THERMAL CONDUCTIVITIES AND POROSITIES OF STONY METEORITES

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Introduction: The thermal conductivity of meteorites is a fundamental property of these materials and an important indicator of their chemical and physical nature. In addition, it is an important factor in modeling the thermal evolution of meteorite parent bodies, the light curves of meteors, and processes such as the Yarkovsky and YORP effects where thermal emission alters the orbits and spins of meteoroids. However, until recently the only measurements available (1) were derived from thermal diffusivities measured over a limited temperature range for ordinary chondrites. Using modern equipment that automates these measurements we have confirmed the trends of these earlier measurements and extended them to carbonaceous chondrites.

Previous work: We have reported (2) the measurement of the thermal conductivity at low temperatures (5K to 300 K) of Chronstad (H5), Lumpkin (L6), Abee (EH4), 5515 (CK4 find) and Cold Bokkeveld (CM2). All measurements were made on samples cut into 0.5 - 1 cm prisms using a Quantum Design P670 TTO. The conductivity of all the samples gave values that were much lower than those of pure minerals and most were nearly constant above 100K. The L and CK sample conductivities at 200 K were both 1.5 W/mK, that of the H was 1.9 W/mK, and that of the CM sample was 0.5 W/mK; by contrast the literature value at 300 K for serpentine is 2.5 W/mK and that of enstatite and olivine is 4.5 to 5 W/mK (comparable to our Abee value).

New results: Our first results were consistent with earlier work (1), but the previous workers had found that thermal conductivities ranged over nearly an order of magnitude from sample to sample, even within a meteorite class. Thus our next step has been to measure more ordinary chondrites including multiple samples of the same meteorite to look for this variation.

In recent measurements we find one sample of Holbrook (L6) has a conductivity of only 0.44 W/mK and the conductivity of Collesciopoli (H5) is 0.81 W/mK, while that of a second piece of Holbrook, cut from the same rock, gives a conductivity of 1.15 W/mK, nearly three times the value of the first piece and closer to that of the H5 meteorite Pultusk (at 1.25 W/mK). Two pieces of Bath Furnace (L6) gave even higher values of 2.3 and 2.7 W/mK. (All values cited here are at 200K; we will present data ranging from 5K to 300K for these samples.) This confirms the wide range, and great overlap, of thermal conductivities among ordinary chondrite classes. Interestingly, there does not seem to be any simple relationship between conductivity and metal content in ordinary chondrites.

From the size and mass of our samples we are able to derive their bulk densities and, using the grain densities of similar samples in our collection, compute the porosity of each samples. Surprisingly, we see no obvious correlation between meteorite porosity and thermal conductivity.

Future Work: As of this writing, we are continuing to make measurements of meteorite samples and in the near future we hope to have additional values to report for both chondrites and basaltic achondrites.

References: [1] Yomogida K. and Matsui T. 1997. *Journal of Geophysical Research* 88:9513–9533. [2] Opeil C. P. et al. 2010. *Icarus*, in press.