

Mineral replacement reactions and element mobilization

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When a mineral is out of equilibrium with an aqueous fluid, reactions will take place in an attempt to reach a new equilibrium. Commonly in the Earth dissolution at a mineral–fluid interface initiates a coupled reaction involving dissolution and precipitation (Ruiz-Agudo et al., 2014). This is a ubiquitous reaction during such processes as metamorphism, metasomatism and weathering. When rock-forming minerals such as feldspars, olivine, pyroxenes are in contact with aqueous fluids (typically NaCl-rich) resultant new phases are formed and elements present in the parent mineral are released to the fluid and therefore mobilized for transport elsewhere. This has been shown in a number of systems such as the albitisation of feldspars (Hövelmann et al., 2010) when a Ca-bearing plagioclase is replaced by albite (NaAlSi₃O₈). However during this reaction not only is Ca released to the fluid but most other minor elements, such as Mg, Pb, rare earth elements amongst others, are almost totally mobilized and removed in solution. This interface-coupled dissolution-precipitation reaction has many implications for the redistribution of elements in the crust of the Earth. It is also of note that albitisation occurs often in areas of high mineralization, such as in the Curnamona Province in S. Australia (Au-Cu and Ag-Pb-Zn deposits) and the Bamble District of S. Norway.

Secondly atomic force microscopy (AFM) has been used to image these reactions at a nanoscale, especially at the calcite-fluid interface, such as the formation of apatite from phosphate-bearing solutions, and the sequestration of toxic elements, eg., Se and As.

References

- Ruiz-Agudo E., Putnis C.V., Putnis A. (2014) Coupled dissolution and precipitation at mineral–fluid interfaces. *Chemical Geology*, 383, 132-146.
- Putnis C.V. and Ruiz-Agudo E. (2013) The mineral-water interface: where minerals react with the environment. *Elements*, 9, 177-182.
- Hövelmann J., Putnis A., Geisler T., Schmidt B.C., Golla-Schindler U. (2009) The replacement of plagioclase feldspars by albite: observations from hydrothermal experiments. *Contrib. Min. and Pet.* 159, 43-59.