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A novel reactor for the simulation of gas and ash interactions in volcanic eruption plumes

Paul M. Ayris (1), Corrado Cimarelli (1), Pierre Delmelle (2), and Donald B. Dingwell (1)

(1) Department of Earth and Environmental Science, Ludwig Maximilians Universität, Munich, Bavaria, Germany (paul.ayris@min.uni-muenchen.de), (2) Earth and Life Institute, Université Catholique de Louvain, Louvain la Neuve, Belgium

The chemical interactions between volcanic ash and the atmosphere, hydrosphere, pedosphere, cryosphere and biosphere are initially the result of rapid mobilisation of soluble salts and aqueous acids from wetted particle surfaces. Such surface features are attributable to the scavenging of sulphur and halide species by ash during its transport through the eruption plume and volcanic cloud. It has been historically considered (e.g., Rose, 1977) that the primary mechanism driving scavenging of sulphur and halide species is via condensation of acid aerosols onto ash surfaces within the cold volcanic cloud. However, for large explosive eruptions, insights from new experimental highlight the potential for scavenging via adsorption onto ash within the high-temperature eruption plume. In previous investigations on simple SO_2 (Ayris et al. 2013a) and HCl systems (Ayris et al. 2013b), we identified ash composition, and the duration and temperature of gas-ash interaction as key determinants of adsorption-mode scavenging. However, the first generation of gas-ash reactors could not fully investigate the interactions between ash and the hydrous volcanic atmosphere; we have therefore developed an Advanced Gas Ash Reactor (AGAR), which can be fluxed with varying proportions of H_2O, CO_2, SO_2 and HCl. The AGAR consists of a longitudinally-rotating quartz glass reaction bulb contained within a horizontal, three-stage tube furnace operating at temperatures of 25-900˚C. A sample mass of up to 100 g can traverse a thermal gradient via manual repositioning of the reaction bulb within the furnace. In combination with existing melt synthesis capabilities in our laboratories, this facility permits a detailed investigation of the effects of ash and gas composition, and temperature on in-plume scavenging of SO_2 and HCl. Additionally, the longitudinal rotation enables particle-particle interaction under an ‘in-plume’ atmosphere, and may yield insight into the effects of gas-ash interaction on aggregation processes. Large quantities of material can be processed in the AGAR. We invite discussions regarding collaboration with “downstream” projects that would benefit from use of such materials, or from access to and further development of, the advanced gas-ash reactor.

References

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