POSSIBLE IMPACT MELT FEATURES IN UNEQUILIBRATED ENSTATITE CHONDRITES. D. van Niekerk[1] and K. Keil[2], [1]Hawai'i Institute of Geophysics and Planetology, University of Hawai'i at Manoa, Honolulu, HI 96822, dionysos@higp.hawaii.edu.

Introduction: The identification of pristine chondrites is an important endeavor that allows distinction between solar nebula and parent body processes. The pristinity (degree to which primary features are retained) of unequilibrated enstatite chondrites is less well documented than for other chondrite groups. The importance of doing so is evident however, when one considers that the uniqueness of their reduced mineral assemblages and terrestrial-like oxygen isotopic composition presumably paint a different picture of nebula conditions than other chondrites. We are studying ~27 unequilibrated enstatite chondrites to establish their petrological characteristics and relative pristinity. Here we report our first, preliminary findings.

Methods: Polished sections and polished thin sections of seven EL3 and fourteen EH3 chondrites have been studied by optical microscopy, SEM, and electron microprobe analysis. X-ray maps were made of each section using the JEOL 5900LV scanning electron microprobe equipped with an energy-dispersive X-ray spectrometer.

Results:

EL3 meteorites. All of the EL3 chondrites we have studied to date, contain assemblages (~50-200µm in size) of kamacite or troilite enclosing euhedral crystals of predominantly enstatite, but also rare feldspar and graphite (e.g., Figs. 1-3). Most of the objects contain kamacite as opposed to troilite. These objects are never found inside well defined chondrules but appear to be exclusive to inter chondrule regions and are often in the shape of globules. No prominent metal or sulfide veins have been observed connecting to them.

In some instances, kamacite encloses enstatite crystals with none protruding into the groundmass (we use groundmass to indicate enstatite grains and fragments of various sizes outside of chondrules). In such cases fragmented groundmass enstatite and chondrule fragments of various sizes are in contact with the kamacite objects, which make delineation of the object boundary straightforward. The globules even show evidence of plastic deformation in some such instances.

In other instances, enstatite also protrudes into the surrounding groundmass. Boundaries between these globules and the surrounding groundmass are not readily distinguished. Sometimes there appears to be uniform sized enstatite grains surrounding the globules, but brecciated material in such zones make any definitive boundary delineation difficult. Furthermore, the protruding enstatite does not appear to be nucleated onto any large, well defined chondrules, although it has been observed on chondrule-fragment rims.

It is thus difficult to determine whether the globules plus protruding enstatite represent coherent clastic components within the rocks (i.e. having a source external to the accreted rock), or whether they represent *in situ* products (i.e. derived after accretion, from local precursors).

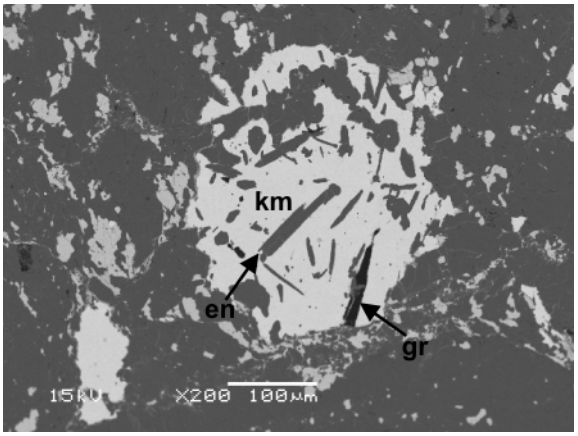

Figure 1. Back scattered electron image of metal/sulfide-euhedral graphite/silicate assemblage in EL3 PCA 91020 (en=enstatite; km=kamacite; gr=graphite).

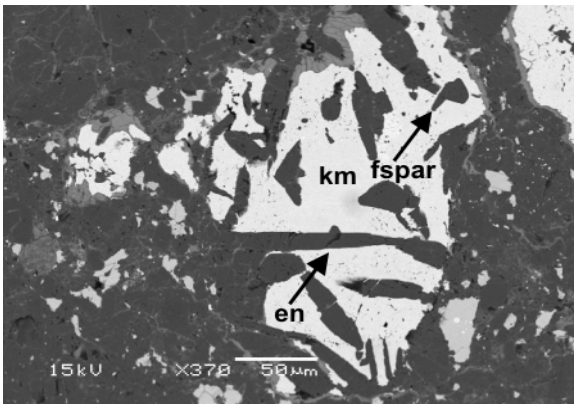

Figure 2. Back scattered electron image of metal/sulfide-euhedral graphite/silicate assemblage in EL3 MAC 88136 (en=enstatite; km=kamacite fspar=albite composition).

