Geophysical Research Abstracts
Vol. 18, EGU2016-5764, 2016
EGU General Assembly 2016

The potential of micromagnetic tomography

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Methods to derive paleodirections or paleointensities from rocks currently rely on measurements of bulk samples (typically ∼10 cc). The process of recording and storing magnetizations as function of temperature, however, differs for grains of various sizes and chemical compositions. Most rocks, by their mere nature, consist of assemblages of grains varying in size, shape, and chemistry. When dealing with lavas, this differing magnetic behaviour often hampers paleointensity experiments; while occasionally a reliable paleodirection is obscured (e.g. Coe et al. (2014)). If we would be able to isolate the contribution of each magnetic grain in a sample to the bulk magnetic moment of that sample, a wealth of opportunities for highly detailed magnetic analysis would be opened, possibly leading to an entirely new approach in retrieving paleomagnetic signals from complex mineralogies.

Firstly, the distribution and volume of the remanence carrying grains in the sample must be assessed; this is done using a MicroCT scanner capable of detecting grains >1 micron. Secondly, the magnetic stray field perpendicular to the surface of a thin sample is measured using a high-resolution DC SQUID microscope. A mathematical inversion of these measurements yields the isolated direction and magnitude of the magnetic moment of individual grains in the sample. Here we show the results of inversions on a synthetic sample that was magnetised under different angles with respect to the scanned surface. Computational limitations constrain us to inverting only up to tens of grains at the same time. Besides presenting new results of the first successful non-destructive micromagnetic tomography study, we will discuss the current potential and limitations of this technique.