

Discussion

# Reply to comment on “A comparison of a quasi-perpendicular method of absolute palaeointensity determination with other thermal and microwave techniques”

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Accepted 15 October 2007

Available online 22 October 2007

With reference to the comments of Derek Walton and Harald Böhnel, our experimental evidence shows that 14.2 GHz is able to demagnetise all ceramics that we have tried. This has not always been the case because our first cavity design operating at 14.2 GHz failed to demagnetise most ceramics. It was not until we managed to get our second microwave system operational (with a new 14.2 GHz cavity) that we were able to demagnetise all samples, usually using less than 40 W of power. Clearly the problem for us was the design of the cavity and the coupling slot by which power is coupled from the waveguide into the cavity.

We agree with Walton and Böhnel that there is heating of some samples (there are also some samples that are not significantly heated at all) but certainly not to 300 °C under normal operating conditions (5 seconds microwave application). We have investigated the source of heating and it appears to be independent of the magnetic content of the sample. In theory a small sample in the centre of the cavity will not be subject to high electric fields but in practice they are. The magnetic and electric field distribution inside the cavity is influenced by the coupling slot, the sample rod, and the sample. Applying power to a pure quartz sample at

14.2 GHz will eventually heat it clearly demonstrating the effect of dielectric heating and the presence of alternating electric fields in the sample. Moving to higher frequencies will increase the effect of dielectric heating and for this reason we are staying at 14.2 GHz (it demagnetizes samples and doesn't heat them very much).

We also point out that there was no clear-cut evidence of magnetomineralogical alteration occurring in any of the 18 microwave experiments reported in the original paper whereas it was clearly visible in the results of the thermal experiments when the samples were heated above 350–450 °C. However, even for the thermal experiments, alteration was not the major problem leading to the rejection of results by the selection criteria. Rather, in both the thermal and microwave experiments, the visible non-ideal behaviour causing the rejection of results by the selection criteria was dominantly caused by multidomain effects.

Walton and Böhnel are keen to demonstrate the theoretical prediction that magnetic grain size demagnetization is microwave frequency dependent. We wish them every success in this endeavour. It is not something that we can do with our existing facilities.

DOI of original article: [10.1016/j.epsl.2007.03.016](https://doi.org/10.1016/j.epsl.2007.03.016).

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