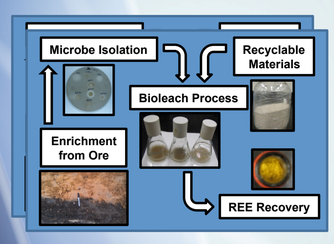


CMI | Critical Materials Institute

An Energy Innovation Hub

Microbial Mediated Recovery of Rare Earth Elements

The objective of this project is to develop a bioleaching and bioadsorption strategy for recovery of rare earth elements (REE) from recyclable materials.

Typically application of high concentrations of acids at elevated temperatures are necessary for leaching of REE from electronic components found in batteries, computer parts, lamp phosphors, cracking catalyst, etc. Biohydrometallury could offer an environmentally friendly, economical alternative.

Leaching using microbially produced acids

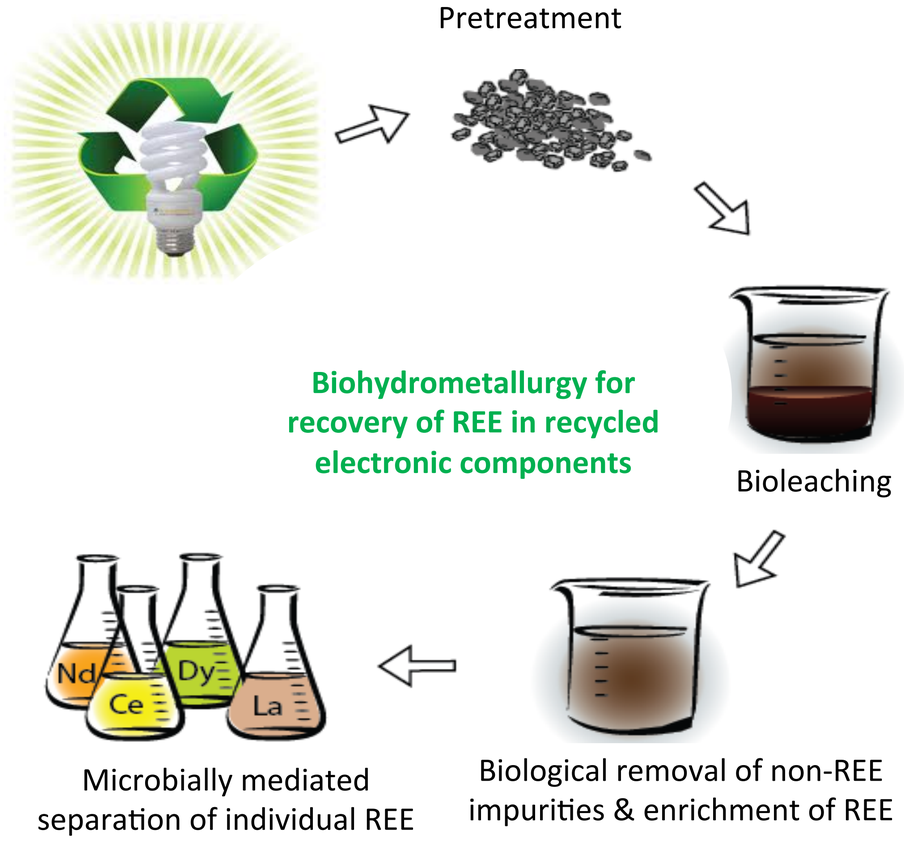
- Organic or mineral acids produced by microorganisms solubilize and release REE from a solid matrix.

Sorption using microbially produced material

- Removal of REE from an aqueous solution with a biologically produced matrix (cell wall, ligands).

