

# Critical Minerals in Western States

Western Interstate Energy Board – December 2023

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Taylor Quinn, Dr. Ian Lange

# Introductions

## Dr. Ian Lange

- Director of Mineral and Energy Economics program (Only mineral economics program in the US)
- Associate Professor at Colorado School of Mines
- Former Senior Economist for Energy at the Council of Economic Advisers

## Taylor Quinn

- Master's student in the Mineral & Energy Economics Program at Colorado School of Mines
- B.S. Economics from University of North Carolina at Charlotte
- Research Assistant (WIEB, Critical Materials Innovation Hub)



# Agenda

1. What are Critical Minerals?
2. Mapping Critical Minerals in Western States
3. Mining Methodologies
4. Permitting Mines
5. Takeaways



# What are critical minerals?

According to...

## USGS

U.S. Geological Survey List of Critical Minerals		
<b>Aluminum</b>	Germanium	Rhodium
Antimony	<b>Graphite</b>	Rubidium
Arsenic	Hafnium	Ruthenium
Barite	Holmium**	Samarium**
Beryllium	<b>Iridium</b>	Scandium**
Bismuth	Lanthanum**	Tantalum
Cerium**	<b>Lithium</b>	Tellurium
Cesium	Lutetium**	<b>Terbium**</b>
Chromium	<b>Magnesium</b>	Thulium**
<b>Cobalt</b>	Manganese	Tin
Dysprosium**	<b>Neodymium**</b>	Titanium
Erbium**	<b>Nickel</b>	Tungsten
Europium**	Niobium	Vanadium
Fluorspar	Palladium*	Ytterbium**
Gadolinium**	<b>Platinum*</b>	Yttrium**
<b>Gallium</b>	<b>Praseodymium**</b>	Zinc
		Zirconium
<b>Overlap with DOE Critical Minerals List</b>		
*Platinum Group Metals		
**Rare Earth Metals		

## DOE

U.S. Department of Energy Critical Minerals	
Aluminum	Magnesium
Cobalt	Natural Graphite
Copper	Neodymium*
Electrical Steel	Nickel
Fluorine	Platinum
Gallium	Praseodymium*
Iridium	Terbium*
Lithium	Silicon, Silicon Carbide
*Rare Earth Element	

