



## **SO<sub>2</sub> and HCl scavenging by ash at high temperature in volcanic eruption plumes: insights from laboratory experiments**

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Sulphur dioxide-rich plumes emitted by volcanic explosive eruptions can induce tropospheric cooling on a global scale. The magnitude and duration of this cooling is dictated by the mass of SO<sub>2</sub> injected into the stratosphere, its conversion to sulphate aerosols and the subsequent stratospheric dispersion of these aerosols. Similarly, stratospheric injection of HCl by explosive eruptions has been suggested to induce ozone destruction. The masses of erupted SO<sub>2</sub> and HCl are dependent on magmatic conditions but in-plume scavenging processes reduce the fraction injected into the stratosphere. While progress has been made to describe SO<sub>2</sub> and HCl removal by water and ice hydrometeors, the mechanisms driving SO<sub>2</sub> and HCl scavenging by silicate ash remain poorly understood.

Based on laboratory experiments, we suggest that the reaction of SO<sub>2</sub> and HCl with ash in the high temperature environment of the eruption plume is an important scavenging mode which begins immediately after magma fragmentation. We constrain the reaction mechanisms and incorporate these into a simple model that allows calculation of the mass of SO<sub>2</sub> and HCl which may be removed. We apply the model to different eruption scenarios and infer that scavenging by ash at high temperature may considerably reduce the masses of SO<sub>2</sub> and HCl injected into the atmosphere during an explosive eruption, although the magnitude of the reduction depends strongly on the initial particle size distribution of the ash and on the gas-to-ash ratio in the hot eruption plume.