The aim of the research project is the synthesis of natural origin composite materials based on alginic acid salt and their use as adsorbents of rare earth elements (REEs). According to the European Union directives, these elements are classified as critical raw materials. Due to their wide application in almost every area of life, their demand is constantly increasing while the resources and availability are decreasing due to supply disruptions. The reason is the export quotas imposed by China, which is the main exporter of these raw materials. Currently, China contributes to around 70% of global rare earth production and possesses half of REE's global reserves. Therefore alternative sources of rare earth elements as well as effective and ecological methods of their recovery are sought. The project assumption is to prepare new adsorbents - the composites in which sodium alginate will be a matrix and natural materials will be the dispersed phase. To modify the matrix, natural zeolite - clinoptilolite, waste raw material - biochar and biopolymers - lignin and cellulose will be applied. The use of these sorbents for rare earth ions removal from aqueous solutions is not fully understood, therefore research in this area is justified. To achieve this, the obtained materials will be used to determine the sorption properties in the removal of rare earth elements, i.e. lanthanum (La(III)), cerium (Ce(III)), praseodymium (Pr(III)) and neodymium (Nd(III)) from the model aqueous solutions. The sorption studies of the above-mentioned metal ions from the multicomponent systems on the most effective materials will be also carried out.

The subject of the planned research assumes carrying out optimization of the sorption process of La(III), Ce(III), Pr(III) and Nd(III) ions on the alginate composites. It is planned to determine the effects of various parameters, i.e. solution pH, sorbent mass, phase contact time, initial solution concentration and temperature. To assess the regeneration possibility of the materials after the sorption studies, the desorption process will be performed and the materials reuse in the subsequent sorption/desorption cycles will be made possible. Sorption and desorption tests will be carried out using a static method. The obtained test results will allow to determine basic parameters characterizing the sorption process, such as equilibrium capacity, sorption and desorption percentage. Additionally, in order to confirm the effectiveness of the static method, it is planned to conduct the sorption process by the dynamic method using the columns filled with the adsorbent bed. After sorption and desorption the metal ion content will be analyzed by means of inductively coupled plasma optical emission spectrometry. The key step will be to compare the equilibrium capacities obtained before and after the alginate modification which will allow to determine the influence of the modification process on the metal ion removal efficiency. The obtained composites will be subjected to physicochemical characteristics before and after the sorption process using X-ray diffraction methods, scanning electron microscopy, gas adsorption and porosimetry analysis, Fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy, elemental analysis and thermogravimetry. There will be also determined the surface charge of the materials by the potentiometric titration method and the grain size distribution by the sieve method. The analysis of the physicochemical characteristics and the determination of kinetic, equilibrium and thermodynamic parameters will enable evaluation of the process rate and the mechanism of metal ions sorption on the tested materials.

The expected project results should be considered in the aspect of obtaining new adsorption materials used in the recovery of rare earth elements. The obtained results will allow to broaden the knowledge about the physicochemical and adsorption properties of the obtained composites and their interactions with the rare earth ions having an oxidation state of +III. It is also worth pointing out that they constitute a significant supplement to the literature reports in the analyzed thematic area.