AN OVERVIEW OF ACHONDRITE DENSITY, POROSITY AND MAGNETIC SUSCEPTIBILITY. D. T. Britt[1], R. J. Macke [1], W. Kiefer[2], and G. J. Consolmagno[3]; [1]University of Central Florida, 4000 Central Florida Blvd., Orlando FL 32816 macke@alum.mit.edu, [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058, [3]Specola Vaticana, V-00120 Vatican City State.

Introduction: Achondrites represent a huge range of parent bodies, mineralogies, formation conditions, and physical evolution; many, though not all, are igneous in origin. To provide context for the Macke et al [1] report on new measurements of the density, porosity, and magnetic susceptibility of Apollo samples and lunar meteorites we present a comparison with our measurements of achondrite meteorites. These data are part of an ongoing comprehensive study of the physical properties of meteorites using consistent, non-destructive, non-contaminating methods for determining bulk and grain density, porosity, and magnetic susceptibility. The methodology is outlined in Consolmagno et al. [2]. Grain density is measured by helium ideal-gas pycnometry. Bulk density is measured by the glass bead method developed by Consolmagno and Britt [3]. Porosity is calculated directly from bulk and grain densities: $P = 1 - \left(\rho_{bulk} / \rho_{grain}\right)$. Magnetic susceptibility is measured with a handheld SM-30 magnetic susceptibility meter following techniques of Rochette et al. [4], and corrected for sample geometry according to the calibration by Gattacceca et al. [5].

In figures 1-4 we present the compiled data for the following classes of materials (with abbreviations used in the figures): Apollo lunar samples (Apollo), Lunar meteorites (Lun. Met.), Martian meteorites (SNC),

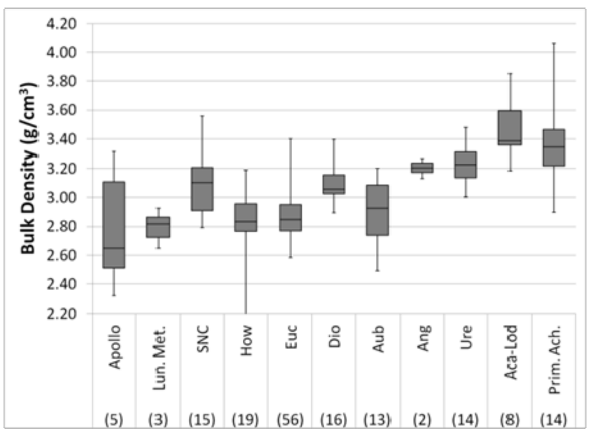

Figure 1: The bulk density of 9 types of achondrite meteorites with Lunar meterorites and Apollo samples

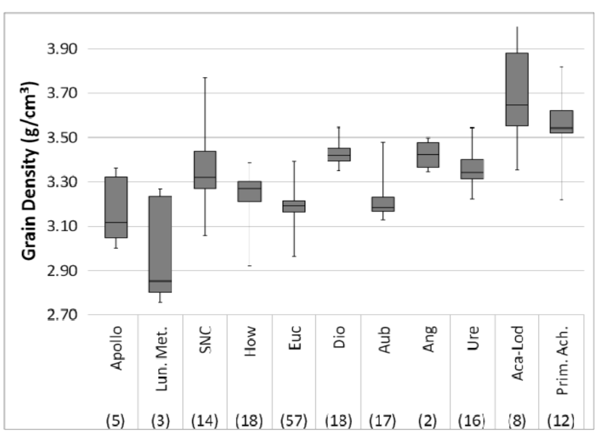

Figure 2: The grain density of 9 types of achondrite meteorites with Lunar meterorites and Apollo samples.

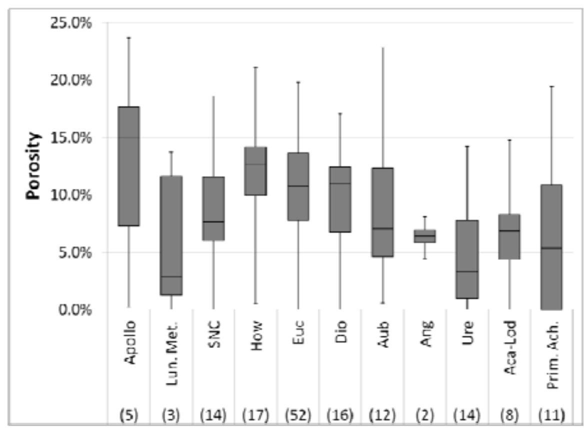

Figure 3: The porosity of 9 types of achondrite meteorites with Lunar meterorites and Apollo samples.

