EPSC Abstracts
Vol. 6, EPSC-DPS2011-244-2, 2011
EPSC-DPS Joint Meeting 2011

Life origination hydrate hypothesis (LOH-hypothesis): What markers testify to the possibility of the living-matter occurrence at exoplanets?

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Abstract

The markers that testify to the possibility of the living matter occurrence at exoplanets are considered in the context of the thermodynamically-grounded Life Origination Hydrate Hypothesis (LOH-hypothesis). Just formation of DNAs from minerals is the key factor that makes possible origination of living matter; proteins are the side products of DNAs interaction with environment and of replication. DNAs and proto-cells originated under ground and (or) under seabed at 270 ± 20 K in solid ice medium from CH_4 (or CH_4-hydrocarbons), niter, and phosphate with liberation of O_2, N_2, and, possibly, NH_3. Just the occurrence of these gases and their combinations in the planetary atmosphere and the above-specified underground temperature are the markers of the possible occurrence of living matter. CH_4 formed from CO_2 and H_2 or is of nebular origin.

1. Introduction

The markers that testify to the possibility of the living matter occurrence at exoplanets are considered in the context of the thermodynamically-grounded Life Origination Hydrate Hypothesis (LOH-hypothesis). It is developed in the last decade and repeatedly published in pure-reviewed journals [1–8] and presented at physical, chemical, biological, geological, and specialized international conferences.

The LOH-hypothesis is based on the following main principles. (1) The gross-scale processes in nature proceed progressively in the direction of decrease in the Gibbs free energy in any Universe subsystem that can be approximated as the isolated one. (2) All natural phenomena proceed as a result of regular and inevitable transformations regulated by the universal physical and chemical laws. (3) Nature makes no jumps (Nature non facit saltus (Lat.)). (4) The DNA occurrence and reproduction are the principal features of living matter; the proteins are side products of DNAs interaction with the environment and of their replication. (5) The living matter originates from inorganic and simplest organic minerals as an inevitable product of atomistic world. (6) Stable undisturbed conditions favored living matter origination. (7) The reacting system, which goes to living matter formation, transforms so slowly that it passes step by step all possible states in the direction of gradual decreases in the Gibbs free energy. (8) Living matter originated repeatedly in many of localizations; and different DNAs originated in each of them. (9) The diversity of the available forms of living matter is caused mainly by some variations in parameters of the native medium. (10) In contrast to the Panspermia, the LOH-hypothesis considers the question about how rather than where the living matter originated. (11) The LOH-hypothesis mechanism is universal and is realizable in any celestial body under appropriate conditions.

3. The LOH-hypothesis content

The thermodynamic calculations showed that RNAs and DNAs can be formed simultaneously from simple mineral substances at the expense of the internal energy. This feature discriminates principally the LOH-hypothesis from the hypotheses by Oparin and his followers, who thought mistakenly [1–3] that external energy of electric discharges, hydrothermal sources, etc. is necessary for living matter origination.

According to the LOH-hypothesis, the primary nitrogen bases, riboses, nucleosides, nucleotides, DNAs, and RNAs originated at 270 ± 20 K within widely distributed underground and underseabed honeycomb CH_4-hydrate structures from CH_4 (or other CH_4-hydrocarbons), niter, and phosphate with liberation of O_2, N_2, and, possibly, NH_3 and with the subsequent water diffusion into the reacting system, formation of soup, origination of amino-acids and proto-cells, and their carryover to the ocean or to the Earth surface [1–8].

Each CH_4-hydrate honeycomb structure consists of waters (hosts) forming a frame and of CH_4 molecules (gests) housed within the structural cavities (Fig.1).

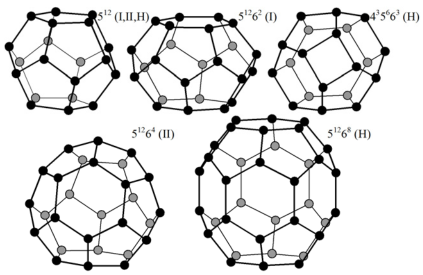

Figure 1: Intra-structural cavities of hydrate structures I, II and H: the vertexes are the O-atoms of H_2O molecules, and the length of each edge corresponds to the sum of the lengths of the O–H valence bond in any H_2O molecule and H···O hydrogen bond between this and an adjacent H_2O molecule; above each cavity, its free diameter, the number of its facets (the superior figures) restricted with the definite number of the edges (the lower-case figures), and the indexes of the hydrate structures into which this cavity is included are given.

The DNA (Fig. 2) sizes allow housing of N-bases within large hydrate cavities and of riboses and phosphates within small hydrate cavities of the honeycomb structure (the details, see [1–3, 8]).

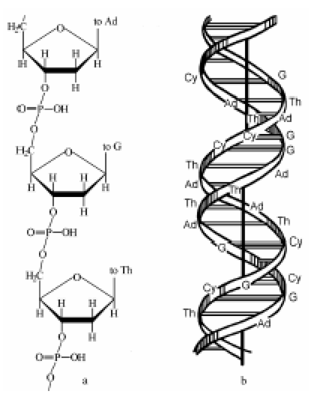

Figure 2: DNA and double helix fragments

The thermodynamic grounds of the LOH-hypothesis are developed in [1, 2, 8].

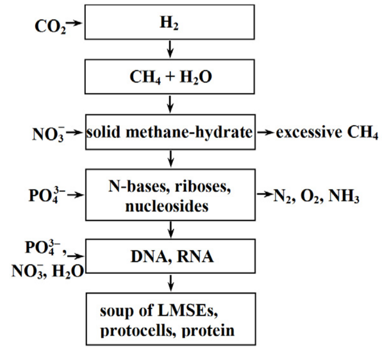

Figure 3: The sequence of living matter origination

The LOH-hypothesis gives a new possibility for understanding the monochirality of nucleic acids. A PC experiment and a laboratory chemical experiment capable of testing the LOH-hypothesis are proposed. The experimental and observational facts that count in favour of the LOH-hypothesis are presented in [1, 3, 8].

4. The life markers, what are they?

The LOH-hypothesis allows the following conclusion. At an exoplanet, the gaseous N_2, O_2, H_2O, CO_2, and, maybe, NH_3 and CH_4 in definite combinations, solid phosphates and niters, and the underground temperatures of about 270 K could be considered as the markers that point to the possibility of the life occurrence there (see Fig. 3).

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