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Understanding the key requirement and the conditions that sparked life on Earth and beyond:clues and new knowledges supporting MuGeRo hypothesis.

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The aim of this work is to present and discuss the results of recent and ongoing wet and in silico laboratory experiments supporting Multiple Root Genesis (MuGeRo) hypothesis already proposed in search of approaches surrounding the mysterious primeval steps of life emergence on Earth and elsewhere in the Universe. There are and have been reported many theories on how the very first life began on Earth, and also on how life itself evolved, some even say that life might have arisen on Earth more than once, and since it is hard to prove or disprove them there is no fully accepted theory.

Approaching the primordial step of life emerging and possibile evolutionary scenarios from nonliving-matter towards answering the fundamental question about when, where and how life was born on Earth I'll discuss essential requirement for the first emergence of life on Earth and Earth-like planets.

As examples of proto-metabolic reactions occurred in a pre-biotic hydrogel context and as a model for the emergence and early evolution of life on Earth, I'm proposing the self-organizing M4 materials, having a complex chemistry, that I've obtained from both some meteorites and terrestrial rocks and minerals. Moreover, they are certainly the result of several coordinated activities and only some of them can be attributed to the meteorite or terrestrial rock components.

The results so far obtained could point a way towards understanding how Earth kick-started metabolism emerged on landmass that arose from Archean oceans rather than in the depths near a deep sea hydrothermal vent.

This work puts forward also an evolutionary scenario that satisfies the known constraints by proposing that life on Earth emerged, powered by solar radiation because the M4 catalytic activities might be a primitive form of reaction network supporting abiogenic development of life on Earth or elsewhere in the Universe. This in addition the idea that microbial or virus or early forms of life were already present in our solar system at the time of Earth's formation so that panspermia or abiogenesis results are not rival but two complementary theories.

Concerning the role that minerals may have played in organizing organic matter rising towards life from supports to scaffolds or energy sources or molecular-level information. There are some hints concerning the role that some minerals may have played in organizing matter in its rise towards life, from simple supports to scaffolds, from energy sources to even maybe providers of molecular-level

information.

The work that remains to be done is huge is there an "interfacial" path from the disorganized complexity of prebiotic and "primitive-jam" to the functional systems that have been the precursors of life? To answer this question I hope soon to analyze with systems chemists the results already obtained and they will be obtained from new weighted experiments designed in scientific cooperation.