THE RESPIRATORY HEALTH HAZARDS OF VOLCANIC ASH: A REVIEW OF CURRENT KNOWLEDGE FROM A MINERALOGICAL AND TOXICOLOGICAL PERSPECTIVE

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Following the eruption of Mt St Helens, USA, in 1980, it was recognised that volcanic ash had the propensity to cause acute and chronic respiratory disease. In particular, the presence of cristobalite, a form of crystalline silica, was of concern as it may cause silicosis and is a carcinogen. Despite a number of epidemiological, clinical, toxicological and mineralogical studies at Mt St Helens, the overall hazard of the ash remains unclear, particularly as exposure was fairly limited.

Dedicated research on the respiratory health hazards of volcanic ash resumed in 1995 following the onset of eruptions at Soufrière Hills, Montserrat (still ongoing today) where, in addition to abundant crystalline silica, it was recognised that reactive iron on the particle surfaces could provide a mechanism for toxicity. Here we present a summary of detailed studies done by our group and collaborators on ash from the Soufrière Hills eruptions, as well as Chaitén (Chile), Vesuvius and Etna (Italy), Sakurajima (Japan), Rabaul (Papua New Guinea), Merapi (Indonesia) and Eyjafjallajökull (Iceland), which have erupted a range of ash compositions (mafic to highly silicic).

Our analyses have shown that volcanic ash erupted from the collapse of lava domes is the most hazardous in terms of cristobalite content but also that efficient fragmentation in dome-collapse pyroclastic flows generates abundant inhalable material. Particularly fine ash is also during interaction between fresh magma and water (phreatomagmatic activity) e.g. at Mt Vesuvius in AD79. Basaltic eruptions usually generate coarser ash but the high iron content of the magma correlates with increased iron-catalysed surface reactivity (measured through generation of the deleterious hydroxyl radical). Many volcanoes produce fibre-like particles but we have only observed these as rare occurrences amongst 'normal' angular, blocky ash particles.

In recent years we have included toxicological assessment within our 'rapid analysis' protocol. To date our results concur with the overall view of more detailed studies at Mt St Helens and Soufrière Hills: the ash is not as toxic as expected given the presence of cristobalite. Fundamental research on the properties of the cristobalite has found that the cristobalite's toxicity may be impaired because of substituted cations (particularly Al) in the crystal structure and because the surfaces of cristobalite particles may be occluded by coatings of glass or adhered mineral grains.

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