribution of an volcanic aerosol assuming monophasic, spherical aerosol particles. Ash dispersal models are also based on same assumptions. Volcanic aerosols, however, are usually composed of more than one phase, each with a distinct density and preferred shape. In general, the main components are glass particles, phaenocrysts of minerals, which have crystallized before the eruption occurred, particles, which are formed through resublimation of volatile components, and externally mixed particles composed of the previous components. Particles of same size may have different travel distances because of differences in density and/or shape. During transport, therefore, not only the average size of particles but also the phase composition and the morphological character of a volcanic aerosol will change.

When assessing the societal and environmental impact of a volcanic plume these continuous physico-chemical changes will ultimately have to be taken into account. The eruption of Eyjafjallajoekull 2010 and the entrainment of its plume into European airspace gave the possibility to sample a volcanic aerosol after several thousands of kilometers of transport both in the air and on the ground. We compared the mineralogical composition and the morphology of particles of the following samples: 1) collected from an air filter of a piston- engined plane, which entered the plume close to the crater, 2) resuspended particles sampled at 20 km from Eyjafjallajoekull, and 3) taken from an airplane, which crossed the plume over the Dutch-German border. A clear change in mineralogy and morphology could be observed. The airborne samples sampled in Europe are impoverished in phaenocrysts. This reflects most probably the difference in density between the volcanic glass and the phaenocrysts. The aspect ratio of the particles evolves also during the transport. Particles with high aspect ratio are almost absent in the plume over Europe. Possible explanation is the higher specific surface of such particles, which will enhance the tendency of aggregation. The average physical properties of the aerosol thus changes with transport. The average hardness of the aerosol, important to assess the mechanical impact on airplane components, decreases with transport. Particles with high melting points e.g. olivine and pyroxene phaenocrysts are also decreasing in concentration with transport.