Recognition of Thermal/Chemical Remanent Magnetization in Rocks and Meteorites

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TRM/SIRM acquisition

TRM/SIRM acquisition of minerals with minimal shape anisotropy obeys the empirical law (Kletetschka et al., 2004). TRM/SIRM acquisition does not depend significantly on grain size and creates a base for determination whether magnetization of the sample is thermal or isothermal in origin (Figure 1). Such a procedure allows discrimination between the various possible processes responsible for the magnetization of the sample: for example it can separate viscous, isothermal, and thermal/chemical components.

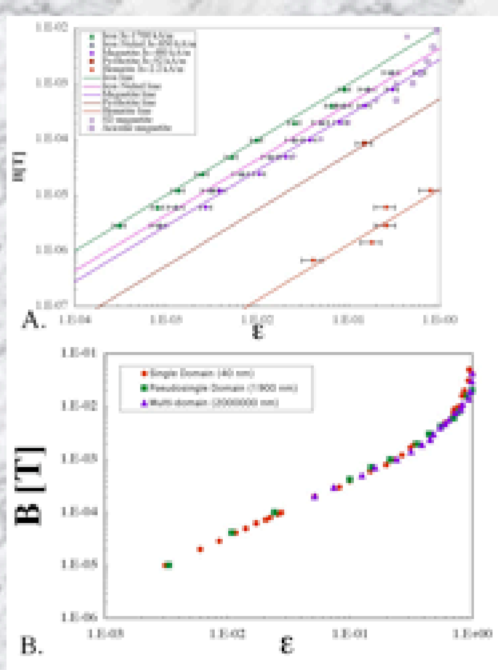

Figure 1: TRM acquisition of equidimensional minerals A. Low Js magnetic minerals acquire TRM more easily than minerals with latge Js, B. TRM/SIRM acquisition for particular mineral is independent of grain size.

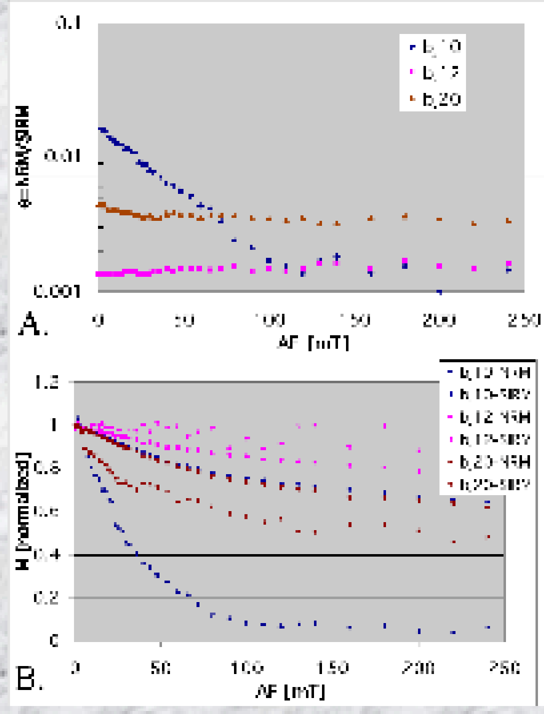

Figure 2: Alternating Field demagnetization of three chondrules from Biurbole meteorite. A. Two chnodrules indicate stable TRM component. One chondrule contains low temperature magnetic contamination (low coercivity grains are mo efficiently magnetized than large coercivity grains. B. AF demagnetization normalized to initial value.

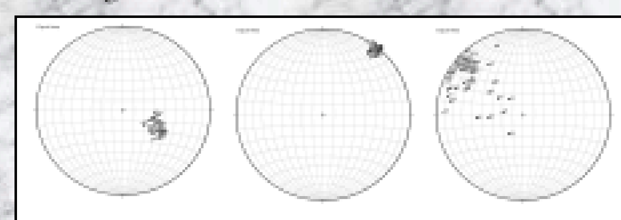

Figure 3: Stereographic projections of the vector direction during the AF demagnetization. Left: BJ20, Middle: BJ12, Right: BJ10

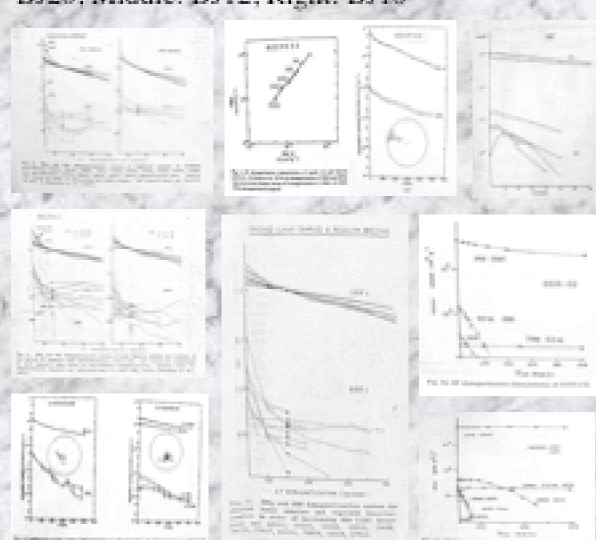

Figure 4: Multiple examples of TRM acquisition of Lunar samples. Several samples suggest they contain TRM/CRM component.

Technique

The technique utilizes a detailed alternating field (AF) demagnetization of the natural remanence, followed by saturating the sample in a large external field and demagnetizing it in the very same AF demagnetization steps (Figure 2). The ratio of the data (AF(NRM)/AF(SIRM)) results in a curve whose slope contains information about the nature of NRM acquisition. The method assumes that the magnetic grains do not change shape when going from small to large size. Vector directions are shown in Figure 3.

Examples

We apply this method on natural rocks of various origins and lunar rocks. Interestingly, some of the lunar samples indicate that their remanence may be thermal in origin (Figure 4), requiring heating to and cooling from temperatures exceeding 1000K. We also found that chondrules that are part of the Biurbole meteorite indicate TRM component as well as isothermal (Figure 2).

Conclusions

Demagnetization of both NRM and SIRM by alternating field has potential to reveal if the nature of the remanence is thermal/chemical or viscous/isothermal.

Problems

-Magnetic anisotropy of fraction of assemblage will amplify NRM/SIRM for their coercivity window
-Multiple components need to be compiled into one component
-Different mineralogy will cause separation of NRM/SIRM according to their saturation magnetization

Reference

G. Kletetschka, M. H. Acuna, T. Kohout, P. J. Wasilewski, and J. E. P. Connerney, An Empirical Scaling Law for Acquisition of Thermoremanent Magnetization, Earth and Planetary Science Letters, 226 (3-4), 521-528, 2004