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How does cooling rate affect the intensity of thermoremanent magnetisation in samples containing multidomain and interacting single domain ferrimagnetic grains?

A.J. Biggin (1), S. Badejo (1), J. Shaw (1), M.J. Dekkers (2), and A.R. Muxworthy (3)

(1) University of Liverpool, School of Environmental Sciences, Geomagnetism Laboratory, Liverpool, United Kingdom (biggin@liv.ac.uk), (2) Utrecht University, Fort Hoofddijk Paleomagnetic Laboratory, Utrecht 3584 CD, Netherlands, (3) Imperial College London, Department of Earth Science and Engineering. London, UK

The rate of cooling is known to produce a strong effect on the intensity of thermoremanent magnetisation (TRM) imparted to samples containing non-interacting single domain (SD) grains. This is a relatively well-studied phenomenon with significant implications for palaeointensity studies. By contrast, until very recently, there has been very little investigation into the same effects in coarser vortex-state or multidomain (MD) grains or in assemblages of SD grains interacting with one another. Here we present the results of a study investigating the magnitude of TRMs imparted to synthetic samples using two different cooling rates (77.7°C/min and 0.38°C/min) and a range of different applied field intensities. The samples used comprised crushed powders of magnetite (vortex to true MD state) and oxyexsolved titanomagnetite (effectively assemblages of interacting SD grains) in salt or K-Br pellets enclosed in evacuated quartz capsules (mean grain size ranging from sub-micrometre to several hundreds of micrometre).

In all 16 samples, the measured intensities of slower cooled TRMs were either higher on average than the faster cooled ones or else the two were indistinguishable. This contrasts with previously published findings (albeit from limited datasets) of an inverse relationship between cooling time and TRM intensity in samples containing multidomain grains (i.e. slower cooling induces weaker TRMs). Our findings suggest that assemblages of vortex-state and MD grains exhibit qualitatively the same relationship between TRM intensity and cooling rate as non-interacting single domain grains but with reduced dependence such that a 200 times difference in the latter induces an average difference in the former of generally less than 10%. Similarly, we show for the first time that the effect of strong interactions between SD grains is to suppress the cooling rate effect so that it does not exceed a few percent in these experiments. The implications of these findings for studies aiming to measure the palaeointensity will be discussed.