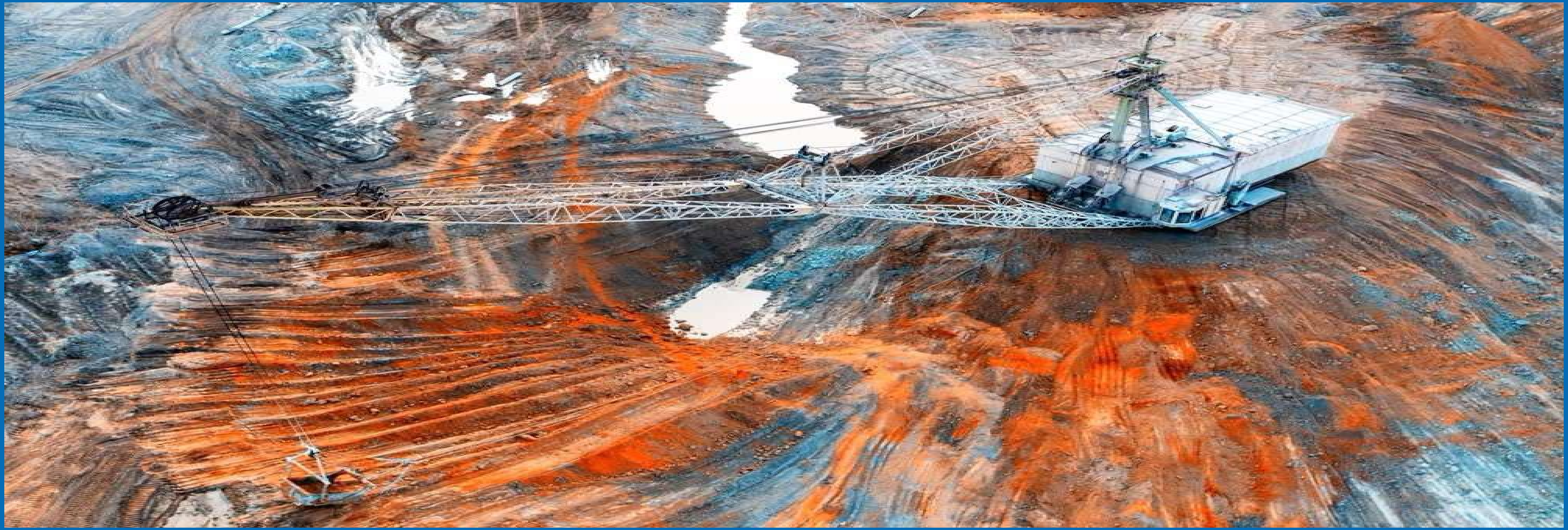
ORD/OMDP Ongoing Research in Critical Minerals at Superfund Mining and Mineral Processing Sites

IEA (2022), Critical Minerals Policy Tracker, IEA, Paris



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EPA United States Environmental Protection Agency

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What are Critical Minerals?

Executive Order 13817 (2017) defines a “critical mineral” as a mineral identified by the Secretary of the Interior* to be:

- a non-fuel mineral or mineral material essential to the economic and national security of the United States
- the supply chain of which is vulnerable to disruption, and
- serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security.

*Further language stipulates that DOI shall consult other influential Departments such as DOD and DOE to identify critical minerals.

Executive Orders (EO) Addressing CMs

- 2017: EO 13817 “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals”
- 2020: EO 13953 “Addressing the Threat to the Domestic Supply Chain From Reliance on Critical Minerals From Foreign Adversaries and Supporting the Domestic Mining and Processing Industries”
- 2021: EO 14017 “America’s Supply Chains”
- 2025: EO 14285 “Unleashing America's Offshore Critical Minerals and Resources”
- 2025: EO 14241 “Immediate Measures to Increase American Mineral Production””

Plus other EOs, Presidential Actions and Executive Memoranda by reference, but general idea is:

To ensure the U.S. has critical mineral resources and the ability to extract those resources so our economic base for these important minerals (i.e., everything electronic) is not disrupted by intentional or unintentional supply chain shortages.

