High-coercivity magnetic minerals in archaeological ceramics: new insights from remanence acquisition and demagnetization measurements at elevated temperatures

Andrei Kosterov\textsuperscript{1}, Mary Kovacheva\textsuperscript{2}, Maria Kostadinova-Avramova\textsuperscript{2}, Pavel Minaev\textsuperscript{3}, Nataliya Sal'naya\textsuperscript{3}, Leonid Surovitckii\textsuperscript{1}, Svetlana Yanson\textsuperscript{1}, and Elena Sergienko\textsuperscript{1}

\textsuperscript{1}St. Petersburg, Earth Physics, Russian Federation (a.kosterov@spbu.ru)
\textsuperscript{2}National Institute of Geophysics, Geodesy and Geography, Sofia, Bulgaria
\textsuperscript{3}Schmidt Institute of Physics of the Earth RAS

The thorough understanding of magnetic mineralogy is a prerequisite of any successful palaeomagnetic, and in particular, archaeomagnetic study. Magnetic minerals in archaeological ceramics and baked clay may be inherited from the parent material, or, more frequently, formed during the firing process. The resulting magnetic mineralogy may be complex, including ferrimagnetic phases not commonly encountered in rocks. Towards this end, we carried out a detailed rock magnetic study on a representative collection of archaeological ceramics (baked clay from combustion structures and bricks) from Bulgaria and Russia. Experiments included measurement of isothermal remanence acquisition and demagnetization as a function of temperature between 20°C and >600°C, and a variant of Lowrie 3-axis IRM test with measurements performed at elevated temperatures. For selected samples, low-temperature measurements of saturation remanence and initial magnetic susceptibility between 1.8 K and 300 K have been carried out.

All studied samples contain a magnetically soft mineral identified as maghemite probably substituted by Al and/or Ti. Stoichiometric magnetite has never been observed, as evidenced by the absence of the Verwey phase transition. In addition, one or two magnetically hard mineral phases have been detected, differing sharply in their respective unblocking temperatures. One of these unblocking between 540°C and 620°C is believed to be substituted hematite. Another phase unblocks at much lower temperatures, between 140°C and 240°C, and its magnetic properties correspond to an enigmatic high coercivity, stable?, low unblocking temperature (HCSLT) phase of McIntosh et al. [McIntosh, G., M. Kovacheva, G. Catanzariti, M. L. Osete, and L. Casas (2007), Geophys. Res. Lett., 34, L21302, doi: 10.1029/2007GL031168]. In a few samples high- and low-unblocking temperature magnetically hard phases appear to coexist, in the others the HCSLT phase is the only magnetically hard mineral present. We finally compare the samples performance in archaeointensity experiments with their respective magnetic mineralogy.

This study is supported by Russian Foundation of the Basic Research, grant 19-55-18006, and Bulgarian National Science Fund, grant KP-06-Russia-10.