

Exploring the Origins of the Earth and Life

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We, as the Earth-Life Science Institute, aim to explore the origins of both Earth and life, because life was born in the early history of the Earth. More than a few thousands of planets are known in addition to those in our solar system, and the process of planet formation around a central star is relatively well understood. However, the details of planet formation, more specifically the delivery of volatile elements such as carbon, hydrogen, and nitrogen to the Earth, are not known yet. A key question regarding the origins of the Earth and life is; how, when, and how much were these key volatile elements transported to our planet?

The metallic core of the Earth is about 10% less dense than pure iron, suggesting the presence of large amounts of light elements in the core. The identification of such core light elements remains one of big questions in geoscience. Recent experiments and calculations demonstrate that hydrogen is a major light element in the core, suggesting that several tens times ocean mass of water was delivered to the Earth by the time of core formation.

The origin of life is a transition from geochemistry to biochemistry. How building blocks for life were formed by geochemistry? Proto-metabolism may have started at hydrothermal vents, where a reduction of CO₂ to CO and subsequent reactions to α -ketoglutarate may have been driven by electrochemistry. A series of such reactions (carbon fixation + a part of r-TCA cycle) can provide precursors of several important amino acids and nucleobases. I will also introduce recent researches at ELSI, which tries to address the specific characteristics of the 20 amino acids that consist of proteins that were presumably already determined during the era of Last Universal Common Ancestor (LUCA). Furthermore, an attempt to synthesize various peptides with limited set of amino acids has been in progress to go back beyond LUCA and to address the structure and functions of perhaps earliest proteins on this planet.