THE CATALYTIC ROLE OF CHONDRITIC METEORITES IN PRESENCE OF WATER AND FORMAMIDE

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Introduction: The meteorites known as carbonaceous chondrites (CCs) are among the most pristine materials arriving to the Earth's surface, and their chemical content reveal that they formed part of small asteroids that kept the primordial components of the protoplanetary disk. In the early solar system these bodies were subjected to planetary perturbations and fragmentations during close approaches being easily disrupted [1-2]. We estimated that the early Earth was subjected to a meteoritic flux that was about 5-6 orders of magnitude the current one [3]. It traduces in huge amounts of chondritic materials reaching the Earth's surface at an annual rate of thousands of billions of metric tons [3]. Consequently the amount of volatiles delivered under such high-flux circumstances were very significant, probably fertilizing the Earth's surface [4-5]. Our study demonstates that the reactive minerals contained in CCs in a warm environment and the presence of water and formamide could have promoted the first steps towards the origin of life [6].

Technical procedure: We analyzed the catalytic effect of six CCs in presence of water and formamide [6]. 50 mg of the stone were ground in an agate mortar. The extrac-tion of the meteorite powder to remove endogenous organics was carried out in two steps. Mass spectrometry was performed by the following program: injection temperature 280°C, detector temperature 280°C, gradient 100°C×2min, 10°C/min for 60 min. To identify the structure of the products, two strategies were followed. First, the spectra were compared with commercially available electron mass spectrum libraries such as NIST. Secondly, GC-MS analysis was repeated with standard compounds. The results indicate that the CCs catalyze the synthesis of natural nucleobases, carboxylic acids, and amino acids from mixtures of NH_2CHO and water at 140 °C. Two general scenarios were analyzed: thermal water (TW) and seawater (SW), both tested in the presence of the CCs [6].

Results and discusion: Our experiments [6] confirm that carbonaceous chondrites minerals in presence of warm water and formamide catalyze the synthesis of natural nu-cleobases, carboxylic acids, and amino acids from mixtures of NH_2CHO and water at 140 °C. This experimental evidence supports a parent body origin for the complex organic compounds found in CCs, probably coming from hydrated asteroids as previously suggested [7-9]. Secondary minerals found in CCs were produced by the primordial aqueous alteration originated in a first stage of water release due to radiogenic heating [7-8], and show evidence of static aqueous alteration with limited water availability producing complex organic chemistry [8-11]. Still in such restrictive conditions the reactive minerals could act as catalyzers and promote increasing organic complexity in chemical evolution, tens of millions of years before to be completed the formation of Earth [6]. We envision an exciting prebiotic scenario consisting of CCs debris reaching the Earth's surface and acting as catalysts in a volcanic-like environment.

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