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Role of Microbes in Glass Dissolution with Implications for Radioactive Waste Disposal

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Immobilization of radioactive waste within silicate glasses is generally accepted as a safe, long-term disposal option. Understanding the mechanisms of glass corrosion in a near-surface environment is important, as the release of radionuclides is proportional to the glass corrosion rate. Microbial processes occurring at or near the glass surface can potentially influence glass corrosion. Microorganisms can alter the glass through biomechanical and biochemical processes, where the glass may serve as a metabolic nutrient source or as a scaffold for microbial growth. Previous work on archeological glass analogues, to evaluate glass alteration in the natural environment over long time scales, revealed microbial colonization of the glass surface. The objectives of this work are to: (i) characterize potential microbial-glass interactions; and (ii) identify any bio-alteration signatures or leached elements from simulant glass. Two glass compositions were tested, a synthetic glass representative of the analogue glass, and a “join” glass that included boron and additional sodium, to be more consistent with radioactive waste glass formulations. The glasses were tested as coupons to evaluate surface alteration by biofilm formation, and as powders to accelerate alteration. *Paenibacillus* bacteria were selected as the inoculum, as they are known to weather glass, thrive in subsurface environments of relevance to nuclear waste glass disposal, and were also shown to be enriched on the surface of the archeological glass analogues. The simulant glasses were exposed to the inoculated minimal growth medium at room temperature, and the glass and solution were sampled periodically for up to 200 days. Samples were analyzed using a suite of multimodal techniques, including microscopy, nuclear magnetic resonance spectroscopy, secondary ion mass spectrometry, and biogeochemical measurements. The bacteria successfully colonized both glass compositions as coupons and as powders, with a higher concentration of biomass measured in the presence of glass. Biogeochemical solution analyses showed a greater elemental release from the glass powders incubated with bacteria compared with powders without bacteria. Our results suggest that microbial processes could influence glass durability, underscoring the need for continued evaluation of the long-term impacts of radioactive waste glass disposal under site relevant conditions.