

Title of Project : Aqua planetology

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【Purpose of the Research Project】

Recent advances in spacecraft explorations have revealed the present/past existence of liquid water on planetary bodies beyond Earth in the Solar system, which include Mars, icy satellites, and planetesimals in the protoplanetary disk.

Our research project proposes a new field of research – aqua planetology – that aims at comprehensive understanding on the roles of liquid water in the origin and evolution of planets and on habitability there. This requires research interactions among geology, geochemistry, biosphere science, astronomy, and planetary science. We try to achieve this goal both by constructing a theory of chemical reactions and hydrological cycles on planetary bodies and by collecting observational evidence through spacecraft missions, such as Hayabusa2, and geochemical analyses of extraterrestrial samples.

【Content of the Research Project】

On a planet that can hold liquid water, similar physicochemical processes occur (Fig.). These include photolysis of water/ice and oxidization on the surface, and water-rock reactions providing reductants and metallic ions to water in the subsurface. These components are connected through hydrological cycles, which in turn results in chemical gradients on the planet and could provide energy for chemotrophic life. To construct a theory of hydrological and geochemical cycles on planets, we set the following research subgroups: A01 water-rock reactions, A02 water-ice interactions, and A03 modeling of cycles.

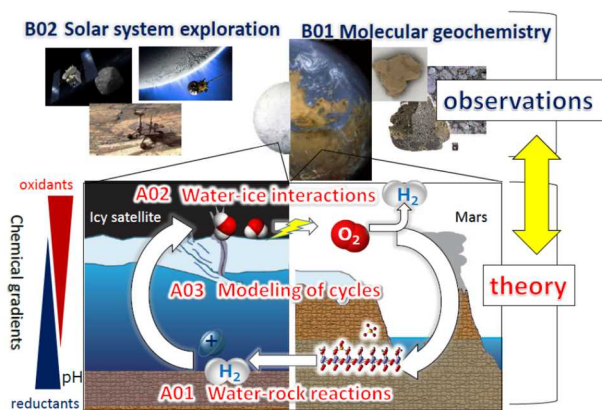


Figure. A conceptual image of this research project.

Based on this theory, we will interpret observational data provided by spacecraft and molecular geochemical analyses of samples. In particular, we focus on revealing chemical properties and physical conditions of water beyond Earth. To this end, we also set the following research subgroups: B01 molecular geochemistry and B02 Solar system exploration.

【Expected Research Achievements and Scientific Significance】

The expected achievements of our research project include 1) understanding of hydrological and geochemical cycles within planetesimals and the factors that control water volume of Earth, and 2) revealing the evolution of aqueous environments and prediction of biosphere on Mars and icy satellites. The former allows to treat the fate of water in planetary formation theory and thus to predict probability of formation of Earth-like aqua planets in the Solar system and beyond. The latter enables us to predict biomarker and biomass on Mars and icy satellites.

These knowledge will be critical in the upcoming ages of both astronomical observations of Earth-like exoplanets and space missions to find life in the Solar system. Aqua planetology will be a unique science to address fundamental questions – Are there any Earth-like planets in the Universe? Is there life beyond Earth?

【Key Words】

Water-rock reactions: Chemical reactions between liquid water and rock materials, including ion exchanges, dissolution, and alterations.
Hayabusa2: Japanese spacecraft mission to C-type asteroid, Ryugu. The spacecraft launched in 2014, and will arrive at the asteroid in 2018. Collected samples will return to Earth in 2020.

【Term of Project】 FY2017-2021

【Budget Allocation】 1,079,400 Thousand Yen

【Homepage Address and Other Contact Information】

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