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Interfacial tension between immiscible liquids in the system K_2O-FeO-Fe_2O_3-Al_2O_3-SiO_2 and implications for the kinetics of silicate melt unmixing

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Abstract

Interfacial tension between immiscible liquids is an important thermodynamic parameter of silicate melt unmixing and a property that determines the kinetics of phase separation. In this study, we present experimental measurements of interfacial tension between immiscible Fe-rich and silica-rich melts in the system K_2O-FeO-Fe_2O_3-Al_2O_3-SiO_2. We have also measured densities and surface tensions of the individual immiscible liquid phases. The measurements were carried out in air at 1500–1550 °C by the maximum detachment force method employing vertical cylinder geometry and using a gravimetric balance system. We have chosen the most oxidized and contrasting liquid compositions containing 73 and 17 wt% SiO_2 and 14 and 80 wt% FeOt, respectively, that have been shown to coexist in air at and above 1465 °C. Interfacial tension between the synthetic immiscible liquids decreases with increasing temperature from 16.4 ± 3.1 mN/m at 1500 °C to 7.8 ± 1.1 mN/m at 1550 °C. Interfacial tension between natural, less compositionally contrasting ferrobasaltic and rhyolitic melts should be even lower by a factor of 2 or 3. Very low interfacial tension implies easy nucleation of immiscible liquid droplets and very slow coarsening of resulting silicate emulsions.

Keywords: Immiscibility, interface, tensiometry, nucleation