A pseudo-single domain theory of paleomagnetic recording

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The common theory of paleomagnetic recording is based on the acquisition of thermoremanent magnetization in single-domain (SD) particles (Neel, 1955). The physical consequences of this theory agree well enough with observations as to be of utmost use in understanding and assessing the quality of paleomagnetic data in almost all practical applications in paleomagnetism. This is to a large extent due to the statistical nature of the interpretations based on SD theory, which apparently is sufficiently robust to make up for minor descrepancies between the real remanence carriers and their physical description on which the statistical interpretation is founded. Exceptions to this rule are becoming more important as increasingly sophisticated technical methods for paleomagnetic measurements are developed and used, that involve fewer and fewer individual magnetic particles to contribute to the measured signal. Examples are the determination of paleointensity from individual mineral grains, and the development of scanning magnetometers that average over relatively small numbers of magnetic grains in a sample. The statistical uncertainties of paleomagnetic quantities resulting from using small sample sizes have been studied for SD particle ensembles for example by Berndt et al. (2016). First experimental data indicate that in case of PSD particles the statistical sample size required to reconstruct paleomagnetic field direction may be smaller than for SD particles. Here, a theoretical study is presented that describes the micromagnetic background of this hypothesis and allows to test it for a simplified mathematical model of TRM acquisition in PSD particles.