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Role of meteorites and terrestrial rocks in prebiotic chemistry

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Abstract

A new approach, aimed at revealing the ability of meteorites and some terrestrial rocks to perform reactions operative in present-day life activity is here presented. To this aim we have carried out experiments on several fragments of meteorites (iperstenic chondrites and siderites) and on terrestrial minerals and rocks (magnetite, peridotite) searching for conditions allowing them to express catalytic activity.

1. Introduction

We begin considering that life on Earth is a complex system founded on the chemistry of carbon-based biomolecules in water. Simple organic compounds have formed organized molecular systems which could have originated primordial life forms on Earth. Moreover there is a growing evidence that "life" began in the interstellar clouds before the Solar System was formed. On such assumption a number of scientists now believe that micro-organisms may be transferred to and from celestial bodies, including the Earth. [1, 2, 3, 4]. The temperature limits compatible with the existence of life are imposed by the intrinsic properties of chemical bonds involved in this type of chemistry. Two requirements are mandatory. Firstly, the covalent bonds between carbon and other atoms involved in the structure of biological molecules should be sufficiently stable to permit the assembly of large macromolecules with catalytic or informational properties or both. Secondly, non-covalent links (hydrogen and ionic bonds, Van der Waals interactions) should be labile. This is an important point since only weak bonds can allow fast, specific and reversible interactions of biological molecules and macromolecules. These chemical constraints also define the upper and lower temperatures for life ranging from -12ºC to 113ºC.

2. Results

We reporte evidences indicating that, in suitable environments, the components of some meteorites and terrestrial rocks, catalyze inorganic and organic reactions, leading to production of metallorganic materials organized as micro-nano hollow objects, orange-red in colour, structured in repetitive units, rich in iron having a composite structure [5]
These metallorganic structures are self assembled only in aerobic conditions upon external physical stimulation. They show physical and chemical properties, such as magnetic behaviour, strong light energy absorbtion and catalytic capabilities.
The production of pigments with spectroscopic properties similar to those of the carotenoids might indicate even a kind of non conventional reactions endowed of peculiar non enzymatic activities.

3. Summary and Conclusions

Complexity of modern life makes it difficult to understand how life itself could have emerged from chemical processes on the early Earth. Moreover not much is known about the plausible pathways of prebiotic evolution. Convincing evidence is reported that the formation of molecular building blocks in the prebiotic era occurred in a variety of different conditions and chemical environments. In this context, the most significant alternative between theories suggesting a mechanism for the origin of life may be that between "metabolism-first" and "replicator first" points of view.
Several research activities are at present focused on the exploration of catalysts in giving rise to those capable of supporting reactions that lead to the proliferation of biologically favourable molecules, able to form living units. The results so far obtained do not prove or exclude the possibility that structures made of M4 are a kind of non conventional form of pre-terrestrial life, but demonstrate that they are certainly the result of reactions, depending on type of crystal or rock, that might be considered as prebiotic catalysts. Under this perspective, we propose that the reactions thought to occur in the young Earth (6), might have provided the starting organic molecules

acting as catalysts of complexity, actually initiating life processes that, as has been proposed (7), are "spontaneous and inevitable".

In conclusion, we hold that early forms of life were already present in our solar system at the time of Earth formation (8), this is in addition to the hypothesis that life could also spontaneously emerge from prebiotic geochemical processes occurring on the early Earth, as previously proposed (9) and further supported by our experimental data (10). In order words, we propose a multiple root genesis (MuRoGe) hypothesis in which an Earth-centric origin of life is considered not necessarily alternative and biology is considered in multiversal perspective in which all living beings are descendants from a plurality of ancestral form of life. Not only a single LUCA (Last Universal Common Ancestor), as proposed before (11), but a number of them.

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