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CO_2 diffusion in basaltic melts: experimental insights

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Carbon dioxide is the second most abundant volatile in magmatic systems after H_2O. Although CO_2 solubility is significantly lower than that of H_2O across a wide range of melt compositions, its role is equally critical as that of water in various processes. Dissolved CO_2 acts as a driving force for bubble formation in ascending magmas and may significantly enhance the explosiveness of eruptions [1]. Since bubble growth rates are limited by the transport properties of volatiles within the melt, diffusion data on volatiles at magmatic temperatures are essential for understanding and modelling degassing and eruption mechanisms in silicate magmas. Despite its importance, CO_2 diffusion remains poorly constrained experimentally [2-5]. Furthermore, previous studies have primarily focused on the effects of anhydrous melt compositions, overlooking the significant influence of H_2O on CO_2 diffusion [3-5].

To generate a systematic dataset of CO_2 diffusion coefficients in silicate melts as function of water content for key magma types on Earth, our study begins with an investigation of CO_2 diffusion in a basalt from Stromboli. Diffusion couple experiments were conducted at 300 MPa and temperatures between 1200 and 1300 °C using a rapid-quench internally heated pressure vessel. The starting glasses contained CO_2 concentrations ranging from 0 to 0.18 wt.%. Symmetrical CO_2 concentration-distance profiles were measured via FT-IR micro-spectroscopy on doubly polished glass sections and fitted with error functions to calculate individual diffusion coefficients (D_{CO2}).

Preliminary results under anhydrous conditions exhibit clear Arrhenius behavior under the investigated P-T-X conditions and CO_2 concentrations, with D_{CO2} values consistent with previous findings for Fe-free basalt [2]. Experiments are in progress to investigate the effect of water on CO_2 diffusion, and to extend the temperature range of investigation, providing new insights into CO_2 mobility in melts.

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