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Stability of equidimensional pseudo-single-domain magnetite over billion-year timescales

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Abstract

 Interpretations of paleomagnetic observations assume that naturally occurring magnetic particles can retain their primary magnetic recording over billions of years. The ability to retain a magnetic recording is inferred from laboratory measurements, where heating causes demagnetization on the order of seconds. The theoretical basis for this inference comes from previous models that assume only the existence of small, uniformly magnetized particles, whereas the carriers of paleomagnetic signals in rocks are usually larger, nonuniformly magnetized particles, for which there is no empirically complete, thermally activated model. This study has developed a thermally activated numerical micromagnetic model that can quantitatively determine the energy barriers between stable states in nonuniform magnetic particles on geological timescales. We examine in detail the thermal stability characteristics of equidimensional cuboctahedral magnetite and find that, contrary to previously published theories, such nonuniformly magnetized particles provide greater magnetic stability than their uniformly magnetized counterparts. Hence, nonuniformly magnetized grains, which are commonly the main remanence carrier in meteorites and rocks, can record and retain high-fidelity magnetic recordings over billions of years.

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Keywords

Geomagnetism, Micromagnetics, Paleomagnetism, Thermal stability, Thermoremanence

References