The roles of decompression rate and volatiles (H_2O+Cl±CO_2±S) on crystallization in basaltic magma

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The decompression rates (r) and the amount of volatile species (mainly H_2O±CO_2±S±Cl) are crucial parameters for the physical behavior of ascending magmas; volatiles affect magma degassing and crystallisation paths, as well as thermal stabilities of mineral phases [e.g., 1]. Decompression-induced crystallization and vesiculation have a significant effect on bulk viscosities of volcanic suspensions and their eruptive styles (e.g., effusive vs. hazardous explosive eruptions). In this study, we investigated the decompression-induced crystallization of a trachybasaltic magma, as a function of different volatile contents (5 wt% H_2O; 0.7 wt% Cl; from 0 to 2000 ppm CO_2; from 0 to 3000 ppm S) and r. Isothermal decompression experiments were conducted at 1030 °C and $\log(fO_2) \approx$ QFM+2 by releasing pressure from 300 to 70 MPa at r = 0.01, 0.1 and 1 MPa/s. The phase assemblages before the onset of decompression were composed of 91-99 area% melt, 2-9 area% clinopyroxene (cpx), 0-0.4 area% spinel (spl) and 0-0.3 area% bubbles. The experimental results show that the crystallization of cpx during decompression is strongly enhanced by the presence of S, whereas spl shows less significant variations. Plagioclase (plag) and olivine (ol) only occur in the S-bearing samples decompressed at r = 0.01 MPa/s. We compared our results to modeled degassing trends (using SolEx and DCompress), phase assemblages (using MELTS) and available experimental constraints on phase equilibria in S-bearing and S-free systems. We suggest, that the presence of S strongly increases the thermal stability of cpx at lower P (~70 MPa) and has also a slight positive effect on the stability of spl, plag and ol. The remarkable increase of the modal abundance of cpx (and spl) observed in the S-bearing systems leads to a strong increase of the effective magma viscosity and, thus, can slow down magma ascent within the conduit and affect eruptive style.

[1] Parat et al. (2008) *J. Petrol.* **49**, 1373-1380.