Université d'Orléans
Institute Sciences de la Terre Orléans (ISTO)
Observatoire des Sciences d'Univers (OSUC)
1A rue de la Férollerie
45071 Orléans Cedex 2
FRANCE

Title: Experimental magmatic geochemistry of sulfur isotopes

Supervisors: Ken Koga (ISTO, Univ. Orleans) and Estelle Rose-Koga (ISTO, CNRS)

Description:

Sulfur is a ubiquitous element on Earth. In magmatic systems, particularly those linked to volcanic arcs, sulfur research provides information on the flow of magmatic volatile elements, as well as on the oxidation state of magmas. Siderophile elements (with an affinity for iron) and chalcophile elements (with an affinity for sulfur) of economic interest are favorably associated with sulfide phases (mineral and liquid), and consequently, the transport and partitioning (fractionation) of these elements in the Earth are intimately linked to sulfur behavior. Sulfur is abundant in volcanic gases, and magmatic sulfur degassing has an impact on the environment (e.g. acidification of rainfall, influence on climate...), so there are many reasons to study sulfur in Earth Sciences. However, among the magmatic volatile elements (H, C, F, S and Cl), sulfur is undoubtedly the element that behaves in the most complex way, with its multiple oxidation states in natural conditions ranging from -2 to +6. Research into the geochemical behavior of sulfur is therefore still active and timely. The applications of sulfur isotope geochemistry are diverse, encompassing topics such as Earth formation history, economic ore formation, and the assessment of magma flux beneath active volcanoes.

Sulfur has four stable isotopes: ^{32}S, ^{33}S, ^{34}S, and ^{36}S, with ^{32}S being the most common with 95% abundance. Typically, chemical reactions at high temperature do not differentiate between isotopes. However, fractionation of sulfur isotopes is observed in materials derived from volcanic eruptions, often attributed to fractionation during volcanic degassing. Though the mechanism and extent of this fractionation are not fully understood, several possible explanations exist.

We propose to lead this study on sulfur by a coupled approach consisting of isotopic geochemistry and experimental petrology, by quantifying the fractionation of sulfur isotopes in geological settings related to volcanic eruptions, especially those involving silicic magmatic system. This research is conducted in a laboratory using one-of-a-kind gas mixing furnace system capable of replicating high-temperature magmatic conditions including redox states. The calibrated isotope fractionation values obtained are crucial for interpreting geochemical processes, allowing for quantitative assessments of sulfur budget and transfer inside the Earth.

An educational background at the Master's level in Earth Sciences or related physical sciences is required for this research opportunity. Ideal candidates should possess familiarity with thermodynamic and kinetic theories, along with proficiency in computational skills using widely accessible scripting languages like MATLAB, Python, and R. While experience in high-temperature material synthesis is advantageous, it is not mandatory. A keen interest in working within an experimental petrology laboratory and a strong commitment to achieving the highest data quality are highly regarded qualities in potential applicants.

Application procedure:

The applications are accepted via email (kenneth.koga@univ-orleans.fr) until May 5th. Please include CV and a cover letter highlighting your research experience, and explaining your interests in the project.