Volatiles mobilization and redistribution during orogenesis

Volatiles (e.g., H2O, CO2, Cl, F, Br, I) are molecules that generally move between the Earth's biosphere and atmosphere following a cycle. This cycle can extend also to the Earth's interior, it is defined deep volatile cycle and it is possible because of plate tectonics. The deep cycle although mostly hidden inside the Earth has/has had a strong influence on the evolution and differentiation of our planet. In particular, it affected the formation of oceans and atmosphere, the presence of life on Earth and climate changes.

The contribution of geological processes to the global budget of volatiles is a topic of great interest in the scientific community although the contribution of orogenic processes, i.e., formation of mountain belts, remains to be deciphered in its entirety. Mountain-building processes taking place in convergent margins have the potential to remobilize and redistribute a significant amount of volatiles during the different stages of orogenesis. The deep cycle starts with the segregation of volatiles in oceanic and continental crust rocks within minerals, in pores between the grains and in microfossils and organic matter especially on the seafloor. In convergent margins, when two plates move toward each other, the denser plate continues to move under the lighter one and toward the mantle in a process called subduction. During subduction, the crust transports the volatiles from the surface to the mantle. The crust on its journey is subject to processes such as dehydration and partial melting that release the volatiles and other incompatible elements (i.e., elements that are preferentially concentrated in a liquid phase rather than a solid) in fluids and melts. These fluids and melts, responsible for the volatiles transport, can interact with the overlying mantle enriching it in volatiles with a process called metasomatism. This process can trigger the partial melting of the mantle and thus the partial re-emission of volatiles to the atmosphere via volcanic eruptions above the mantle; hence closing the deep cycle.

Numerous studies of quantification of volatiles remobilization during the deep cycles concentrate on the subduction of the oceanic lithosphere whereas the study of the same processes during the subduction of the continental crust is still in its infancy. However, the data available show that it plays a role on the volatile global budget. Most of the studies focus only on one stage of orogenesis and a comprehensive study of volatiles mobilization during the different steps of orogenesis in the different portions of the orogen itself is missing.

This project aims to fill this gap and tackle the role of mountain-building processes in the remobilization and redistribution of volatiles by studying the agent responsible for these processes, i.e., melt and fluid inclusions, now trapped in high-grade rocks located in different portions of one of the major collisional orogen in Europe: the Caledonian orogenic belt. We additionally aim to pinpoint the timing at which volatiles' remobilization and redistribution occurred. For these purposes, we have selected three different localities belonging to three different portions of the orogen: Baltica (Western Gneiss Region, Norway) and Laurentia (North-east Greenland) plates margin and Baltic-Iapetus Ocean transition zone (Heia Nappe, Norway). The hypothesis that orogenic processes play a significant role in the remobilization and redistribution of volatiles in the different stages and portions will be tested. Suitable samples for the study of melt and fluid inclusions will be selected and detailed petrological and geochemical analyses will be performed. The inclusions will be characterized with a wide series of high-resolution techniques. Most inclusions occur in the typical metamorphic rock mineral i.e., garnet and the garnet shells in which the inclusions are trapped will be dated *in situ* with U-Pb method to obtain the timing of partial melting and volatiles-bearing fluid mobilization.

Among the volatiles the focus will be C and halogens (Cl, F, Br and I) and their distribution and concentration will be quantified primarily in melt and fluid inclusions but also in bulk rock and mineral phases. This set of information will allow us to calculate the volatile fluxes via mass balance calculations of the different portions of the orogens and during the different stages providing a better understanding of the contribution of orogenic processes to the global volatile budget. More generally this project will provide additional precious information for the global understanding of carbon and halogens behaviors and their remobilization and redistribution during the building of a mountain chain.