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Planetary tectonics: A new tool to judge the presence or absence of life on planets

Shigenori Maruyama[1*], James Dohm[1]

[1]Earth-Life Science Institute, Tokyo Institute of Technology

Concept of habitable planet has been suggested around 1965 to discuss the possibility of presence of life on planets, because liquid water is major component of life, which has a tight stability field of T<100 degrees depending on pressure. Discovery of icy satellites of Jupiter, which may contain water under the icy surface, pointed to the possibility of presence of life there. Titan has a landmass, which is partly occupied by methane lakes, enveloped by CH4-rich atmosphere. If the landmass comprises rocky materials and an energy circulation system, such discoveries would certainly change the original definition of habitable planet.

Here, we propose a new tool of planetary tectonics as an index for the presence of life on planets. The phenomenon of life is possible only where there is a steady-state supply of nutrients, as well as water circulation and thermal energy. If these conditions are not satisfied, life will terminate. Considering these conditions, the Earth has only two life-sustaining places: (1) the surface of the Earth fed by a climate driven by the Sun, and (2) endogenic-influenced aqueous environments, best exemplified by both continental lake environments, which interact with basement structures such as rift systems and associated hydrothermal systems (the structures serve as conduits for the migration of volatiles and heat energy often related to magma), and deep-sea hydrothermal systems driven by MORB magma (though the biomass at mid-oceanic ridge is 10-6 times smaller than that of the surface of the Earth; negligibly small when compared to the continental lake environments). Understanding planetary tectonic systems that can generate such environments is significantly important in the search for life beyond Earth, including providing an index not only for finding life in our Solar System but also extrasolar planets.