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THE RELATIVE IMPORTANCE OF PREBIOTIC SYNTHESIS ON THE EARTH AND INPUT FROM COMETS AND METEORITES

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We have been studying the prebiotic synthesis of hydrogen cyanide and formaldehyde by the action of electric discharges on various model primitive atmospheres containing CH_4 , CO and CO_2 . Photochemical production rates would also have been important and have been calculated for HCN and H_2CO . A reasonable rate of synthesis of amino acids from these sources is about $10 \text{ n moles cm}^{-2}\text{yr}^{-1}$ or $0.10 \text{ moles cm}^{-2}$ in 10^7 yrs. This would give a concentration of $3 \times 10^{-4} \text{ M}$ in an ocean of the present size ($300 \text{ liters cm}^{-2}$). The amino acids cannot accumulate over a longer period because the entire ocean passes through the 350°C submarine vents in 10^7 yrs, which decomposes all the organic compounds.

A number of workers have calculated the influx of comets and meteorites on the primitive earth, both as a destructive process for organic compounds and for any life that was present, as well as a source of organic compounds. Some of the amino acids from the meteorite proposed to have hit the earth 65×10^6 yrs ago have been detected at the Cretaceous/Tertiary boundary sediments.

The problem with proposing a large scale input of organic compounds from meteorites and comets is that they must survive passage through the atmosphere and impact. There are some processes that would allow survival such as showers of centimeter to meter sized meteorites and various aerodynamic braking processes for larger objects. Even if a significant amount of the organic material survived impact, the destructive processes in the hydrothermal vents would remove these compounds on the average in 10^7 yrs or less. If it is assumed that the input rate was sufficient to overcome these destructive processes, then too much carbon and water, especially from comets, would have been added to the surface of the earth. We conclude that while some organic material was added to the earth from comets and meteorites, the amount available from these sources at a given time was only a few percent of that from earth based syntheses.