The role of alkalis in the solubility of H_2O and CO_2 in silicate melts

FRANCESCO VETERE*, HARALD BEHRENS, ROMAN BOTCHARNIKOV, FRANCOIS HOLTZ AND SARA FANARA

Institute for Mineralogy, Leibniz University of Hannover, Callinstr. 3, Hannover, D-30167, Germany

Solubility experiments were performed on phonotephritic compositions in order to investigate the role of alkalies in the behavior of water and CO_2 in magmatic systems The investigated melt compositions are based on natural phonotephrite from Alban Hills (Ab1) with Na_2O/K_2O (in wt %) = 0.26. Two additional compositions with different Na_2O/K_2O ratios, Ab2 (Na_2O/K_2O=0.98) and Ab3 (Na_2O/K_2O=3.82), were synthesized. Experiments were run at 1250°C and 500 MPa in an internally heated gas pressure vessel. The proportions of water and CO_2 in the systems were systematically varied in the range from 0 to 1. For the calibration of carbon-related IR bands, the total carbon content of the synthesized standards was measured by combustion and subsequent IR spectroscopy using an ELTRA CS800 analyzer. Karl Fischer Titration method was used in order to quantify H_2O content in the melts. Absorption spectra were recorded in the mid-infrared (MIR) using a Bruker IFS88 FTIR spectrometer coupled with an IR-ScopeII microscope.

CO_2 is bound in the investigated glasses as CO_3^{2-} exclusively and its concentration was quantified by the peak height of the 1430 cm^{-1} band. A drastic change was observed in the absorption coefficients, ε, with values of 265 ± 27.2, 228 ± 22.4 L/(mol·cm) and 308 ± 26.6, for Ab1, Ab2, and Ab3, respectively, so that the highest ε value is related to the Na-rich composition. There is no detectable effect of the Na/K ratio on the concentrations of dissolved H_2O and CO_2 in the melts. The solubility of CO_2 and H_2O in those melts at 500 MPa is 1.2 wt % and 10.07 wt%, respectively. Results are compared with the existing literature data and models and confirm the very high solubility of CO_2 in phonotephritic melts [1]. Our experimental data indicate that the melt composition in terms of alkali contents influences significantly the extinction coefficient values for CO_2 and that appropriate coefficients must be selected to estimate accurately the amount of dissolved CO_2 in glasses and/or melt inclusions using IR spectroscopy.

[1] H. Behrens, V. Misiti, C. Freda, F. Vetere, R. Botcharnikov, and P. Scarlato (2009). Solubility of H_2O and CO_2 in ultrapotassic melts at 1200 and 1250 °C and pressure from 50 to 500 MPa. American Mineralogist, *Volume 94, pages 105–120*.

Magma droplets in coexisting olivine and spinel phenocrysts hosted in the Pohang basalt (South Korea)

ENIKŐ JUDIT VETLÉNYI[1], LÁSZLÓ ELŐD ARADI[1], CSABA SZABÓ[1]*, ZOLTÁN ZAJACZ[2] AND KYOUNGHEE YANG[3]

[1]Lithosphere Fluid Research Lab, Eötvös University, Budapest, Hungary

[2]Department of Earth Sciences, Institute of Geochemistry and Petrology, ETH Zürich, Switzerland

[3]Department of Geological Sciences, Pusan National University, Busan, South Korea

*correspondance: eniko.vetlenyi@gmail.com, http://lrg.elte.hu

Primary silicate melt inclusions (SMI) in different host minerals provide a unique possibility to reconstruct the evolution path of the host magma. The 2 million years old Pohang alkaline basalt from South Korea contains such silicate melt inclusions hosted in olivine and spinel phenocrysts.

The Pohang basalt has porphyritic texture and contains forsteritic (mg#=0.84-0.88) olivine, Cr-bearing (cr#=0.15-0.24), high Mg (mg#=67.0-69.0) spinel phenocrysts and anorthite-rich plagioclase. The microphenocrystal groundmass consists of olivine, clinopyroxene, spinel, plagioclase and glass. Olivine and spinel phenocrysts have negative crystal shaped or rounded SMIs in size up to 150 microns in diameter. These magma droplets are identified in zoned clinopyroxene, Al-Mg-rich spinel, K-Na-Si-Al-rich residual glass, Ni-Fe-rich sulfide blebs and bubble(s). In addition, olivine daughter minerals occur in the spinel hosted SMIs.

Based on the results of homogenization experiments (with heating-quenching technique) and the equilibrium temperature calculated from olivine–spinel pairs, the homogenization temperatures are in the range of 1050-1240°C in the SMIs irrespectively their host minerals. The estimated oxygen fugacity values are -1.810 to -0.942 log units below the fayalite-magnetite-quartz buffer indicating SMIs entrapment from a relatively reduced magma. Based on geochemical data, it is suggested that the SMIs in both host minerals were entrapped at the very early stages of the crystallization process and it shows the same crystallization sequence: spinel, olivine, sulfide blebs, clinopyroxene, residual glass and bubbles.

The REE patterns of SMIs are flat or slightly decrease from La to Lu, with (La/Lu)N between 1.6 and 17. The low La/Y and Zr/Nb ratios suggest spinel lherzolite source rock for the Pohang basalt.

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