

Nucleation on a dissolving mineral surface

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When the dissolution of a mineral results in an interfacial fluid composition that is supersaturated with respect to a more stable phase, nucleation on the surface of the dissolving mineral is generally not the rate-controlling step in the equilibration process. Nucleation within this interfacial fluid results in a coupling between the dissolution and nucleation rates such that dissolution is the rate-controlling step in the reequilibration process. We investigate the mechanism of such reequilibration processes by in situ observations in a fluid cell of an Atomic Force Microscope and macroscopic experiments in batch reactors. The dissolution of calcite in an aqueous solution containing anions that can form low solubility phases with Ca^{2+} such as phosphates, or oxalates demonstrates the phenomenon of autocatalysis i.e., the feedback between dissolution and precipitation that results in a pseudomorphic replacement. We will discuss how factors such as molar volumes, epitaxial relations and relative solubilities between parent and product phases control the replacement mechanism. These replacement processes are ubiquitous within the Earth wherever aqueous fluids occur and are important in such large-scale processes as metamorphism, metasomatism, weathering, as well as providing environmental remediation strategies for the capture and removal of toxic elements in aqueous fluids, both in natural and industrial systems.