# BIO-OXIDATION TECHNIQUE GENERATES A BREAKTHROUGH IN RARE EARTH EXTRACTION TECHNOLOGIES

Enhanced bio-oxidation accelerates Rare Earth Element (REE) leaching and eliminates most acid rock drainage, improving economics and environmental sustainability.

## LOW-COST TECHNOLOGY TO EXTRACT AND RECOVER MIXED RARE EARTH ELEMENTS (REE) GREATLY EXCEEDS GOALS

The University of Utah and Virginia Tech, in coordination with NETL, successfully demonstrated: (1) separation technologies to enrich pyrite for bio-oxidation; (2) column leaching with bio-oxidation and extraction of REEs; (3) concentration of REEs by solvent extraction; and (4) iron removal and REEs recovery by precipitation. The project goal of achieving a 2–8% by weight mixed REOs product was far exceeded with the successful production of 36.7% mixed REOs equivalent by weight.
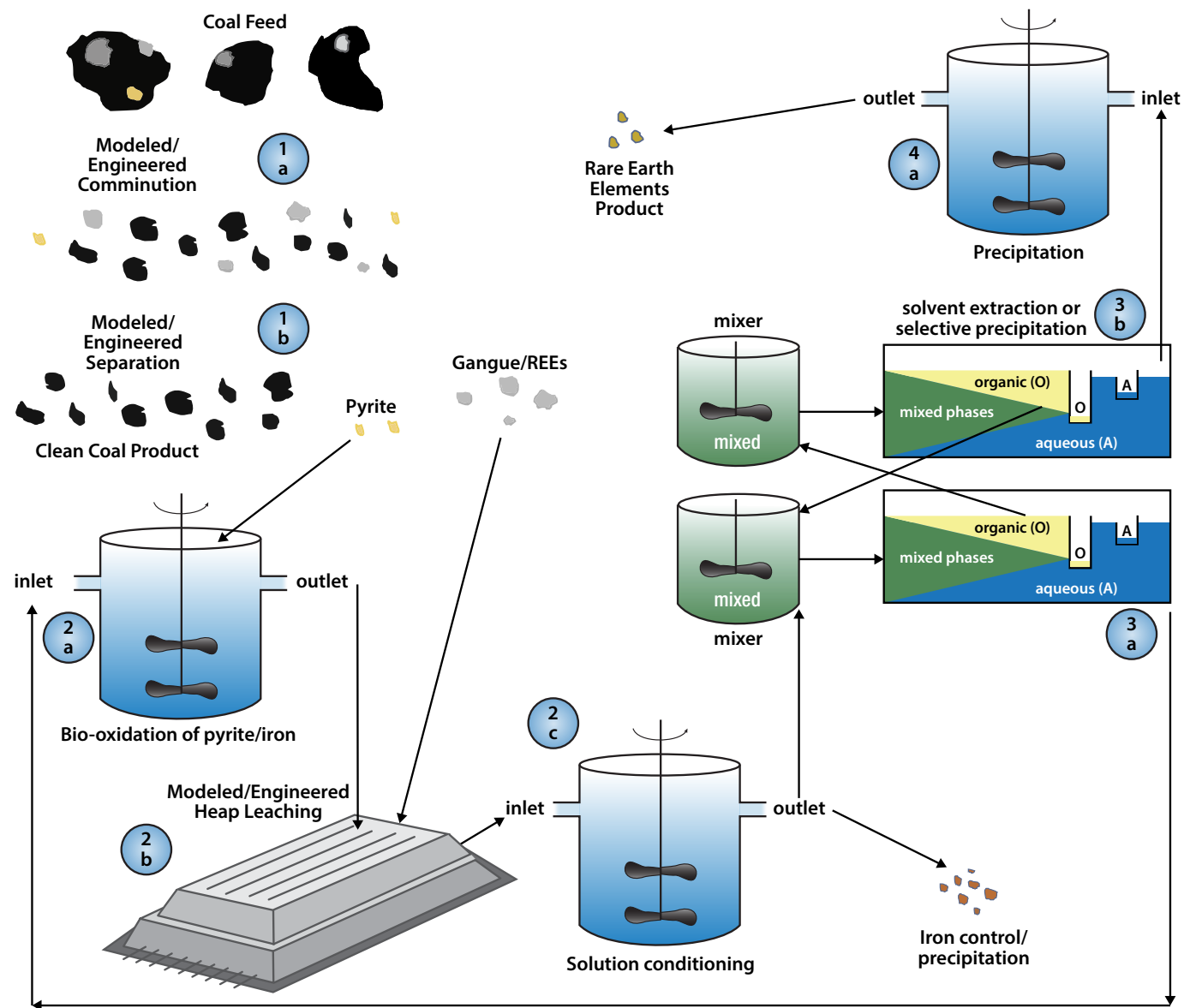
Schematic diagram showing flow sheet and processing steps as well as task assignments for extraction, recovery, and upgrading of rare earth elements from coal-based resources

