Abstract for the general public:

The fate of metallic elements during mineral carbonation of ultramafic rocks and associated mining and smelting wastes.

The climate changes we are seeing today are largely due to anthropogenic emissions of greenhouse gases. The changing composition of the atmosphere has made 2020 one of the hottest years since the start of regular temperature measurements. Carbon dioxide, which is a direct product of the combustion of fossil fuels and broadly understood as industrial production, is the main component that enhances the greenhouse effect on Earth. For years, solutions have been developed to reduce the carbon dioxide present in the atmosphere. One of the methods of CO_2 bonding is the mineral carbonation of rocks (ultramafic rocks) and anthropogenic materials (iron and steel slags). As a result of the reaction of silicates (the main components of rocks and slags) with CO_2, carbonates that are stable under surface conditions are formed. Mineral carbonation allows CO_2 to be permanently bound and removed from the atmosphere. It should be noted, however, that both ultramafic rocks and metallurgical slags contain elevated concentrations of the so-called heavy metals. These elements can be mobilized during mineral carbonation and reach the environment (soil, surface waters, groundwater). The main goal of the project is to determine how the mineral carbonation of ultramafic rocks and related mining waste (laterite Ni-bearing crust) and metallurgical waste (nickel slags) affects the distribution and mobility of heavy metals. The implementation of the project will allow answering several research questions important from the environmental point of view. It will be verified whether the environmentally hazardous metallic elements are stably bound in the structure of newly formed carbonates, or whether they are removed from the system and get into the environment. In addition, the stability of mineral carbonation products in terms of the mobility of metals bound in these materials will be determined. The project will be implemented in several stages. First, the exact mineralogical and chemical characteristics of the tested materials will be performed. After selecting representative samples of rocks and industrial waste, experiments will be carried out to simulate the processes of natural carbonation (low pressure and temperature conditions) and carbonation, which is usually carried out on an industrial scale (high pressure and temperature conditions). The next stage of the research involves carrying out experiments aimed at optimizing the process of mineral carbonation and analyzing more diverse materials. The reaction products will then be carefully analyzed after the experiments using the same set of methods as before the experiment (chemical and phase analysis of solid carbonation formations). Additionally, the chemical composition of the solutions in which the rock and waste samples reacted with CO_2 during the experiments will be examined. The final step will include experiments aimed at testing the long-term stability of the carbonated materials using leaching tests simulating environmental conditions. Such a multi-stage and multi-approach research will enable determining the distribution and mobility of heavy metals in mineral carbonation products and analyzing their migration paths resulting from the mineral carbonation process.