Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SMP49-01 会場:314 時間:5 月 1 日 16:15-16:30

ナノから解き明かす地球惑星物質の性状と起源の趣旨説明
Introduction of NANO-EPS

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固体のナノ領域は、地球惑星科学全体に広がるフロンティアである。固体の元素濃 度は、電子線マイクロアナライザ (EPMA) に代表されるマイクロの分析 (ppm) からナ ノ分の 1 の濃度 (ppb) の分析が可能になり、また X 線回折装置 (XRD) に代表されるバルクからナノ固体 (>200 nm から<5 nm) の鉱物解析へと進化している。従来サブミク ロンと呼ばれるナノスケール内での元素・同位体組成の不均質性や変動パターンの 解析やナノ粒子自体のバルクとは異なる特性は、地球惑星科学に新たな知見をもたらす可能性を秘める。本セッションは惑星・生命の誕生から現在の地球表層環境に 至る広大な時空間スケールを対象とし、特にナノ領域に研究の重要性について論じる。

キーワード: ナノ
Keywords: nano

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表層水圏環境で生成するサブミクロンスケールのマンガン酸化物の特性・環境
Properties and depositional process of sub-micron scale manganese oxide minerals in the aqueous surface enviromnent

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表層水圏環境においては，主に表層水（海洋，河川，土壌，地下水，温泉水，生体など）を媒体として，様々な鉱物が生成している．重金属元素の中では特に，鉄とマンガンは，表層環境で移動しやすい元素であり，陸域から深海底にいたる多様な環境において酸化物の沈殿現象あるいは溶解・再沈殿などが認められる．また，沈殿に伴って多くの種類の副成分を取り込むことがしられており，マクロには非常に効率的な沈殿形成と副成分の吸着という結果として認められる．

一般には ppm 未満のオーダーの溶液から，サブミクロンサイズの粒子が形成されると予想されるが，単体の粒子は光学，低解像度 SEM で観察することは困難なため，その鉱物学的，化学的な特徴付けが充分になされていない．海洋含んだ表層環境での物質循環，鉱物資源形成，環境解読の考察にあたって，その特徴づけが求められている．

ここでは，海底マンガン酸化物の生成に深く関わる，元素の供給源，生成する鉱物の性状，特徴などに関して，レビュー及び筆者らの予察的研究を紹介する．

キーワード: マンガン酸化物, マンガンクラスト, マンガン団塊, 層状マンガン鉱物, 低温熱水活動, 酸化還元環境
Keywords: manganese oxide mineral, manganese crust, manganese nodule, low-temperature hydrothermal activity, phyllomanganate, redox condition

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PF-STXM（走査型透過 X 線顕微鏡）の開発と環境地球化学研究への応用
Development of PF-STXM and its application to environmental geochemistry

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Scanning transmission X-ray microscopy (STXM) has been applied to various fields in earth and environmental sciences such as aerosol chemistry, geomicrobiology, soil science, and nanomineral sciences. In particular, the technique has been used in the world because of its great importance in imaging distribution of carbon, or in particular carbon functional group, with about 50 nm spatial resolution. However, STXM that can be used to measure NEXAFS at carbon K-edge has not been in use in Japan. We have constructed STXM in Photon Factory (PF-STXM) from 2012 and started to use it for various topics in earth and environmental sciences.

In the PF-STXM, soft X-rays from the undulator are monochromatized by the grating and focused at the four-way aperture slit. The FZP with the outermost zone width of 30 nm is placed at 1 m distant from the aperture slit. First order diffraction selected through an order sorting aperture (OSA) is focused onto the sample with the focal distance of 0.7-5 mm, and then the transmitted X-rays are detected. The PF-STXM at present is mainly operated at BL-13A in Photon Factor, where the energy range available is from 250 eV to 1600 eV, which covers K-edges of carbon, nitrogen, oxygen, potassium, and aluminum. The beamize of the STXM was around 50 nm focused with Fresnel zone plates (FZP). The intensity of focused X-rays at the sample was expected to be up to 10^7 photons/s. Instead of a photomul-tiplier tube (PMT) which is commonly used in STXM, a silicon avalanche photodiode (APD) is utilized to detect the transmitted X-rays in PF-STXM. Compared with other STXM system in the world, our STXM is made so compact and light that it is easily connected to and removed from the multi-purpose beamlines. The experiments reported below are performed at BL-13A and BL-16A of Photon Factory.

The PF-STXM has been used for various applications. Among them, we would like to present recent results on (i) speciation of calcium in mineral dust with 50 nm spatial resolution, (ii) characterization of carbon adsorbed on particulate matter in river water, and (iii) spatial distribution of rare earth elements in bacterial cell.

キーワード: STXM, PF, エアロゾル, 懸濁粒子, バクテリア
Keywords: STXM, PF, Aerosol, Particulate matter, Bacteria

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走査型透過 X 線顕微鏡 (STXM) の微生物－鉱物相互作用解明への応用
Nano-scale investigation of the microbe-mineral interaction by scanning transmission X-ray microscopy

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Microorganisms in the environment critically impact global geochemical cycles and redox reactions of various elements. Many geochemically important redox reactions (e.g., sulfate reduction, Fe(II) oxidation) are largely associated with microbial activity. In addition, microbes can mediate both mineral formation (biomineralization) and mineral dissolution (bioleaching). Recent studies suggest a significant relationship between Fe(II)-oxidizing bacteria and ancient Banded Iron Formation, one of the large geochemical events in Earth's history. The general ecological importance of environmental microbial reaction has been well recognized; however, the specific mechanisms of the reactions in the environments such as the reaction rate and spatial dynamics are poorly understood. In the environment such as sediments, microbial reactions and habitability vary locally and form complicated geochemical networks, which makes it difficult to characterize the specific biogenic reactions in detail.

Scanning transmission X-ray microscopy (STXM), which uses near-edge X-ray absorption spectroscopy (NEXAFS) is a powerful new tool that can be applied to hydrated biological materials with high spatial resolution. The STXM provides spatial resolution of better than 50 nm, which is suitable for imaging bacteria and bacterial biofilms.

In the present study, we applied the STXM into the bioleaching of sulfide mineral (pyrite) to determine carbon, oxygen, and iron species in nano-scale. Both metal and biogenic organic materials in pyrite-microbe interface were investigated in the single cell level. Our study shows that the STXM could be a potential technique to provide direct information on specific biogenic reaction microorganism.

キーワード: 走査型透過 X 線顕微鏡, パイライト, バイオリーチング
Keywords: STXM, pyrite, bioleaching

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レーザーアブレーション ICP 質量分析計を用いた局所微量元素組成分析
In-situ trace element quantification of geological samples using LA-ICPM

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Laser-Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) is a type of mass spectrometry which is capable of in-situ trace element quantification of a solid sample. We introduce an typical application to characterize sub-micron scale particles based on the variation of their geochemical compositions.

キーワード: LA-ICPMS, フェムト秒レーザー, 局所分析, 微量元素組成分析
Keywords: LA-ICPMS, femtosecond laser, in-situ analyses, trace-element quantification