



**Développement des mesures isotopiques in situ Rb-Sr et K-Ca par LA-ICP-MS et microsonde ionique pour la datation à petite échelle des processus géologiques hydrothermaux**

**Development of in-situ isotopic measurements of Rb-Sr and K-Ca by LA-ICP-MS and SIMS for small-scale dating of hydrothermal geological processes**

PhD jointly supervised at GeoRessources and CRPG (Nancy, France)

Period : 1 november 2018-october 2021 (36 months)

Supervision: Julien Mercadier (GeoRessources) and Etienne Deloule (CRPG)

**Summary** : the objective of the PhD is to develop new tools based on the K-Ca and Rb-Sr isotopic systems to date low to medium temperature geological processes at micro-scale. A significant part of mineral, petroleum and gas resources known worldwide can be linked to large-scale circulation of hydrothermal fluids ( $T < 400^{\circ}\text{C}$ ) in the crust. The understanding of the exceptional geological conditions which favored the transport and deposition of the resources is strongly linked to our capacity to define the age and duration of these processes. The temporal parameter is poorly constrained in the model of formation of resources because: i) the minerals and methods commonly used to date the geological processes cannot be adopted due to absence of these minerals (e.g. zircon, monazite) in hydrothermal conditions; ii) the potentially datable minerals by bulk methods are often too small and complex (several temporally disconnected processes potentially registered); iii) minerals could present alteration that perturbed their isotopic systems. Providing new temporal constraints for hydrothermal processes thus requires geochronometers that are adaptable to such conditions and applicable at small scale (micrometer) and *in situ*.

**Objectives**: the PhD project is centered on the development of *in-situ* dating based on K-Ca and Rb-Sr isotopic systems. K and Ca are two ubiquitous elements in hydrothermal systems and thus are present in numerous mineral phases. The use of these two isotopic systems is however limited by isotopic interferences linked to nearby masses of several isotopes ( $^{87}\text{Rb}$  and  $^{87}\text{Sr}$  for example) which did allow their application at small-scale. This project proposes to establish the conditions of use of these two isotopic systems using the recent advances in the analytical capacities of secondary ion mass spectrometer (SIMS) and LA-ICP-MS, for *in situ* and high-resolution dating of minerals. Our project proposes to take a new step in the development of geochronometers adapted for analysis of hydrothermal processes through the use and comparison of i) the last generation of high-resolution SIMS and ii) new generation of QQQ (triple Quadrupole)-ICP-MS allowing the specific management of isotopic interferences by La-ICP-MS. Following the establishment of the analytical procedure, the two isotopic systems will be applied to geological materials previously studied at Nancy. The first

target is the European Variscan belt and its numerous hydrothermal deposits enriched in Pb-Zn, W-Sn, Sb, U and related critical metals (Ge, In, Ga, REE, F, Li, Nb, Ta).

**Context:** the PhD student will co-located in GeoRessources lab (supervisor: Julien Mercadier) and at CRPG (supervisor: Etienne Deloule) at Nancy (France). The project fits into the research research themes Magma and deep fluids and Tectonic, erosion and evolution of relief of CRPG, and in the research theme "Ore Deposit" of GeoRessources lab. The student will develop K-Ca and Rb-Sr dating using the best tools worldwide, i.e. the LA-QQQ-ICP-MS (GeoRessources) and large geometry SIMS equipped with RF source (CRPG). The development of the new isotopic approaches will done in direct collaboration with the researchers and engineers of the SIMS and LA-ICP-MS teams from both laboratories. The results will be published in top scientific journals including specialized journals in analytical developments and geosciences and during international conferences Goldschmidt and equivalent).

**Prerequisite:** the candidate will have a Master degree in Earth Sciences or a related scientific disciplines. The candidate will have a solid scientific background, with knowledge in mass spectrometry. The candidate will like to work in team and in different scientific environments. Knowledge in LA-ICP-MS and/or in SIMS is considered as a bonus. The candidate will have a English level will allow him to write scientific articles in the best English-speaking journals.

**Contacts** :CV, cover letter and name of two references to be sent to Julien Mercadier ([julien.mercadier@univ-lorraine.fr](mailto:julien.mercadier@univ-lorraine.fr)) and Etienne Deloule ([etienne.deloule@univ-lorraine.fr](mailto:etienne.deloule@univ-lorraine.fr))

### **Deadlines**

Applications should be sent by July, 1<sup>st</sup>

Interviews will take place in July and/or August

The intended starting date is November, 1<sup>st</sup>

GeoRessources lab website: [georessources.univ-lorraine.fr/en](http://georessources.univ-lorraine.fr/en)

CRPG website : <http://www.crbg.cnrs-nancy.fr/index.php>

