DENSITY, POROSITY AND MAGNETIC SUSCEPTIBLITY OF THE MURRILI METEORITE RECOVERED BY THE DESERT FIREBALL NETWORK.

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Introduction: Fireball observation networks such as the Desert Fireball Network in Australia expand the ability to recover meteorites quickly after their fall to earth, minimizing their exposure to terrestrial environments that may alter the specimens not only through chemical contamination, but also weathering such as the oxidation of embedded metals. The Murrili fireball was observed by DFN in late November, 2015, and about one month later a single intact 1.68 kg stone was found embedded in the mud of Lake Eyre [1]. The Murrili meteorite has been classified as an H5 ordinary chondrite of shock stage S1. We obtained a 51.5 gm fragment of this stone for physical properties measurements. We report here the density, porosity, and magnetic susceptibility of this specimen of Murrili.

Measurement: Bulk volume and density was measured using a NextEngine ScannerHDPro laser scanner at high resolution [cf. 2]. The laser scanner produced a 3-dimensional computer model of the meteorite, from which the volume enclosed by the outer surface could be calculated in the software. Grain volume and density was determined by helium ideal gas pycnometry using a Quantachrome Ultrapyc 1200e [cf. 3]. Porosity is calculated from these two densities: $P = 1 - \rho_{bulk}/\rho_{grain}$. Magnetic susceptilibity was measured using an SM-30 handheld device, with volumetric and shape corrections according to [4] and [3].

Results: Bulk density of this specimen of Murrili is 3.47 ± 0.01 g cm^{-3}. Grain density is 3.59 ± 0.01 g cm^{-3}. Together, these two densities yield a porosity of (3.4 ± 0.4)%. Magnetic susceptibility for this specimen is $\log \chi = 5.19 \pm 0.09$ (SI units).

Discussion: For a fresh fall with a very low shock state, Murrili has a very low porosity. The average H fall is about 10% porous. Among the S1 H falls, most meteorites are between about 7-14 % porous. Average porosity does decline as shock stage is increased, but for an S1 the porosity of 3.4% is remarkably low [3]. There are two possible explanations for this observation: the meteorite could have experienced some oxidation, either during its brief exposure to terrestrial environments or in situ, or it could in fact be more shocked than initial estimates seemed to indicate. In this case, the former explanation appears more likely when other physical properties are taken into account.

For most ordinary chondrite falls, a plot of grain density vs. magnetic susceptibility will separate H, L, and LL chondrites into three distinct populations [5]. When Murrili is added to the plot, it falls at the very edge of the H population, with much lower than average grain density and magnetic susceptibility. (Average H grain density is 3.71 g cm^{-3} and average magnetic susceptibility is $\log \chi = 5.30$.) This places it at the boundary with the L population. These results are more consistent with those of weathered finds. Weathering effects on the Fe metal in ordinary chondrites results in the reduction of grain density and magnetic susceptibility, without a corresponding shift in bulk density. This results in reduction of porosity as the low-density weathering products expand to fill existing pore space. The density and magnetic susceptibility, as well as the porosity, are consistent with a mildly weathered H find of W1-2 [3]. The circumstances of the meteorite recovery also support weathering, given that the meteorite was recovered from salt-rich mud after having resided there for a little more than one month [1]. The salty environment probably accelerated the oxidation reactions with Fe metal in the meteorite at least in the near-surface regions. When the stone was cut for study, the presence of red oxides was noted. The cut faces of the sample used for this study also exhibit signs of oxidation.

References: [1] *Meteoritical Bulletin* 105. [2] Macke R. J. et al. 2015. Abstract #1716. 46th Lunar and Planetary Science Conference. [3] Macke R. J. 2010. *Survey of Meteorite Physical Properties: Density, Porosity and Magnetic Susceptibility*. Ph.D. Thesis, University of Central Florida. [4] Gattacceca J. et al. 2004. *Geophysical Journal* 158:42-49. [5] Consolmagno G. J. et al. 2006. *Meteoritics & Planetary Science* 41:331-342.