



Sulfur solubility in hydrous Etna Basalt at temperatures from 1150 to 1250 °C and 200 MPa

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Degassing of magmatic volatiles is strongly dependent on fluid-melt interaction at the onset of degassing under given pressure and temperature. Most magmatic fluids are composed of hydrous multicomponental mixtures, e.g. H-O-C-S-Cl-F-Br bearing fluids. In particular the partitioning behaviour of S and Cl between basaltic melt and hydrous fluid is of interest, because the S/Cl ratio of emitted volcanic gases correlate to the eruption style (e.g. [1], [2], [3]). In particular, this was also observed for the 2002 eruption of Mt. Etna (Sicily) [4], which is one of the worlds most active and best investigated volcanoes.

Since now, there even exist no reliable data on the solubility of sulfur in hydrous silicic melts at geologic relevant temperatures for basaltic magmas (above 1050 °C), because sulfur is known to be a very aggressive component limiting the application of experimental approaches that use noble metal capsules, especially Pt and AuPd.

Thus, the experiments in this study, concerning the solubility of S in natural hydrous Etna basalt at 200 MPa and temperatures from 1150 to 1250 °C at $fO_2 \sim NNO + 2.5$ and 1200 °C at $fO_2 \sim NNO$, were performed in olivine-AuPd double capsules, using single crystal olivine capsules (San Carlos olivine) as sample containers, which were inserted into outer Au₈₀Pd₂₀ capsules.

The starting material was a fused and water presaturated trachybasalt from Mt. Etna (2001 eruption), containing 5 wt.% H₂O. For sulfur source pyrrhotine (FeS) was used, obtaining initial S concentrations between 1-1.5 wt.% (with respect to the amount of starting material). For some experiments an olivine disc was placed between FeS and starting glass powder to avoid FeS dispersion in the melt. All experiments were conducted in internally heated argon pressure vessels (IHPV) equipped with rapid quench device. For the reduced runs an Ar-H₂ mixture was load into the vessel and the H₂ pressure was monitored, using the shaw membrane technique. The experimental run time was 6-24 h at 1200, 24 h at 1250°C and 67 h at 1150 °C.

All glasses obtained from these experiments contained FeS and were enriched in MgO due to reequilibration with MgO-rich olivine. Independent on the run duration, each of the experimental glasses had large variations of S concentration, ranging from 500 to 1600 ppm S at $\sim NNO$ and 250 to 3000 ppm S at $\sim NNO + 2.5$ (calculated by the S peak shift of WDS spectra, recorded by electron microprobe analysis), where the highest S concentrations were measured near to the FeS source material. However, no direct dependence of temperature on the S solubility and, furthermore, no correlation on S concentration, dependent on the distance to the FeS source was observed, indicating that mobilisation of S seems to be dominated by other mechanisms (e.g. convection) than diffusion.

Water concentrations of H₂O-presaturated basaltic glasses decreased from 5 wt.% to ~ 2 wt.% (IR-analysis). No sulfur could be detected outside the olivine containers, improving this experimental setup to be a sufficient barrier for sulfur or S-rich compounds. To get more reliable data, a longer run duration (> 3 d) and a more detailed determination of S species, prevailing in the glasses, is required.

[1] Thordarson et al. (1996) Bull. Volcanol. 58, 205-225.

[2] Harms & Schmincke (2000) Contrib. Mineral. Petrol. 138, 84-98.

[3] Webster et al. (2001) Mineral. Petrol. 73, 177-200.

[4] Aiuppa et al. (2004) EPSL 222, 469-483.