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Solid Characterization of Phosphate Mining Waste and Byproducts for Rare Earth Element Recovery

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Waste from phosphate mining represent significant unconventional resources for the recovery of rare earth elements (REEs). In Florida alone, approximately 11,080 tons of REEs can be recovered annually, which are critical for the U.S. economy. This collaborative research with DOE national laboratories, academic institutions, and industrial partners aims to recover mixed rare earth oxide/salts from phosphate processing wastes such as phosphoric acid evaporation sludge and phosphogypsum.

The objective of this research is to establish REE production in Polk County, Florida, addressing the environmental justice challenges faced by this historically underserved community. With over fifty years of phosphate mining history, Polk County grapples with environmental issues such as waste settling ponds, phosphogypsum stacks, and compromised groundwater. This research ensures equitable implementation of the Bipartisan Infrastructure Law, focusing on DOE priorities like workforce investment, community engagement, diversity promotion, and adherence to Justice 40 principles. By leveraging collaboration with DOE labs, academic institutions, and industry partners, this project aims to extract REEs from phosphate processing wastes, contributing to economic growth and environmental sustainability in Polk County.

The study focuses on characterizing solids to evaluate the mineralogy, surface morphology, and elemental composition of fresh acidic sludge, leached residuals, and phosphogypsum samples. These analyses aim to understand the mineralogical makeup and elemental distribution in waste materials to support REE leaching. Both initial samples and leached residuals were analyzed using X-ray Diffraction (XRD) and scanning electron microscopy/energy-dispersive X-ray spectroscopy (SEM/EDS). Mineralogy assessments were conducted using the D2 PHASER Bruker X-ray diffractometer with an LYNXEYEXET detector, operating at 30 kV and 10 mA. SEM/EDS analysis of experimental samples was performed using the JEOL JSM-5900LV at 25.0 kV. The results revealed the mineralogical composition, indicating that rare earth elements (REEs) were predominantly associated with iron (Fe) and iron-phosphate (Fe-P) bearing particles. Specifically, dysprosium (Dy) and terbium (Tb) were found to be linked with Fe, while yttrium (Y) and scandium (Sc) were aligned with phosphorus (P) and fluorine (F). Additionally, larger-sized particles, particularly those in the +35 and -35+100 mesh fractions, exhibited higher concentrations of P and Fe and were associated with Y, Dy, europium (Eu), and Tb.