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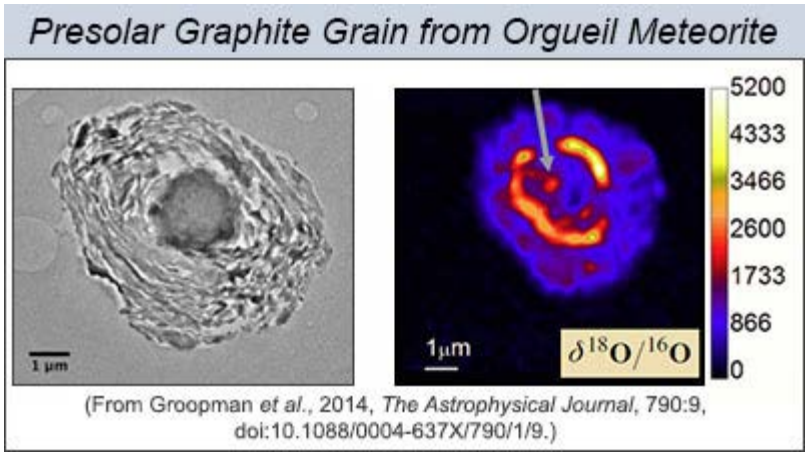
Presolar Graphite Grain Isolated from a Carbonaceous Chondrite

Investigations using a variety of microanalytical techniques allow researchers to delve into the microstructural and isotopic details of presolar graphites from the Orgueil ***primitive CI*** chondrite [***Data link*** from the Meteoritical Bulletin]. The NanoSIMS (Nano-scale secondary ion mass spectrometer), TEM (transmission electron microscope), STXM (scanning transmission X-ray microscope), and XANES (X-ray absorption near-edge structure) spectra combine to give researchers the data they need to understand the formation of the presolar grains and their chemical evolution through accretion into meteorite parent bodies in the early Solar System.



[LEFT] TEM micrograph of a section of the graphite grain, G6, containing a nanocrystalline core studied by Groopman and coauthors. [RIGHT] Oxygen isotope ratio image showing an example of ring-like structure of oxygen anomalies in another section of graphite grain, G6. Arrow indicates a hotspot of excess ^{18}O corresonding to a TiC subgrain.

In their study of presolar graphites from Orgueil, Evan Groopman, Thomas Bernatowicz, Ernst Zinner (Washington University in St. Louis) and Larry Nittler (Carnegie Institution of Washington) found an anomalous shell-like structure in a ~6.5 µm-diameter grain (named G6), including the first reported nanocrystalline core in a low-density ***supernova*** graphite grain (see figure). The core is surrounded by a mantle of turbostratic graphite (misaligned graphene sheets).

The supernova origin for graphite grain, G6, is indicated by Groopman and colleagues' measurements of large excesses relative to Solar System isotopic compositions in ^{12}C, ^{15}N, and ^{18}O. A TiC subgrain has correlated excesses in ^{18}O (see figure) and ^{15}N. Furthermore, the high inferred initial $^{26}Al/^{27}Al$ and excesses in $^{42,43,44}Ca$ and $^{49,50}Ti$ make the supernova origin of this grain unambiguous. The authors suggest data for this graphite grain indicate mixing and/or granular transport in the supernova ejecta.

See Reference:
· Evan Groopman, E., Nittler, L. R., Bernatowicz, T., and Zinner, E. (2014) NANOSIMS, TEM, and XANES Studies of a Unique Presolar Supernova Graphite Grain, *The Astrophysical Journal,* v. 790(1), doi:10.1088/0004-637X/790/1/9. [***abstract***].

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