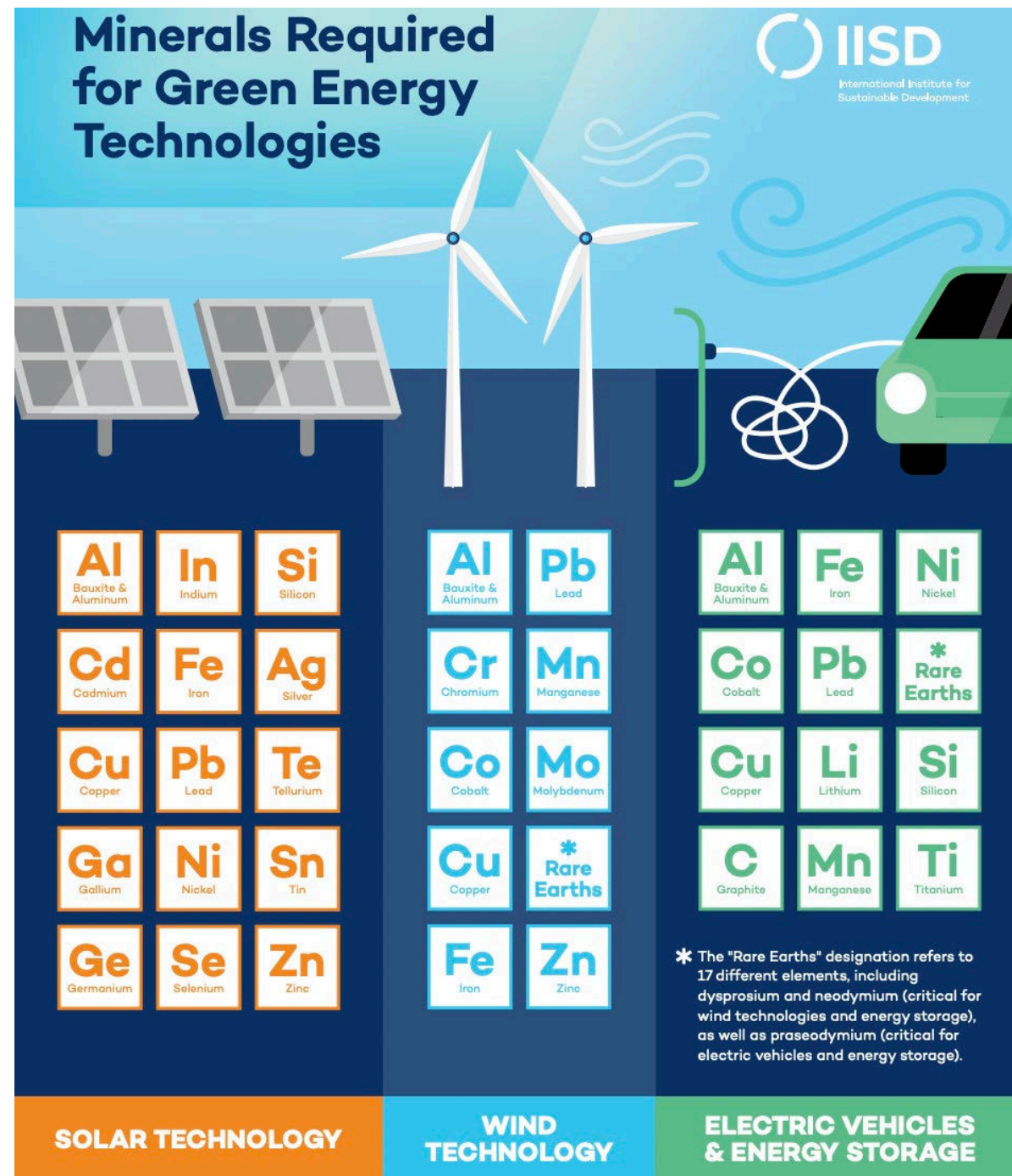


# Critical minerals are necessary for clean energy!

The IEA forecasts that clean energy technologies will account for...

- 40% of copper demand
- 40% of rare earth elements demand
- 60% of nickel demand
- 60% of cobalt demand
- 90% of lithium demand

...globally over the next two decades.



# Critical Minerals Discussion – The Basics

## United States is a net importer of 86% of USGS critical minerals

- U.S. completely relies on China for 16 critical minerals
- China dominates the downstream mineral value chain (processing & refining) and the battery supply chain

## Building Domestic Supply Chains – IRA regulations for tax credits

- 2024: Domestic sourcing bonuses if CMs come from North America or a country with which the U.S. has a free-trade agreement
- 2025: Batteries must not have any CMs from a Foreign Entity of Concern

## Incentivizing faster permitting timelines for domestic mines: FAST-41 Projects

### U.S. reserves in metric tons and percentage of apparent consumption imported



Source: Payne Institute of Public Policy

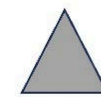


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# Mapping Critical Minerals in Western States

