Comparison of thermal and microwave paleointensity estimates in specimens that violate Thellier's laws

Conference or Workshop Item

Comparison of thermal and microwave paleointensity estimates in specimens that violate Thellier's laws

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Deep within the Earth, thermodynamic behavior drives the geodynamo and creates the Earth's magnetic field. Determining how the strength of the field, its paleointensity (PI), varies with time, is vital to our understanding of Earth's evolution. Thellier-style paleointensity experiments assume the presence of non-interacting, single domain (SD) magnetic particles, which follow Thellier's laws. Most natural rocks however, contain larger, multi-domain (MD) or interacting single domain (ISD) particles that often violate these laws and cause experiments to fail. Even for samples that pass reliability criteria designed to minimize the impact of MD or ISD grains, different PI techniques can give systematically different estimates, implying violation of Thellier's laws. Our goal is to identify any disparities in PI results that may be explainable by protocol-specific MD and ISD behavior and determine optimum methods to maximize accuracy.

Volcanic samples from the Hawai'ian SOH1 borehole previously produced method-dependent PI estimates. Previous studies showed consistently lower PI values when using a microwave (MW) system and the perpendicular method than using the original thermal Thellier-Thellier (OT) technique. However, the data were ambiguous regarding the cause of the discrepancy. The diverging estimates appeared to be either the result of using OT instead of the perpendicular method or the result of using MW protocols instead of thermal protocols. Comparison experiments were conducted using the thermal perpendicular method and microwave OT technique to bridge the gap. Our data generally show that the perpendicular method gives lower estimates than OT for comparable H_{lab} values and that MW estimates are generally lower than thermal estimates using the same protocol. One of the largest factors affecting the estimates is the use of only the low temperature Arai plot slopes or using (with a lower β value) the entire data set, but it does not account for the entire difference.