In Situ Observation of Carbonaceous Globules in the Tagish Lake Chondrite

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Introduction:

Tagish Lake is a unique carbon-rich carbonaceous chondrite with 1.3 wt% of total car-bon in organic components including interstellar SiC and graphite [1]. Over the last decade, workers have succeeded in characterizing extracts of refractory organics and interstellar materials from meteorites [2], however work on acid soluble organics has not pro-ceeded at the same pace; especially lacking are studies of organic phases in situ to elucidate their original morphologies and mineralogical context. Here we report in situ observation of carbonaceous grains in Tagish Lake with a novel hollow spherical morphology. These globules may have formed during aqueous al-teration on the asteroid from hydrophobic hydrocar-bons.

Sample preparation:

Multiple fragments were picked from matrices of Tagish Lake sample, embedded in sulfur and ultramicro-tomed for TEM investigation, complemented by EDX and EELS.

Results:

Numerous hollow, bubble-like globules have been observed from the phyllosilicate matrix, with a distribution of one for every of 100 mm2 (Fig.1). The globules have apparent diameters of 140-1700 nm; and wall thicknesses of 30-200 nm. Cylindrical or ta-pered forms have not been observed. These globules often display a layered structure. Some globules contain saponite flakes between layers(Fig.1). The EDX spectra of the globules show that they consist pre-dominantly of C, associated with minor amounts of O, Si, S, Fe and Cl. The presence of these latter elements is probably due to analytical contamination from the surrounding matrix and included saponite flakes. Hy-drogen is undoubtedly also present, but not detectable by this analytical technique. The EELS spectrum shows that the globules consist of amorphous carbon, indicating that this material has never been signifi-cantly heated, otherwise the carbon would have crys-tallized to poorly graphitized carbon.

Discussion and conclusion:

Direct observation of such amorphous carbon globules has not been previously reported from meteorites, although organics extracted from the Murchison form similar structures when dis-persed in alkaline-buffered to neutral water [3]. The carbon globules in Tagish Lake are also similar to the vesicle-forming compounds produced by the simula-tion of some interstellar ice mixture photolytic prod-ucts [4]. Authors in [4] suggested these authors sug-gested, could have formed naturally if such interstellar ice mixture photolyzation products fell into weakly alkaline aqueous environments on the early Earth, to serve as one of the organic precursors to life. The car-bon globules in Tagish Lake may have formed in a similar manner, but did so on a primitive asteroid rather than on Earth. The survival of the structures, as well as the large amount of associated interstellar ma-terial, indicates that the parent asteroid for Tagish Lake was unusually cold for its entire history.

Figure: The amorphous carbon globule at lower right has a concentric form, and tiny bubbles (5nm) between each spherical layer. There is an empty core in the carbon globule at upper left, and saponite flakes are situated between the layers of this sphere, as well as bubbles. The matrix consists of fine grained crystals of saponite with an entangled ribbon-like structure. The grains in dark contrast are sulfides.

References:

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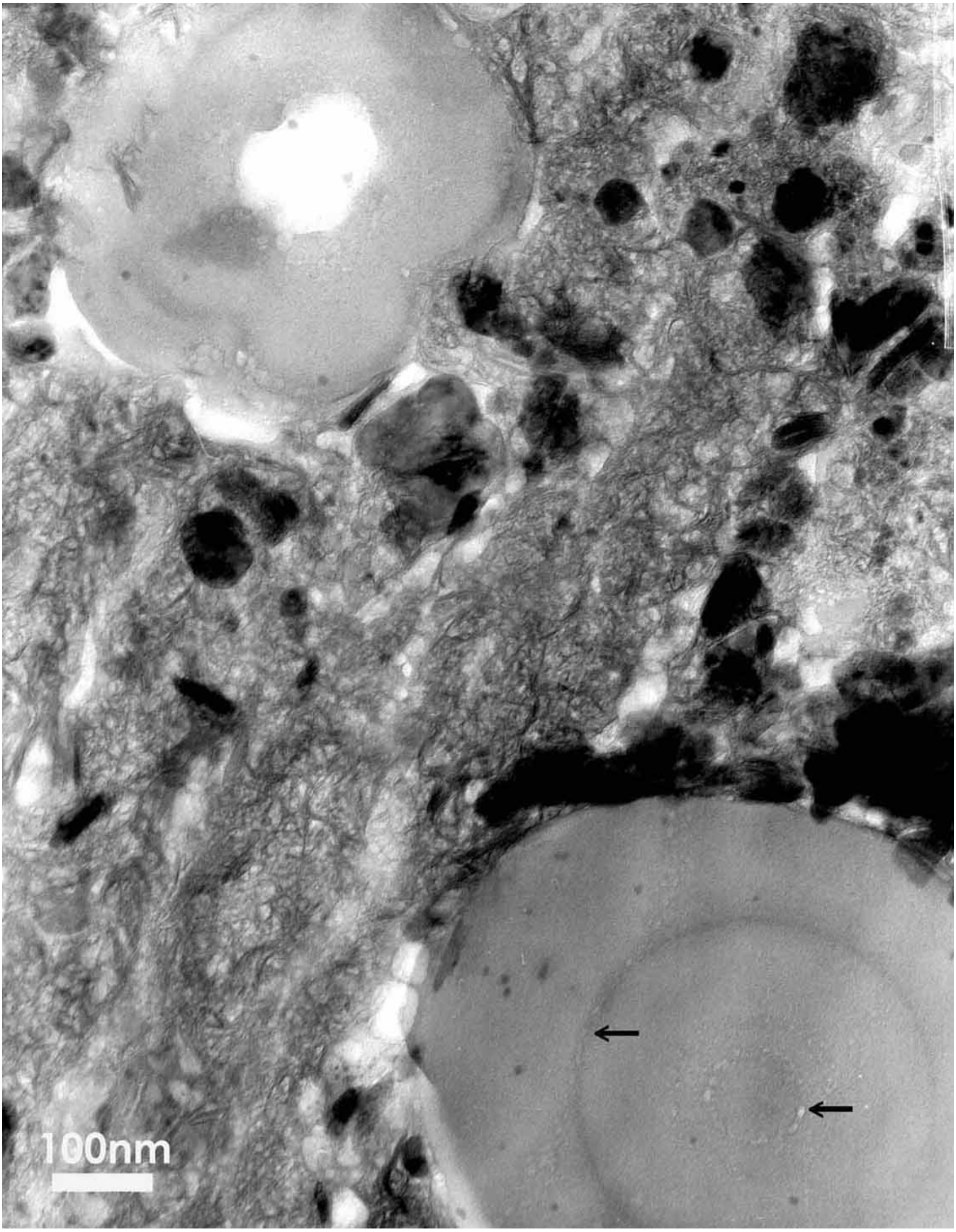
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