# Western United States: Comprehensive Mineral Map



= Active Mine



= Project in Advanced Stages



= Proven & Commercial Deposit



= Lithium



= Cobalt



= Nickel



= Rare Earths



= Zinc



= Copper



= Graphite



= Vanadium



= Uranium



= PGMs

*\*Tribal lands shaded in orange*

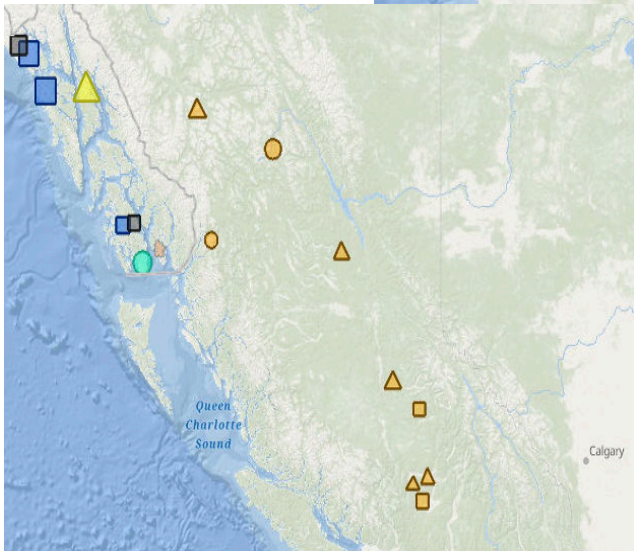
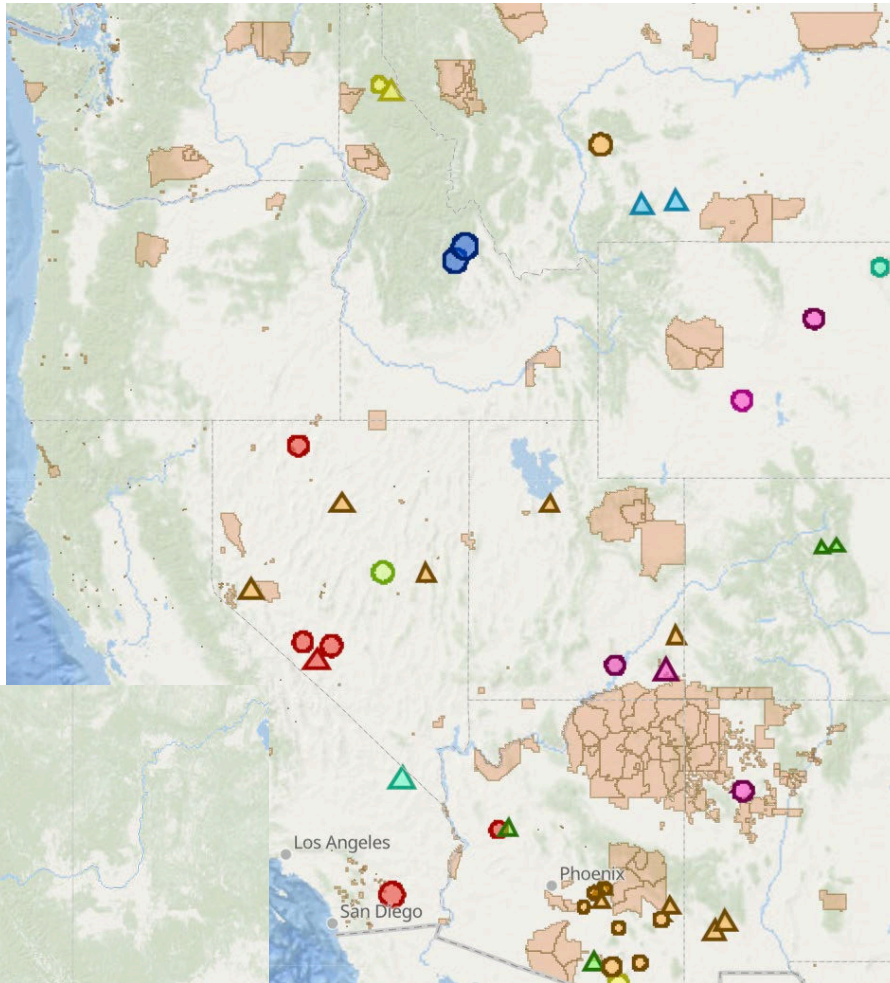
[Map Link](#)

# MINERAL MAPS

## Active Mines & Projects in Advanced Stages

- The West has an abundance of proposed mines in advanced pre-production phases
- All possess a proven commercial deposit
- **IMPORTANT:** A production decision is not guaranteed

[Map Link](#)



# Case Study: Successes & Setbacks from Critical Mineral Projects

## Success: Gibellini Mine (Nevada)

- First Vanadium mine in the United States – expected to produce ~60% of total U.S. demand
- Project efficiently underwent the permitting process and received a positive decision from the BLM in October
- Mine is expected to be powered by solar energy and battery storage, and utilize electric haul trucks

## Setback: Bear Lodge (Wyoming)

- Over \$140 million invested by both its owner (Rare Earth Resources) and state government
- Project was indefinitely suspended in 2016 due to regulatory and price concerns
- Rare Earth Resources has since invested nearly \$50 million to develop a new processing method
- Must restart the permitting process once the test results come back



# How do we mine critical minerals?

# Conventional Mining

- **Open-pit**
  - Best for shallow, low-grade deposits and typically the cheapest mine-type
  - Generates waste rock and tailings, which is the uncommercial ore left after processing
- **Underground**
  - Best for deposits that are deep underground and high-grade
  - Relatively expensive and environmental concerns over groundwater contamination
- **In-situ Leaching**
  - Chemical method of extracting minerals from hard rock
  - Minimal environmental disturbance if done right
  - Technically difficult: geology must be just right



