

# DOE-NETL'S REE-CM PROGRAM ACCELERATES MINERAL EXTRACTION FROM DOMESTIC COAL-BASED RESOURCES

Mineral extraction technologies using domestic coal enable our Nation's independence for Critical Minerals and Rare Earth Elements.

## THREE FIRST-OF-A-KIND RARE EARTH ELEMENT (REE) AND CRITICAL MINERAL (CM) PILOT-SCALE FACILITIES MOVE TECHNOLOGY CLOSER TO FULL-SCALE COMMERCIALIZATION

Domestic pilot-scale REE-CM extraction-separation-recovery facilities have generated high purity, mixed rare earth oxide (MREO) concentrates of 80–99 wt.% purity from diverse coal-based materials, including coal refuse, acid mine drainage, and power generation ash. These first-of-a-kind pilot-scale facilities enable rapid development and evaluation for fully integrated systems that are the next step in technology commercialization.



Courtesy of Prakash Joshi & David Gamliel, Physical Sciences Inc.



Courtesy of Rick Honaker, University of Kentucky



Courtesy of Paul Ziemkiewicz, West Virginia University

Roe-Hoan Yoon, Virginia Tech

## REE SEPARATION PROCESS ACHIEVES PRODUCTION OF HIGH PURITY, SINGLE RARE EARTH OXIDE (REO)

Battelle Memorial Institute and Rare Earth Salts are utilizing acid digestion and a novel electrowinning separation and purification process to produce a ~90% pure single individually separated REO. The high purity of the REO product and the techno-economic analysis of the process support technical feasibility and economic viability of REE extraction from coal-based resources.

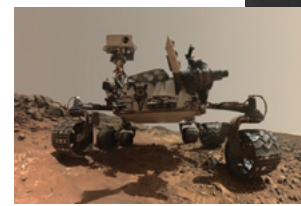


REEs are used in many advanced energy, defense, and high-tech applications and industries. Courtesy of NETL REE-CM Website

## LEVERAGING NATIONAL LABORATORY EXPERTISE

National laboratories, including National Energy Technology Laboratory (NETL), Los Alamos National Laboratory (LANL), Idaho National Laboratory (INL), Lawrence Livermore National Laboratory (LLNL), and Pacific Northwest National Laboratory (PNNL), are enhancing REE-CM technology development in materials characterization, sensor development, and separation processes.

NETL LIBS Sensor



Mars Land Rover to Use LANL LIBS Sensor, Courtesy of LANL



LANL LIBS-Raman Sensor, Courtesy of LANL



NETL Fiber Optic Sensor

- LANL utilizes laser-induced breakdown spectroscopy (LIBS) technology developed for the Mars Land Rover to produce a lightweight backpack LIBS to advance rapid characterization of promising coal-based REE resources, significantly reducing characterization costs and time.
- LANL demonstrates actinide separation technology transfer to lanthanide (REE) extraction from coal-based resources.
- NETL's Research & Innovation Center's REE Sedimentary Resource Assessment Method is a first-of-its-kind, big-data, machine learning (ML)-enabled, geoscience approach to improve prediction and identification of domestic coal-based resources and deposit locations with high REE and CM concentrations.



These achievements in 2020 lay the foundation for accelerated RD&D to produce 1–3 tonnes MREO/day in engineering prototype facilities to enable future REE-CM commercialization.

### PROGRAM NAME

**FEASIBILITY OF RECOVERING RARE EARTH ELEMENTS-CRITICAL MINERALS SUSTAINABILITY**

### PROGRAM BUDGET

FY20 FUNDING



### CONTACTS

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### CORE COMPETENCIES

MATERIALS ENGINEERING and MANUFACTURING

PROGRAM EXECUTION and INTEGRATION

### PARTNERS

