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IMPACT SHOCK SYNTHESIS OF CYSTEINE: EXPLORING THE CREATION OF LIFE'S PRECURSORS BEYOND EARTH

Abstract

Cysteine is the only sulfur-bearing amino acid and is considered essential for life due to its ability to act as a cross-linker between adjacent polypeptide chains. This capability directly results in protein tertiary structure (3D shape) formation, giving way to protein function. It is now known that sulfur is present on the surface of several Galilean moons and small icy bodies, including Europa, and that these objects have been bombarded over the eons by high-velocity impacts that leave scars on their icy surfaces. Previous work at the University of Kent has shown that glycine – the simplest amino acid – can be created from shocking simple ice mixtures. Here, we report on the results of a new set of experiments designed to see if sulfur-rich ice mixtures, similar to the surface composition of icy satellites, synthesize cysteine when impacted using the University of Kent's two-stage light gas gun.

Initial results have shown that at speeds $\leq$ 6 km s^{-1} cysteine is not detectably synthesized when an ice target mixture of ammonium sulfate + water ice + CO_2 ice is impacted using a 3 mm diameter Al projectile. The results of an ongoing series of experiments where a variety of sulfur-rich ice mixtures are impacted using inert projectiles, at speeds up to approximately 7.5 km s^{-1} (the maximum speed of the University of Kent's light gas gun), will be presented. Additionally, the self-luminous plume produced during hypervelocity impacts was studied, to determine the temperatures required for successful synthesis to occur. These temperatures were derived using a Boltzmann distribution calculation and STAR-MELT, a Python package developed by the University of Dundee.

The potential creation of cysteine is very exciting, as we know the chemical ingredients and impact energy are available on icy moons. This would provide a mechanism for the production of an amino acid which mediates self-replication and is critical to the effective biological function of numerous organisms.