

Rare Earth Elements and Critical Minerals from Coal Resources

SME Statement

Rare Earth Elements (REEs) and Critical Minerals (CMs) are widely used in defense and commercial electronics, renewable electricity generation and batteries. Their use is expected to expand rapidly as battery use and renewable electricity generation expands. The U. S. domestic supplies of REEs and CMs are extremely limited and vulnerable to disruption because the U.S. is dependent on other nations, many of which are considered as unfriendly and could easily restrict their supply. The U.S. Department of Energy (DOE) has funded research of coal resources (strata, coal mining wastes, coal mine drainage and coal ash) to determine potential resource concentrations and to develop new process technologies to economically recover the REEs and CMs. This technical brief will provide SME's perspective of this potential opportunity.

Background

The 2012 report that Leonardo Technologies, Inc. (LTI), prepared for the DOE's Natural Energy Technology Laboratories (NETL) documents rare earth concentrations in coal deposits in the United States. Using the United States Geological Survey (USGS) Coal Quality Database of over 13,000 samples, LTI reported that "Various coal deposits showed elevated levels of rare earths". Subsequent to the LTI report, NETL engaged Tetra Tech Inc. (Tetra Tech), as a subcontractor to LTI, to assess the REE content in select U.S. coal basins. The Tetra Tech report, dated January 2015, concluded "Studies conducted in recent years by the USGS and private concerns noted that REEs are present in coals throughout coal basins of the United States. These REEs appear to be concentrated in the waste products of coals such as finely mixed clays, coal-partings, under-clays, waste rock and fly or bottom ash. The results of this study support the contention that REE occurrences in coal and associated waste materials have the potential to be an important and viable source of rare earths, especially if mining costs can be minimized by coupling the extraction process with conventional coal mining practice. "

NETL expanded on the Tetra Tech study by completing additional sampling and testing of coal strata, coal wastes, fly ash and acid mine drainage. In 2016 NETL funded five projects to identify, field sample and chemically analyze coal, coal by-products and acid mine drainage from various geologic regions. Subsequently, NETL further funded research by numerous universities, including Duke University, Kansas University, New Mexico University, Pennsylvania State University, University of Illinois, University of Kentucky, University of North Dakota, University of Utah, University of Wyoming, Virginia Polytechnical Institute and State University, and West Virginia University, of mineral processes to economically recover REEs and CM's from the various feedstocks. Several feasibility studies were also completed. The NETL research can be found at www.netl.doe.gov.

Speaking as the 2021-22 SME Henry Krumb lecturer, Ms. Mary Ann Alvin gave a paper entitled “Rare Earth Elements and Critical Minerals”. The abstract to this paper states “REEs and CMs are vital to the increasingly high-tech economies of the modern world. They are used in the production of medical equipment, clean energy components, electric vehicles, electronics, military weapons and guidance technology and a wide variety of consumer goods. However, most of the world’s REE supply chain are produced and controlled overseas. NETL and the U.S. DOE are dedicated to establishing a domestic supply of REEs and other economically vital CMs, which has been the focus of NETL’s research. Alternative domestic sources of REEs and CMs, apart from mining operations, focus on recovering them from the country’s vast supplies of carbon ore and by-products, such as fly ash and acid mine drainage. NETL is pursuing a portfolio of projects with its partner organizations aimed at optimizing REE and CM production from these unconventional sources, which can lead to economic and environmental benefits such as new jobs in remediating or restoring old mining sites and collecting the sought-after elements in the process.”

The U. S. National Coal Council (NCC) also completed a report on REEs and CMs in October 2021, entitled “Carbon Forward – Advanced Markets for Value-Added Products from Coal.” The National Coal Council at that time was a Federal Advisory Committee established under the authority of the DOE. The NCC report addressed recovery of REEs and CMs from coal and concluded “Recovering REEs from coal waste resources would have numerous advantages. Mining and logistics costs would be negligible compared with traditional REE/CM mining methods. The carbon resources are “shovel ready” in that they are surface mine reserves and the material is already beneficiated for the most part, requiring less energy and expense to produce. These factors significantly reduce the cost of extraction and separation. Distribution of REE separation plants sited at or near the reserve sites would eliminate the need for extensive transportation. Finally, REE recovery from waste carbon material would aid in the mitigation of legacy environmental issues associated with waste coal disposal ponds.”

SME Statement of Technical Position

SME recommends continued support of the DOE and other federal agencies for the US coal industry to coproduce REEs and CMs during the production of carbon ore. Funding of certain plants within the U.S. could act to demonstrate the economic viability to industry and financial institutions. SME also suggests that the financial risk to new REE and CM suppliers can be reduced by: 1) federal agencies establishing a domestic stockpile of REEs and CMs to provide a domestic market for a new developing industry and to support DOD needs during market shortages if a conflict develops; 2) providing permit guidance to applicable agencies that would reduce the timeline for new projects; and 3) demonstrating the economic viability by partially funding a new plant to limit the risks to a new supplier.

References

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USGS 2014 National Resources Data System – U.S. Coal Quality Database (Coal Qual)
<http://energy.er.gov/coalqual.htm>

Leonardo Technologies Inc. and Tetra Tech Inc., “Assessment of Rare Earth Elements Contents in Select United States Coal Basins” January 2015 prepared for US DOE NETL

Mary Ann Alvin, “Critical Minerals Sustainability” Presented at 2021 Virtual International Pittsburgh Coal Conference or her 2023 presentation at SME

National Coal Council “Carbon Forward – Advanced Markets for Value-Added Products from Coal” October 2021