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Hydromaghemite, an intermediate in the hydrothermal transformation of 2-line ferrihydrite into hematite

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ABSTRACT

The hydrothermal transformation of 2-line ferrihydrite into hematite proceeds slowly if a sufficient quantity of some strongly adsorbing ligand, such as phosphate or citrate, is sorbed on the starting product. In this work, we studied such transformation at temperatures ranging from 125 to 200 °C, a molar P/Fe ratio of 0–6%, and a molar citrate/Fe ratio of 3%. The products were characterized by X-ray diffraction (XRD), infrared spectroscopy, Mössbauer spectroscopy (MS) at various temperatures and in an applied field of 60 kOe, magnetic and thermal analysis, and transmission electron microscopy (TEM). At 150 °C, pure 2-line ferrihydrite transformed rapidly into hematite. The products of transformation of 2-line ferrihydrite with P/Fe = 2.75% or citrate/Fe = 3% had a magnetic susceptibility of $>240 \times 10^{-6}$ m^3/kg and were, according to XRD and MS data, mixtures of hematite with structural P, 6-line ferrihydrite, and a magnetic phase. This phase exhibited most of the characteristic reflections and MS features of maghemite, and occurred as 7–30 nm subrounded particles with lattice fringes corresponding to the maghemite (310) and (220) planes. It was designated "hydromaghemite" because it lost >3% water between 110 and ~350 °C. At 150 °C, complete transformation into hematite occurred in <120 days.