Experimental constraints on sulfur transfer during magma mixing

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Intrusions of mafic magma into more silicic magma chambers in arc settings are often assumed to be the source of large amounts of sulfur (S) released to the atmosphere during volcanic eruptions [1]. Here, S may be transferred via mixing processes from the mafic to the silicic host magma. However, experimental data for magma mixing processes are limited, especially for geologically relevant P-T-X-fO_2 conditions.

We performed diffusion-couple experiments to simulate magma mixing and to investigate, e.g., the transfer of volatiles (incl. S) between an evolved host magma and a primitive re-charge magma. We used samples of the 1846-47 effusive and the 1932 Plinian eruptions of Quizapu volcano, Chile, representing, respectively, *i)* the evolved dacitic host rock (~66 wt% SiO_2) and *ii)* the primitive, basaltic andesite (~54 wt% SiO_2) re-charging the magma chamber. In a two-step experimental approach we *1st* synthesized hydrous (0.5 - 3 wt% H_2O), S-bearing (0 - 2000 ppm S) starting materials at 900 (dacite) or 1030°C (andesite), 150 MPa and various fO_2. *2nd*, diffusion-couple experiments were conducted for 0.1 to 100 h at similar P-fO_2 and intermediate T (950 - 1000°C).

First experiments carried out at mixing T of 950°C, 150 MPa and fO_2 ~ FMQ+3 for 1 and 10 h using a hydrous andesite (initial melt: ~2.0 wt% H_2O, ~700 ppm S, ~300 ppm Cl) and a hydrous dacite (~2.3 wt% H_2O, ~100 ppm S, ~4700 ppm Cl) reveal a crystallization induced fluid saturation in the andesite. The S content within the andesitic melt decreases to ~300 ppm within 1 h and below 80 ppm after 10 h. Considering that the S content in the dacitic melt phase remains constant at ~100 ppm and that no S diffusion profiles across the dacite-andesite interface are detectable, it is proposed that the S of the andesitic melt strongly partitions into the fluid phase. Hence, in contrast to the scenario of a mafic magma contributing significantly to the SO_2 measured at the surface upon eruption, S may be trapped within the mafic magma, where the fluid acts as a sink for S. However, a transfer of the S-rich fluid phase from the andesite to the dacite during eruption may be possible at reasonable timescales depending on, e.g., magma crystallinity, vesicularity, and viscosity. Here, the fluid is presumably being transported from the andesite to the dacite via permeable channels along the crystal-melt interface.

[1] Kress V., 1997, *Nature* **389**, 591-593