Critical Minerals (CMs) defined by USGS - 50

Aluminum	Metallurgy and many sectors of the economy.
Antimony	Flame retardants and lead-acid batteries.
Arsenic	Pesticides and semiconductors.
Barite	Hydrocarbon production.
Beryllium	Aerospace and defense.
Bismuth	Medical, metallurgy, and atomic research.
Cerium	Catalytic convert., ceramics, glass, metallurgy, polishing compounds
Cesium	Research and development.
Chromium	Metallurgy.
Cobalt	Batteries and metallurgy.
Dysprosium	Data storage devices, lasers, and permanent magnets.
Erbium	Fiber optics, glass colorant, lasers, and optical amplifiers.
Europium	Nuclear control rods and phosphors.
Fluorspar	Cement, industrial chemicals, and metallurgy.
Gadolinium	Medical imaging, metallurgy, and permanent magnets.
Gallium	Integrated circuits and optical devices.
Germanium	Defense and fiber optics.
Graphite	Batteries, fuel cells, and lubricants.
Hafnium	Ceramics, nuclear control rods, and metallurgy.
Holmium	Lasers, nuclear control rods, and permanent magnets.
Indium	Liquid crystal displays.
Iridium	Anode coatings for electrochemical processes and chemical catalysts.
Lanthanum	Batteries, catalysts, ceramics, glass, and metallurgy.
Lithium	Batteries.
Lutetium	Cancer therapies, electronics, and medical imaging.
Magnesium	Metallurgy.
Manganese	Batteries and metallurgy.
Neodymium	Catalysts, lasers, and permanent magnets.
Nickel	Batteries and metallurgy.
Niobium	Metallurgy.
Palladium	Catalytic converters and catalysts.
Platinum	Catalytic converters and catalysts.
Praseodymium	Aerospace, batteries, ceramics, colorants, permanent magnets.
Rhodium	Catalytic converters, catalysts, and electrical components.
Rubidium	Research and development.
Ruthenium	Catalysts, electronic components, and computer chips.
Samarium	Cancer treatments, nuclear, and permanent magnets.
Scandium	Ceramics, fuel cells, and metallurgy.
Tantalum	Capacitors and metallurgy.
Tellurium	Metallurgy, solar cells, and thermoelectric devices.
Terbium	Fiber optics, lasers, permanent magnets, and solid-state devices.
Thulium	Lasers and metallurgy.
Tin	Metallurgy.
Titanium	Metallurgy and pigments.
Tungsten	Metallurgy.
Vanadium	Batteries, catalysts, and metallurgy.
Ytterbium	Catalysts, lasers, metallurgy, and scintillators.
Yttrium	Catalysts, ceramics, lasers, metallurgy, and phosphors.
Zinc	Metallurgy.
Zirconium	Metallurgy and nuclear.

Rare Earth Elements (REEs) in **Bold,** these are the 14 Lanthanides, with Scandium and Yttrium –does not include Promethium (radioactive)

Full list of Critical Minerals: https://www.federalregister.gov/documents/2022/02/24/2022-04027/2022-final-list-of-critical-minerals

Research to Address CM Characterization & Recovery Technologies

- An internal EPA report (EPA/600/X-23/191) and external presentation were developed in coordination with OLEM/OMDP and the TSCD/SCMTSC & ETSC
- Conducted to identify technologies for critical minerals recovery that are applicable to Superfund mine and mineral processing sites
- The research included:
  - Review of 96 mining and mineral processing sites on the Superfund NPL
  - Investigation into existing and innovative technologies for recovering critical minerals from site waste (OTS, sold-as-service, or SBIR)
- Results synthesized to describe:
  - Types of waste at sites
  - Potential for critical minerals in these wastes
  - Existing and innovative technology to potentially recover CM from waste at those NPL sites

Findings and Future Directions

- Results indicate sources of CMs exist in mining and mineral processing waste, but high uncertainty in magnitude (concentration of CMs) surround this finding
- Recovery can be complicated due to colocation of radionuclides (Th, Ra and U) with rare earths in ore bodies, reenforcing fact that recovery may generate ‘unknown or complicated’ waste streams
- Results revealed 20 traditional mining (i.e., what mining companies do now) and 34 non-traditional companies (not mining co.) with CM recovery tech
  - Majority of companies identified focused on REE recovery
- Additional site characterization and recovery technology research needed before consideration of mine waste as a reliable CM source to support a domestic supply chain.

Example of ‘Additional Research’ Conducted

- Conducted one field research project to date:
  - Collaborated with EPA Region 9 on an OMDP-funded CM recovery technology assessment
  - Technology used high-pressure slurry ablation (HPSA) to recover Uranium from Navajo Nation (NN) mine wastes (Vanadium also present)
  - HPSA technology achieved greater than 90 percent reduction in U concentrations in mine waste/tailings. Analysis not conducted for V but may be recoverable in similar percentages.
  - Process waste from HPSA treatment at NN sites do not leach metals or radionuclides above water quality standards
  - HPSA processing technology at 100 ton/hr system, operating 24 hours a day would cost ~$40/ton of mine waste treated. This amounts to 80% to 90% cost savings compared to offsite disposal.

