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The plausibility of origins scenarios requiring two impactors

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Hydrogen cyanide delivered by cometary impactors can be concentrated as ferrocyanide salts, which may support the initial stages of prebiotic chemistry on the early-Earth. One way to achieve the conditions required for a variety of prebiotic scenarios, requiring for example the formation of cyanamide and cyanoacetylene, is through the arrival of a secondary impactor. In this work, we consider the bombardment of the early-Earth, and quantitatively evaluate the likelihood of origins scenarios that invoke double impacts. Such scenarios are found to be extremely unlikely settings for the initial stages of prebiotic chemistry, unless (i) ferrocyanide salts are stable on 1000 yr timescales in crater environments, (ii) there was a particularly high impact rate on the Hadean Earth, and (iii) environmental conditions on the Hadean Earth were conducive to successful cometary delivery (i.e., limited oceanic coverage, and low ($\lesssim 1$ bar) atmospheric surface pressure). Whilst environmental conditions on the early-Earth remain subject to debate, this work highlights the need to measure the typical lifetime of ferrocyanide salts in geochemically realistic environments, which will determine the plausibility of double impact scenarios.

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