Ecole Doctorale des Sciences Fondamentales

Title of the thesis: Sulfur-selenium-tellurium fractionation in vapor phase

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Summary:
Sulfur (S), selenium (Se), tellurium (Te) belong to the same column in the periodic table of the elements. The three elements are thus expected to have similar behaviors in petrological and geochemical cycles. For instance, in the condensation sequence of the Solar nebula, the three elements are moderately volatiles, with similar condensation temperatures, of the order 700K. In addition, in condensation sequence models, S and Se are considered as being chalcophile, condensing in FeS, whereas Te is considered siderophile, condensing in the Fe alloy phase [1]. Because sulfidation reactions may be an important process in the Solar nebula, it is critical to understand the relation between sulfidation reaction and element and isotope budget at the early stage of planetary formation [2-3]. With this respect, the elements S, Se, and Te have the potential to provide key information on the processes involving transport in a sulfur-bearing vapor phase. Similarly, in magmatic systems both Se and Te are highly compatible in sulfide melts, but only Se is compatible in monosulfide solid solution (MSS) [4]. Large Se-Te fractionation is thus expected during sulfide saturation, crystallization and resorption. A major consequence is that volcanic gases will have very different Se/Te ratios depending on the timing of magma degassing relative to that of sulfide saturation and crystallization [5].

This project aims at experimentally determining S-Se-Te fractionation during evaporation, as a function of temperature, pressure, and oxygen and sulfur fugacities. In addition, we will attempt to determine isotope fractionation associated with evaporation for the considered elements. The planned measurements will help constrain the behavior of these elements in contexts such as the reactions in the Solar nebula, the reactions associated to flash heating during high energy impacts on the Moon of other planetary body surfaces, as well as present day volcanic emissions on Earth.

The experiments will be carried at Laboratoire Magmas et Volcans, using a recently installed high-temperature furnace that will be fitted to either cold traps for selective phase separation or an inductively-coupled plasma mass spectrometer for direct analyses of the vaporized material.

[1] Lodders (2003); [2] Fehr et al. (2018); [3] Labidi et al. (2018); [4] Helmy et al. (2010) ; [5] Edmonds et al. (2018)