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NITRILE AMPLIFICATION IN ORGANIC-RICH CLASTS FROM THE TERRESTRIAL PLANET REGION.

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Nitrile compounds are crucial for the origins of life as they serve as precursors to amino acids and nucleobases, but their formation on potentially habitable planets remains poorly understood. Since an oxidizing early Earth atmosphere would have inhibited their production [1, 2], identifying new generic pathways for nitrile production is critical to understand the conditions that led to the emergence of life on our planet. In this study, we investigate the thermal history and organic chemistry of dark clasts, potential proxies of Earth's fossil micrometeorite flux, from the NWA 5697 L3.05 ordinary chondrite. Using Raman spectroscopy, atomic force microscopy- nano infrared spectroscopy, and laser ablation inductively coupled plasma mass spectrometry, our results reveal a continuum of thermal alteration with two distinct endmember groups. The first group consists of minimally altered clasts with a fine-grained matrix and no significant depletion of moderately volatile elements. Their organic matter is less thermally processed and show a higher concentration of carboxylic acids and a lower nitrile content. In contrast, the second group comprises thermally altered clasts with a coarse-grained matrix presenting a partially graphitized/matured organic-rich phase [3], and a notable loss of moderately volatile elements. This group exhibits a higher abundance of nitrile functional groups and a lower concentration of carboxylic acids. This enrichment of nitrile compounds correlated with the volatile element depletion patterns highlights the formation of nitrile compounds by thermal alteration of organic matter, most likely facilitated by thermal annealing in the protoplanetary disk. Because graphitization/organic maturation is likely a generic process operating in the inner regions of protoplanetary disks, our results imply that nitrile-rich materials are ubiquitous in the formation regions of rocky planets. Thus, this mechanism may be highly relevant for kick-starting the prebiotic chemistry necessary for life on the early Earth and, by extension, on potentially habitable worlds beyond our solar system.

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