Earthquakes are a common phenomenon and testify Earth's lithosphere tectonic activity. Large earthquakes frequently occur in subduction environment when stress is released upon the rupture of the locked part of the interface between two plates. In subduction zones, during a progressive burial of the lithosphere, the increasing temperature triggers a series of dehydration reaction producing a large amount of the aqueous fluid phase. The released fluid affects the behavior and seismic features of the megathrust and contributes to triggering so-called intermediate-depth earthquakes at a depth of 60 - 300 km. However, due to the scarcity of recognized exhumed seismometamorphic rocks (i.e. rocks which formation is initiated and facilitated by seismic activity), the triggering mechanism for intermediate-depth earthquakes and the source of the fluid are largely unexplored. In such circumstances, the question arises - if earthquakes are so common, why there are so few geological reports of seismometamorphic rocks? In this project, we aim to overcome a gap in our understanding of seismometamorphism by assigning microstructural and geochemical features of dehydration reactions and related brittle fluid-release microstructures in (ultra)high-pressure metamorphic rocks of fossil subduction zones that represent the region affected by intermediate-depth seismicity.

In this project, we will study rocks from the Tsäkkok Tectonic Lens (hereafter as TTL) located above an Arctic Circle in Norrbotten, Sweden. The TTL is a part of Scandinavian Caledonides, an approx. 1000 km long Himalayan type orogen, which is composed of a series of long-transported allochthonous nappes thrust onto the autochthonous Baltica Shield. Scandinavian Caledonides has formed due to the collision of Laurentia and Baltica, in modern-day coordinates representing Northern America with Greenland and Northern Europe, respectively. The TTL represents a pre-Caledonian volcano-sedimentary succession which was buried at an exceptionally cold subduction zone prior to the final collision, metamorphosed and dehydrated at eclogite-facies conditions.

The project will comprise a laboratory work in order to (1) characterize microstructures that form during continuous and/or periodic fluid release events at high pressure conditions, and (2) constrain a distribution and composition, as well as the geochemical signature of released fluids. All in all, collected data will be compared to seismological observables to evaluate if the reconstructed mechanisms and fluid-release events match the seismic record in active subduction zones. To achieve our goals, we aim to employ a state-of-the-art methodology of 3-dimension electron backscatter diffraction (EBSD) coupled with micro-computed tomography (μ-CT) to unravel a complex microscale deformation recorded by the Tsäkkok eclogites. The chemical nature of the fluids involved in dehydration reactions will be assessed by micro-Raman spectroscopy, microthermometry and electron microprobe analyses (EMPA). This multi-method approach will be utilized to trace an elusive, and most frequently obliterated by later processes, signs of fluid-rock interaction.

Due to an extensive erosion which exposed the exhumed (ultra)high-pressure rocks at mid-crustal levels in the old Caledonian orogenic belt in Scandinavia, we have access to rocks which are undergoing similar processes nowadays within subduction zones in Japan, Alaska and Cascadia among many other regions. Our investigation brings forth the importance of seismic-related structures and will fuel the recognition of similarly deformed rocks that may be more widespread than currently realized. As a result of the collected data, the worldwide number of recognized localities recording intermediate-depth seismicity will significantly increase. This study will initiate interdisciplinary scientific debate by offering a new perspective to the record of subduction zones seismicity and fluid-rock interaction.