太陽系天体における水-岩石反応とハビタビリティ
Water-rock reactions and habitability in Solar System bodies

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The discovery of deep-sea hydrothermal vents at the Galapagos spreading center in 1977 is widely believed as one of the greatest findings of the twentieth century in the field of biology. This was because the hydrothermal vents in barren ocean floor hosted unique but diverse biological communities that human beings had never seen, and because the organisms were spiritedly living without energy from sunlight. Over the following four decades, hundreds of hydrothermal vents have been found from ocean floors, which revealed that subseafloor water-rock reactions strongly influence the chemistry of ocean and that the most primitive microorganisms are sustained by hydrogen-rich hydrothermal activities. These significant achievements were brought about by the developments of not only exploration technology in extreme environments but also experimental and modeling methods for water-rock-microbe interactions at elevated pressures and temperatures.

Meanwhile, the Solar System exploration since 1960s have revealed the presences of liquid subsurface oceans within icy satellites of Saturn and Jupiter, liquid water beneath the ground of Mars, and vast oceans on Mars in the past. Furthermore, it was recently elucidated that hydrothermal activities are going on at the seafloor of Enceladus' subsurface ocean. Such aquaplanets have recently attracted much attention in terms of their habitability and even the presence of extraterrestrial life forms there. Therefore, we apply the experimental and modeling methods developed for the researches on terrestrial hydrothermal systems to the water-rock interfaces in the aquaplanets.

Here we show the preliminary results of the thermodynamic modeling and experiments of water-rock reactions, simulating the past and present hydrothermal alterations/weathering in the Solar System bodies such as Enceladus, Ceres, Mars and the parent body of asteroid Ryugu (the target of Hayabusa2). The results provide the mineral assemblages and the composition of hydrothermal fluids, which will be available for the constraints on energetic habitability in hydrothermal systems in the aquaplanets and for the prediction of observations in future explorations.

