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Shedding new light on basaltic glass weathering by combining reactor and soil column experiments.

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The weathering of calcium and magnesium silicates plays a significant role in the long-term carbon cycle, by initiating the formation of carbonate rock and providing important nutrients for surface ecosystems. Basaltic glass, one of the most reactive and abundant silicate phases, has been extensively studied in laboratories for its dissolution rates and kinetics under varying pH, temperature, and solution compositions. However, laboratory measurements made on freshly ground powders and surface area conversions relying mainly on BET are not necessarily suitable for scaling with dissolution rates. Additionally, only considering surface alteration layers and potential biotic enhancements fails to explain weathering rates measured in natural settings.

To address this gap, this study examined the dissolution of basaltic glass using monoliths with controlled initial surface properties. An approach based on surface sensitive techniques, including vertical scanning interferometry (VSI) and atomic force microscopy (AFM), enabled accurate scaling of the weathering rates to geometric surface area. In-depth investigations of the resulting surfaces unraveled signatures of weathering processes associated with various dissolution conditions. In parallel, similar samples were introduced in soil columns cored from Réunion Island to shed light on factors controlling basaltic glass dissolution in more complex environment. The effect of the colonization of glass surfaces by microbial communities inhabiting soils developed on basaltic substrates was thereby quantified. This study will help adjusting previous findings of basaltic glass dissolution in a three-dimensional domain of temperature, solution content, and substrate age. The use of reaction environments with contrasting levels of complexity will help bridging the gap between laboratory experiments and field measurements and will aid the exploration of biotic impacts on weathering.