EH3 meteorites. The EH3 chondrites we have studied so far, do not contain similar features. An exception might be paired meteorites PCA 91238, PCA

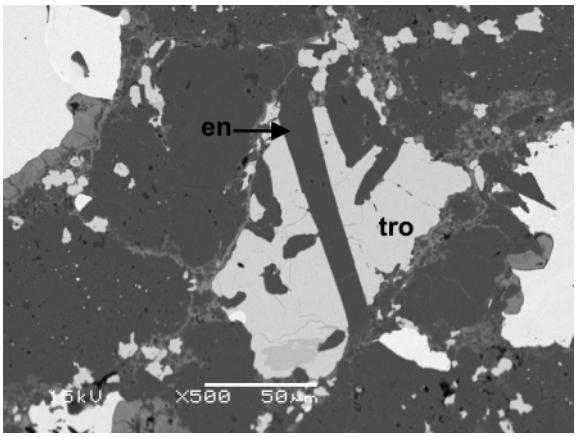

Figure 3. Back scattered electron image of euhedral enstatite (en) cutting through troilite (tro) in EL3 QUE 94594.

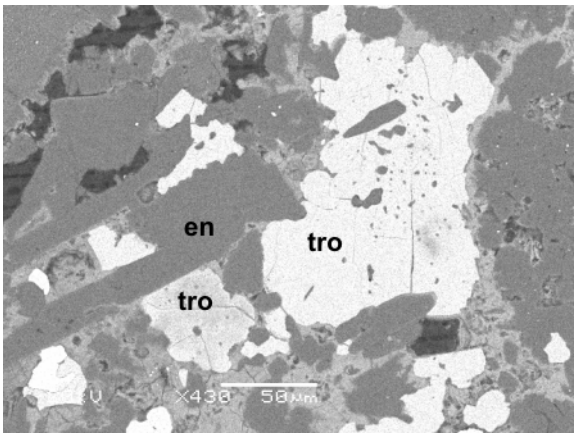

Figure 4. Back scattered electron image of metal-free enstatite (en) rimming kamacite-bearing (km) enstatite in EH3 PCA 91238.

82518, and PCA 91383. Severe weathering and unusual textures make recognition of the objects difficult, and it is unclear whether they are in fact similar. (Figs. 4 and 5).

Discussion: Our preliminary work suggests that these objects are similar (although not exactly the same) to features of higher petrologic type enstatite chondrite impact melt breccias described by [1]. These authors interpreted such features to have formed by crystallization from impact melts. Likewise we interpret the assemblages we have observed to indicate that enstatite, kamacite, and possibly graphite were molten and formed immiscible melts. The origin of such immiscible melts are unlikely to be the result of flash heating in the nebula, and are probably attributable to either *in situ* shock melting or incorporation of impact melt ejecta. The rounded nature of many objects, the

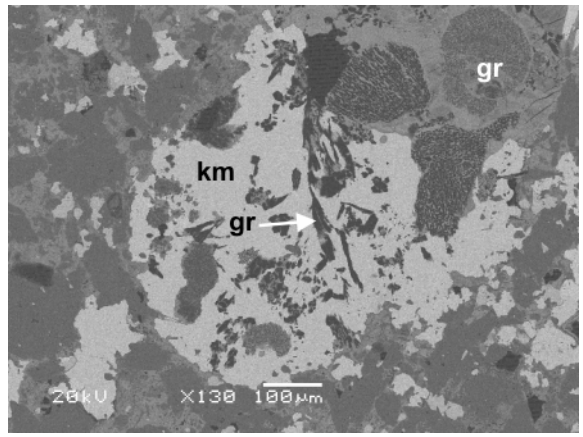

Figure 5. Kamacite (km) globule in EH3 PCA 91238 containing laths and globules of graphite (gr). Globules in the upper right consist of microcarbon spherules that appear to have the metal weathered from between them. The light grey material surrounding these globules are iron oxide weathering products.

absence of nucleation to large, well defined chondrules, and the general absence of melt veins in these meteorites argue against *in situ* shock melting. Furthermore, these meteorites have shock classifications that range from shock stage 2 to 3, except one which is stage 5 [2], and thus one would not expect the same high intensity shock melt features in all of them.

Chondrites from other groups do not contain such features to our knowledge. If they are in fact impact melt related products, their presence in unequilibrated chondrites would be surprising, since unequilibrated chondrites are usually considered to contain only pristine or altered nebular products. This may imply coaccretion of nebular chondritic components concurrently with hypervelocity impact ejecta, or alternatively, that ejecta was combined with more primitive material during regolith processes (and thus all these meteorites are fragmental or regolith breccias as suggested for MAC 88136 by [3]).

In future we intend to extend our observations to other features in these rocks, that might aid in resolving their origin. Regardless whether they formed *in situ* or externally, these features indicate that some unequilibrated enstatite chondrites were formed at a dynamically energetic region or time of the solar nebula that is unique relative to that recorded by other unequilibrated chondrite groups.

References:

[1] Rubin A. and Scott E. R. D. (1997) *GCA, 61,* 425–435. [2] Rubin A. et al. (1997) *GCA, 61,* 847–858. [3] Lin Y. T. et al. (1991) *LSPC XXII, 811-812*.