

Understanding microbial signatures on naturally weathered basaltic glass

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Understanding silicate weathering and associated biosignatures resulting from microbial activity has great interest in a wide range of fields. These encompass the understanding of the evolution of climate and the study of the emergence of life on early Earth.

In that perspective, microorganisms associated with silicate surfaces and signatures suspected to relate to biogenic activity have been extensively studied over the past decades. Yet, only a few studies did evidence a strong correlation between organisms and observable dissolution features on the surface, with a particular lack of studies in natural settings.

Here we studied synthetic basaltic glass samples incubated in soils developed on volcanic bedrock at close-to-natural experimental conditions for over 10-18 months. We aimed to narrow this gap by correlating the presence of microbial organisms to changes in the glass surface. We used a combination of optical and fluorescent microscopy, scanning electron microscopy (SEM), and atomic force microscopy coupled to infrared spectroscopy (AFM-IR) measurements to evidence bacterial and fungal specimens or remains. Vertical scanning interferometry (VSI) and AFM measurements were combined with focused ion beam (FIB) milling coupled to transmission electron microscopy (TEM) to quantify the impact of these organisms on mineral weathering.

From this detailed investigation we evidence enhanced weathering both from fungal and bacterial origin, which constitutes up to a 100% increase additional to the non-specific weathering observed on the samples.

These findings will help assess biogenic contribution to basalt weathering and thus carbon drawdown. They show strongly correlated examples of biosignatures on basalt at early stages of mineral weathering. Such approaches can be applied to the investigation of extraterrestrial material, and describe a comprehensive toolbox for evidencing microorganisms and their impact on many types of surfaces of environmental and industrial interest.

