Composition of carbonatite-related orthomagmatic fluids

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Abstract

Fluids that are associated to carbonatite magmatism are known to play a significant role in REE mineralization [1] and in the formation of highly peralkaline silicate melts/rocks [2]; occurring at Oldoinyo Lengai (OL) [3] and worldwide [4]. Moreover, these fluids can contribute to the formation of Na-carbonatite melts [2], as well. However, the characterization of carbonatite-related orthomagmatic fluids can be challenging as their composition can be easily changed [5] after a separation from carbonatite-silicate parent melt(s). Several studies suggested a NaCl-H2O-CO2 composition for fluids exsolved from carbonatites [6]. In contrast to this, fluids, coexisted with an immiscible silicate-carbonate melts rather support a H2O-poor, S-bearing, alkali-carbonate-CO2 composition [7]. These controversial results motivated us to study fluid inclusions from recently active OL volcano.

The studied fluid inclusions are secondary and hosted in quartz originated from a metamorphic xenolith that interacted with both fluid and melt from OL magmatism. At room temperature the fluid inclusions (n=30) consist of numerous daughter phases (sulfates, hydrocarbonates, carbonates) together with liquid-CO2 and vapor-CO2 (Fig. 1a). Raman microspectroscopy (n=200) showed that the overwhelming majority of daughter minerals are thenardite, arcanite, nahcolite and natrite. We carried out 3D Raman-imaging (n=5, Fig. 1b) to estimate the proportions of the daughter minerals and CO2. During heating of the fluid inclusions, we observed a homogeneous fluid phase at 800-850 °C, confirmed by Raman spectroscopy. Our results show a H2O-poor (up to 6 wt%), sulfate-rich, alkali-carbonate-CO2 composition in the studied fluid inclusions at OL, supporting that such compositions are common in carbonatites instead of NaCl-H2O-CO2 fluids.

References