# Investigation of silicate dissolution processes through the combination of microstructural, chemical and isotopic methods

## Description:

The prediction of reaction kinetics of fluid/rock interactions represents a critical issue for several geological and engineering concerns, which requires an in-depth knowledge of silicate dissolution mechanisms to develop kinetic rate laws of silicate dissolution. The current paradigm is based on three fundamental principles: 1) the congruence of reactions, which states that the elemental release is stoichiometric; 2) the temporal invariance of reactivity, which states that the kinetics of dissolution obeys a single rate constant, independent of the reaction progress, and 3) the directional invariance of reactivity, which states that all crystallographic planes dissolve at the same rate. We have recently pioneered the demonstration that the reactivity of minerals, and in particular, the reactivity of silicates, does not verify any of these three principles, which could contribute to explain the systematic difference observed between the outputs of reactive transport simulations and the field observations.
The present PhD project aims to clarify the elementary reactions that control the reactivity of mineral surfaces in order to result in a more realistic mechanistic model of the dissolution of silicates. The innovative nature of this project is based on the unique and unprecedented combination of state-of-the-art expertise in submicron mineral surface characterization and isotopic fractionation measurements available at LHyGeS. In addition, this thesis will contribute in collaboration with CEMHTI (Orléans) to the methodological development of nuclear magnetic resonance-dynamic nuclear polarization (NMR-DNP), in order to study the evolution of the local chemical environment of silicon at the fluid-mineral interface during dissolution, thus establishing a link between atomic organization and macroscopic dissolution kinetics.

## Methods:

- Fluid-mineral experiments (including high pressure high temperature vessels)
- Isotope geochemistry
- Wet chemistry
- Microscopy (scanning electron microscopy and vertical scanning interferometry)
- X-ray spectroscopy (X-ray reflectivity)

## Profile:

- Master degree (or equivalent) in Earth sciences, mineralogy, chemistry, physical chemistry, or a closely related discipline.
- Fluency in English and good communication skills.
- High degree of motivation and independence and ability to work well in a team environment.

## Salary:

~ 1600 euros, in accordance with the French Ministry of Research.

## Location:

Laboratoire d'Hydrologie et de Géochimie de Strasbourg (LHyGeS), Université de Strasbourg /EOST-CNRS UMR 7517, 1 Rue Blessig, 67000 Strasbourg, France

## Contact:

Please forward your applications with the standard documentation (cover letter, letter of motivation, CV and, optionally two references/letters of recommendation) by 15/05/2019, by e-mail to: Damien Daval (ddaval@unistra.fr) and Damien Lemarchand (lemarcha@unistra.fr).