

**The mineral-fluid interface: where
minerals react with the environment
- *W. Stumm Science Innovation Medal*
*Lecture***

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Understanding mineral-fluid reactions at the nano-scale enables a clearer understanding of mechanisms at the larger scale. The equilibration of minerals in the presence of an aqueous fluid phase has been described in terms of a number of potential mechanisms, specifically mainly either by solid state exchange of elements within the solid phase and the aqueous solution, or by interface-coupled dissolution-precipitation where equilibration is approached by the incremental dissolution of the parent solid and the coupled precipitation of a new product solid (Ruiz-Agudo et al., 2014). Mineral surfaces are complex energy landscapes and conditions determining an equilibration mechanism can be defined by the specific chemical potential differences at the mineral interface, the kinetics of potential reactions, the solubility of the solid phase in the specific fluid at the mineral-fluid interface, and physical properties such as the mineral : fluid ratio as well as the surface area : fluid ratio, temperature and pressure. This presentation will focus on the mechanism of ion exchange in a range of minerals in the presence of an aqueous solution occurring by interface-coupled dissolution-precipitation (Putnis and Putnis, 2022). Amongst the many implications revealed from an understanding of this mechanism at the nanoscale are mineral growth, weathering, mineral carbonation as a means of CO₂ sequestration, as well as contaminant remediation and element mobilization that ultimately leads to ore deposit formation. Specifically designed functional materials, using a geomimetic pathway, can also follow a similar process once the governing mechanism is clearly understood.

References

- Putnis C.V. and Putnis A. 2022. A mechanism of ion exchange by interface-coupled dissolution-precipitation in the presence of an aqueous fluid. *J. Crystal Growth*, 600, 126840
- Ruiz-Agudo E., Putnis C.V., Putnis A. 2014. Coupled dissolution and precipitation at mineral fluid interfaces. *Chemical Geology* 383, 132-146.