DAUBREELITE AND TROILITE AS A SOURCE OF COMETARY AND MINOR BODY MAGNETISM IN COLD ENVORONMENT.

T. Kohout[1, 2, 3], A. Kosterov[4, 8], M. Jackson[4], L. J. Pesonen[1], G. Kletetschka[3,5,7], M. Lehtinen[6], [1]Division of Geophysics, University of Helsinki, Finland, e-mail: tomas.kohout@helsinki.fi, [2]Department of Applied Geophysics, Charles University in Prague, Prague, Czech Republic, [3]Institute of Geology, Academy of Sciences of the Czech Republic, Prague, Czech Republic, [4]Institute for Rock Magnetism, University of Minnesota, Minneapolis, MN, USA, [5]Department of Physics, Catholic University of America, Washington D.C., USA, [6]Geological Museum, University of Helsinki, Finland, [7]GSFC/NASA, Code 691, Greenbelt, MD, USA, [8]Kochi Core Center (KCC), Kochi University, Nankoku City, Kochi, Japan.

Introduction: Various FeNi phases (kamacite, taenite, tetrataenite) are dominant magnetic phases in most chondritic meteorites. In addition, iron-bearing sulphides are detected in meteorites as well as in cometary dust. The low-temperature magnetic properties of the daubreelite ($FeCr_2S_4$), troilite (FeS), and kamacite (FeNi) minerals were investigated. At room temperature daubreelite is paramagnetic and troilite is antiferromagnetic, thus not contributing to remanent nor induced magnetizations. However, at low temperatures magnetic transitions occur enhancing significantly their magnetic properties.

Daubreelite: Daubreelite is paramagnetic at temperatures higher than its Curie temperature $T_c = 150$ K. Below T_c daubreelite is ferrimagnetic. The magnetic susceptibility and saturation magnetisation of ferrimagnetic daubreelite are approximately 5-10 times lower than those of FeNi. On cooling down through the T_c saturation magnetization of daubreelite sharply increases and reaches maximum of 32 Am^2/kg at 80 K. Below T_c, magnetic susceptibility of daubreelite ranges between 0.5-3.5 10^{-4} m^3/kg reaching maximum value immediately below it.

Troilite: At room temperature troilite is antiferromagnetic. However, at temperature $T_m = 60$ K a magnetic transition of uncertain origin occurs, which might be due to a canting of magnetic spins. Below T_m the saturation magnetization of troilite significantly increases to its maximum value 0.8 Am^2/kg – roughly two orders of magnitude lower than FeNi. Magnetic susceptibility of troilite is low (~4 10^{-7} m^3/kg) with a local maximum around T_m (~1.7 10^{-6} m^3/kg)

Discussion: The magnetization and susceptibility of iron bearing sulphides, especially daubreelite, is significantly increased in low temperature range. Those minerals can contribute to or even control magnetic properties of bodies in the cold regions of our Solar System.

The thermal conditions of the objects in the main asteroid belt are probably above those temperatures. However the icy trans-Neptunian objects as well as comets containing “magnetic” iron sulphides within the dusty fraction are among candidate objects for recording low-temperature magnetic events. This can be also the case of the comet 67P/Churyumov-Gerasimenko which will be visited by the Rosetta space probe with the magnetometer on board as well as on the lander. The magnetic properties of iron bearing sulphides must be considered while interpreting the magnetic observations of such bodies.