DINGLE DELL DENSITY AND OTHER PHYSICAL PROPERTIES

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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. Through the efforts of the DFN, several meteorites have been located and recovered shortly after their fall event. Even so, the environment in which they fall is critical; for example, the H5 meteorite Murrili was recovered after a terrestrial exposure of about one month in a briny mud that led to extensive oxidation of metallic inclusions [1]. By contrast, the meteorite Dingle Dell—initially classified LL6—was observed by the DFN to fall over western Australia on Halloween night in 2016 and a single 1.15 kg stone was recovered on hard, dry ground just six days later, during which time the meteorological record lists no precipitation in the area. It bears no signs of terrestrial weathering at all, and has a weathering grade of W0 [2].

We obtained a 78.9 gm cut of the 1.15 kg stone for the purpose of measuring physical properties (density, porosity, and magnetic susceptibility) using non-destructive and non-contaminating techniques. We report here the results of this study, which forms just one aspect of a more extensive project to characterize the meteorite.

Measurement: Bulk volume and density was measured using a NextEngine ScannerHDPro model 2020i laser scanner at medium resolution ($1.6\text{x}10^4$ points per in^2) [cf. 3]. 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 nitrogen ideal gas pycnometry using a Quantachrome Ultrapycnometer 1000 [cf. 4]. Porosity is calculated from these two densities: $P = 1 - \rho_{bulk}/\rho_{grain}$. Magnetic susceptibility was measured using an SM-30 handheld device, with volumetric and shape corrections according to [5] and [4].

Results: Bulk density of this specimen of Dingle Dell is 3.23 ± 0.02 g cm^{-3}. Grain density is 3.61 ± 0.01 g cm^{-3}. Together, these two densities yield a porosity of (10.5 ± 0.5)%. Magnetic susceptibility for this specimen is $\log \chi = 4.78 \pm 0.09$ (SI units).

Discussion: The porosity of about 10% is close to the mean for lightly shocked (S2) fresh ordinary chondrite falls. The grain density is almost two standard deviations higher than the average for LL falls of 3.52 g cm^{-3}. The magnetic susceptibility is higher than that of the general LL population, which ranges from $\log \chi = 3.3\text{-}4.7$ [4]. Most ordinary chondrite falls, when grain density is plotted agains magnetic susceptibility, will fall into three distinct populations (H, L, LL) with very little overlap between them [6]. When Dingle Dell is added to the plot, its physical properties are more consistent with the L population than LL. However, there is also an intermediate population of L/LL chondrites such as Holbrook and Knyahinya whose range of physical properties lies between and overlaps both the L and LL populations. Dingle Dell's grain density and magnetic susceptibility are consistent with this intermediate population. This supports Dingle Dell's revised classification (based on other evidence) of L/LL5 [7].

References: [1] *Meteoritical Bulletin* 105. [2] *Meteoritical Bulletin* 106. [3] Macke R. J. et al. 2015. Abstract #1716. 46th Lunar and Planetary Science Conference. [4] Macke R. J. 2010. *Survey of Meteorite Physical Properties: Density, Porosity and Magnetic Susceptibility*. Ph.D. Thesis, University of Central Florida. [5] Gattacceca J. et al. 2004. *Geophysical Journal* 158:42-49. [6] Consolmagno G. J. et al. 2006. *Meteoritics & Planetary Science* 41:331-342. [7] Benedix G. K. et al. (2017) *This conference*.