Nano-scale observations of interface between lichen and basaltic rock: Pseudomorphic growth of amorphous silica on silicate minerals

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Introduction: In primary succession, lichen can be a typical pioneer species of terrestrial habitats. Recently, lichens are recognized as agents of mineral weathering at the interface between lichens and surface rocks. Much interest has been therefore devoted in recent years to the weathering induced by the lichen colonization. Here, we report nano-scale observations of the interface between lichens and basaltic rock by TEM and STXM techniques.
Methods: Some basaltic rocks totally covered by lichens were collected from the 1986 lava flows on the northwest part of Izu-Oshima volcano, Japan. To prepare specimens for the nano-scale observation, we utilized the focused ion beam (FIB) system. The microstructure and local chemistry of the specimens were thoroughly investigated by TEM equipped with energy-dispersive X-ray spectroscopy (EDX). Chemical components and chemical heterogeneity at the interface were observed by scanning transmission X-ray microscopy (STXM) at Advanced Light Source branch line 5.3.2.2 and at UVSOR branch line 4U.
Results and discussion: The basaltic rocks collected were classified into the augite-pigeonite-bronzite basalt including 6 to 8% plagioclase phenocrysts. The lichen adhering to the rocks was mainly *Stereocaulon vesuvianum*, fruticose lichen, which is widespread over the study area. The metabolites of the *S. vesuvianum* exhibited a mean pH of 4.5 and composed of atranorin and stictic acid. The STEM-EDX observations revealed that the interface between augite and lichen was completely covered with amorphous silica layer with a thickness of less than 1 μm. Ca L-edge and Fe L-edge STXM-XANES spectra of the augite showed that there was little difference among the spectra at each depth from the interface between augite and amorphous silica. It indicates that intrinsic structure of the augite was maintained up to the interface. These results suggest that amorphous silica layer was formed by the process that is a synchronous coupling of stoichiometric dissolution of augite and reprecipitation of amorphous silica layer on the surface (Fig. 1).

Keywords: lichen-rock interaction, TEM, STXM, nano-scale

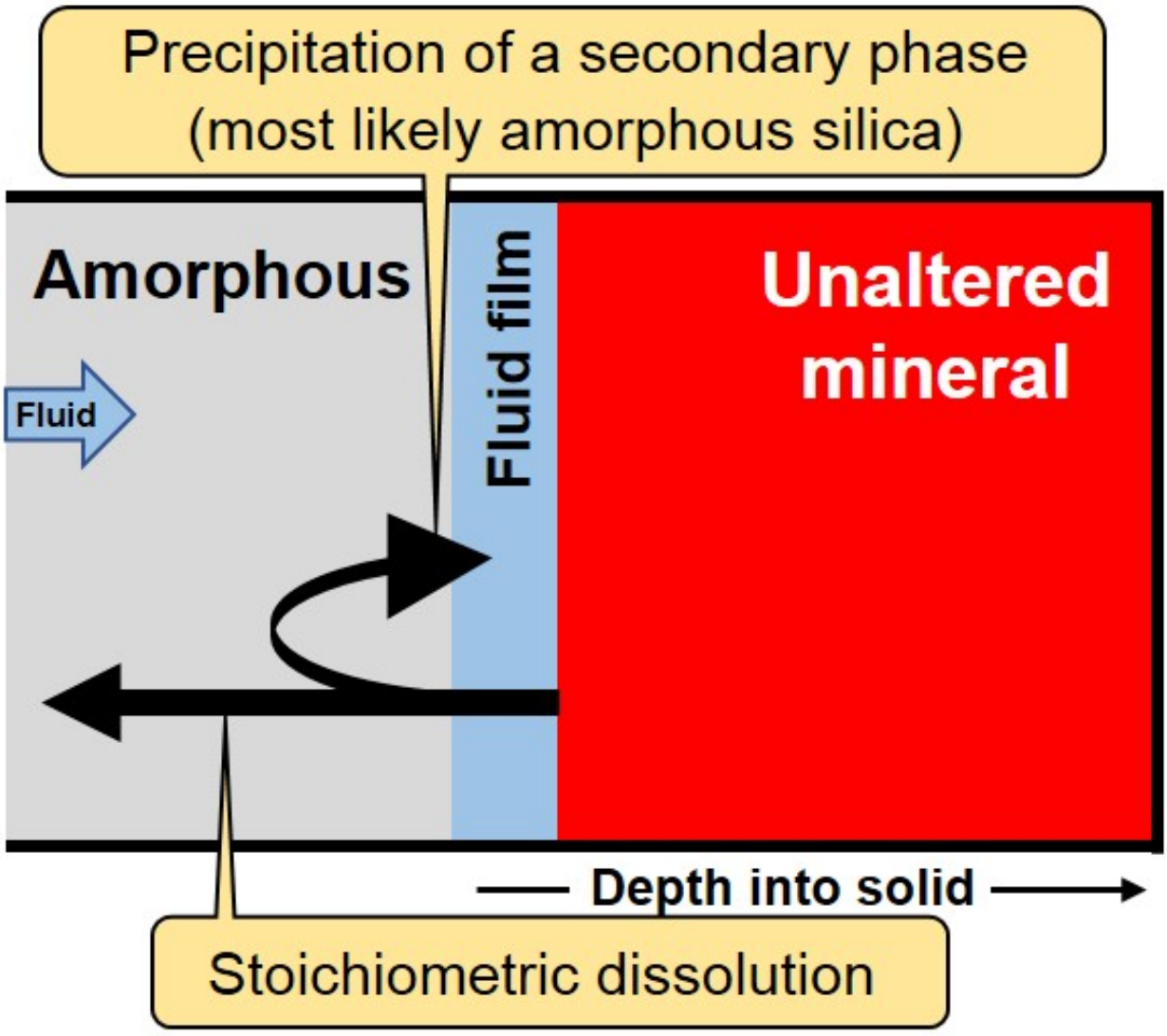

Fig. 1 Coupled interfacial dissolution-reprecipitation mechanism (Hellmann et al., 2012).

