Critical Minerals from Waste Streams in the Powder River Basin of Wyoming and Montana, USA

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Background/Objectives. Critical minerals (CM) are essential for numerous industrial and defense applications, including green technologies that will help to meet carbon emission reduction goals. Many CM are currently mined and processed in countries that lack stringent environmental and labor regulations. Unconventional sources such as existing industrial waste streams could play a part in building an ethical CM supply chain. Additionally, waste streams created in the extraction and processing of CM could be used for other industrial or commercial purposes, thereby reducing waste and advancing a circular economy.

Approach/Activities. The Department of Energy-funded Powder River Basin (PRB) CORE-CM project is exploring all aspects of the carbon ore, rare earth element (REE), and CM value chain, including the potential for extraction of CM from industrial waste streams in the basin. Waste streams that have potential as CM feedstocks are being inventoried to assess the concentration of CM in each waste stream and to estimate volume and accessibility. Although basin-specific technologies for extraction of CM are still in development, waste streams that may be produced during these processes are being cataloged and mapped to potential secondary uses.

Results/Lessons Learned. Initial studies of the CM potential of PRB coal ash show that this waste stream contains concentrations of greater than 300 ppm total REE (Bagdonas et al., 2022, Renewable and Sustainable Energy Reviews). Moreover, calcium-rich PRB coal ash is amenable to REE extraction (Taggart et al., 2016, Environmental Science and Technology). Wyoming coal is shipped to 28 states, meaning that coal ash produced at power stations across the US represents a potential widespread resource for the extraction of REE.

In addition to coal mining and coal fired electricity generation, the PRB is home to other energy industries including oil and gas production, in-situ uranium mining, and bentonite mining. Historically, precious and base metal mining has taken place on the perimeter of the PRB. Waste streams from these industries are currently being evaluated for their CM potential.

Assessing the CM resource potential of waste streams could contribute to the development of an ethical CM supply chain. Results from these studies can be replicated for other waste streams, increasing the likelihood of successful creation of circular economies.