Low-temperature magnetic properties of iron-bearing minerals and their contribution to magnetism of cometary bodies

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In this study, we present a review of low-temperature magnetic properties of alabandite (Fe,Mn)S [1], daubreelite $FeCr_2S_4$ [2], pyrrhotite $Fe_{1-x}S$ [2], troilite FeS [3], and chromite $FeCr_2O_4$ [4] including new experimental data. The results indicate that, besides FeNi alloys, mainly daubreelite, with its Curie temperature of $T_C = 150$ K and strong induced and remanent magnetizations, may be a significant magnetic mineral in cold environments and may complement FeNi or even dominate the magnetic properties of sulfide-rich bodies at temperatures below T_C. Comets are known to contain iron-bearing sulfides within their dusty fraction. Their surfaces are subject to temperature variations in the range of 100–200 K down to the depth of several meters, whereas the cometary interior is thermally stable at several tens of Kelvin which is within the temperature range where chromite, daubreelite, or troilite are "magnetic". Thus, not only FeNi alloys, but also chromite and sulfides have to be considered in the interpretation of magnetic data from cometary objects such as the data that will be delivered by the Rosetta mission. Modeling indicates that magnetic interactions between cometary nuclei containing iron-bearing sulfides or chromite and the interplanetary magnetic field would be difficult, but not impossible, to detect from orbit. Rosetta's Philae lander present on the surface would provide a more reliable signal.

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