WHY ARE THE RESULTS OF MICROWAVE AND THERMAL PALEOINTENSITY EXPERIMENTS SYSTEMATICALLY DIFFERENT?

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It has been argued both theoretically and empirically that the microwave (de)magnetisation process is equivalent to its thermal counterpart and several studies have produced indistinguishable palaeointensity results using the two methods. However, here it is shown that the majority of studies in which microwave and thermally-derived results can be compared directly exhibit systematic differences. Specifically, the thermal results tend to be higher (often by several tens of percent) than the microwave results derived from the same rock units or even the same core samples. Furthermore, the thermal experiments more frequently produce concave-up Arai plots.

It is argued that the process dominantly responsible for these discrepancies is the enhanced expression of “multidomain” grains in the results of the thermal experiments relative to their microwave counterparts. The term “multidomain” is used loosely here and also likely applies to grains in the vortex state as well as, possibly, interacting single domain grains. Such grains have the tendency to produce curved (concave-up) Arai plots and here we show that this tendency seems to be worse in the results of thermal experiments than in those of microwave experiments performed on the same samples.

This difference may, in part, be put down to the different variants of the Thellier method used in the two types of study. In particular, microwave experiments frequently make use of the single-heating perpendicular method which has been shown to suppress Arai plot curvature resulting from multidomain grains. Thermal Thellier studies by contrast almost universally use double-heating protocols. However, the fact that differing protocols are often used may not be able to explain all of the discrepancies observed. Some other, as yet unknown, process also appears to be suppressing the effects of multidomain grains in microwave experiments.

The findings of this study suggest that in most cases where discrepancies between microwave and thermal results have been observed, the microwave result is the more reliable of the two. They also suggest that biasing of Thellier-type palaeointensity results to high values by multidomain grains may be more widespread and more severe than previously believed. Future palaeointensity studies should therefore seek to design their experiments to minimise this source of bias.