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The influence of bulk composition on the diffusivity of carbon dioxide in Na aluminosilicate melts

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ABSTRACT

The bulk diffusivity of dissolved carbon dioxide (CO_2 and CO_3^{2-}) in $NaAlSi_3O_8 + nNa_2O$ (n = 0–6.87 wt%) and in $NaAlSi_3O_8 + nH_2O$ (n = 0–2 wt%) melts was investigated at 1523 K and 0.5 GPa using the diffusion couple technique. CO_2 contents of the starting glass pairs varied between 0 and 0.2 wt%. Symmetrical concentration-distance profiles of bulk CO_2 were determined by infrared spectroscopy. An error function was fitted to the profiles to obtain apparent chemical diffusion coefficients of bulk CO_2. In the investigated compositional range, the diffusivity of bulk CO_2 increases exponentially with Na_2O and H_2O content and thus exponentially with the ratio of non-bridging oxygen atoms per tetrahedral cations (NBO/T). The bulk CO_2 diffusivity increases from $\log D_{CO_2} = -11.38$ (D_{CO_2} in m^2/s) in $NaAlSi_3O_8$ melt to $\log D_{CO_2} = -10.92$ in $NaAlSi_3O_8$ melts containing 6.87 wt% Na_2O excess, and to $\log D_{CO_2} = -10.91$ in $NaAlSi_3O_8$ melts containing 2 wt% H_2O. These data imply that either: (1) the diffusivities of the CO_2 species (molecular CO_2 and CO_3^{2-}) are very similar, or (2) the speciation of CO_2 in the quenched glasses is very different from the speciation in the melt.