

Reactions at mineral-fluid interfaces: Specifically coupled dissolution and precipitation

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An aqueous fluid will induce some dissolution even in a highly insoluble phase, such as most minerals, producing an interfacial boundary layer of fluid that may be supersaturated with respect to one or more more stable phases. One of these phases may then nucleate at the surface of the parent phase initiating an autocatalytic reaction that couples the dissolution and precipitation rate. If an epitaxial crystallographic matching exists between the parent substrate and the product, the nucleation of the new phase transfers crystallographic information from parent to product. In order to propagate a pseudomorphic replacement front, mass transfer pathways must be maintained between the fluid reservoir and the reaction interface. This requires that the replacement process is a volume deficit reaction, and that the resulting product is porous and hence allows continued infiltration of the fluid phase to the interface within the parent phase.

The basic principle behind reactions occurring at the mineral-fluid interface is that one mineral may be replaced by another more stable mineral by an interface-coupled dissolution-precipitation mechanism.

Examples will be discussed where this scenario exists in nature to show that this is a ubiquitous mechanism occurring in the crust of the Earth during such processes as metamorphism, metasomatism and weathering.