Subject offered for a contract starting October 2018

**SUBJECT TITLE: Active acoustic monitoring of phase transformations under lithosperic pressure and temperature conditions**

Advisors: **SCHUBNEL, Alexandre, CNRS-CR, aschubnel@geologie.ens.fr**
**LABROUSSE Loïc, Prof. ISTEP, loic.labrousse@upmc.fr**

Host lab/ Team : **ENS- Laboratoire de Géologie de l'ENS- UMR 8538**

Financing: ERC consolidator REALISM

*For more information go to http://ed560.ipgp.fr, section: Offres de these ( PhD offer), You must apply on the Doctoral School website*

**Context:**

Geologists have long used the occurrence of high-pressure minerals, or mineral paragenesis, at the subsurface, as markers of past burial at mantle depth in convergent plate boundaries. The estimate of pressures is mostly based on thermodynamic data derived from equilibria reached in hydrostatic conditions in piston-cylinder apparatus experiments. Even though controversy about possible effect of "tectonic overpressure" is vivid in the geodynamics community, only few experimental studies have actually explored how shear stress and deformation can promote phase transformations, both in terms of kinetics and effective equilibrium conditions.

**Project:**

The experimental centerpiece of this project is a new generation of solid pressure medium deformation apparatus, designed to perform controlled rock deformation experiments on large volume samples (5mm diameter, 10mm long) up to 4GPa confining pressure and 1100°C temperature and monitored deviatoric stress. In this apparatus, where P and S elastic wave velocities can be measured *in situ* contemporaneously to deformation, metamorphic reactions can be monitored during strain, and feed-back between strain rates, reaction rates and development of textures can be quantitatively assessed. Elastic wave propagation will indeed be used as a non-destructive technique to track mineral reaction extent, in order to describe the exact **σ**-P-T envelopes of the phase transitions by combining the rock mechanics approach (plastic yield envelopes in the **σ**-P domain) with the thermodynamics and petrology approach (PT plots of mineral stability field). Relationships between reaction overstepping, strain rates and reaction kinetics will also be explored by varying strain rates and distance to expected equilibrium conditions. Experimental results will be complemented by thermo-dynamic modeling of reactions and elastic properties of minerals and post-mortem microstructural analysis (Raman, SEM, EBSD).

Three distinct, first order metamorphic reactions, occurring at depth in convergent settings and expected to have significant impact on elastic wave propagation will be studied experimentally within the course of this PhD. project:

- Melting of the continental crust, with the muscovite-dehydration melting,
- Mantle dehydration with the antigorite-out reaction.
- Olivine $\alpha$ to spinel structure transition in the Germanate system

As a by-product of this study, experimental data on S and P waves velocities will be acquired in realistic conditions and on complex assemblages, such values being so far derived from modeling or extrapolation of data acquired at lower pressures at least. This could have a first order impact on interpretation of tomography images in the convergent zones where the two mentioned reaction are inferred to occur, and therefore reach an even broader community.

This project is funded through the H2020 ERC 'REALISM', held by A. Schubnel.