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Bridging Geochemistry and Rock Magnetism: A Novel Non-destructive Approach to Magnetic Noise Detection in Lunar Sample 15445.277

GUNTHER KLETETSCHKA[1,2] AND RADEK NOVOTNY[2]

[1]University of Alaska Fairbanks, USA
[2]Charles University

This study exemplifies how geochemistry bridges multiple scientific disciplines by combining chemical analysis, rock magnetism, and physics to solve complex planetary science questions. Traditional paleomagnetic studies often rely on thermal manipulation, which can compromise sample integrity through chemical alterations. By integrating geochemical characterization with non-destructive magnetic techniques, we developed an alternative analytical approach for two Apollo 15 lunar breccias.

Our interdisciplinary methodology revealed distinct relationships between chemical composition and magnetic behavior. Within the broader context of lunar breccia magnetic classification, where Natural Remanent Magnetization (NRM) versus Saturation Isothermal Remanent Magnetization (SIRM) relationships span six orders of magnitude in paleofield strength (Figure 1), our samples showed distinctive characteristics. Sample 15405's pure iron carriers exhibited stable paleomagnetic signatures ranging from 10-800 microteslas, as demonstrated by eight subsamples from a single 15-mm specimen (Figure 2). Conversely, sample 15445's Fe-Ni carriers (kamacite and taenite) displayed magnetic noise without detectable paleomagnetic signatures.

The study showcases geochemistry's role as a connector between fundamental sciences: chemical analysis provides compositional data, physics explains magnetic behavior, and geological context informs environmental conditions during sample formation. This integration of multiple scientific approaches offers new pathways for investigating planetary materials where traditional methods fall short.

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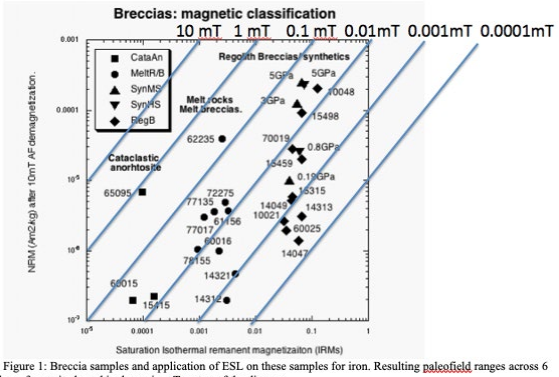

Figure 1: Breccia samples and application of ESL on these samples for iron. Resulting paleofield ranges across 6 orders of magnitude and is shown in mT on top of the diagram.

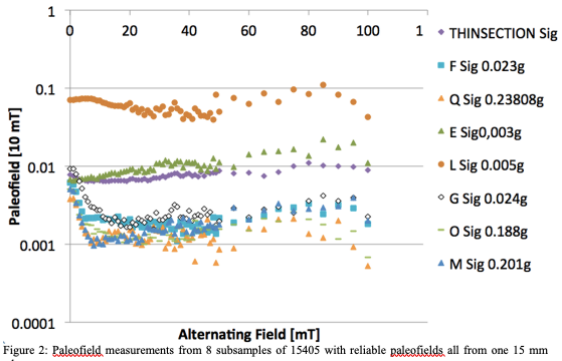

Figure 2: Paleofield measurements from 8 subsamples of 15405 with reliable paleofields all from one 15 mm sample.