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Magnetic Characterization of Synthetic SD-like Pyrrhotite and Its Demagnetization under Hydrostatic Pressure up to 1.8 GPa

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Monoclinic pyrrhotite (Fe_7S_8) is a common ferrimagnetic mineral in both terrestrial rocks and meteorites (e.g., SNC, Rumuruti chondrites…). It is also recognized as a candidate magnetic mineral for Martian magnetic anomalies. We synthesized SD-like monoclinic pyrrhotite at 245°C using the molten-salt synthesis method [1]. Here we characterize its magnetic properties including its behavior under hydrostatic pressure up to 1.8 GPa. Data were collected in the 10K to 360°C temperature range and include measurements of low-field magnetic susceptibility (χ_0), thermomagnetic curves $\chi_0(T)$, major hysteresis loops, back-field remanence demagnetization curves, first-order reversal curve (FORC), alternating field and pressure demagnetization of saturation isothermal remanent magnetization (SIRM or M_{rs}), low temperature MPMS datasets (field and frequency dependencies of χ_0, field-cooled and zero-field-cooled remanence FC-ZFC and room temperature SIRM heating-cooling cycles) as well as X-ray diffraction (XRD) spectra. $\chi_0(T)$ indicates a single Curie point at 320°C characteristic of monoclinic pyrrhotite.

For application of hydrostatic pressure up to 1.8 GPa we used a nonmagnetic high-pressure cell of piston-cylinder type entirely made of "Russian alloy" ($Ni_{57}Cr_{40}Al_3$) with 8 mm of inner diameter similar to the cell, described in [2]. Application of 1.8 GPa resulted in demagnetization (decrease in SIRM) of the sample by 38%. Repeated cycling from 1.8 GPa to atmospheric pressure and back resulted in further decrease in remanence by 44% (for 3 cycles). The characteristic Besnus transition of pyrrhotite is observed at ~34 K. The observed hysteresis parameters (M_{rs}/M_s=0.53, B_{cr}/B_c=1.17, B_{cr}=41 mT, where M_s is saturation magnetization, B_c and B_{cr} are coercivity and remanent coercivity, respectively) are consistent with pseudo-single-domain range, previously established in literature [3]. Superparamagnetic (SP) grains are not present in the sample as no frequency dependence of χ_0 is observed.

References: [1] Chareev D. A., Voronin M. V., Osadchii E. G. 2014. *Amer. Mineral.*, doi:10.2138/am-2014-4753 (accepted). [2] Sadykov R.A. et al. 2008. *Rev. Sci. Instr.* 79: 115102. [3] Dekkers M.J. 1988. *Phys. Earth Planet. Int.* 52, 376-393.