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Element mobilization resulting from mineral replacement reactions

Christine V. Putnis[1,2], Encarnacion Ruiz-Agudo[3], Helen E. King[4], Jörn Hövelmann[5], Francois Renard[6,7,8]

[1]Institut für Mineralogie, University of Münster, Germany putnisc@uni-muenster.de

[2]Nanochemistry Research Institute, Curtin University, Perth, Australia

[3]Department of Mineralogy and Petrology, University of Granada, Spain

[4]Department of Earth Sciences, Utrecht University, The Netherlands

[5]GFZ Potsdam, Germany

[6]Univ. Grenoble Alpes, ISTerre, Grenoble, France

[7]CNRS ISTerre, Grenoble, France

[8]Physics of Geological Processes, University of Oslo, Norway

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When minerals are out of equilibrium with aqueous fluids, 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 [1]. 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 [2] when a Ca-bearing plagioclase is replaced by albite ($NaAlSi_3O_8$). 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 redistributon of elements in the crust of the Earth [3]. It is also of note that albitisation often occurs 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.

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

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