OBJECTIVE TAXONOMY OF SOLID ORGANIC MATERIAL IN CHONDRITES

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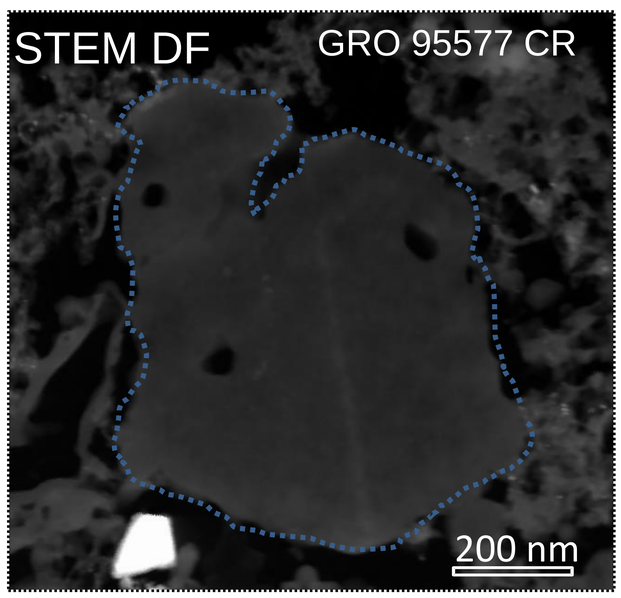
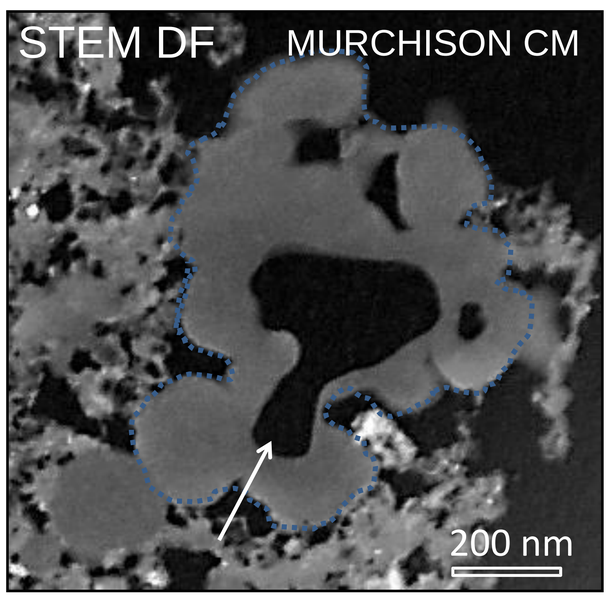
Introduction

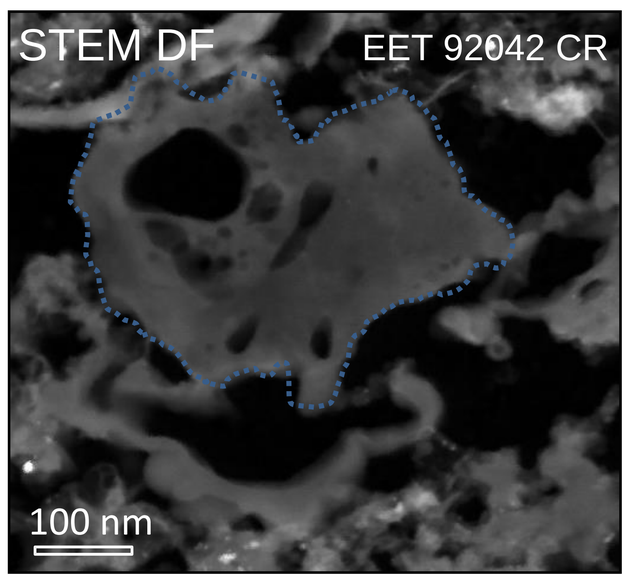
Organic Material (OM) occurs in chondrites in minor to trace concentrations. The acid insoluble fraction of OM (IOM) makes up the major fraction of OM [1]. Organic micron-submicron features are found in chondrites intermixed with other chondritic components. They are morphologically and functional chemically indicative of IOM. The largest features of IOM are typically spherical compounded or hollow particles termed as 'nanoglobules' [2]. This has stimulated investigation into their properties and origins [e.g. 3]. Here, the challenges faced in identifying nanoglobules are addressed. A classification system is also proposed for comparing organic features *in situ*.

▲An organic globule described in [2]. This is only one type of morphology that co-exists with various other organic features.

