Ice nucleation and its role in the incipient stages of physical weathering

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Mineral weathering represents a balanced interplay among a number of physical, chemical and biological processes. Research on ice formation and its influence on mineral weathering has been limited despite the need for quantitative data that allows us to better model atmosphere-geosphere-biosphere interactions. The goal of this project is to examine ice nucleation as a physical weathering mechanism in the initial stages of mineral transformation in laboratory and field systems. We are assessing the effects of ice nucleation in the weathering of granular samples (basalt, granite, quartz sand; 250-53 μm) used in model ecosystem laboratory experiments at Biosphere 2 and deployed in field studies encompassed by the Catalina Critical Zone Observatory (Arizona, USA) and the Calhoun Critical Zone Observatory (South Carolina). Ice formation experiments performed on mineral grains from the field studies suggest the potential for chemical and morphological transformations of mineral surfaces following water uptake and ice growth. Active sites for ice formation may differ as a function of organic and inorganic surface coatings and weathering features (pitting, tunneling) as suggested by pilot data. Our work contributes to an improved understanding of how ice formation physically transforms mineral surfaces in laboratory and large-scale field studies. Our coupled laboratory-field experiment design allows us to connect grain-scale processes to landscape-level mechanisms. This work also allows us to better differentiate among the effects of ice nucleation as a physical weathering agent in the early stages of mineral weathering in controlled and natural settings (semiarid, sub-humid, humid landscapes).