Mineral surface-assisted abiotic peptide synthesis under Enceladus alkaline hydrothermal condition.

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Introduction: Enceladus, one of the icy moons of Saturn system, has alkaline ocean and sweater spurts from the vicinity of its South Pole [1]. The liquid portion contains water as the main component, as well as inorganic substances and simple organic matter [2]. The solid portion is composed of icy particle and salt, and the inclusion of such salt in the plume suggests that there is a liquid ocean under the Enceladus ice crust [3]. Nanosized silica is contained in the solid component; hydrothermal activity of 90°C or higher is necessary for the formation of nanosized silica [4]. Therefore, it is suggested that Enceladus has a hydrothermal environment similar to that of Earth's alkaline hydrothermal vents [4,5]. Based on these characteristics, possible ongoing chemical evolution in the subsurface ocean of Enceladus has been suggested, however evolution of simple organic molecules under such condition has not yet been presented. Given the major constituents of the core to be chondritic rocks that contain organic substances, a precursor of amino acids are likely to be present in the alkaline seawater of Enceladus.

Experiments: In this study, we conducted a laboratory-based simulation experiment to describe the chemical alteration of six prebiotically relevant amino acids over 147 days. The starting materials were reacted in the reaction cell made of Inconel alloy for 147 days at 200 bar with periodic thermal cycling between 30°C and 100°C to simulate water-rock interaction. As a result, we detected 28 out of 36 possible dipeptide species during the entire reaction period. We propose that peptide-bond formation is coupled to rock surface chemisorption of amino acids under alkaline condition, which was further supported by the elemental analysis showing carbon and nitrogen signature on the rock surface only when amino acids are added. The above result suggests that ongoing chemical evolution on Enceladus is likely producing short abiotic peptides on porous core surface.

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