

## The role of sulfur viscosity in priming and triggering volcanic eruptions

TERESA SCOLAMACCHIA<sup>1</sup> SHANE J. CRONIN<sup>2</sup>

<sup>1</sup>Kapuzinerstrasse 23, 80337, München, Germany.  
tscolamacchia@gmail.com

<sup>2</sup>School of Environment, The University of Auckland, 0620  
Auckland, New Zealand

Sulfur is ubiquitous at volcanoes within gaseous, liquid and solid forms. Besides oxides, metal-complexes and crystalline solids, it exists in its elemental state ( $S_e$ ).

Due to its complex polymerization behaviour,  $S_e$  viscosity is highly temperature-dependent. A well known 10,000-fold increase in viscosity occurs at  $T \sim 160$  °C, reaching a maximum (93.2 Pa·s) between 186 and 188 °C. Viscosity decreases until  $\sim 0.1$  Pa·s at its boiling point (444.6°C) [1,2]. Nevertheless, old industrial experiments demonstrated that in the presence of impurities (mostly organics) or under the exposure of certain gas types (i.e.  $H_2S$ , HCl, HF), the viscosity trends of pure  $S_e$  are altered depending on the maximum  $T$  attained on heating and on heating rate [1]. For  $T < 160$ °C,  $S_e$  viscosity remains unchanged even in the presence of impurities, but different viscosity trends manifest already when a  $T$  threshold of 180-200 °C is exceeded.  $S_e$  is highly impure in volcanic environments. The accumulation of “S-layers” within hydrothermal systems has been inferred at several volcanoes worldwide [e.g. 3,4]. We suggest that impure  $S_e$  behaviour influences the gas permeability of volcanic-hydrothermal systems depending on maximum temperatures, heating rates experienced, and types of emissions from degassing magmas. Impure  $S_e$  may allow gas to bubble through it, until viscosity variations cause a seal in porosity, with a sharp rise in gas pressures, triggering explosive eruptions, which are not heralded by common precursory signals of magmatic eruptions. Impure  $S_e$  behaviour may also offer an alternative explanation to the “cyclic” gas emissions (e.g.  $SO_2$ ,  $CO_2$ ) observed at several volcanoes, attributed to characteristics of the plumbing system or physical conditions within the conduits, and to the constant ground oscillation observed at calderas.

1. Bacon, R. F., Fanelli, R. (1943), *J Am Chem Soc*, 65, 639-648.
2. Meyer, B. (1976), *Chem Rev*, 76(3), 367-388.
3. Christenson, B.W. and Wood C.P. (1993) *Bull Volc*, 55, 547-565.
4. Takano, B. (1987), *Science*, 235, 1633-1635