STONY METEORITE CHARACTERIZATION BY NON-DESTRUCTIVE MEASUREMENT OF PETROPHYSICAL PROPERTIES.

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Introduction: The National Meteorite Collection of Canada comprises over 700 different stony meteorites. There are statistically large numbers of different meteorites in many classes. Work on these meteorite samples complements previous studies [1]; see also ref. in [2]. Non-destructive measurement of their petrophysical properties is being systematically undertaken to: (1) define a range of properties for each chondritic and achondritic class; (2) develop simple techniques to discriminate among classes, and within classes, i.e. to rapidly and non-destructively classify meteorites, or to check their classification; and (3) gain insights into their conditions of formation, and the nature and history of parent bodies.

Techniques: We have modified previously published bulk magnetic susceptibility measurement techniques by varying frequencies; so far 304 specimens have been measured for bulk susceptibility at two frequencies (825 and 19000 Hz). In addition, 67 specimens have been measured for anisotropy of magnetic susceptibility at a frequency of 19000 Hz [2]. We also plan natural remanent magnetization (NRM) and bulk density measurements.

Classification Parameters: Currently we recognize four parameters which show promise as classification tools and discriminants: frequency dependence, bulk susceptibility, degree of anisotropy, and shape of anisotropy. The achondrites appear to have a larger frequency dependence than the chondrites with acapulcoites (ACA), aubrites (AUB) and SNC (Martian meteorites) showing the highest dependence. Plots of susceptibility vs. degree of anisotropy show a clear distinction between chondrites and most achondrites. Acapulcoites (ACA) and Ureilites (URE) are exceptions. They plot at higher susceptibilities than expected for their metal contents. Aubrites (AUB) are particularly distinct, with low average susceptibility (3.41 ± 0.51)[log χ in units $10^{-9} m^3/kg$, $\pm 2\sigma$ error] but a remarkably high degree of anisotropy (30-50%). They also have a prolate anisotropy fabric in contrast to most other meteorite types. These characteristics may indicate a distinctive origin and/or provenance. The eucrites (EUC) have the lowest susceptibilities (2.97 ± 0.62). The highest susceptibilities belong to the E-chondrites (5.29 ± 0.37), and there is a general trend, on bulk susceptibility vs. degree of anisotropy plots, from C-chondrites through LL, L, and H to E, probably largely controlled by metal content.

The shape of anisotropy of the classes measured is dominantly oblate ellipsoidal. The degree spread of ellipsoid shape varies among classes. The L, H and E chondrites display the largest spread with E-chondrites showing no preferred oblate or prolate shape. The C-chondrites display the tightest ellipsoid groupings ranging from 1 to -10% as well as the tightest groupings for degrees of anisotropy (1 to 10%).

Sub-classes: There are some within-class differences that may be significant and related to provenance and parent body history. Camel Donga has a bulk magnetic susceptibility of 4.31 -- distinct from other EUC, e.g. Millbillillie, 2.66. CM2's have a distinctively lower susceptibility range then the other measured classes (CO, CV, CR, CK and C3.x). The ability of bulk magnetic susceptibility alone to help distinguish among the various C-chondrite sub-classes makes it a potentially valuable parameter for their classification, given their complexities, and sample fragility.

Summary: By continuing to measure different petrophysical properties, and identifying more parameters for discriminating among stony meteorites, we expect to contribute to a worldwide database that allows rapid systematic and non-destructive classification [1], and also to gain new knowledge of their provenance.

References: [1] Rochette P. et al. 2001. *Quaderni di Geofisica*, 18: 30 p. [2] Smith D.L. et al. 2004. Abstract 1243, *AGU/CGU/SEG/EEGS Joint Assembly, Montréal* .