Geophysical Research Abstracts
Vol. 13, EGU2011-4568, 2011
EGU General Assembly 2011

Toward a theoretical basis for paleointensity data selection

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Understanding the evolution of the geomagnetic field can provide important constraints on our knowledge of the geodynamo. In recent years great effort has been focused on understanding the causes and effects of non-ideal behaviour on paleointensity data and great progress has been made. Despite this effort, little work has been undertaken to assess the variability of ideally behaved specimens and to quantify was can be deemed as acceptable behaviour. A new model of experimental errors in paleointensity experiments has been developed to investigate the range of results that can be obtained from an ideal specimen that is measured with some degree of experimental noise. Preliminary results for a Coe protocol Thellier-type paleointensity model indicate that, at the 95% confidence level, experimental noise can produce paleointensity inaccuracies of up to $\sim$3.0%. This implies some results may suffer from a small degree of non-ideal behaviour, but can still produce acceptable and accurate results. Quantitative predictions of the limits of detection for checks designed to identify non-ideal behaviour (i.e. the threshold below which non-ideal behaviour cannot be distinguished from background noise) can be made using this model. At the 95% confidence level the model predicts threshold values of partial thermoremanent magnetization (pTRM) checks on the order of $\sim$10% (DRAT $\leq$ 9.2% and δCK $\leq$ 10.7 %), which suggests that typically used pTRM check section criteria are appropriate for excluding non-ideal behaviour. The threshold values for pTRM tail checks, however, are lower than used in most studies (DRATTail $\leq$ 5.2% and δTR $\leq$ 6.0 %). The ratio of the laboratory to ancient field strength can greatly influence these results if the ratio is extreme (i.e. an order of magnitude difference). δCK is sensitive to extremely low ratios, and δTR to high ratios; the DRAT parameters are less sensitive. The sensitivity of all parameters is reduced (< 4%) if the laboratory field is within a factor of two of the ancient field, as suggested by some researchers. Although preliminary, the results of this model provide a means with which to assess the impact of experimental noise on the analysis of absolute paleointensity data. The predicted thresholds for the detection of non-ideal behaviour represent a step forward in providing a theoretical basis for the exclusion and acceptance of paleointensity data.