Coupled processes control dissolution and precipitation

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Solubilities and dissolution rates from experiments using monomineralic reactants and/or pure water have limited applicability for real processes and mechanisms of fluid-mineral interaction in the Earth. Aqueous solutions in the Earth carry dissolved inorganic and organic species that control the dissolution and reaction of the whole mineral assemblage. Fluids also change composition along their flowpaths or along neighbouring grain boundaries as they interact with different minerals. Reacted fluids may become supersaturated with respect to a new solid phase. When the precipitation occurs on the surface of the dissolving phase, an autocatalytic reaction resulting from the coupling between dissolution and precipitation increases the dissolution rate of the parent phase. This has been demonstrated to increase the dissolution rate of quartz, for example (de Ruiter et al., 2019). When dissolution and precipitation are not spatially coupled, the dissolution and reaction of one phase can be profoundly influenced by components from another reacting phase. Recent experiments on the serpentinisation of olivine have documented the significant effect of the presence of enstatite in the reaction. Also, the enrichment of Ni in secondary sulphides during hydrothermal alteration of peridotite, originally containing magmatic pentlandite, is enhanced by the serpentinisation of olivine (Wengorsch et al., submitted). The coupling between chemically distinct and spatially separated mineral-fluid interfaces is important for the understanding of fluid-driven rock alteration reactions.

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