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Temperature dependence of Fe,Mg partitioning in Acapulco olivine

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ABSTRACT

The temperature dependence of the intracrystalline Fe,Mg partitioning (K_D) in two olivine crystals (Fa_{11}) separated from the Acapulco meteorite was determined by single-crystal X-ray structure analysis. The independent atom model (IAM) was compared with a "bond model" which accounts for bond-induced charge accumulations on the Si-O bonds. Outliers in the set of structure amplitudes observed when using the IAM disappeared upon introducing the bond model. The crystals were equilibrated at 750, 650, and 500 °C. The refined site occupancies yield the relation $\ln(K_D) = 0.345(60) - 204(53)/T$, where T is in K, which is in qualitative agreement with earlier work. Comparison of these data with the higher temperature data of Artioli et al. (1995) suggests an unusual temperature variation of the Fe,Mg distribution within two temperature regimes. Below 880 °C, Fe tends to order onto the M1 site with increasing temperature whereas it concentrates on the M2 site above 880 °C. In principle, olivine may serve as a geospeedometer similar to orthopyroxene. However, at present its usefulness is restricted because (1) the relatively weak dependence of $\ln(K_D)$ on temperature needs to be even more tightly constrained than presented here and (2) low-temperature extrapolation of the rate constants for the Fe,Mg site exchange, derived from interdiffusion coefficients, is uncertain.