SYNTHESIS AND CHARACTERIZATION OF SINGLE CRYSTALS OF MONOCLINIC PYRRHOTITE: POSSIBLE IMPLICATIONS FOR EXTRATERRESTRIAL MAGNETISM.

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Introduction: Ferrimagnetic iron sulfide Fe_7S_8 (also known as monoclinic pyrrhotite) is a mineral of paleomagnetic and rock magnetic significance due to its wide occurrence across a variety of terrestrial environments and meteorites [1-3]. Single-domain (SD) pyrrhotite is also a candidate magnetic mineral for the Martian magnetic anomalies [4]. We present here a new synthesis and characterization of monoclinic pyrrhotite single crystals and discuss possible implications for extraterrestrial magnetism.

Samples and methods: We made three runs of synthesis and conducted full characterization of synthesized single crystals using a variety of standard analytical techniques and a range of rock magnetic techniques including magnetic domain imaging using the Asylum Research MFP-3D MFM at the Institute for Rock Magnetism (IRM), University of Minnesota (USA). The chemical composition was investigated with a digital scanning electronic microscope TESCAN Vega II XMU with energy dispersive micro analysis system INCA Energy 450/XT (20 kV)

Results: Crystals of pyrrhotite with large amount of sulfur have been grown in the eutectic mixtures of salts of alkaline metals (CsCl/KCl/NaCl or RbCl/NaCl/KBr/KI) in a stationary temperature gradient [5, 6]. The reactionary vessel represented a quartz glass ampoule which was in the furnace in a temperature gradient. Temperatures of the hot and cold ends were 660°C and 585°C, respectively. In a hot part of a reactionary vessel there was a $Fe_{0.87}S$ furnace charge, which was gradually dissolved in salt fusion, migrated in the cold end of an ampoule and formed crystals (Fig. 1). Growth of crystals continued about three weeks. The parts of ampoules with crystals were dissolved in distilled water, alcohol and acetone using the ultrasonic cleaner. Then the product was dried in a muffle at 70ºC for few minutes. The size of crystals was usually ~ mm-range (Fig. 1). The analysis showed that the approximate chemical composition is close to $Fe_{0.85}S$. No impurity elements (Cs, Rb, K, Na, Cl, Br, I) were found. Some of the obtained crystals were annealed in a vacuum for a month at 240 and 190ºC. Temperatures of annealing have been chosen according to stability of monoclinic pyrrhotite [6]. Rock magnetic analyses indicate a single Curie point of 320C with no signs of lambda-transition typical for hexagonal pyrrhotites and a pseudo-single domain grain size range. Samples are strongly anisotropic consistent with previous investigations [8]. Magnetic behavior of those samples is important for investigations, because monoclinic pyrrhotite represent a major magnetic mineral of some types of achondrites and potentially carries a record of the ancient magnetic fields of the corresponding parents bodies [8]. Other implications for extraterrestrial magnetism will be discussed at the meeting.

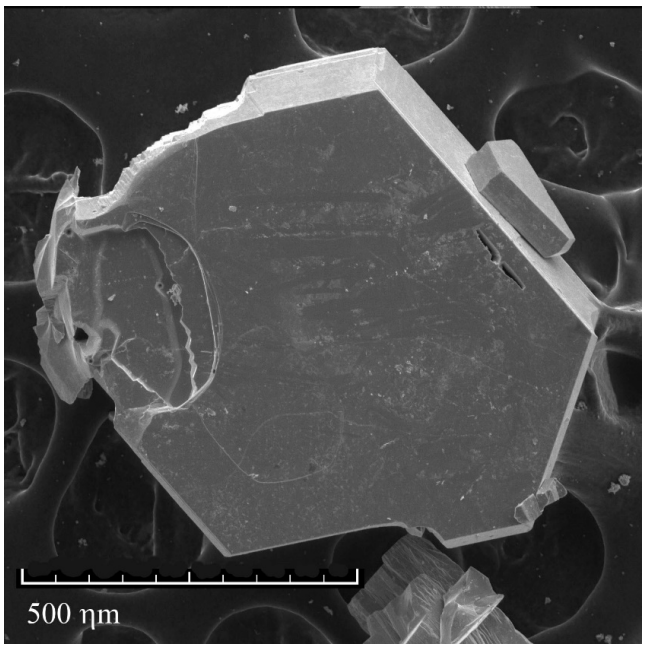

Figure 1. SEM image of pyrrhotite single crystal (secondary electrons). Indicated scale: 500 microns.

Acknowledgements: The work is supported by RFBR grant no. 18-55-15014 and by Act 211 Government of the Russian Federation, agreement № 02.A03.21.0006 and is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University. The IRM is supported by grants from the Instruments and Facilities Program, Division of Earth Science, NSF (USA).

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