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# Magnetic characterization of non-ideal single-domain monoclinic pyrrhotite and its demagnetization under hydrostatic pressure up to 2 GPa with implications for impact demagnetization

Natalia S. Bezaeva [a,b,c,*], Dmitriy A. Chareev [d,b], Pierre Rochette [e], Myriam Kars [f], Jérôme Gattacceca [e], Joshua M. Feinberg [g], Ravil A. Sadykov [h], Dilyara M. Kuzina [c], Sergey N. Axenov [h]

[a] Faculty of Physics, M.V. Lomonosov Moscow State University, Leninskie Gory, 119991 Moscow, Russia
[b] Ural Federal University, 19 Mira Str., 620002 Ekaterinburg, Russia
[c] Kazan Federal University, 18 Kremlyovskaya Str., 420000 Kazan, Russia
[d] Institute of Experimental Mineralogy, Russian Academy of Sciences, 142432 Chernogolovka, Moscow Region, Russia
[e] Aix-Marseille Université, CNRS, IRD, CEREGE UM34, Technopôle de l'Environnement Arbois-Mediterranée, BP80, 13545 Aix-en-Provence, France
[f] Center for Advanced Marine Core Research, Kochi University, B200 Monobe, Nankoku 783-8502, Japan
[g] Institute for Rock Magnetism, Dept. of Earth Sciences, University of Minnesota, Minneapolis, MN 55455, United States
[h] Institute for Nuclear Research, Russian Academy of Sciences, Prospekt 60-letiya Oktiabria 7a, 117312 Moscow, Russia

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ABSTRACT

Here we present a comprehensive magnetic characterization of synthesized non-ideal single-domain (SD) monoclinic pyrrhotite ($Fe_7S_8$). The samples were in the form of a powder and a powder dispersed in epoxy. "Non-ideal" refers to a powder fraction of predominantly SD size with a minor contribution of small pseudo-single-domain grains; such non-ideal SD pyrrhotite was found to be a remanence carrier in several types of meteorites (carbonaceous chondrites, SNC...), which justifies the usage of synthetic compositions as analogous to natural samples. Data were collected from 5 to 633 K and include low-field magnetic susceptibility ($\chi_0$), thermomagnetic curves, major hysteresis loops, back-field remanence demagnetization curves, first-order reversal curves (FORCs), alternating field and pressure demagnetization of saturation isothermal remanent magnetization (SIRM), low temperature data (such as zero-field-cooled and field-cooled remanence datasets together with room temperature SIRM cooling–warming cycles) as well as XRD and Mössbauer spectra. The characteristic Besnus transition is observed at ~33 K. FORC diagrams indicate interacting SD grains. The application of hydrostatic pressure up to 2 GPa using nonmagnetic high-pressure cells resulted in the demagnetization of the sample by 32–38%. Repeated cycling from 1.8 GPa to atmospheric pressure and back resulted in a total remanence decrease of 44% (after 3 cycles). Pressure demagnetization experiments have important implications for meteorite paleomagnetism and suggest that some published paleointensities of meteorites with non-ideal SD monoclinic pyrrhotite as remanence carrier may be lower limits because shock demagnetization was not accounted for.



## 1. Introduction

It is now recognized that the ferrimagnetic iron sulfide $Fe_7S_8$ known as monoclinic pyrrhotite (4C superstructure) is a mineral of paleomagnetic and rock magnetic significance due to its wide occurrence in a considerable variety of natural environments, terrestrial rocks and meteorites (Arnold, 1967; Sassen et al., 1989; Rochette et al., 1990, 2005; Cournede et al., 2015; Tikoo et al., 2015). Single-domain (SD) pyrrhotite is also a candidate magnetic mineral for the Martian magnetic anomalies (Dunlop and Arkani-Hamed, 2005; Rochette et al., 2005). Additionally, Gilder et al. (2011) discuss pyrrhotite inclusions hosted by diamonds and argue that these inclusions act as geobarometers, preserving information about the pressure conditions under which the diamonds formed in the Earth's mantle.

* Corresponding author at: Faculty of Physics, M.V. Lomonosov Moscow State University, Leninskie Gory, 119991 Moscow, Russia.
*E-mail addresses:* bezaeva@physics.msu.ru (N.S. Bezaeva), chareev@iem.ac.ru (D.A. Chareev), rochette@cerege.fr (P. Rochette), mkars@kochi-u.ac.jp (M. Kars), gattacceca@cerege.fr (J. Gattacceca), feinberg@umn.edu (J.M. Feinberg), rsadykov@inr.ru (R.A. Sadykov), dikuzina@gmail.com (D.M. Kuzina), axenov@inr.ru (S.N. Axenov).

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