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Meteorite impacts on the early Earth and origin of life

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How and when abundant organic molecules appeared on the early Earth are fundamental inquiries into the origin of life. Intense impacts of extraterrestrial objects melted the embryonic Earth, forming an inorganic body with a CO2, CO and N2-rich atmosphere. Such slightly oxidized ancient atmosphere is not favored for pre-biotic organic synthesis on the Earth, and therefore, creates large number of supporters for Panspermia hypothesis.

However, Panspermia hypothesis does not explain variety and abundance of amino acids required for life. It is hypothesized that the uniqueness of the Earth, such as presence of abundant liquid water and slightly oxidized conditions, and dynamics of the early solar system were responsible for origin of life (Nakazawa, 2006). The late heavy bombardment is a representative dynamics of the early solar system and strongly modified the early environments of Earth.

Here we report a facile impact synthesis of some organic molecules from the mixture of solid carbon, iron, nickel, water, and nitrogen all of which would have been available during impact events on Earth's early oceans. Geological and geochemical studies indicate that ordinary chondrite, the most abundant meteorite, contains a substantial amount of iron-nickel and small quantities of solid carbon.

Biomolecules and their precursors identified in the present shock recovery experiments are carboxylic acids (fatty acids), amines, and an amino acid (Furukawa et al., 2009). The key reaction to produce those organic molecules was a water-splitting reaction by water-mineral interaction, followed by various redox reactions. Such process was not most likely realized in the early solar system except the Earth. The late heavy bombardment may have been related to re-arrangement of the early solar system. Such dynamic solar movement was also important for origin of life.

References

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