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DANA LECTURE*

Rates of Fe, Mg, Mn, and Ca diffusion in garnet

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ABSTRACT

Extraction of the thermal and chemical histories preserved by modified compositional zoning in garnet is compromised by large uncertainties in experimentally determined diffusion coefficients for principal divalent cations. Some of this uncertainty derives from long down-temperature extrapolations, but much of it arises from an inability to account accurately for large variations in diffusivity as a function of garnet composition. Numerical simulation of stranded diffusion profiles in partially resorbed natural garnets constrains diffusivities at low temperature, and reveals a systematic dependence of diffusion rates on host garnet composition. A comprehensive model incorporating a simple compositional dependence allows accurate prediction of diffusion rates for Fe, Mg, Mn, and Ca for nearly all garnet compositions across the full range of geologically relevant temperatures, pressures, and oxygen fugacities.

Keywords: Diffusion, Fe, Mg, Mn, and Ca in garnet, kinetics, metamorphic petrology