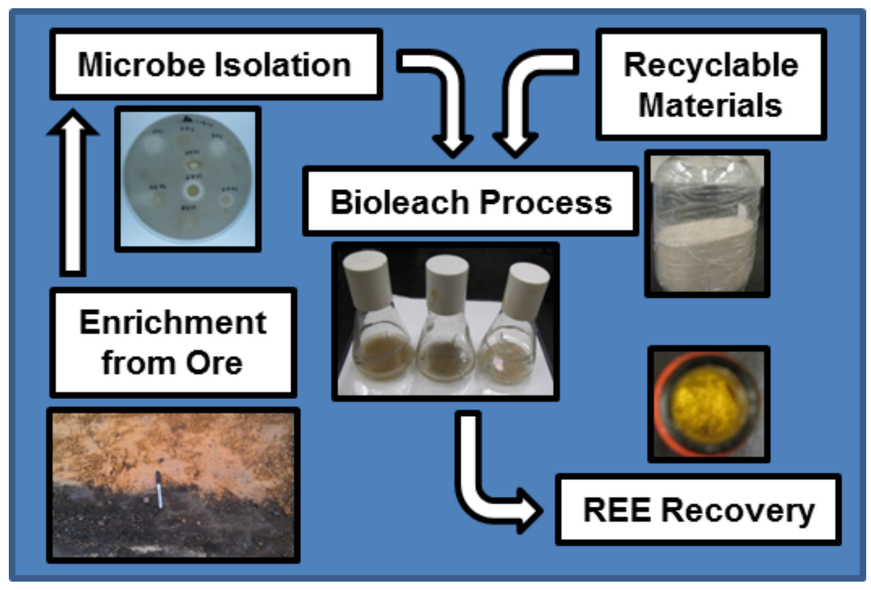
Cross-cutting technology

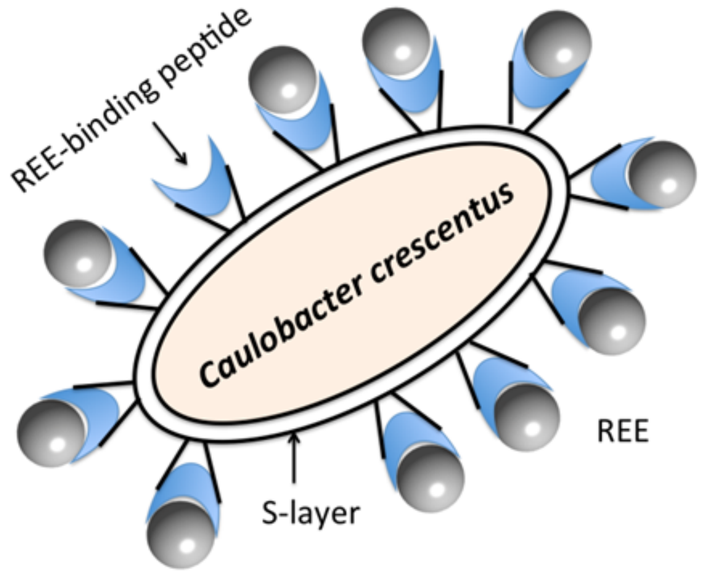
- Technology developed for urban mining could be used to complement hydrometallurgical processes currently used for REE ores.



Accomplishments:

- Isolated 100+ organic acid producing REE-solubilizing microorganisms
- Majority of isolates most closely related to *Pseudomonas, Acinetobacter* and *Talaromyces.*
- Isolates produced a variety of organic acids including gluconic, succinic and citric acid.
- Gluconic acid appeared to be the most effective for REE dissolution from the recyclable materials (phosphors and fluidized cracking catalyst).
- Initial results indicated the catalyst was more susceptible to bioleaching than the phosphor; >33% of the total REE content could be extracted from the catalyst whereas less than 5% was extracted from the phosphor.
- We genetically engineered *Caulobacter crescentus* to express lanthanide binding tags (LBT) on the cell surface S-layer protein.
- Terbium (Tb) binding was greater for the LBT clones compared to the wild type strain.
- The double LBT was twice as effective at binding Tb as the single LBT clone.





Research in partnership:

Lawrence Livermore National Laboratory

Idaho National Laboratory