GROUND-BREAKING TECHNOLOGIES ACCELERATE COMMERCIALIZATION OPPORTUNITIES FOR RARE EARTH EXTRACTION FROM COAL

NETL researchers advance extraction technologies, producing high-purity (>95%) rare earth oxides from a diverse array of coal wastes.

STAGED LEACHING TECHNIQUE MINIMIZES THE COST OF EXTRACTING RARE EARTH OXIDES (REO) FROM ASH

NETL researchers produced high purity REO via a novel extraction technique for Powder River Basin (PRB) ash. By dissolving only a small portion of the ash and operating at ambient conditions, chemical and equipment costs are minimized, improving commercialization possibilities. PRB coal comprises 50% of the coal produced in the U.S. and is consumed throughout America.

PRB Fly Ash
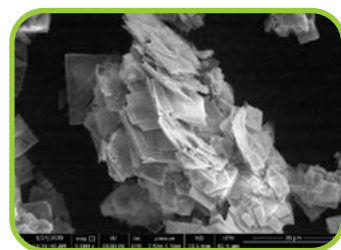
96 wt.% REO
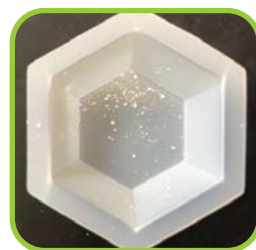
ACID MINE DRAINAGE TECHNOLOGY TRANSFORMS AN ENVIRONMENTAL ISSUE INTO AN ECONOMIC OPPORTUNITY

Researchers surpassed a major milestone in producing a 95wt% REO concentrate from acid mine drainage (AMD) both by treating AMD directly and processing the solid waste from passive AMD treatment systems. Each pathway can eliminate an expensive processing step—solvent extraction—to reduce cost, paving the way to address a widespread environmental issue in Appalachia.

AMD and AMD Sludge (Photos courtesy of B. Hedin)

TAKING INNOVATIONS FROM THE LABORATORY TO COMMERCIALIZATION

NETL's Staged PRB Ash Leaching project was one of 222 projects selected for a Technology Commercialization Fund award, resulting in $1.6 million of DOE and partner-matched funding. The project will result in a small pilot facility that validates and de-risks the commercialization of NETL's PRB extraction inventions. Separately, the ability of NETL's BIAS sorbent is being validated for rare earth elements (REE) recovery from AMD in a field test.

TECHNOLOGY TO "WASH" REE OUT OF CLAY MINERALS AND COAL REFUSE

A patent was filed for a minimally invasive technology to extract REE from clays and coal refuse using mild acids at room temperature and pressure. The technique doesn't dissolve the host material, which translates to reduced costs, and may be broadly applicable to non-coal resources domestically and abroad (particularly in South America).

PROVISIONAL *SUBMITTED* PATENT

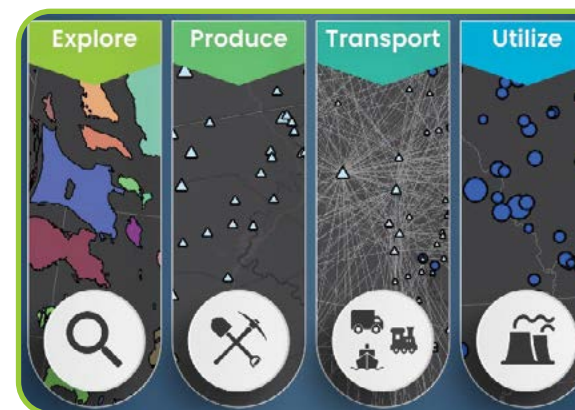## REAL-TIME SENSING CAPABILITIES SPARK INTEREST FROM INDUSTRY

NETL's real-time sensors enable the analysis of REE-containing resources in minutes (instead of hours), enabling innovation in REE separation processes and rapid identification of which feed sources warrant processing. The opportunity to leverage these sensors for rapid analysis and process control have led to industry interest and potential licensing opportunities.
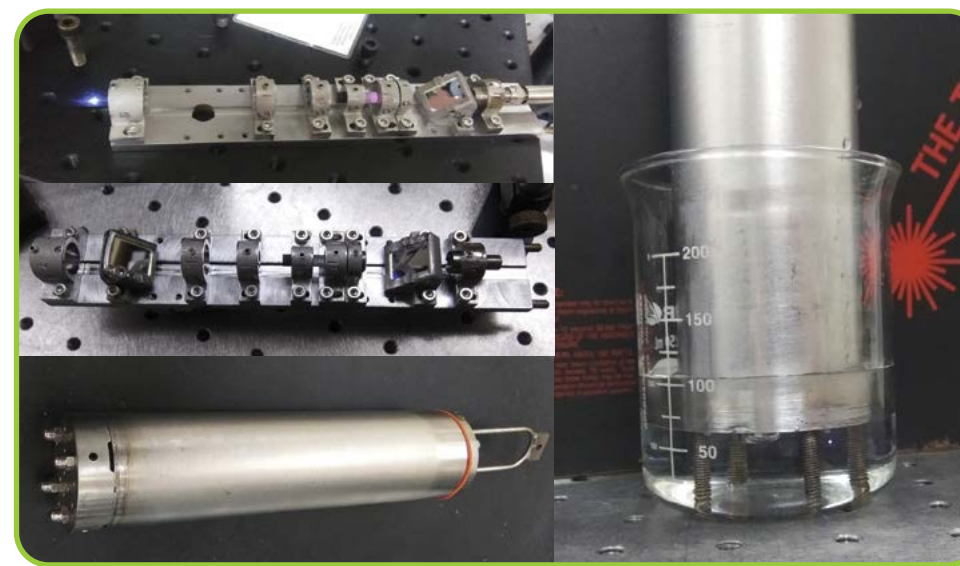
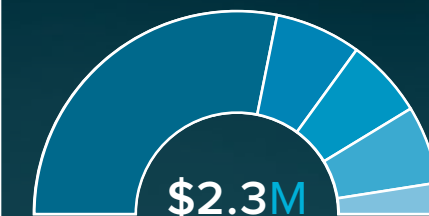Submersible laser-induced breakdown spectroscopy prototype

IDENTIFYING HIGH PRIORITY REE-CRITICAL MATERIALS RESOURCES THROUGH MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

NETL has implemented a revision of their REE sedimentary resource assessment method, which leverages 21st century capabilities to identify promising REE resources in sedimentary systems. Modeling results for the PRB are being validated using geologic cores, and the method is being applied to other basins.

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