Meteoritic Input of Amino Acids and Nucleobases: Methodology and Implications for the Origins of Life

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Abstract:

The discoveries of amino acids of extraterrestrial origin in many meteorites over the last 40 years have revolutionized the Astrobiology field. A variety of non-terrestrial amino acids similar to those found in life on Earth have been detected in meteorites. A few amino acids have even been found with chiral excesses, suggesting that meteorites could have contributed to the origin of homochirality in life on Earth. In addition to amino acids, which have been productively studied for years, sugar-like molecules, activated phosphates, and nucleobases have also been determined to be indigenous to numerous meteorites. Because these molecules are essential for life as we know it, and meteorites have been delivering them to the Earth since accretion, it is plausible that the origin(s) of life on Earth were aided by extraterrestrially-synthesized molecules. Understanding the origins of life on Earth guides our search for life elsewhere, helping to answer the question of whether biology is unique to Earth. This *tutorial review* focuses on meteoritic amino acids and nucleobases, exploring modern analytical methods and possible formation mechanisms. We will also discuss the unique window that meteorites provide into the chemistry that preceded life on Earth, a chemical record we do not have access to on Earth due to geologic recycling of rocks and the pervasiveness of biology across the planet. Finally, we will address the future of meteorite research, including asteroid sample return missions.