**CARBON MINERALOGY – A COMPREHENSIVE APPROACH FOR THE PLANETARY SCIENCES.**

Marc Fries, Planetary Science Institute, Tucson, AZ. E-mail: fries@psi.edu

Carbonaceous materials compose a mineral system independent from, and complimentary with, traditional mineralogy when it comes to studies of geologic/geochemical systems. A broad suite of carbonaceous materials occur in rocks which can be analyzed to quantitatively define limits on the pressure, temperature, chemical environment, shock processing, and oxygen fugacity histories of a given lithology. These phases range from graphite, diamond, macromolecular carbon (MMC)*, vitreous carbon, amorphous carbon and even exotic phases such as buckminsterfullerenes, and graphite whiskers. **Each of these phases forms under and retains properties of a distinctly limited range of physical and chemical conditions, describing a range of values for a given lithology to produce useful constraints on the formation and alteration history of that lithology**. At this point, technology and methodologies in existence are sufficiently mature to define a comprehensive new field of "carbon mineralogy" capable of quantitatively describing the formation/alteration of extraterrestrial materials based on their carbonaceous phases. By assembling expertise and previous work with new work intended to fill gaps, it should be possible to produce a body of work which will serve as a comprehensive reference on the structure, chemical composition, and phase identities of the carbonaceous materials expected for any given pressure, temperature, and chemical environment that a parent lithology was subjected to. Conversely, for any given extraterrestrial lithology, the pressure, temperature and chemical environment can be described in terms of the fine structure of the carbonaceous material found within. While considerable work has been done on carbonaceous materials in terrestrial settings, additonal work needs to be done for extraterrestrial carbon found in meteorites, cometary materials, IDPs, etc., the majority of which formed by condensation from hot, diffuse gases.

*Pressure*: Carbon phases such as amorphous carbon, diamond, lonsdalite and others constrain a range of temperature and pressure limits for a given lithology. For most extraterrestrial materials this may be most pertinent to shock processing.

*Thermal metamorphic history:* MMC exists across a range of sub-micron structure that describes the thermal alteration history of a given material. The presence and microstructure of diamond, crystalline graphite, aliphatic compounds and other phases also place limits on the thermal history of a given lithology.

*Chemistry:* Carbonaceous phases can be sensitive indicators of the chemical environment of their parent lithology, as seen in the direct measurement of heteroatomic composition of MMC, the presence and structure of vitreous carbon, the chemical composition of aliphatic compounds, and other features.

*Techniques:* Instrumental techniques already exist to measure carbon properties, such as Raman spectroscopy, TEM, SEM/EDS, FTIR, mass spectroscopic techniques, XRD and others. Quantifying and cross-corrolating these results into a non-instrument-specific format will allow generic description of extraterrestrial carbonaceous materials.

**MMC is defined here as a reduced, primarily carbon solid spanning a continuous range of structural ordering between amorphous carbon and graphite.*

*References for this abstract are omitted with apologies, as they are too numerous for the abstract format.*