## COAL-BASED MATERIALS FOUND TO BE ENRICHED WITH RARE EARTH ELEMENTS

Automated cross belt samplers collected eleven 55-gallon barrels of coal refuse representing six unique material types from four different mines in three states. Six different coal waste samples were found to have enriched REE content greater than 300 parts per million (ppm). Robust sampling and characterization of enriched REE samples enhance rapid technology development and evaluation.
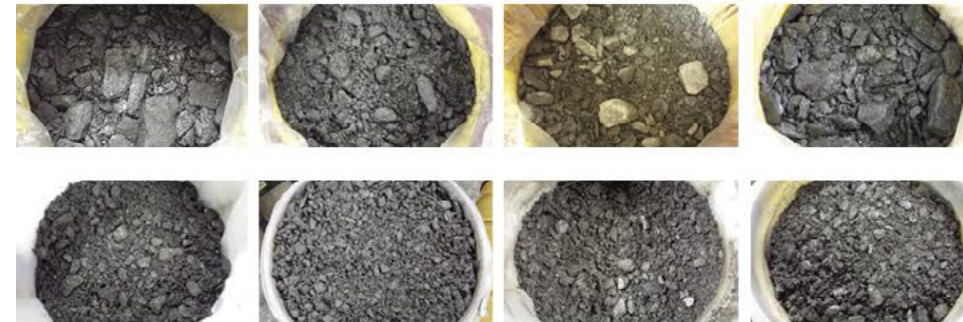
REE enriched coal refuse samples

DUAL-SCAN X-RAY SORTING FURTHER IMPROVES ECONOMIC RECOVERY OF REES

Precise separation of REE-bearing coal refuse using dual-scan X-ray sorting, comminution, and spiral concentration concentrates pyrite-rich coal refuse improving process economics.
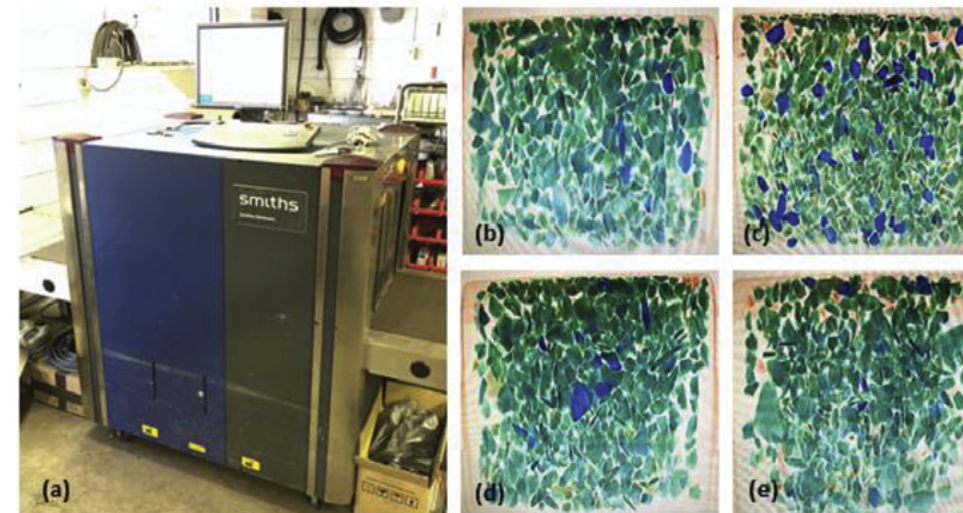
(a) X-ray scanner and x-ray images of Coal Refuse (b-e)

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