

**AN H CHONDRITE CLAST IN AN LL CHONDRITE:
IMPACT MELT OR INCIPIENT PARTIAL MELT?**

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Introduction: In the course of studying impact melts in ordinary chondrites (OC) from the U.S. Antarctic Meteorite Collection at the Smithsonian [1-3] we have identified a number of impact melt and other secondary clasts within OC impact breccias. This is part of an ongoing search for ancient melt clasts to gain insight into the lunar cataclysm [4-9] and small body scattering in the early Solar System (thereby causing the late heavy bombardment [10-12]). In this abstract, we examine a clast of apparent impact origin for which bulk chemical data suggests a more complicated history, perhaps even an indigenous igneous origin.

MET 01004 clast: The ~3 x 4 cm clast exhibits H chondrite mineral compositions (Fa₁₉ and Fs₁₅), despite its occurrence in an LL chondrite host. Oxygen isotopic compositions confirm an H chondrite relationship [13]. It is composed mainly of pyroxene, olivine and plagioclase, some of which is seen poikilitically enclosing olivine. Very little (<1 vol.%) metal or sulfide is present (significantly less than the ~3-6% of each typical for LL chondrites [14,15]). The overall texture of the clast is achondritic.

Results from ICPMS data [16, 17] suggest a more complicated history. Depletions of siderophile (~0.02×H_{avg}) and chalcophile (~0.1×H_{avg}) element analyses are consistent with efficient removal of metal and sulfide. Moderately volatile elements are depleted (e.g., Cs, Zn and Bi), consistent with a high-temperature igneous origin. Enrichments of ~1.3×H_{avg} for Mg, K and Na may be consistent with metal-sulfide removal. However, consistent modest depletions in Al and REEs, with an overall REE pattern that is LREE depleted and exhibiting a pronounced Eu anomaly (~0.5×H_{avg}) suggest some complexity.

One possibility is that plagioclase and/or phosphates were segregated during impact melting. The metal-sulfide-free H_{avg} abundances of Ca, Na and K might argue against such a model, although P appears to be depleted. Alternatively, plagioclase and/or phosphates might have been partially segregated during incipient partial melting of the chondritic precursor. These phases are among the first to melt. However, chondritic partial melting typically produces residues depleted in sulfides, plagioclase, and phosphates, but with significant residual metal, contrary to our observations. This could be another type of silicate clast, such as that from a IIE iron, thought to come from a parent body similar to that of the H chondrites [18]. Ongoing work will include modal analyses to examine the distribution and abundance of plagioclase and phosphates, as well as age-dating, in an attempt to distinguish between chondritic impact melts and IIE iron silicates.

References: [1] Corrigan et al. 2012 *LPSC* 43 #1577 [2] Corrigan & Lunning 2012 *MAPS* 47 #5320 [3] Corrigan & Lunning 2013 *LPSC* 44 #2615 [4] Turner et al. 1973 *LPSC* 41889 [5] Tera et al. 1974 *EPSL* 1 19 [6] Kring & Cohen 2001 *JGR* 107 doi: 10.1029/2001JE001529. [7] Cohen et al. 2005 *MAPS* 40 755 [8] Ryder et al. 2002 *JGR* 107 6-1 [9] Hartmann 2003 *MAPS* 38 579 [10] Tsiganis et al. 2005 *Nature* 435 459 [11] Morbidelli et al. 2005 *Nature* 435 462 [12] Gomes et al. 2005 *Nature* 435 466 [13] Corrigan et al. 2015 *LPSC* 46 #2678 [14] Jarosewich 1990 *Mets* 2 323 [15] Gomes & Keil 1980 *Braz. Stone Mets.* UNM, ABQ [16] Friedrich et al (2003) *GCA* 67 2467 [17] Wolf et al (2012) *Talanta* 100 276 [18] Bogard et al. (2000) *GCA* 64 2133.