Ambiguity in counting organic phases in IOM Residues

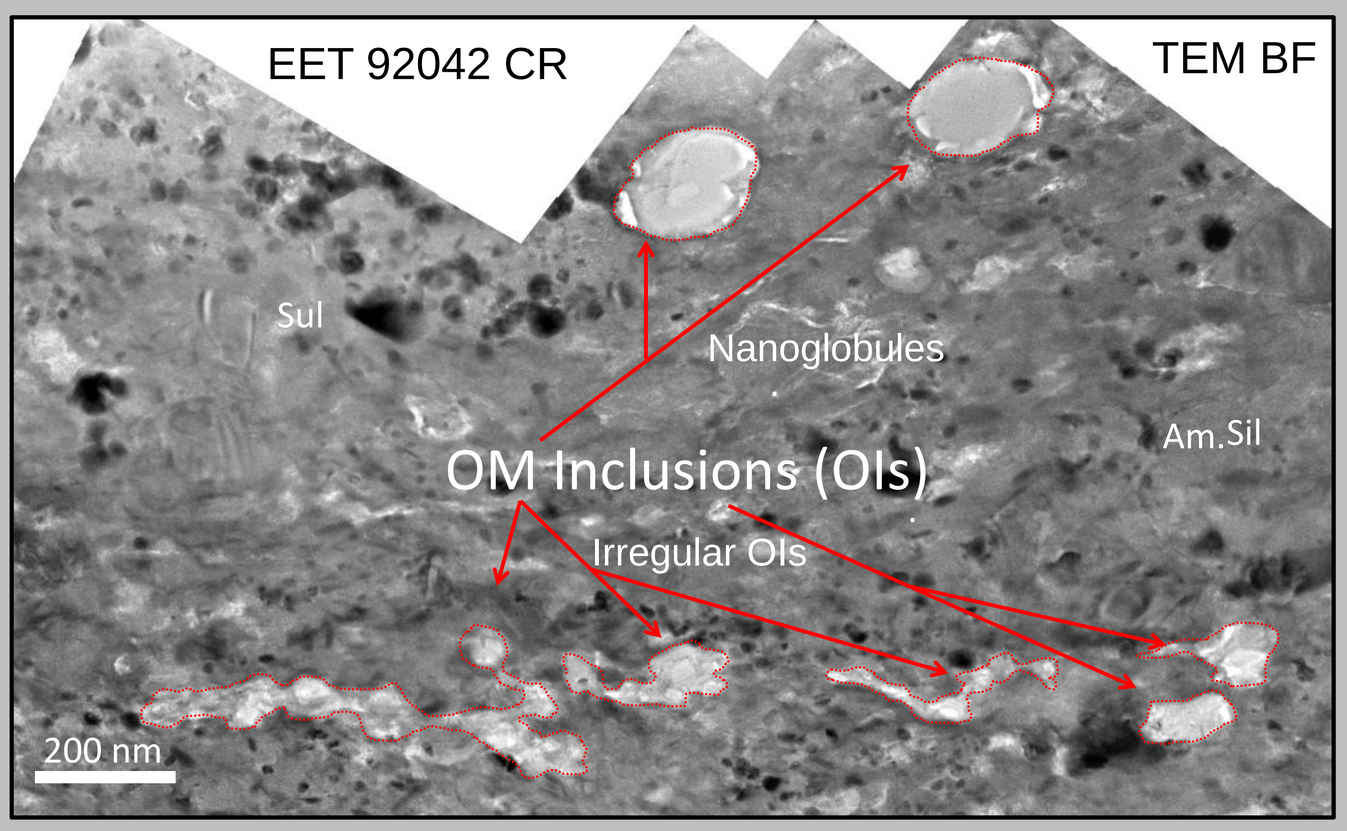






The current definition of a nanoglobule can be ambiguous in relation to IOM. For instance, how many nanoglobules are there in these IOM features from [4]? The examples above are discrete objects in IOM residues. They contain internal morphologies such as a hollow feature characteristic of a single hollow nanoglobule [2] (arrowed). Is it therefore one object or an aggregate of many? Note the smaller features in the rest of the IOM around the outlined objects that have similar nanoglobular shape across the entire image as well, complicating the identification of nanoglobules from the rest of the IOM.

Objective Taxonomy of OM Phases *in situ*



BF TEM montage from [5]

In order to disambiguate the identification of solid organic features, and to understand the significance of discrete spherical objects when compared with other organic features, a classification system for organic material is proposed when characterising OM *in situ*.

Organic features exist as discrete organic objects surrounded by other chondrite components that are inorganic. A first order definition of OM features can then be:

An organic object surrounded by inorganic material

→ **OM Inclusion (OI)**

A second order definition for a morphological type of OM inclusion can then be defined as:

A discrete single spherical or rounded OI

→ **Nanoglobule**

And,

A non-rounded OI

→ **Irregular OI**

Comparing Functional Chemical and Isotopic Properties of OM Inclusions (OIs) by Morphological Type

Measurements can now be made to compare the properties of certain morphologies of an OM Inclusion (OI). Some irregular OI textures suggest a process that resulted in the filling of OM in chondrite matrices (e.g. the irregular OIs above). However, it is still not clear whether they were the result of an assembly of smaller units such as discrete nanoglobules that were carried by e.g. a fluid or whether they perhaps derived from the precipitation/solidification of an e.g. precursor organic fluid. If discrete nanoglobules display unique chemical or isotopic signatures to these irregular OIs, they may suggest unique origins. Observations are required to determine this. Thus far, it has been shown that discrete nanoglobules display indistinguishable functional chemistry by C-XANES to irregular OIs within micron regions of the CR chondrite matrices [5]. Do the irregular OIs compared with the nanoglobules e.g. above display noticeably different stable isotopic compositions?

References: [1] Alexander C. M. O'D. et al. (2007) *Geochim. Cosmochim. Acta,* 71, 4380-4403. [2] Nakamura-Messenger K., et al. (2006) *Science* 314, 1439–1442. [3]De Gregorio B. T. et al. (2013) *Meteorit. Planet. Sci.* 48(Nr 5), 904–928. [4] Changela H. G. (2015) *Geochim. Cosmochim. Acta*, 159, 285-297. [5] Changela H. G. et al. 45th LPSC (Abstract #2393).