MINERALOGICAL FACTORS AFFECTING THE POTENTIAL TOXICITY OF VOLCANIC ASH

DAVID DAMBY*, CLAIRE HORWELL

Durham University, Durham, DH1 3LE, UK
d.e.damby@dur.ac.uk

Multidisciplinary research into volcanic ash as a respiratory health hazard arose from the eruption of Mt. St. Helens (MSH), USA in 1980 and has returned to mainstream prominance in the wake of the recent Eyjafjallajökull, Iceland eruption in 2010. Exposure to ash is known to trigger acute respiratory diseases, such as asthma and bronchitis, and has the potential to instigate chronic diseases if the particles are sufficiently fine to deposit in the alveolar region of the lungs. One suspected disease-causing mechanism arises from the existence of crystalline silica in volcanic ash, specifically as cristobalite, which is classed as a human carcinogen. Recently, we have established that the potential toxicity of volcanic ash is likely to vary depending on the type and style of eruption. Dome-forming eruptions in particular tend to generate substantial quantities of crystalline silica, which crystallises as the lava dome slowly cools. An inherent feature of domes is their instability, resulting in collapse and the generation of respirable cristobalite-rich ash. The effects of structure and composition on volcanic cristobalite toxicity are ill-defined as the physiological burden has only been sufficiently studied at one location; Soufrière Hills volcano (SHV), Montserrat. Here we present results from a systematic characterisation of the mineralogical properties of cyrstalline silica from a suite of volcanic locations. To further define the disease-causing potential of ash and to elucidate the properties responsible for adverse biological responses, the abundance, purity, crystallographic form, and crystal shape of volcanic silica were determined using XRD, electron microprobe, SEM, and Raman spectroscopy. As with previous observations at SHV, the cristobalite is found within the groundmass as well as growing into vugs in dome rock, in both platy and euhedral forms. The composition is impure, containing traces of other cations such as aluminium (up to 3 wt%). The quantity of cristobalite differs between volcanic settings due to variability in activity and duration of dome growth. Collating mineralogical results from MSH, SHV, Merapi, Unzen, and Santiaguito will provide insights into the global respiratory hazard posed by volcanic ash. As higher levels of cristobalite in ash raise concerns about the onset of chronic, injurious disease following exposure, it will be possible to recognize hazards based on existing settings and significantly aid risk mitigation.

Keywords: ash, cristobalite, toxicity