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Nanoscale imaging of coupled dissolution and precipitation reactions at the mineral-fluid interface.

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Aqueous fluids are ubiquitous in the crust of the Earth and probably even deeper. Understanding how minerals react in the presence of these fluids is essential to track the evolution of the rocks in the crust. In undersaturated solutions minerals will dissolve. However if the mineral-fluid interfacial fluid becomes supersaturated with respect to a new phase, precipitation may take place at the mineral surface. Such interface-coupled dissolution-precipitation reactions are surprisingly common in the Earth during processes such as metamorphism, metasomatism, diagenesis and weathering. Different conditions, such as, fluid composition, pH, redox, t, T and P, all influence nucleation and growth processes and whether or not one mineral can be pseudomorphed by another mineral. The concomitant formation of porosity and subsequent porosity evolution governs element mobility in the Earth. Atomic force microscopy (AFM) has enabled us to observe these reactions in situ at the nanoscale and thereby to elucidate the mechanisms of these coupled processes. This can also be applied to other systems whenever minerals are in contact with aqueous fluids, such as biomineralisation, scale formation and industrial systems, material science and ultimately enables us to predict potential reactions and hence design new materials for specific functional purposes.