

Critical and Strategic Material Recovery from Domestic Geothermal Resources

Presentation to NAS Committee on Earth Resources Spring Meeting

May 9, 2018

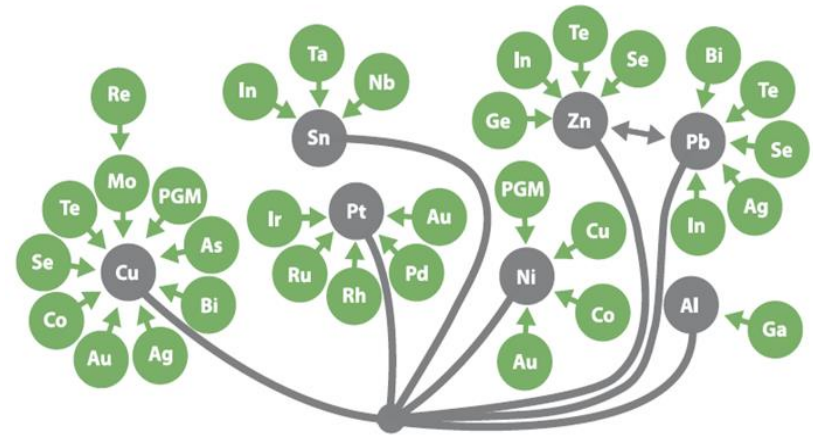
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Geothermal R&D in Mineral Recovery

Coupling mineral extraction with geothermal power provides substantial added value

- Strategic minerals such as lithium, zinc, and manganese are found in some geothermal brines
- These **elements are critical to domestic industries** such as electronics, automotive, and aviation
- Processing large fluid volumes provides attractive technical/economic scenarios for material extraction



Many critical metals are byproducts of base elements...



...with essential, wide-ranging uses across multiple domestic industries

Diagram: "Critical Materials for Sustainable Energy Applications"
Resnick Institute - California Institute of Technology, 2011

GTO Strategic and Critical Material Recovery

High-risk / High-reward:

Research and Development conducted by industry, universities and National Labs addressing critical US supply risks; either stand alone or additional value

Network

USGS, DOE Critical Materials Institute, and DOE Fossil Energy collaborated to define project needs and activities for critical materials including rare earths

Strategic Materials

Resource assessment including mining and oil and gas produced fluids, following value chain for high-value, strategic, or critical materials

Competitive Solicitations

Phase 1 (2014 – 2016):

Technical feasibility and economic viability of extraction and assessment of Rare Earth Element (REE) and near-critical metal domestic resource base

Phase 2 (2016 – Present):

Expanded to include elevated temperature fluids produced by oil and gas or mining operations, verify extraction methods

Phase 1 Awardees

National
Labs:



Industry:

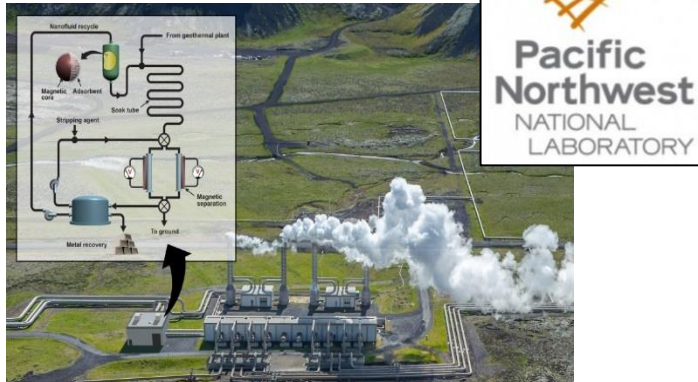


Universities:

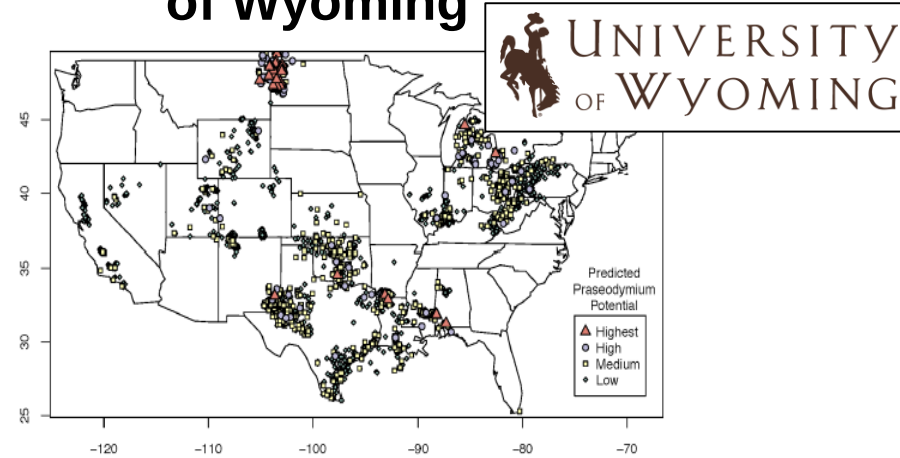


Phase 2 Awardees

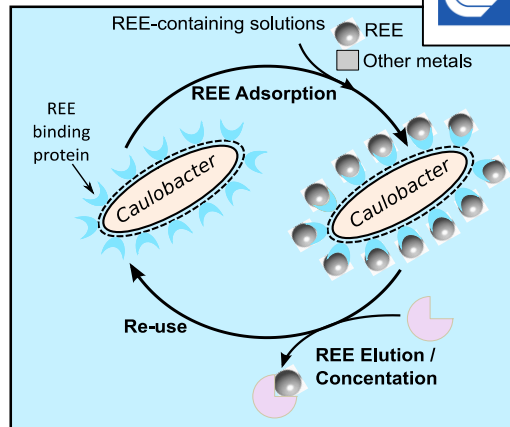
Pacific Northwest National Laboratory



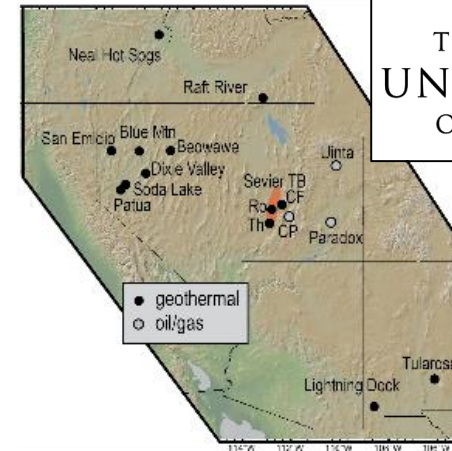
University of Wyoming



Lawrence Livermore National Laboratory



University of Utah



Results and Lessons Learned

RESEARCH SUCCESSES:

- Advanced sorbant structures demonstrate over 98% REE recovered from test solutions.
- Proprietary media demonstrated 39% – 42% REE recovery
- Metal-ion imprinted polymer recovered 87% of manganese.
- Hi-temp thermophilic microbes selectively extract greater than 90% of targeted critical materials (Zn & Gd)
- Determined dissolved REE values in US high temperature fluids made public on National Geothermal Data System

LESSONS LEARNED:

- Mineral recovery at both high and low concentrations is a challenge for economic recovery.
- Collecting high value materials can be economically feasible in the right conditions.