OMDP + ORD Cooperative Agreement to Evaluate CM Characterization & Recovery Technologies

- In 2023, collaborated with OMDP to create COOP for evaluating CM charact. & recovery technologies
- COOP was announced, competed and awarded late 2023

Advantages of a cooperative agreement vs. other vehicles:

- Cooperative agreements (CO-OPs) are similar to grants, but provide Fed **substantial involvement** in carrying out activities
- COOP allows Federal experts and cooperator to conduct research together
- Cooperator creates external expert panel to identify mining technologies that need to be assessed/tested (not steered by one party, reduces potential for Conflict of Interest)
- Based on expert panel input, cooperator announces (thru Clu-In & others) list of technologies to be assessed
- Vendors respond to the announcement directly to cooperator. Most were small/startups.
- Cooperator uses EPA funds in COOP account, and sets up side agreements/contracts with vendors to pay for tech assessments
- Cooperator generates reports from assessment/testing, careful to **not 'pick winners and losers'** (no endorsement)

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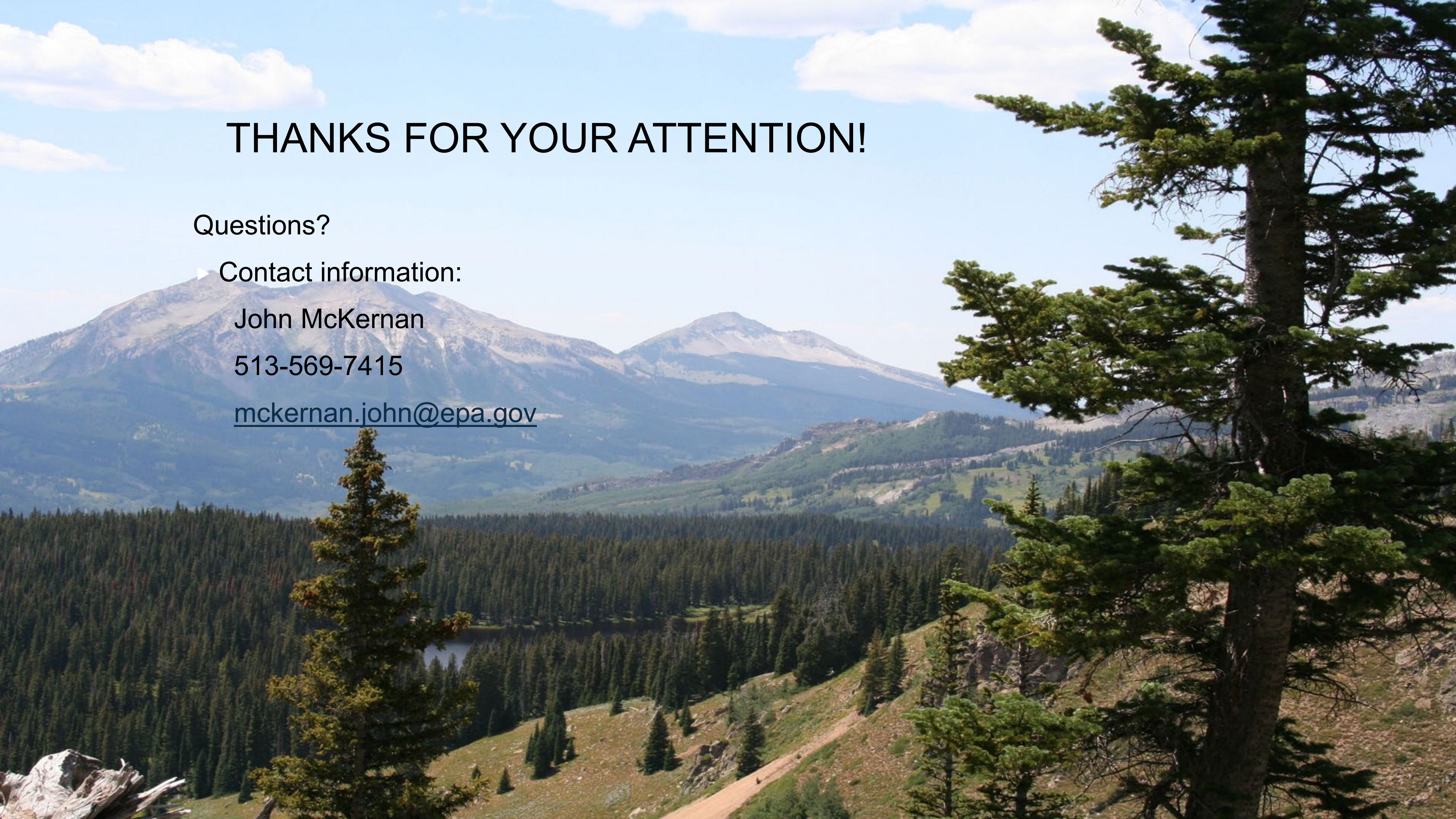
Identifying & Working with Small/Startup Companies

Four themes of working with companies:

1. Reduce barriers to collaboration and technology implementation
   - EPA can provide real-world complex contaminated media for testing and de-risking their tech
2. Provide value (to both parties)
   - Small start-ups have limited staff, funding, and time – we want to be sure that they are using those resources wisely
3. Connect technology vendors to stakeholders – provide framework for market entry
   - Connect/introduce vendors to your contacts (stakeholders, decision makers)
4. Bridge the research-to-application divide by including performance metrics valued by stakeholders/consumers/decision makers
   - Technical panels to guide protocol development to foster rigor, transparency, technical excellence, and relevance
   - Important to listen to vendors to design processes and products that support their technological advancement



THANKS FOR YOUR ATTENTION!

Questions?

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