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Direct observation of spinodal decomposition in the magnetite-hercynite system by susceptibility measurements and transmission electron microscopy

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ABSTRACT

The magnetic susceptibility and Curie temperatures T_c have been investigated for a series of synthetic samples with solid-solution compositions ranging from pure magnetite (Fe_3O_4) to hercynite ($FeAl_2O_4$). The determined T_c can be fitted by a straight line, which also fits the theoretical values for these end-members. With increasing hercynite concentration, susceptibility curves for one heating and cooling cycle become irreversible, indicating changes in the structural state of the samples during annealing. These changes occur in specific temperature ranges for each composition. For a sample of composition $Mag_{40}Hec_{60}$, irreversible changes occurring between about 200 and 300 °C are likely due to changes in the cation distribution, whereas above 300 °C, compositional fluctuations due to spinodal decomposition are evident. The exsolution mechanism has been investigated using energy-filtered transmission electron microscopy, which has allowed direct imaging of the compositional fluctuations consistent with the theoretical predictions of spinodal decomposition.