Studying quartz behavior in (ultra)high-pressure metamorphic rocks: common mineral with underappreciated potential

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The advance in modern technologies allowed the society for the exploration of the Universe which included f.E. successful landing on Mars (Pathfinder mission) or collecting geological data from Mercury and Venus using orbital probes. Although we are able to acquire information from other planets we are still having trouble exploring our planet Earth. One of the difficulties is to get access to the deeper part of the crust. The deepest borehole ever drilled on the Earth reached a depth of 12 262 m (Kola Superdeep Borehole finished in 1989), the second deepest borehole got to 9 101 m (German Continental Deep Drilling Program). The diameters of the drill cores do not exceed a few centimeters; hence the available material is limited. The global understanding of the natural hazards impacting the communities all around the globe, including f.E. earthquakes and volcanic eruptions, requires an in-depth understanding of the processes happening in the Earth's crust and mantle. Geophysics can provide data from the depths of a few tens to a few hundred km. However, the only way to get information about the processes happening deep under the Earth's surface is the detailed study of the very rare fragments of the crust that was subducted to the greater depths, metamorphosed and exhumed back to the surface. Such a situation can occur mostly in the subduction setting, where the high-pressure (HP) and under extreme conditions, ultrahigh pressure rocks (UHP) such as eclogite and UHP gneisses could form.

Hence the primary goal of this project is to investigate the deeply subducted metamorphic rocks that experience (U)HP conditions. We are going to look for (U)HP metamorphism indicators, although the main focus will be on quartz and its HP polymorph - coesite. Quartz is a very common mineral in metamorphic rocks, which has been given some attention in the past but still remains under investigated. The subject of this study will include both natural examples, well described (U)HP rocks from Scandinavia, Svalbard and the Alps, as well as synthetic materials i.e. products of experiments that were performed in the broad range of pressure – temperature conditions. The proposed analytical approach consists of a combination of novel techniques, which will allow for a detailed characterization of quartz and coesite within a set of representative samples. It is planned to apply Raman elastobarometry, trace element thermometry, speedometry, electron backscatter diffraction and acoustic impedance studies. The latter technique is a tool successfully applied in f.E. petrological studies of sedimentary rocks studies but is very rarely applied to other rocks. The new geothermobarometry for (U)HP rocks based on the acoustic impedance will be developed and tested on natural and experimental samples in the proposed research. Last but not least, a series of experiments will validate the transition between quartz and coesite.

The proposed project will provide significant input into the global debate about the deep burial of the crust. Moreover, the results of this project will extend our knowledge about quartz behavior under (U)HP conditions. This, in turn, will help in the further recognition and characterization of (U)HP terranes.