

Solubility of CO₂ in mafic melts up to 8.5 GPa, measured by Raman spectroscopy

PHILIPPE SARDA¹, JULIEN AMALBERTI², CHARLES LE LOSQ³, NICOLAS SATOR⁴, TAHAR HAMMOUDA⁵, EVA CHAMORRO-PÉREZ⁶, BERTRAND GUILLOT⁴, SYLVIE LE FLOCH⁷ AND DANIEL NEUVILLE³

¹Université Paris Saclay, GEOPS

²Potsdam University

³Université Paris Cité, IPGP

⁴Sorbonne Université, LPTMC

⁵Université Clermont Auvergne, LMV

⁶ENS - Lyon, LGLTPE

⁷Université de Lyon, ILM

Presenting Author: philippe.sarda@universite-paris-saclay.fr

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Solubility of CO₂ in magmas is poorly known at pressures higher than 2 GPa. We present high pressure-high temperature experiments on CO₂-enriched mafic and intermediate melts, from 1.5 to 8.5 GPa and 1800-2100 K, in oxidizing conditions. These experiments were realized with a Belt press at Institut Lumière Matière of Lyon, and with a multi-anvil press at Laboratoire Magmas et Volcans of Clermont-Ferrand. Samples were quenched after HP-HT experiments.

Large quantities of CO₂ are dissolved, and the concentrations were measured by micro-Raman spectroscopy, where the n1 stretching vibration of the carbonate group was measured. By coupling this measurement with H₂O measurement, also by Raman [1], we established a calibration line that is virtually identical to the one published by other authors [2].

CO₂ saturation is indicated by the presence of a bubble. The Raman technique allows generating a CO₂ map of the samples, showing heterogeneities influenced by proximity of the bubble and that must be averaged. Above 5 GPa, samples are partially crystallized, and their CO₂ concentration recovered by image analysis and by micro-Raman mapping.

Our data show that CO₂ solubility in mafic melts increases with increasing pressure much more rapidly than expected from Henry's law (e.g., at 5 GPa, CO₂=7–8 wt% as compared to 2.5–3 wt% from Henry's law), confirming previous molecular dynamics simulations [3]. At 8.5 GPa, our sample is undersaturated at 13.6 wt% and the simulation yields 25 wt%. Possible consequences bear on various processes, including mantle melting, Earth degassing, the generation of kimberlites and carbonatites and core-mantle interactions.

Our work confirms known difficulties to obtain glass on quenching from a HP-HT mixture of silicates and carbonates. We stress that measurements performed *in situ* during HP-HT experiments are certainly better than traditional quenching.

[1] Le Losq, Neuville, Moretti, Roux (2012), Am. Mineral. 97, 779–790. <https://doi.org/10.2138/am.2012.3831>.

[2] Morizet, Brooker, Iacono-Marziano, Kjarsgaard, (2013), Am. Mineral. 98, 1788–1802. <https://doi.org/10.2138/am.2013.4516>.

[3] Guillot, Sator, (2011), Geochim. Cosmochim. Acta 75, 1829–1857. <https://doi.org/10.1016/j.gca.2011.01.004>.

