LOW-TEMPERATURE HEAT CAPACITY OF OC FALLS AS A FUNCTION OF OLIVINE CONTENT

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Introduction: Meteorite physical properties such as bulk density and thermal conductivity depend on the physical state of the sample – the amount and nature of the sample porosity – while other properties, such as grain density, should be purely a function of the meteorite composition. Heat capacity should also depend solely on composition. Previously [1] we observed that ordinary chondrite (OC) falls exhibited a correlation between heat capacity and grain density, and we posited that the observed trend was due to variations in olivine abundance: olivine is the dominant mineral in these meteorites and has both higher density and higher heat capacity than the typical OC fall. To test this hypothesis we have measured heat capacities for 18 falls of known olivine content (from [2], who calculated CIPW mineral abundances including olivine from measured oxide abundances).

Measurement: Our novel technique [3], non-contaminating and non-destructive, determines the heat capacity of hand-sized specimens (typically 20-40 gm) by immersing them in liquid nitrogen and determining the mass of nitrogen boiled off as the sample cools down. This yields a temperature-averaged heat capacity, equivalent to the heat capacity at approximately 175 K. We have now measured heat capacities for 57 ordinary chondrites in the Vatican collection (42 falls and 15 finds).

Results: We find that the correlation between heat capacity and olivine abundance alone is much stronger than the correlation between heat capacity and grain density for OC falls. This correlation spans H, L and LL falls.

We also calculated a model 175 K heat capacity for each meteorite based on the mineral abundances given in [2]. Measured heat capacities trend systematically slightly lower than the calculated heat capacity, with some notable outliers at significantly higher heat capacity. Since the model assumes no weathering, and phases such as magnetite and goethite have much higher heat capacity than unweathered metal, weathering can account for these outliers. The systematic difference between the model and our measurements may be interpreted as (a) our measurement is valid at a temperature slightly less than 175K; (b) one or more low-T heat capacities for mineral components in the model are not correct; or (c) the mineralogy in [2] omitted a component that significantly affects heat capacity.

The correlation between measured and model heat capacities is not significantly better than the correlation between heat capacities and olivine abundance, suggesting that olivine is the dominant influence in variation in heat capacity.

Conclusions: The correlation between model and measured heat capacities validates our novel measurement technique, and it confirms our hypothesis that heat capacity is a function of composition, where olivine composition plays a central role. Furthermore, the strong correlation we find between composition and heat capacity suggests that, in conjunction with grain density and magnetic susceptibility measurements [4], heat capacity measurements could serve as a part of a non-destructive method for characterizing meteorites compositions.

References: [1] Macke R. J. et al. 2014. Abstract #5046. 77th Meteoritical Society Meeting. [2] McSween et al. 1991. *Icarus* 90:107-116. [3] Consolmagno G. J. et al. 2013. *Planetary and Space Science* 87:146-156. [4] Consolmagno G. J. et al. 2006. *Meteoritics and Planetary Science* 41:331-342.