Volatiles in primitive plagioclase-hosted melt inclusions

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Despite their grouping as volatile species, H_2O, Li, CO_2, F, Cl and S often behave very differently during the generation, evolution and eruption of basaltic magmas. Although numerous recent studies have investigated the behaviour of volatiles in olivine-hosted melt inclusions, comparatively few studies have investigated volatiles in plagioclase-hosted melt inclusions. We therefore present SIMS and EPMA analyses of volatiles in matrix glasses and predominantly plagioclase-hosted (~An_{90}), naturally quenched melt inclusions from the voluminous (>1–30 km^3) 10 ka Grímsvötn tephra series, Iceland. Corresponding major and trace element data have been published recently [1]. High, variable and correlated matrix glass H_2O and S contents (0.1–0.5 wt.% and 800–1200 ppm respectively) suggest that eruption-related degassing was arrested prematurely owing to quenching in a phreatomagmatic setting. Conversely, comparatively soluble Li, F and Cl show no evidence of having degassed from matrix glasses. Primitive plagioclase-hosted melt inclusions contain more H_2O and Li than expected from on their trace element compositions (assuming H_2O/Ce = 180 and Li/Yb = 1.7 in primary melts). We attribute these excesses to the diffusive gain of volatiles after the entraiment of primitive crystals by a H_2O- and Li-rich carrier melt in the days to months before eruption. While matrix glasses and olivine-hosted melt inclusions record coherent F/Nd values of ~13, which are probably representative of the mantle source, primitive plagioclase-hosted inclusions have uniformly higher F/Nd values that reach up to ~190. These extremely high F contents (350–1050 ppm) probably reflect inclusion formation by dissolution-reprecipitation; F diffused down activity gradients into Al-rich melt pools around dissolving plagioclase grains that subsequently recrystallised to trap inclusions. In contrast with F, Cl behaved similarly to incompatible trace elements such as K. Initial magmatic H_2O/Ce and F/Nd values of ~180 and ~13 suggest that the mantle under Grímsvötn is depleted in H_2O and F with respect to the Mid-Atlantic Ridge.

[1] Neave et al. (2015) *Contrib. Min. Petrol.* **171**, 21.