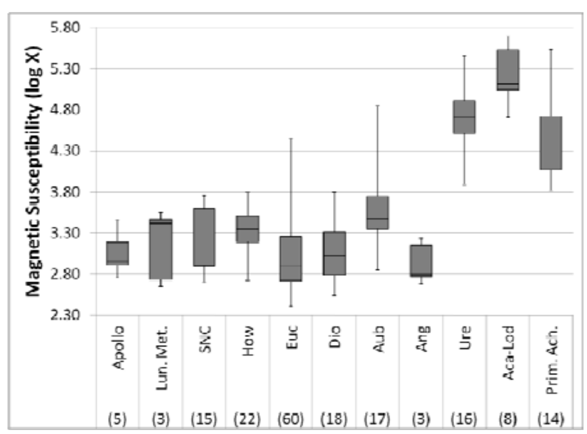

Figure 4: The magnetic susceptibility of 9 types of achondrite meteorites with Lunar meterorites and Apollo samples.

Howardites (How), Eucrites (Euc), Diogenites (Dio), Aubrites (Aub), Angrites (Ang), Ureilites (Ure), Acapulcoites and Lodranites (Aca-Lod), and Primitive Achondrites including Brachinites and Winonaites (Prim. Ach.). For each data point, the central bar is the median value of all the samples of that type. The grey shaded region is the 50% population range. The "error bars" represent the remaining population plus uncertainties of the extreme data points. The associated numbers in parentheses under the group names are the number of individual sample measurements included in the data. (Since not every sample underwent all of the measurements, the numbers vary between plots.)

Lunar Materials: We measured five fragments taken from Apollo samples including two basalts and three breccias. The three lunar meteorites were all breccias North West Africa (NWA) 482, NWA 773, and NWA 5000. The numbers of measured samples are still far too small for any solid conclusions. In general lunites seem to mimic Apollo samples roughly in bulk and grain density as well as magnetic susceptibility. Interestingly, lunites appear (with this limited sample) to be less porous than Apollo samples.

SNCs: Martian meteorites are, in general, iron-rich igneous rocks that are almost all unbrecciated, which is reflected in the high values for bulk and grain density. Magnetic susceptibility is in the same range as other igneous rocks like lunar materials and HEDs, but distinctly lower than Ureilites, Lodranites or Primitive Achondrites. Porosity values for SNCs are about average for the achondrite group.

HEDs (Howardites, Eucrites and Diogenites): Eucrites are basalts, either near-surface or cumulates formed deeper in the crust, composed of pigeonite and anorthite. A number of these meteorites are regolith breccias. Diogenites are plutonic rocks made primarily of Mg-rich orthopyroxene derived from deep layers in the parent asteroid. Howardites are regolith breccias consisting of a mixture of Eucrite and Diogenite materials. Measured properties follow the mineralogy and mixture trends of HEDs. Diogenites have the highest bulk and grain densities, with Howardites tending to average the Eucrite and Diogenite values. Porosity and magnetic susceptibility are similar in the three classes.

Aubrites: Aubrites are mostly breccias primarily composed of large crystals of enstatite indicating a deep plutonic origin. Because of their almost monomineralogic composition, grain densities have a tight distribution despite the fact that most Aubrites are brecciated and many are polymict. The range in bulk densities reflects the surprisingly large range in porosities of 0-25%. The large range in magnetic susceptibility may reflect varying amounts of nickel-iron metal and troilite.

Angrites: Angrites are vesicular basalts indicating near-surface flows, primarily composed of augite. They tend to be about average in porosity, with high bulk and grain densities reflecting the dominate augite composition.

Ureilites: Ureilites are carbon-rich (up to 3 wt.%) igneous material dominated by olivine and pigeonite. Bulk and grain densities reflect the higher-density silicates. Porosity tends to be lower than average, while magnetic susceptibility is surprisingly, on average, the second highest of the achondrite group.

Acapulcoites and Lodranites: Lodranites are dominated by olivine and have large amounts of iron-nickel metal. Acapulcoites are dominated by orthopyroxene with H-chondritic amounts of metal and troilite. What are striking about these meteorites are their high grain density and their high magnetic susceptibility, both presumably due to the relatively abundant metal and troilite.

Primitive Achondrites: This group includes Brachinites and Winonaites as well as one ungrouped primitive achondrite. Brachinites are dominated by olivine with minor amounts of pyroxene and troilite. Winonaites have an ordinary chondrite composition with an igneous texture. Their bulk and grain densities reflect the relatively high metal content in Winoanates or the abundant olivine in Brachinites. The high magnetic susceptibility of this group may also relate to the relatively iron-rich mineralogy.

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