Microorganisms involved in the formation of distinctive iron oxide in deep-sea environments of Earth and even in extraterrestrial bodies

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It has been suggested that iron is one of the most important energy sources for photosynthesis-independent microbial ecosystems in the ocean crust of Earth. Iron-metabolizing chemolithoautotrophs play a key role as primary producers in anoxic-oxic interface environments, but little is known about their distribution and diversity, and ecological roles, particularly iron-oxidizers. Recently, many iron-dominated flocculent sediments have been discovered at the deep-sea hydrothermal fields in the world. These sites are excellent place for studying iron-utilizing microbial communities and their mineralization of Fe-(oxy)hydroxides associated with deep-sea hydrothermal activities. Indeed, it is still unclear how such microbial populations are involved in iron-dominated flocculent deposit formation. In this study, we analysed iron-dominated sediments from various deep-sea hydrothermal environments in the Western pacific by using culture-independent molecular techniques and X-ray mineralogical analyses. The SEM-EDS analysis and X-ray absorption fine structure (XAFS) analysis reveal chemical and mineralogical signatures of biogenic Fe-(oxy)hydroxides species as well as the potential contribution of iron-oxidizing bacteria to the *in situ* production. These key findings provide important insights into the mechanisms of both geomicrobiological iron cycling and formation of iron-dominated sediments in deep-sea hydrothermal fields. In addition, the formation and preservation mechanisms of biological produced iron-dominated sediments point to the possible microbial metabolisms and functions in the fossil records of iron oxide deposits such as banded iron formation (BIF) in the past Earth. Now, many peoples know that iron-oxide mineral deposits are also present in extraterrestrial bodies of our solar system such as Mars and Jupiter’s moon Europa. The formation mechanisms of these extraterrestrial iron-dominating mineral deposits are highly unknown. However, if in situ observations and sample-return-based analyses in future astrobiological exploration of these extraterrestrial red-orange deposits will find certain specific iron oxide structures such as helical, twisted and stringing shapes associated with organic materials, the specific iron oxide structures will be significant bio-markers and will be useful for further detail exploration planning and strategy.

Simulated Enceladus fly-through experiment using aerogel and peptides

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One of the main goals for Astrobiology is to understand the limits and distribution of life in the universe. *In situ* detection of organic molecules in the extraterrestrial environment thus provides an important step towards better understanding of the variety, distribution and chemical evolution of the organic building blocks of life that could ultimately lead to the detection of extraterrestrial life within our Solar System. Here we performed a concept study for the Enceladus fly-through plume sampling and extraction using eight different short peptides as a candidate biomolecules. Hypervelocity impact experiment was carried out at JAXA/ISAS with peptide-bearing micro-silica particles accelerated to a speed of 2-6 km/sec and captured by ultra-low density (0.01 g/cm_3) hydrophobic and hydrophilic aerogels respectively. Each of the eight peptides possesses unique hydrophobicity/hydrophilicity properties with a C-terminal tyrosine residue for UV detection. We are currently testing different extraction procedures and analyses to understand whether difference in the chemical properties of aerogels and peptides affect the overall extraction efficiency. Furthermore, we will evaluate the impact-driven degradation and alteration of peptides to discuss the likelihood of aerogel application for future *in situ* life detection mission on icy moons.

キーワード：氷衛星、エアロゲル、生命探査、ペプチド
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Analytical Assessment of Intact Capture Capability for Possible Biological Sigantures within Icy Plume Particles by Using Hydrophilic and Hydrophobic Aerogels

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Cassini Spacecraft's Ion Neutral Mass Spectrometry (INMS) and Cosmic Dust Analyzer (CDA) have provided significant scientific data regarding Saturn's icy moon Enceladus and its ongoing plume activity. Scientific evidences have put constraints on environmental parameters for the subsurface ocean. However regarding life detection, current on-board space mission instruments rely solely on destructive analytical techniques. By targeting the Enceladus plume, we propose a new astrobiology oriented life detection mission concept using silica aerogel for development of sample capture, in situ analysis and sample return technologies. Silica aerogel is a super low density amorphous SiO_2 (density range between 0.01 g/cm_3 and 0.03 g/cm_3) and has optical transparency and low thermal conductivity (0.017 W/mK). These features of silica aerogel are expected to be suitable for non-destructive and non-invasive capture of samples. In this research, we compare the ability of organic sample capture in two different types (hydrophilic and hydrophobic) of aerogel. Currently new aerogel capture system is under development and thus we will discuss advantages and current problems of this system including the application for future space missions related to biosignature detection from the icy moons.

キーワード：氷衛星、エアロゲル、サンプルリターンミッション、宇宙生物学
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