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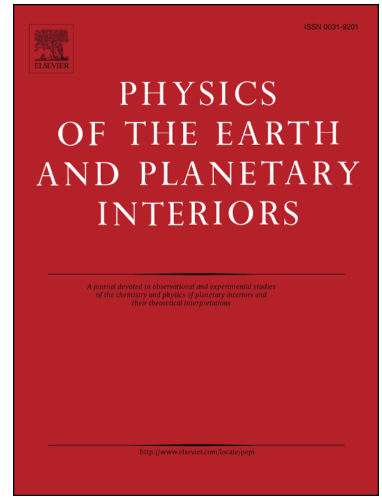

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Fundamental Relations of Mineral Specific Magnetic Carriers for Paleointensity Determination

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Abstract

A fundamental linear relationship exists between the efficiency of thermoremanent magnetization measured at room temperature and the magnitude of the ambient field at the time of acquisition. The magnetic efficiency (the ratio of thermoremanent magnetization to saturation remanent magnetization) multiplied by the saturation magnetization is proportional to the magnetizing field, where the proportionality constant is independent of magnetic mineralogy and domain state. The empirical constant for this equation was determined using existing experimental data of single domain through pseudosingle domain to multidomain states of iron, meteoritic iron, magnetite, maghemite, pyrrhotite, and hematite. We show that the acquired magnetic efficiency is closely related to two types of demagnetizing fields that act as barriers against domain wall pinning during magnetic acquisition. The first relates to the saturation magnetization that is derived from the distribution of Bohr magnetons within the crystal lattice, and the second originates from grain shape. Theoretical considerations imply a factor of two difference in the magnetic efficiency acquired during laboratory and geologic timescales. This equation reveals that troilite may be a potentially important magnetic carrier for extraterrestrial magnetism. Using magnetic scanning techniques, our relationship allows for estimating the paleointensity from samples that contain more than one magnetic species.

Key words: Paleofield determination, TRM, planetary magnetic anomalies, Néel's theory of magnetism, magnetic acquisition, Moon, Mars.