Physical weathering or the process of mechanical disintegration of the rock leads to its physical changes, as a consequence of which it is crumbled into the fragments of a finer fraction. If these changes occur as a result of cyclic changes in temperature causing freezing and thawing of water in rock pores and fissures, then they are referred as the frost weathering. There are several factors that affect the intensity of frost weathering, among which one of the most important is the frequency of the temperature oscillations across the 0˚C point. Conditions favourable for the frost disintegration of rocks occur in a cold climate, especially in the periglacial environment which occupied the foreland of ice sheets and glaciers during the Pleistocene. The present-day periglacial environment affects about 35% of the Earth's land area, however its extent was changing in the past, due to the changes in the extent of ice sheet/glaciers. Therefore, the effects of frost weathering are commonly recorded in the ancient sediments. These effects can be observed both on a macro scale, as cracked and weathered rock blocks or boulders, and on a micro scale, as cracked mineral grains. Frost weathering activity is also marked as a wide range of the microstructures formed on the surface of mineral grains that have been subjected to freeze and thaw cycles. Example of these are sand-sized quartz grains which are more susceptible to this type of weathering than, for instance feldspar grains, what stems from the presence of inclusions in their crystal structure. Considering the widespread occurrence of quartz in the deposits from various sedimentary environments, it can be treated as a source of information about past environments and processes operating within them. Thus, the examination of a single quartz grain using scanning electron microscope (SEM), whose surface was subjected to changes in the periglacial environment, allows the determination of how these processes were recorded on its surface. However, the process of quartz grains frost weathering in the micro scale is still poorly understood, and the factors determining its course are difficult to determine.

The objective of this project is a long-term laboratory experiment (about 5000 cycles) simulating frost weathering of the quartz sand grains (0.5-1.0 mm). The planned experiment will be the first to enable such long-term simulation of the periglacial conditions. Quartz grains will be subjected to cyclic oscillations of temperature around 0˚C. For this purpose, a freeze-thaw device will be designed and equipped with a special software enabling cyclical temperature changes in the range of -5˚C to +10˚C. One full freeze-thaw cycle will last four hours. The experiment will include a total of 28 samples resulting from a combination of four types of quartz (vein quartz, quartz with the overgrowths, aeolian quartz, beach quartz), three different moisture conditions (dry sample, sample lying on a damp surface and completely flooded sample) and three degrees of water mineralization (distilled water, low-mineralized water, high-mineralized water). After a defined number of cycles (300, 1000, 2000, 3000, 4000 and 5000), a sub-sample will be taken from each sample and further subjected to detailed analyses. The grain size analysis, microstructure analysis of the quartz grain surface using scanning electron microscope (SEM) and fractal analysis of the grain surface will be performed.

The planned research is aimed at deepening the knowledge about the micro-scale frost weathering. The obtained results will allow, among other, to answer the following questions: (1) in what size range the grain production occurs due to the frost weathering, (2) what factors determine the course of the micro-scale frost weathering, (3) whether the micromorphology inherited from the earlier environments has an impact on the course of weathering and its intensity, and (4) what microstructures are formed on the surface of quartz grains as a result of the frost weathering. In addition, the relationship between the amount of a silty fraction resulting from the frost weathering and the microstructures forming on the grains will be determined. An extensive literature and numerous research results of scientists from around the world suggest that there is a production of a silty fraction and formation of the microstructures on the quartz grains along with the frost weathering advance. However, our knowledge still lacks the answers for many questions. The conduction of the planned experimental simulation and interpretation of the received dataset will allow to solve the above-mentioned problems. The obtained results will permit not only the reconstruction of the environmental conditions of the previous geological periods, e.g. the extent of the active layer, but also may be of a great application importance, especially in the industry fields connected with the usage of siliciclastic rocks in constructions and the exploration of rock resistance to the weather conditions.