Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9497

Alkali depletion as a trigger for degassing of hydrous melts in magma injection processes

PATRICIA LOUISA PETRI[1], ANJA ALLABAR[2] AND MARCUS NOWAK[1]

[1]Eberhard Karls University Tuebingen
[2]n.a.

Presenting Author: Patricia.Petri@uni-tuebingen.de

The injection of mafic magma into a hydrous felsic magma chamber is a potential trigger mechanism for bimodal explosive volcanism. Contact of hot mafic magma with cooler, H_2O-rich rhyolitic magma leads to an increase in temperature and ascent of the rhyolitic melt, causing a decrease in H_2O solubility at pressures <300 MPa(1) to trigger phase separation by vesicle formation. Mixing processes at the interface of the melt reservoirs(2) may reinforce vesicle formation.

To investigate the importance of the interface, bimodal decompression experiments, as well as reference experiments were performed with basaltic and rhyolitic melts, similar to the compositions of the 1875 Askja eruption in Iceland. Pre-hydrated rhyolite- and basalt-cylinders were perfectly contacted together, heated to 1348 K at 210 MPa, and equilibrated for 10 min. The initial sample properties were determined by a bimodal reference experiment, quenched immediately after equilibration. To simulate the magma ascent, three bimodal samples, and a rhyolite-rhyolite decompression experiment for testing the experimental setup were decompressed with 0.17/1.7 MPaâ˚™s^{-1} to the final pressure of 100 MPa and then quenched.

All decompression experiments resulted in vesiculated samples. The rhyolite reference experiment provided a vitreous sample with homogeneously distributed H_2O vesicles throughout the sample, confirming that the two-cylinder design does not affect the degassing behavior of the hydrous melt. In all bimodal samples, a hybrid zone formed between the rhyolitic and basaltic end members, due to diffusion-induced mixing processes. An enhanced vesiculated zone developed in the rhyolite-dominated hybrid zone compared to the unmixed endmembers of the decompression samples. This can result due to rapid diffusive loss of Na_2O and K_2O from the mildly peralkaline rhyolitic melt into the basaltic melt. The decreased alkali concentration significantly reduces the H_2O solubility(3) and promotes H_2O supersaturation in the depleted rhyolitic melt during decompression.

This suggests that injection of a basaltic melt into a hydrated peralkaline rhyolitic melt reservoir can lead to significantly enhanced H_2O vesicle formation in the hybrid zone. Increased degassing and the associated triggering of explosive eruptions can be expected.

(1)Holtz,F. et al. (1995) Am.Min. 80:84-108.
(2)Caricchi,L . (2021) Nat.Rev.Earth Env. 2(7):458-476.
(3)Allabar,A. et al. (2022) CTMP, under revision.