# Innovative Mining Methods

- **Tailings Recycling**

- New technologies efficiently extract minerals from old tailings piles
- Infrastructure already in place

- **Rare Earths Extraction from Coal Waste**

- High government investment into extraction methods & technologies
- Processing of REEs is expensive

- **Brine Extraction**

- Efficient & lower impact lithium extraction

- **End-of-Life Battery Recycling**

- High potential for this market in the next 15 years



# Sustainable Mining Technology

- **Nth Cycle: Small modular refining systems**
  - Uses only electricity and water to extract battery-grade minerals
  - Easily transportable
- **Electric Mining Equipment**
  - Cripple Creek Gold Mine in CO to host first electrified fleet from Caterpillar
- **Increased use of data analytics**
  - “Pocket Mine”





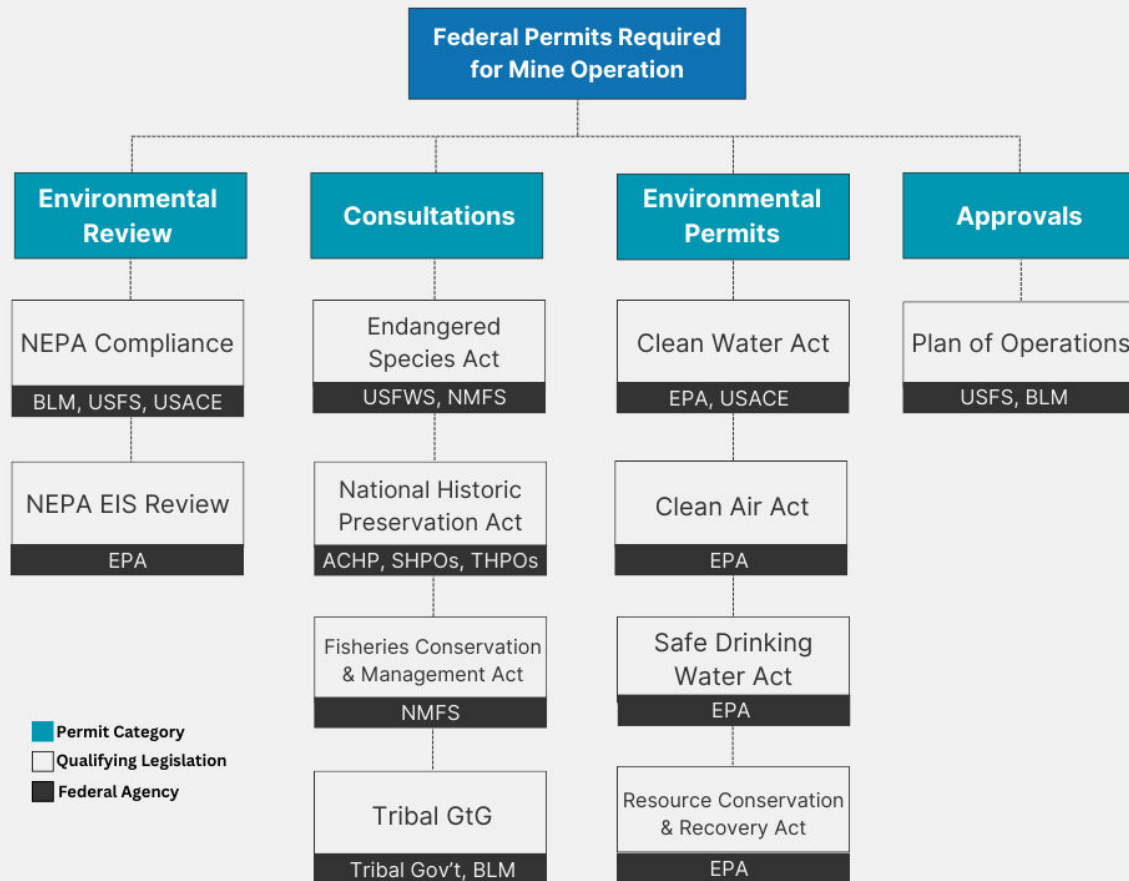
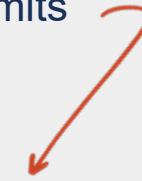
# Permitting Mines in the United States



# Federal Permitting

Mines must receive federal approvals and permits before commencing operations. Federal regulations are broken up into 4 categories:

