A DATABASE OF METEORITE MINERALS. Nina Hooper\textsuperscript{1} and Martin Elvis\textsuperscript{2}, \textsuperscript{1}Harvard University (nina-hooper@college.harvard.edu), \textsuperscript{2}Harvard-Smithsonian Center for Astrophysics (60 Garden St., Cambridge MA02138 USA, melvis@cfa.harvard.edu).

Introduction: The conditions in the cold ($\sim$10K) regions of the Solar nebula in the slowly cooling cores of planetesimals (Myr – Gyr), and in the high speed ($\sim$25 km s$^{-1}$) collisions of planetesimals and their derivatives, are all conditions that cannot be achieved in the laboratory.

The result of these unusual environments is that meteorites contain significant numbers of minerals not found naturally occurring on Earth. These are often called ‘meteorite minerals’. These novel minerals give us clues to the conditions at their formation and so to Solar System history.

In addition, in materials physics, first-principles total-energy calculations for compounds of a given stoichiometry have identified metastable, or even stable, structures distinct from known structures obtained by synthesis under laboratory conditions [1, 2]. The early Solar System explored a wider range of formation conditions than are available in the laboratory. Meteorite/asteroid/comet samples may contain novel structures that could suggest new classes of materials for first-principles and laboratory investigation. See, for example the evidence for the extraterrestrial origin of a natural quasicrystal [3]. Some of the meteorite minerals have unusual properties important for materials science, though these are little explored as yet.

The literature on meteorite minerals and their properties is quite dispersed. In order to foster their investigation we have created an on-line database of meteorite minerals.

Data Aggregation: We performed a literature search for minerals approved by the International Mineralogical Association (IMA) that were found in meteorites. Initial key term searches were conducted on the Harvard University HOLLIS database. Key terms were “meteorite,” “new mineral,” “discovered” and “meteorite mineral.” This series of searches resulted in an initial list of over 31 minerals. Searching the citations for each of these papers led to an additional 26 meteorite minerals being compiled.

Database contents:

The properties can be grouped into three areas:

(1) Discovery details: the mineral type; the meteorites and their types in which the mineral was found; sample size, the number of known samples; and synthesis.

(2) Crystal properties: the unit cell, crystal structure, hardness, density, cleavage and fracture.

(3) Optical properties: color, lustre, diapheney, optics, refractive index and birefringence.

The database is stored in excel format and will be available at the CfA web site (www.cfa.harvard.edu) soon.

Discussion: We have compiled a total of 57 meteorite minerals. Of these 17 were later identified in Earth rocks and 20 were synthesized in the laboratory.

Most of the meteorite minerals are found in milligram, micron-sized particles. This makes measuring their physical properties problematic. Due to the microscopic crystal sizes, it was common for minerals to have unmeasured physical properties. In particular, twinning, cleavage, fracture and tenacity were often unreported.

A few meteorite minerals have been investigated in more depth. Some are discussed below.

Krinovite: There have been over 50 unsuccessful attempts to synthesize krinovite in the laboratory [4], emphasizing the inaccessibility of solar nebula conditions.

Daubréelite: is a very common meteorite mineral, having been found in 34 iron meteorites, including the lunar Hadley Rille meteorite, found by Apollo 15. Daubréelite has neither been found on Earth or synthesized.

Panguite: has a high defect density and contains Ti$^4+$ and Sc$^3+$ making it an interesting candidate for high ion conductivity [5].

In the longer term, large samples from comets and asteroids would offer the chance to find larger crystals as well as more exotic materials. Samples retrieved directly from small bodies in space will also not have been affected by atmospheric entry, warmth or weathering.

Our literature survey for meteorite minerals is surely incomplete. We welcome additions to the database and will of course credit all contributions.

References: