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# Salt-enhanced chemical weathering of building materials and bacterial mineralization of calcium carbonate as a treatment

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Salt weathering is an important mechanism contributing to the degradation and loss of stone building materials. In addition to the physical weathering resulting from crystallization pressure, the presence of salts in solution greatly enhances the chemical weathering potential of pore waters. Flow through experiments quantify the dissolution rates of calcite and quartz grains (63-125 micrometer diameter) when subjected to 1.0 ionic strength solutions of MgSO4, MgCl, Na2SO4 or NaCl. Results indicate that the identity of the cation is the primary control over the dissolution rate of both calcite and quartz substrates, with salt-enhanced dissolution occurring most rapidly in Mg2+ bearing solutions.

It has been observed that weathering rates of rocks in nature, as well as building stones, are slowed down by naturally occurring or artificially produced patinas. These tend to be bacterially produced, durable mineralized coatings that lend some degree of protection to the underlying stone surface [1]. Our research shows that bacterially produced carbonate coatings can be quite effective at reducing chemical weathering of stone by soluble salts. The calcite-producing-bacteria used in this study were isolated from stone monuments in Granada, Spain [2] and cultivated in an organic-rich culture medium on a variety of artificial and natural substrates (including limestone, marble, sandstone, quartz, calcite single crystals, glass cover-slips, and sintered porous glass). Scanning electron microscopy (FESEM) was used to image bacterial calcite growth and biofilm formation. In-situ atomic force microscopy (AFM) enabled calculation of dissolution rates of untreated and bacterially treated surfaces. 2D-XRD showed the mineralogy and crystallographic orientation of bacterial calcium carbonate.

Results indicate that bacterially produced calcite crystals form a coherent, mechanically resistant surface layer in perfect crystallographic continuity with the calcite substrate (self-epitaxy). These calcite biominerals are more resistant to chemical weathering by salt-enhanced dissolution, apparently due to the incorporation of organics (bacterial exopolymeric substances, EPS). Conversely, on silicate substrates, non-oriented vaterite forms, leading to limited protection. These preliminary results indicate that bacterial treatments have a significant potential to protect the stone built cultural heritage.

[1] De Muynck et al. (2010) Ecol. Eng. 36, 118-136. [2] Jimenez-Lopez et al. (2007) Chemosphere 68, 1929-1936.