1. Environmental Review
2. Consultations
3. Environmental Permits
4. Approvals



Legislation	Permit
Clean Water Act	CWA 402 – NPDES Permit CWA 404 – Wetlands & Waste CWA 401 Certification
Clean Air Act	CAA 109 – NAAQSs CAA 111 – NSPSs CAA 111 – PSD Provisions NESHAPs
Safe Drinking Water Act	Underground Injection Control (UIC) Permit
Resource Conservation & Recovery Act (RCRA)	Subtitle C – Hazardous Waste Area of Contamination Policy Corrective Action Management Units Corrective Action Temporary Units

# State & Local Permitting



- Mines must *also* receive state/province and local permits
  - States may require an Environmental Review and Plan of Operations to be submitted to a state agency for approval
- If a federal agency approves a permit, it may still be rejected by the state and vice versa
- Lawsuits from local stakeholders may further slow down the process

# Policy Perception & Investment

## Policy Perception Index:

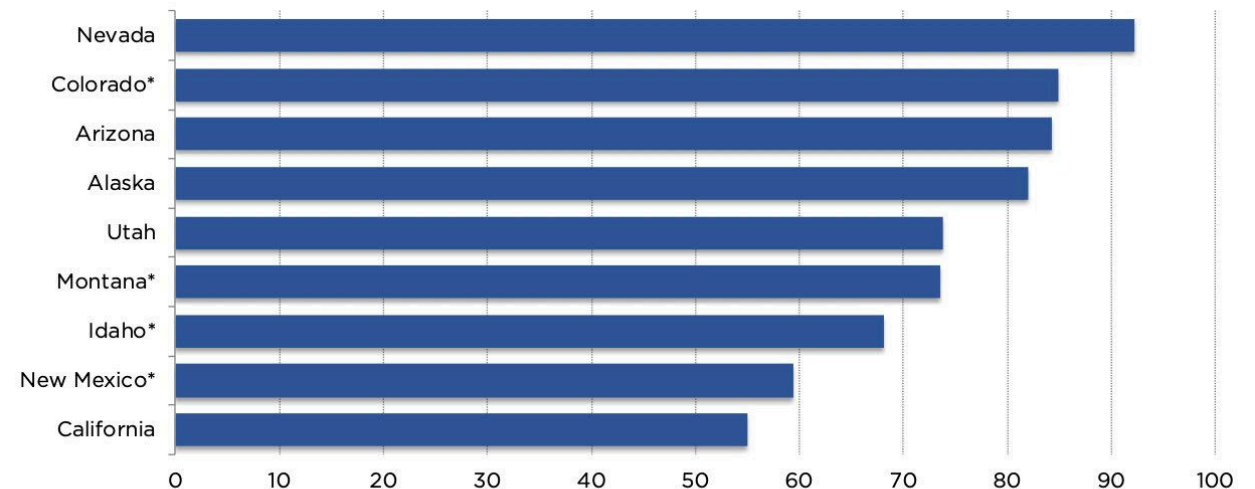
The Western U.S. and Canada remains a great place for mining: 5 regions scored in the Fraser Institute's Top 10 Global Mining Jurisdictions.

1. Nevada
4. Utah
6. Alberta
7. Arizona
9. Colorado

## Investment Attractiveness Index:

Combines the Policy Perception Index with geologic potential. Nevada scored 1<sup>st</sup> place globally, Colorado scored 5<sup>th</sup>, and Arizona scored 7<sup>th</sup>.

### Investment Attractiveness in the United States



\* Between 5 and 9 responses

Source: Fraser Institute

# Tribal Considerations

- Retained inherent authority – tribes pre-date the U.S. government
- Types of tribal lands differ based on history and the particular tribe
  - Influences property rights
- Mines on tribal lands are subject to federal permits (mostly) and any other regulations put in place by the tribe
- Mines on tribal lands may be subject to double taxation which discourages investment
  - Tribes have negotiated with states to avoid this (ex. Nevada)
- The Bureau of Indian Affairs (BIA) is the best place to start the process



# Takeaways

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1. Advocate for FAST-41 Covered Projects
2. Help mining companies complete their due diligence both in the permitting process and stakeholder engagement
3. Encourage public-private partnerships in mining research and development
4. Promote innovative ways to lower mines' environmental impact

# Q&A



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