**MULTIMETHOD STUDY OF E CHONDRITE SHOCK**

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**Introduction:** We have undertaken a multi-technique study of a selection of E chondrites, several of which have not previously been investigated in detail. Our purpose is to further elucidate the petrographic, mineral, chemical and spectral signatures of parent body shock metamorphism, to better distinguish them from thermal metamorphism and terrestrial weathering.

**Methods and Samples:** Polished thin sections and powders (<30 μm) of 11 E chondrites, and a polished chip of Abee were studied. Sections were analyzed using transmitted and reflected light optical petrography, Scanning Electron Microscope (SEM) imaging, micro X-ray Diffraction (μXRD), Electron Probe Microanalysis (EPMA) and Attenuated Total Reflectance IR microspectroscopy (ATR). Powders were investigated using UV-vis-nIR reflectance spectroscopy.

**Results and Discussion:** Established petrographic shock indicators [1] were used to assign shock stages to all thin section samples [2]. Micro XRD crystal structural data show a systematic decrease in long-range order as inferred from the spread of μXRD reflections along the Debye rings which is well-correlated to petrographic shock stage [2]. Micro XRD has also established the polytypism of enstatite and $SiO_2$ phases.

Optical and SEM microscopy has revealed multiple types of inclusions in silicates including arcuate trains of opaque metal and/or sulfide, commonly associated with partially to completely annealed fractures/grain boundaries. Such inclusions can preserve a 'fossil record' of higher shock stage through subsequent annealing, for example by intruding along and preserving planar fractures and twin boundaries in enstatite. Acicular, transparent inclusions with crystallographically-controlled boundaries and enriched in alkalis, Al and Si were observed in highly thermally metamorphosed, lightly shocked specimens, these may be formerly-glassy melt inclusions.

Silicate fundamental vibrational features (2.5-16.7 μm) show greater variability in shape and position in type 3 and 4 E chondrites, due to the combined effects of generally higher shock stages, residual glass, the presence of clino- and orthoenstatite, variable structural order in enstatite, and forsterite in type 3s. UV-vs-nIR spectra (300-2500 nm) show increasing slopes towards lower energy. A broad feature near ~900 nm was observed in 5 heavily-weathered specimens. Grain size effects and Fe-oxyhydroxide terrestrial weathering products exert a stronger effect on UV-vs-nIR spectra than shock and thermal metamorphism.

Observed crystal chemical trends include increased Si in kamacite and decreased Fe in enstatite with increasing petrologic grade. Compositional variability of individual phases decreases with increasing petrologic grade. Shock effects on mineral chemistry distinct from thermal effects (possibly due to shock heating) have not been observed.

**References**: [1] Izawa M. R. M. et al., 2009, Abstract #1322 *40th LPSC*, [2] Rubin A. E. et al., 1997, *GCA* 61: 847-858.