Monazite, xenotime and allanite are accessories representing the main hosts of rare earth elements (REE) in the Earth's crust, and because of their Th and U contents they are used in geochronology. The last two decades of development of microanalytical techniques significantly increased potential of the application of these phases in petrological constraints. Application of electron microprobe (EPMA) or laser ablation – inductively coupled plasma mass spectrometry (LA-ICP-MS) *in-situ* dating of minerals (commonly their internal domains) allows to combine obtain dates with microtextural context to constrain ages of geological processes, that induced formation of particular minerals or their internal domains. Monazite, xenotime and allanite are the accessory minerals that find broad applications in petrochronological reconstructions of igneous and metamorphic processes. Because these phases can be altered due to fluid activity in metamorphic, post-igneous or hydrothermal processes, it is important to constrain factors controlling these alterations, the mechanism of these processes and their influence on age record. It is particularly crucial in terms of our understanding which processes is dated. Moreover, alterations of monazite, xenotime and allanite commonly include replacement by secondary minerals that accumulate REE, Th, U and Pb released from the altered phase. However, the data on transformations of these phases during alterations are limited, and it is required to characterize these processes in nanoscale.

This project aims to reconstruct mechanisms of monazite, xenotime and allanite alterations in nano- and microscale, the influence of these processes in isotopic U-Pb record, as well as includes development of microanalytical methods. The study will be conducted on crystalline rocks from the Sudetes and products of previous experiments of Principal Investigator, that were aiming to constrain stabilities of monazite, xenotime and allanite in the presence of fluids, under broad range of P-T conditions (200–1000 MPa, 250–750°C). Because previously used methods did not provide sufficient data, it is required to apply other techniques to constrain phase transformations in nano- and microscale related to alterations of these minerals, and to characterize REE, Th, U and Pb distribution between these phases. Transmission electron microscopy (TEM) will provide fundamental data to characterize and reconstruct natural processes, where P-T conditions and composition of fluids that induce alterations are commonly difficult or not possible to determine (in opposite to the products of laboratory experiments selected for this project). Application of isotopic LA-ICP-MS analyzes to constrain degree of discordance of U-Pb record in altered monazite and xenotime from previous experiments will provide crucial data to characterize influence of fluid-mediated alterations to age record in natural samples, depending on P-T conditions.

The methodological part of the project involves collection of the Raman spectra for unaltered and altered monazite and xenotime in broad range of P-T conditions. The collected database will serve as the basis for interpretations of Raman micro-spectroscopy in natural monazite and xenotime. Furthermore, the project involves improvement of the EPMA trace elements analytical protocols for REE. The analytical protocols for currently two most commonly used models of electron microprobes will serve as the basis for measurements of trace elements in EPMA laboratories, including analytical procedures of the Th-U-total Pb dating of monazite and xenotime. The methodological study requires the high quality standards for Raman micro-spectroscopy and EPMA trace elements measurements, therefore the project involves synthesis of each REE (Y, La-Lu) phosphate.

The project will provide crucial data for petrochronological reconstructions involving monazite, xenotime or allanite. The increased knowledge on these is necessary for understanding processes occurring in nanoscale for proper interpretations and reconstructions of igneous, metamorphic and hydrothermal processes in the Earth's crust.