Increasing the reliability of optically stimulated luminescence dating through innovative methods of dose rate determination

Luminescence dating, especially with the use of the optically stimulated luminescence method (OSL), is commonly used to determine the age of Quaternary sediments, bricks, and archaeological artifacts. This technique has been recognized by representatives of many scientific disciplines: geologists, sedimentologists and archaeologists. In dating, dosimetric properties of such minerals as quartz and feldspar are used. These properties allow for the accumulation of the effects of the interaction of ionizing radiation with the mineral crystal lattice. The source of ionizing radiation are mainly natural radioactive isotopes included in the uranium and thorium radioactive series and ^{40}K. In order to determine the age of the tested sample, it is necessary to know the values of two parameters: the equivalent dose (corresponding to the stored luminescent signal in the mineral's crystallographic lattice) and the dose rate (corresponding to the rate at which the equivalent dose increases in the natural environment). Determining these two values requires the use of specialized research equipment and a labor-intensive chemical preparation.

Most laboratory techniques and procedures are geared towards the accuracy and precision in determining the equivalent dose value, whereas problems with the dose rate measurements and calculation are marginal. It is for this reason that it was decided to undertake all scientific activities and research aimed at improving the methods of determining the dose rate. The main goals of our project are: 1) the development of luminescence dating methods by improving the dose rate measurements, 2) internal dose rate assessing for different types of materials, 3) comparing independent laboratory instrumentation and verify the dose rate calculation, 4) luminescence analysis and age determination using OSL method. In order to fully achieve the intended goals, we would like to measure approximately 50 samples, including bricks, dune and loess sediments. The project provides for: 1) measurements of the concentration of radioactive isotopes using a semiconductor spectrometer, the μDose system and the ICP-MS spectrometer, 2) the equivalent dose determination, 3) testing the properties of quartz grains by utilizing laser diffraction, rounding and frosting analysis, 4) determination of the modal mineralogy of the tested material using the QEMSCAN analysis. All the above-mentioned studies will be the basis for increasing the precision in calculating the luminescence age of the tested materials and will provide us with information on the microdosimetric properties of quartz grains and its impact on the determination of the dose rate components.

All research tasks planned for the project are inspired by our previous research carried out at the Luminescence Dating Laboratory of the Silesian University of Technology in Gliwice. Our initial analysis indicate that we have created the possibility for advancement of environmental dose rate, what was made by the internal dose rate determination. It should be highlighted that our findings indicate and confirm that pure quartz grains (after etching) contain radioisotopes and that the only source of radioactivity is not radioactive isotopes from outside. Our preliminary results show that ignoring internal alpha and internal beta components during the dose rate evaluating can overestimate the luminescence age. Additionally, in turned out that we cannot use the only one value for the internal correction. These conclusions allowed us to prepare research tasks and increase the thematic scope of the project.