

Nano-phases in carbonaceous chondrites

(Proposers: Dr. Anna Barbaro, Prof. Matteo Ardit)

Carbonaceous Chondrites (CCs) are primitive meteorites representing some of the earliest materials in the solar system. Studying them has provided fundamental insights into the evolution of the early solar system, including the chemistry of the protoplanetary disk, the origins of presolar grains, and the delivery of water and organic matter essential to Earth's habitability. These materials investigation is crucial subjects for future scientific research because technological advances allow us to investigate this enigmatic meteorite class under higher-resolution techniques. Indeed, the new generation of electron diffraction instruments enables us to investigate and identify crystals at the nanoscale.

This proposal aims to investigate Calcium Aluminum Inclusions (CAIs), presolar grains, and nanodiamonds. These components are found in certain types of carbonaceous chondrites, including CI, CM, CR and CV types. The main purpose is to unveil mineralogical components at the nanoscale that can constrain the conditions that shaped the first objects during formation of the Solar System and beyond. These objects typically range in size from 1 to 100 nm and can provide valuable insights into presolar nucleosynthesis processes, such as the chemical vapor deposition of diamonds. They can also shed light on processes in the protoplanetary disk and the effects of hydrothermal alteration on parent bodies.

Nano-phases are understudied in carbonaceous meteorites due to their submicron scale, which challenges conventional electron microscopy techniques. Throughout the project, the candidate will work with various carbonaceous chondrites, including CV chondrites like Allende, where some nano-inclusions in CAIs (calcium-aluminum-rich inclusions) could have been recording higher-temperature nebular condensation or CM meteorites (*e.g.*, Murchison), which could reveal some nano-inclusions in aqueous alteration minerals that are responsible for trapping organics.

The meteorite material needed for the research is now part of the Department of Geosciences' meteorite collection and is on exhibition at the Museum of Nature and Humankind. The methodology for this project will include the following: (i) a new XtaLAB SYNERGY-ED (Rigaku) diffractometer for electron diffraction from the Department of Geosciences at the University of Padova in collaboration with Prof. Fabrizio Nestola, and (ii) a Talos 200X (Thermo Fisher Scientific) transmission electron microscope for high-resolution imaging from the Schwiete Cosmochemistry Laboratory at Goethe University Frankfurt in collaboration with Prof. Frank E. Brenker). The Ph.D. student's mandatory period abroad will be scheduled during the second year in the Geoscience Department at Goethe University Frankfurt, Germany.

Collaborations: Museum of Nature and Humankind, University of Padova, Schwiete Cosmochemistry Laboratory, Goethe University, Frankfurt.

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