Repurposing Historical Iron Slag as a Sustainable Source of Rare Earth Elements: A Case Study from Centre Furnace in Pennsylvania

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Rare earth elements (REEs; including the lanthanides, scandium, and yttrium) are critical to the global transition to renewable energy and advanced technologies, as they are essential components of wind turbine magnets, solar panel glass, display screens, and electric vehicle batteries. However, primary REE deposits are often of low grade and environmentally costly to develop. This study investigates the potential for historical iron smelting slag to serve as a secondary, low-impact source of REEs.

We focus on slag from the Centre Furnace in Centre County, Pennsylvania—a major 18th to early 20th century iron production site. Slag is a silicate-rich, glassy waste product generated during smelting, formed by the reaction of iron ore with limestone flux. Typically discarded or used for aggregate, slag has rarely been evaluated as a potential source of critical minerals. Our geochemical analysis reveals total REE concentrations ranging from 600 to 1,000 ppm in the Centre Furnace slag, exceeding the generally accepted threshold (~300 ppm) for REE resource interest by a factor of 2–3. Importantly, the amorphous and pre-processed nature of slag suggests that REE extraction could be more efficient and cost-effective compared to conventional hard-rock sources.

This case study highlights the potential of historical smelting waste as a viable REE resource and underscores the broader opportunity for re-evaluating legacy mine wastes in the context of critical mineral supply and environmental remediation. Ongoing work aims to determine whether this enrichment is a localized anomaly or characteristic of broader slag deposits across Pennsylvania’s historic iron districts