Magma bouyancy: From supervolcano magma chambers to the core-mantle boundary

WIM J. MALFAIT[1], SYLVAIN PETITGIRARD[2], RITA SEIFERT[3] AND CARMEN SANCHEZ-VALLE[4]

[1]Building Energy Materials and Components, Empa, Switzerland, wim.malfait@empa.ch
[2]Bayerisches Geoinstitut, University of Bayreuth, Germany
[3]Institute of Geochemistry and Petrology, ETH Zurich, Switzerland
[4]Institute for Mineralogy, University of Münster, Germany

Silicate melts constitute only a minor volume fraction of the present day Earth, but play a critical role in Earth's geochemical and geodynamical evolution due to their high mobility and reactivity. The density contrast between melts and minerals determines the rate and direction (up or down) of melt migration and the rate of fractional crystallization.

Over the last few years, we measured the density of dry and hydrous rhyolite [1], phonolite [2] and andesite [3] melts at subduction zone pressures and temperatures (up to 4 GPa and 2000 K) with the X-ray absorption method combined with the Paris-Edinburgh press. These new data on felsic and intermediate melts complement a rapidly growing set of in situ data on (ultra)mafic systems and ambient pressure dilatometry and sound velocity data. The combined dataset indicates that the partial molar volume of water is independent of melt composition, even at high pressure [3]; and serves to calibrate a predictive model for the density of dry, hydrous and CO_2 bearing melts at crustal, upper mantle and mantle transition zone conditions. Our in situ, rhyolite melt density data constrain the bouyancy derived overpressure at the roof of supervolcano magma chambers and indicate that bouyancy alone can be enough to trigger an eruption [1].

Recently, we adapted the X-ray absorption method to the confinement of the diamond anvil cell and measured the density of $MgSiO_3$ glass up to 127 GPa, more than doubling the pressure range over which density data on melts or glasses had been collected before [4]. The density of $MgSiO_3$ glass is the same as $MgSiO_3$ bridgmannite at core-mantle boundary pressures. Thus, taking into account the partitioning of iron, silicate melts will be denser than the mineral phases in the lowermost mantle and melts will sink towards the core-mantle boundary [4].

[1] Malfait et al. (2014) *Nature Geosc*. **7**, 122-125. [2] Seifert et al. (2013) *EPSL* **381**, 12-20. [3] Malfait et al. (2014) *EPSL* **393**, 31-38. [4] Petitgirard et al. (submitted).