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EXPERIMENTAL MICROMETEORITES: PETROLOGY, THERMAL HISTORIES AND ORGANIC COMPOUNDS PRESERVATION

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The aim of this study was to recreate experimentally ultracarbonaceous micrometeorites(UCMMs), in order to understand the behavior of organic compounds in the particles, to predict if this material can be liberated during atmospheric entry to Earth. The experiment was carried out using the Citlalmitl equipment at ICN-UNAM.

Micrometeorites (MMs) are extraterrestrial dust particles that passed through Earth's atmosphere and landed on the surface. MMs come from asteroids or comets, and have sizes between 10 μm to 2 mm (Rubin and Grossman 2010). They are classified by their textures (Genge et al. 2008), but we focus on the ultracarbonaceous micrometeorites (UCMMs) because they could liberate organic compounds during their atmospheric travel and preserve some of them.

In this work, we reproduce UCMMs-like particles experimentally. As precursor material, we use natural minerals from peridotite mantle xenoliths (Hernández-Reséndiz et al. 2020), such as forsterite, enstatite, and the amino acid DL-alanine, as organic matter. We irradiate different proportions of a mixture of minerals and DL-alanine, using Citlalmitl machine (Hernández-Reséndiz et al. 2020), an IR laser with 50 W of power. We use different times and laser intensities to simulate the trajectory of micrometeors through the atmosphere (Table 1); for more details, see Hernández-Reséndiz et al. 2020. We can record their thermal histories and the phase change in real-time using a pyrometer.

To evaluate if the amino acid is preserved, we analyzed the samples resulting with ATR-FTIR spectrometry and use a differentiated scan calorimeter to evaluate the amino acid behavior. We characterized the sample texture using a stereographic microscope.

We obtain that 85% of particles are like non-melted MMs, and 15% are partially melted-like MMs; the IR spectra do not show DL-alanine inside the particle, but it is preserved between the silicate grains remanent. For this reason, we irradiated DL-alanine alone and observed that it sublimates with different textures depending on the irradiated time; the textures are like the alanine found between the silicate grains.

TABLE 1

PARAMETERS USED IN THE EXPERIMENTS

	Experiment 1	Experiment 2	Experiment 4
Time (s)	120	240	8
Main temperature (° C)	1482	1245	1281
Meteor angle-like (°)	70 - 80	80 - 83	25 - 45
Meteor entry velocity (km/s)	20 - 21	11 - 12	11 - 12

We conclude that UCMMs are particles with few or without thermal processes, but most importantly, we demonstrate experimentally that the amino acids could survive the energetic travel to the atmosphere by the capacity to sublimate (Mehta et al. 2018). Then, the meteor phenomena could be the response to liberate amino acids to the atmosphere, such as in a pyrolytic experiment.

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