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Ordering kinetics of Mg-Fe^{2+} exchange in a $Wo_{43}En_{46}Fs_{11}$ augite

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ABSTRACT

The kinetics of Fe^{2+}-Mg exchange between the M1 and M2 sites ($Fe^{2+}_{M2} + Mg_{M1} = Fe^{2+}_{M1} + Mg_{M2}$) were followed by ordering experiments in an augitic clinopyroxene ($Ca_{0.841}Na_{0.019}Mg_{0.888}Fe^{2+}_{0.151}Ti_{0.011}Al_{0.028}Cr_{0.003}Fe^{3+}_{0.054}Mn_{0.006}$)($Si_{1.914}Al_{0.086}$) from a dike on Alicudi (Aeolian Islands, Italy). The same single crystal was annealed in silica tubes in an iron-wüstite buffered Ar atmosphere, at 700, 750, 800, 850, and 950 °C, followed by quenching after each thermal treatment, and was used for the collection of X-ray diffraction data and for microprobe analysis.

Kinetic constants (K) for each isotherm were calculated from the distribution coefficient K_D [= $(Fe^{2+}/Mg)_{M1}/(Fe^{2+}/Mg)_{M2}$] measured during a series of experiments carried out by increasing annealing times until exchange equilibrium was achieved. Calculations of K were performed using the Ginzburg-Landau equation, the kinetic model of Mueller, and the mathematical formulation proposed by Sha and Chappell (1996) to check the responses of various kinetic models for a Ca-rich pyroxene on the same data set. The activation energy of the Fe^{2+}-Mg exchange spans a narrow range, yielding values of 200 (±28) kJ/mol, independent of the method used to calculate K.