

Phosphogypsum stacks: from environmental issues to valorization through circular economy processes

Phosphogypsum is a by-product of the wet production process of phosphoric acid from phosphate minerals. Since the 1950s, many industries in Europe used this process to produce fertilizers and detergents. Processing residues and waste were often dumped near production facilities or dispersed in sensitive areas such as river estuaries or coastal lagoons, resulting in the release of toxic substances into the environment and damage to the ecosystem. In Europe, to this day, there are still many areas with non-contained phosphogypsum deposits, which pose significant environmental, social and economic problems. Phosphogypsum is mainly composed of a calcium sulphate matrix and contains natural radionuclides (mainly ^{226}Ra , ^{210}Pb , ^{210}Po) in different concentrations, depending on the composition of the starting mineral; it can also contain elements such as phosphorus and fluorine, heavy metals as zinc, copper, chromium, cadmium and some Rare Earth Elements (REEs). From the perspective of circular economy, they are therefore increasingly considered a resource from which extract new raw materials. In this webinar, the main environmental issues of phosphogypsum stacks are examined and the options currently under study for the valorisation of phosphogypsum in the perspective of the Fic-Fighters project are evaluated.



Dr. Beatrice Morelli, research fellow at CNR-ICMATE (Padua) since 2023, Bachelor's degree in Archeology and a Master Degree in Geology. Her research is mainly focused on the radionuclides, both natural and artificial, presence in various matrices measured by gamma spectrometer analysis. She studied the applications of the radionuclides, such as a monitoring action, an useful alarm, as geological tracers and the topic of the green economy applied on the dangerous waste materials such as the phosphogypsum by a geological and physical point of view.

Technological proposals for recycling phosphogypsum into the circular economy: challenges from laboratory to industry

The FIC-Fighters project proposes sustainable alternatives for managing phosphogypsum (PG), a waste product that has been accumulating near cities for decades. The initiative focuses on the valorization of PG to generate raw materials for the paper, cement, battery, fertilizer, and detergent industries, ultimately freeing up occupied land for restoration and transformation. To achieve this, the project builds upon laboratory-scale findings to optimize and scale up two key chemical procedures: an alkaline attack of the PG (using pure NaOH or NH_3 or reusing liquid alkaline wastes from the aluminium industry), followed by a carbonation reaction in aqueous media. These procedures have proven to be efficient technologies for reusing PG in carbon capture while producing valuable industrial by-products such as Na_2SO_4 , $\text{Ca}(\text{OH})_2$ or CaCO_3 . To ensure economic and environmental viability, the process is being optimized to maximize PG conversion and by-product quality. Parameters of the reaction such as reactive concentrations, reaction kinetics, reactor design, CO_2 flow, and filtration strategies are being researched. Additionally, the project researches the presence and recovery of rare earth elements (REEs) and critical raw materials (CRMs) found in PG stockpiles. Characterization is conducted using physico-chemical techniques such as XRD, XRF, ICP-OES, and TGA/SDT. Finally, a detailed investigation into the fate of radioactive traces throughout the process is being performed to guarantee the safety of the final products.

Prof. Victor Morales Florez. Dept. Condensed Matter Physics (University of Seville). Materials Physics, Ceramics. Focused from theoretical aspects of structure and mechanical properties of materials to applied research developing industrial applications. Working in the reutilization a decade. procedures of phosphogypsum as a sink of CO_2 and as a source of new raw materials since more than a decade.

Seminar "MATERIALS MATTER"



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