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Enhancement of basaltic glass dissolution rate by hyperthermophilic archaeon *Pyrobaculum islandicum* at ~90°C

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Microorganisms are key drivers of biogeochemical processes in subsurface environments, yet their role in silicate bioweathering remains poorly understood. Specifically, basaltic rocks are well-suited microbial habitats owing to their porous structure and biologically relevant chemical composition. Rich in iron, they provide an important source of this element for energy-harvesting reactions in the nutrient-limited zones. Importantly, the oxidation state of iron on silicate surfaces gradually shifts from Fe(II) to Fe(III) over time, resulting in a passive layer and decreasing dissolution rates. These aged surfaces are essentially the environmental forms of silicates in the majority of bioweathering contexts, while laboratory studies thus far have mostly addressed the dissolution of fresh reactive silicates. To limit discrepancy between laboratory and field observations and to accurately estimate silicates' weathering rates, knowledge on the mechanisms of microbial alteration of surfaces representative of aged silicates is needed. In this work, we report the impact of biological activity of hyperthermophilic iron-reducing archaeal strain, *Pyrobaculum islandicum*, on the dissolution of synthetic basaltic glass representative of aged basalt. The aged-like composition (25% Fe(II) – 75% Fe(III)) of the basalt surface was confirmed using X-ray absorption spectroscopy measurements on the FAME beamline at the ESRF. Basaltic glass surfaces were exposed to microbial cultures at 93°C for 3 to 15 days and characterized using SEM-EDX. We observed strong surface alteration in the presence of microbial cells, with main mineral signatures attributed to pyrite. Furthermore, the step retreat measured using nanotopography vertical scanning interferometry measurements showed a one order of magnitude increase in basaltic glass dissolution rate in presence of *P. islandicum* compared to the abiotic control. The proposed mechanism of dissolution enhancement involves the disruption of outermost surface layer through microbially-mediated pyrite formation. These findings improve our understanding of basalt reactivity in presence of archaeal cells and suggest their high bioweathering potential in environmentally relevant sulfur-rich environments.