What is a critical mineral?

• Material essential to the economic and national security of the United States
• A supply chain vulnerable to disruption
• Serves an essential function in the manufacturing of a product that we cannot live without

Rock → Run-of-Mine Mineral Concentrate → High-purity element/compound Technology-Ready

Natural Flake Graphite.

Excavation  ~$0/t  4% C
Flotation  ~$800/t  95% C
Concentrate  ~$5,000/t  99.99% C
Purification
Advanced Material

Mining

Advanced Material Manufacturing
Critical Minerals

Agriculture

Medical

Energy

Aerospace/Defense
China exerts vast control over every step in the supply chain

Stage One: Mining

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<tr>
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<th>EU</th>
<th>USA</th>
<th>CHN</th>
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</thead>
<tbody>
<tr>
<td>Nickel</td>
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<td>0%</td>
<td>31%</td>
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<tr>
<td>Cobalt</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
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<tr>
<td>Graphite 1</td>
<td>1%</td>
<td>0%</td>
<td>65%</td>
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<tr>
<td>Lithium</td>
<td>0%</td>
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Stage Two: Chemical Processing/Refining

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<tbody>
<tr>
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<td>1%</td>
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<tr>
<td>Cobalt</td>
<td>17%</td>
<td>0%</td>
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<tr>
<td>Lithium</td>
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<td>4%</td>
<td>59%</td>
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Stage Three: Cathode or Anode Production

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<tr>
<td>Cathode</td>
<td>0%</td>
<td>0%</td>
<td>61%</td>
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<tr>
<td>Anode 1</td>
<td>0%</td>
<td>0%</td>
<td>83%</td>
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Stage Four: Lithium ion battery cell manufacturing

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<tr>
<td>Cells</td>
<td>6%</td>
<td>10%</td>
<td>73%</td>
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</table>
Why No New Critical Mineral Supplies in US?

• **Do we not have the correct geology?** – No, massive and diverse geologic terrain

• **Do we lack the money?** – No, we are a wealthy country but one that has not invested in mining for the last 30+ years.

• **Do we not have the demand?** – No, we are a top consumer of these technologies. Although uncertainty of adoption rates for EVs and other renewable technologies in US is not negligible, and is greatly influenced by policy.

• **Do we not have the infrastructure?** – No, and in several cases we already have power, water, rail, highway systems in direct proximity to projects.
U.S. Distribution of Critical Minerals
“The heart of Coal Country is on the verge of becoming the backbone for America’s green-energy future”

Potential for regional vertically-integrated supply chain: Mine -> Battery -> EV
The Real Challenge

1. Vertical integration is key to project success and economics
   - Mining project + Advanced Materials Project
   - Accepted methodology for derisking a new mining project, but there has been a major due diligence gap on how to properly derisk the downstream (run-of-mine concentrate vs. a value-added and technology ready advanced material)
   - Makes traditional mining investors uncomfortable, tech investors don’t like mining

2. Lack of dedicated financing, particularly from the US
   - Unlike China, US investments lacks long-term vision and commitment
   - 1st wave of exploration activity lacked a “poster child” of success
   - Difficulty in properly valuating projects in terms of both financial risk and reward
   - Opaque, unclear terminal markets, most of the critical minerals lack a traditional spot market
   - “Chicken or the Egg” problem: Product value is based on securing long-term contracts with end users with very specific technical specifications requirements and becoming a new supplier requires a lengthy qualification process
The Real Challenge

3. Politicization of Mining and Green Energy
   • NIMBY – US mining earned a bad reputation over the 20th century as bad for the environment and human health
   • Very politicized – traditional mining in US has largely focused on coal industry, which has mostly viewed clean energy as a threat. On the contrary, many proponents of the “Green New Deal” are anti-mining.
   • US has not had a federal agency dedicated to mining since the Bureau of Mining was abolished in 1996

4. Environmental Regulation
   • Permitting can delay projects, particularly when dealing with mining on federal land.
   • This is not irrelevant, but (in my opinion) is not the major hurdle. At least when it comes to the critical battery materials, this has not held up the better projects to date. Many good projects have necessary permits to advance, but lack funding.
2017
- December – Critical Minerals Presidential Executive Order (Executive Order 13817)

2018
- May – Final Critical Minerals List by USGS after input from other federal agencies

2019
- May – American Mineral Security Act introduced by Senator Murkowski (AK)
- June – Department of Commerce releases “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals”
- July - RE-Coop 21st Century Manufacturing Act introduced by Senator Rubio (FL)
- July – President Trump invoked Defense Production Act for Rare Earth Element
- November – Australia and US form Critical Mineral Partnership

2020
- February – The American Energy Innovation Act
- April – US Dept. of Energy announces $18m USD for Research on Critical Minerals
What Needs to Happen?

- Political Unification to Enable Economic Realization
- Increased value placed on sustainable and secure sourcing of raw materials
- Regional Supply Chains
- Increased Government Industry Partnerships/Consortiums
- Federal Backstop to Ensure Offtakes (National Critical Mineral Reserve?)
- Streamlined Permitting Process
- Incentives for US investment into American Critical Mineral Projects
- Increased funding for R&D and commercial demonstration plants
- Federal subsidies, tax breaks when needed

Culture

Policy

Investment

- Mining is part of energy future
- Policy must facilitate transition
- Lack of capital a major barrier to competitive industry
Suggested Web Resources

- Payne Institute - https://payneinstitute.mines.edu/
- Ames Lab DOE - https://cmi.ameslab.gov
- Benchmark Minerals - https://www.benchmarkminerals.com/
- AAPG Critical Minerals – URL
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