

Viscosity measurements of magmas in the Earth's upper mantle: constraints on rates and ascent timescales of a primitive alkaline basalt

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Understanding the rheological properties of magmas at pressures and temperatures at which they form is necessary to model the ascent rate from Earth's mantle up to the surface. Volcanic eruptions are shallow phenomena resulting from density- and viscosity- driven processes that affect the melt migration and ascent velocity from mantle regions.

In this experimental study we determined the viscosity of an alkaline basaltic liquid belonging to the Campi Flegrei Volcanic District (CFVD) at HP-T to shed light on its mobility and ascent velocity from the source rock to the volcanic plumbing system at present day. An anhydrous alkaline basaltic glass was synthesized by melting at 1440°C a natural powdered basalt (APR16 sample) at controlled oxygen fugacity. The viscosity was measured in-situ at pressures of 0.7-7.0 GPa and temperatures above the liquidus using the falling sphere technique with the Paris-Edinburgh press in combination with synchrotron X-ray radiography. Measured viscosities of the alkali basaltic melt were scaled down to realistic P-T regime underneath the CFVD along with its mobility and ascent velocity. Interestingly, when integrated to existing geochemical and petrological data, our results are consistent with those of the literature in locating the depth of the source rock to ~60-80 km. In addition, since this primitive alkaline basalt can directly ascent to the surface and generate effusive eruptions with the emplacements of lava flows as those historically occurred in the CFVD (e.g., 1302 Arso eruption, Ischia Island), or hydromagmatic eruptions when magma interacts either groundwater or surface water, the viscosity measured at the lowest pressure was used to constrain the velocity and ascent timescales of alkaline magmas from Procida Island within dikes along two different paths: from a deep reservoir located at the