A new pTRM method for paleointensity determination

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We present a new method for paleointensity determination based on experimental treatment of partial thermoremanent magnetization (pTRM). Igneous rocks often contain pseudo-single domain (PSD), multidomain (MD), and/or single domain (SD) particles as magnetic remanence carriers under strong magnetic grain (domain) interactions. The magnetic grain interactions have particular disastrous effects on paleointensity experiment which make the determination of paleointensity unreliable. We have critically examined how magnetic grain interactions affect Thellier experiment and developed a new technique based on the extended pTRM theory for avoiding the grain-interaction effects in the experiment of paleointensity estimation. The essential point of our experimental method is that by comparing the thermal demagnetization of natural remanent magnetization (dNRM_loss) with that of an artificial total TRM (dTRM_loss) for estimating its paleointensity, rather than that by comparing the remaining of natural remanent magnetization during thermal demagnetization (NRM_remaining) with a progressive TRM_gain in the traditional Thellier-Coe method, which essentially requires additivity of pTRM and independence of pTRMs. In our new method, a mild alternating field (AF) demagnetization pre-treatment is applied to destroy most of low coercivity remanence, thus make the samples behave more ideal and desirable for paleointensity study. We also make paleointensity estimate with pTRM, which is acquired in a narrow non-overlapping temperature interval and cooled slowly in air, rather than using the progressive TRM in the Thellier-Coe method which is commonly obtained by cooling procedure of a sample to room temperature with a fan. The natural cooling provides an opportunity to obtain blocking temperature spectra as close as possible to the true blocking temperature spectra. In this way, the non-ideal behavior of the sample will be detected most sensitively by the discrepancy between the natural remanent magnetization (NRM) loss and the pTRM gain. Finally, we employ a labor-produced TRM test to elucidate the relation between the TRM_loss and pTRM _gain and to correct interferences caused by the non-ideal behavior. We have applied our new method to several representative suites of historical lava flows with known results and successfully extracted reliable paleointensity with precision higher than 95% from samples even containing PSD and MD grains.