

The currently popular photovoltaics is one of the ecological methods of obtaining energy. Its share in the energy sector is growing every year. Photovoltaic panels hang on houses, roofs, and huge photovoltaic farms are created in order to obtain cheap and safe energy. Are they really so clean? Are photovoltaic-powered so-called 'smart cities' vulnerable to the emergence of new environmental pollutants? Photovoltaic panels are constantly exposed to the sun, wind and precipitation, which may damage them. Are damaged photovoltaic panels by the so-called microdamages do not release the elements they are made of? The photovoltaic panels include, among others, elements from the TCE group (Technology Critical Elements). TCE are used in many industries, including electronics, electricity and many others. Therefore, the authorities of the European Union are paying attention to the scientific community to study these elements, as information in the world literature about TCE and their speciation (forms of occurrence) is extremely scarce, especially for elements such as indium, gallium and germanium. They all play an important role in key new technologies. Germanium accumulates in organs of the human body and may cause inflammations and neoplastic changes. Indium can cause fatal lung diseases by inhaling its particles. Tellurium, contained in some PVs, is considered toxic and teratogenic. The role of gallium in living organisms has not yet been fully understood. However, gallium ions in water lead to diseases of the immune system and a decrease in the number of leukocytes.

The project assumes the implementation of several research goals. The first one is to learn about the transformations and mobility of selected TCE and their species in soils, soil solution and runoff waters in the areas of the immediate vicinity of photovoltaic panels. Another aim will be to study the influence of photovoltaic panels damaged by microcracks on the release of potentially toxic elements into the environment together with critical elements. Soil - as an element of the natural environment, it is the main recipient of potentially polluted wet precipitation (rain, snow, ice) flowing down the photovoltaic panels. Geochemical modeling, based on appropriate input data, can provide a deeper insight into the transport processes of critical elements (and their species) leached from PV, migration, due to sorption or complexing in the soil-water environment. The research will answer a several questions: Does the concentration of gallium, germanium, tellurium and indium increase in nature with the increase of their use in photovoltaics? Does the vicinity of photovoltaic panels increase the concentration of selected TCE in soil and groundwater? How does the concentration of selected TCE in the soil change with the distance from the photovoltaic cells? What are the species of Ge, Te, Ga, In in soils, soil solutions and runoff waters subjected to such anthropopressure? How deeply do selected TCE migrate in the soil profile? What is the level of ecological health risk in the studied areas? How high the adsorption capacity of the studied soils is for In, Ge, Ga, Te ions, how strongly these ions are bound in the different fractions of the soils and how the adsorbed ions behave in relation to the different environmental conditions.

The proposed scope of research and the method of developing and interpreting the obtained results will allow to create an extremely comprehensive and analytically advanced project on the qualitative and quantitative analysis of selected TCE species related to photovoltaics, their mobility and environmental impact. Implementation of the research goals of the project will require interdisciplinary cooperation of specialists in the field of geochemistry, soil science, environmental engineering, instrumental chemistry, metallurgy, geochemical modelling and ecotoxicology. New research, analytical and computational procedures, which may become standards, will also be developed. The project will use a modern research techniques including modern analytical techniques such as ICP-MS, ICP-OES (for determining the total content of elements), combined HPLC-ICP-MS (for the determination of TCE species), SEM-EDX, TEM, electroluminescence, thermal imaging camera and X-ray diffraction. The implementation of a wide range of chemical analyses will also allow for the improvement and optimization of the research methodology in the field of chemical fractionation of TCE.

The project concerns original, experimental research work, undertaken primarily in order to gain new knowledge about the fundamentals of phenomena and observable facts without focusing on direct practical application. Due to the low level of knowledge about TCE, their forms and changes in the environment, as well as the systematic increase in the use of photovoltaic panels (rich in TCE), the research planned in the project is very important. The research will make a significant contribution to the assessment of the mobility of selected elements (Ge, Ga, Te, In) belonging to the TCE. It will provide new information and supplement the current state of knowledge about the speciation of the above-mentioned elements in the environment. The prepared and tested methodologies for determination of the total content of PTE/TCE and species of germanium, gallium and indium in soils will be the important result of the project. The results of the planned research will make a significant contribution to environmental engineering, analytical chemistry, metallurgy, geochemical modelling, soil science, kinetics and adsorption of technology critical elements. The result of the project will be the creation of a geochemical model and guidelines that can be used by local government units. In addition, the project will contribute to numerous scientific publications and conference reports presented on the national and international arena, as well as PhD thesis.