

## TRACKING THE BEHAVIOUR OF SULPHUR IN A POTASSIC MAGMA CHAMBER: SULPHATE-SILICATE MELT IMMISCIBILITY IN INCLUSIONS FROM MAGMATIC XENOLITHS OF THE SABATINI VOLCANIC DISTRICT (CENTRAL ITALY).

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The pre-eruptive behaviour of sulphur in a potassic magma chamber has been investigated using clinopyroxene and feldspar melt and fluid inclusions from syenitic xenoliths of the The Sabatini volcanic district. This volcanic field is part of the Roman Comagmatic Province (RMP) and consists of several vents distributed over a large area located in northern Latium. The volcanic products consist of ultrapotassic pyroclastic rocks of the so called high-potassium series (HKS). Crystalline xenoliths (ejecta) are commonly observed and include sedimentary, metamorphic and igneous rocks. These last ones generally have high-silica compositions (syenites) and are interpreted to represent intrusive equivalent of lavas.

Syenitic xenoliths were collected from three distinct HKS hydromagmatic units (Sacrofano, M. Razzano, Stracciaccappa), which formed during the late stages of activity (0.3 M.y.). Xenoliths (3–10 cm size) show heterogranular textures and consist of large euhedral crystals of sanidine (60–70 % modal; Na<sub>2</sub>O < 1) with subordinate diopside-hedbergite, leucite, zoned melanite, h  yne (SO<sub>3</sub> up to 14 wt%), cancrinite (SO<sub>3</sub> up to 11 wt %), nepheline, amphibole, biotite and plagioclase. Diopside, melanite, h  yne and mica also occur as interstitial phases. Accessory phases include Fe-oxides, sulphate-rich apatite, titanite and rare fluorite. Textural characters suggest that xenoliths represent fragments of walls of magma chamber brought to surface by explosives eruptions.

Melt inclusions are present in clinopyroxene and in many sanidine crystals. In diopside, melt inclusions contain silicate glass and a small shrinkage bubble; glass has phonotephritic composition, similar to most volcanic products. In sanidine, a complex association of melt and fluid inclusions is observed. Silicate-melt inclusions (10–100µm) consist of colourless transparent glass (M1), one or more bubbles ± daughter phases. In many inclusions, several small (1–5 µm) yellowish globules (M2), that might be birefringent at crossed light, are observed within the silicate glass (M1). The relative M1 – M2 ratios vary in the different inclusions. Silicate-melt inclusions containing the two distinct M1 and M2 phases are often associated to large vapour-dominated aqueous fluid inclusions (5–50 µm). Representative analyses of glass inclusions reveal evolved trachytic compositions. The second phase (M2) has a sulphur-rich composition (SO<sub>3</sub> = 6 wt%) and contains low silica and high Al<sub>2</sub>O<sub>3</sub>, CaO and alkalis. Raman spectroscopy on M1 and M2 phases further indicate that the silicate glass (M1) contains sulphur mainly as S<sup>6+</sup> [(SO<sub>4</sub>)<sup>2-</sup>; 995 cm<sup>-1</sup>] and that glass are rich in (CO<sub>3</sub>)<sup>2-</sup> (1075 cm<sup>-1</sup>). Spectra of the immiscible sulphate-rich (M2) phase reveal only the presence of (SO<sub>4</sub>)<sup>2-</sup> vibrations, with minor (CO<sub>3</sub>)<sup>2-</sup>. In some (M2) droplets, Raman analyses further indicate that a hydrated sulphate mineral (probably cesanite; 1004 cm<sup>-1</sup>) is present along with (SO<sub>4</sub>)<sup>2-</sup>.

Aqueous fluid inclusions grains are present as clusters associated to melt inclusions or as short intragranular trails in sanidine. They are vapour-rich and may contain one or two high-birefringent daughter minerals (cesanite ± anhydrite ± calcite by Raman analyses). Low density CO<sub>2</sub> ± H<sub>2</sub>S are present in a few vapour bubbles. Final melting temperatures of ice are between -1 and -5°C. Clathrate melting occurs up to +28°C. Raman investigations indicate that liquid water contains high concentrations of (HSO<sub>4</sub>)<sup>-</sup> and (SO<sub>4</sub>)<sup>2-</sup> ions in solution. Homogenisation temperatures occur to the vapour phase (Th L + V → V) between 365 and 410°C (d=0.17 g/cm<sup>3</sup>).

Present data provide strong evidence that study xenoliths crystallised from an oxidised sulphate-rich alkaline magma, that at late stage exsolved immiscible sulphate-rich melts and aqueous fluids. Abundance of sulphate in these rocks is indicated by the presence of h  yne, cancrinite and SO<sub>3</sub>-rich apatite in the mineral assemblage. The presence of sulphate-rich mineral phases is a distinctive characteristic of most in potassic magmas of the Roman magmatic province and present results suggest that the most plausible explanation is the high-oxidation state of the magma. During crystallisation and cooling, immiscibility between sulphate and silicate liquids occurred. Volatile saturation of the partially crystallised magma resulted in the exsolution of a free sulphate-rich aqueous fluid that may have migrated and interacted with the wall rocks providing a highly mobile metasomatic agent.