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# Synthesis/destruction of building blocks of life during impact-induced hydrothermal activities on the primitive Earth?

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The primitive Earth had witnessed high frequency of impact events, leading to pervasive post-impact hydrothermal activities. The hydrothermal alteration of extraterrestrial materials and primitive crust would generate some highly reducing environments and abundant catalytic minerals, which favor abiotic synthesis and accumulation of organics. However, high temperature is generally believed to be a threat for the stability of organics. Thus, impact event might be a double-edged sword for the origin of life, but the net effect is poorly investigated.

Here, we built a thermodynamic model to examine the synthesis affinity of various building blocks of life under the simulative impact conditions. The synthesis reactions were written using inorganic gases, i.e., $CO_2$ (or CO), $H_2$, and $N_2$ as bases. We have considered a large range of temperature and pH conditions to represent the natural variation of hydrothermal conditions. Our calculations show that methane has strongly positive synthesis affinity over a large range of environmental conditions, implying that impact events might generate a large amount of $CH_4$ on the primitive Earth. However, HCN and formaldehyde have nonexclusively negative synthesis affinity values, implying that impact-induced hydrothermal activities could largely undermine their accumulation in the primitive waters. Other simple organics, e.g., formate, methanol, acetate, and propionate have negative synthesis affinities at high temperatures but positive affinities at relatively low temperatures and/or high pHs. Most of amino acids have negative synthesis affinities at high temperatures but positive synthesis affinities at relatively low temperatures (110 °C or below), except for serine, histidine, asparagine, threonine, and arginine, which have negative synthesis affinities at wide ranges of temperature and pH. Sugars, ribose, and nucleobases have negative synthesis affinities at the investigated ranges of temperatures and pressures. In summary, our results suggest that impact-induced hydrothermal activities might be a net sink for most of the building blocks of life on the primitive Earth. However, at relatively low temperatures and high pHs, abiotic synthesis of some organics could be favorable. Thus, high frequency of impact events would generally threaten the origin or survival of primitive life, but at the dawn of such events, new opportunities might be created.