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ABSTRACT

Differential Diffusion of Isotopes in Silicate Melts

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Isotopes with greater mass diffuse more slowly due to greater inertia but the exact difference cannot be predicted because the diffusion species and mechanisms for most elements in silicate melts are not known. An empirical way to quantify the diffusivity difference of two isotopes is [1]: $D_2/D_1 = (m_1/m_2)^{\beta}$, where D and m are the diffusivity and atomic mass of isotopes 1 and 2, and β is an empirical parameter ≤ 0.5. We have been investigating differential diffusion of isotopes (or diffusive isotope fractionation) in silicate melts. I will present our work on diffusive isotope fractionation and compare with literautre work. The largest β value for diffusion in silica and silicate is 0.29 to 0.47 for H^2 diffusion in silica glass [2-4], then 0.21 to 0.23 for Li diffusion in rhyolite melt [5], 0.16 to 0.18 for Cu diffusion in basalt melt [6], 0.09 to 0.12 for K in basalt melt [7], 0.06 to 0.12 for Cl in dacite melt [8], 0.035 to 0.21 for Ca in various melts [9], 0.04 to 0.10 for Mg in various melts [10], and about 0.03 for Fe [11] and Ti [12] in basalt. This trend of β value with elements is consistent with the diffusivity sequence [13], but there is also large scatter that is likely related to multi-component diffusion effect [9].

[1] F.M. Richter et al., Geochim. Cosmochim. Acta, 63, 2853 (1999).
[2] R.W. Lee, J. Chem. Phys., 38, 448 (1963).
[3] J.E. Shelby, J. Appl. Phys., 48, 3387 (1977).
[4] L. Shang et al., Geochim. Cosmochim. Acta, 73, 5435 (2009).
[5] M.E. Holycross et al., Geochem. Persp. Lett., 6, 39 (2018).
[6] P. Ni and A. Shahar, Earth Planet. Sci. Lett., 624, 118459 (2023).
[7] Y. Zhang, Earth Planet. Sci. Lett., 581, 117405 (2022).
[8] M.A. Fortin et al., Earth Planet. Sci. Lett., 480, 45 (2017).
[9] J.M. Watkins et al., Geochim. Cosmochim. Acta, 139, 313 (2014).
[10] R. Chopra et al., Geochim. Cosmochim. Acta, 88, 1 (2012).
[11] F.M. Richter et al., Geochim. Cosmochim. Acta, 73, 4250 (2009).
[12] S. Zhou et al., Earth Planet. Sci. Lett., 651, 119176 (2025).
[13] Y. Zhang and T. Gan, Rev. Mineral. Geochem., 87, 283 (2022).