Observations on the Appalachian Critical Mineral Supply Chain

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What is Needed

To Get from Here:
- Underclays
- Sandstones
- Coal Preparation Byproducts
  - Coarse Refuse
  - Tailings
- Acid Mine Drainage
- Metallurgical Byproducts
  - Tailings
  - Slags
- New Pitch Sources
- New Needle Coke Sources

To Here?:
- RE Magnets
- Alloy Steels
- Li-Ion Batteries
- Graphite Articles
- Carbon Fibers
- Superalloys
- High Frequency, High Power Transistors
- Refractory PM Parts
## Where Might We Find Supply Chain Parts?

<table>
<thead>
<tr>
<th>STATE APPALACHIAN TOTALS</th>
<th>2009 Population Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appalachian Pennsylvania</td>
<td>5,736,617</td>
</tr>
<tr>
<td>Appalachian Alabama</td>
<td>3,024,719</td>
</tr>
<tr>
<td>Appalachian Georgia</td>
<td>2,924,921</td>
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<tr>
<td>Appalachian Tennessee</td>
<td>2,768,846</td>
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<tr>
<td>Appalachian Ohio</td>
<td>2,013,203</td>
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<tr>
<td>West Virginia</td>
<td>1,819,777</td>
</tr>
<tr>
<td>Appalachian North Carolina</td>
<td>1,662,282</td>
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<tr>
<td>Appalachian Kentucky</td>
<td>1,194,500</td>
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<tr>
<td>Appalachian South Carolina</td>
<td>1,167,523</td>
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<tr>
<td>Appalachian New York</td>
<td>1,049,686</td>
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<tr>
<td>Appalachian Virginia</td>
<td>760,060</td>
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<tr>
<td>Appalachian Mississippi</td>
<td>623,260</td>
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<tr>
<td>Appalachian Maryland</td>
<td>247,997</td>
</tr>
</tbody>
</table>

Data from the Appalachian Regional Commission Web Site, 2020
Example Supply Chain Operations

**Synthetic Graphite**
- Coal, Petroleum
  - Binder
  - Coke
  - Green Shape
  - Baking
  - Impregnation
    - Pitch
    - Baking
- Graphitization
  - Product

**SmCo Magnets**
- Copper, Nickel Byproducts
  - Cobalt Recovery
  - Reduction
  - Cobalt Metal
- Rare Earth Ore
  - Concentration
  - Extraction
  - Separation
  - Reduction
  - Sm Metal
  - Melting
  - SmCo Alloy
  - Fabrication/Finishing
  - Magnets

• Where do Unconventional Resources Plug in?
• Where are the Gaps?
Industry in Pennsylvania: Critical Minerals and Carbon Products Businesses

• There’s Also:
  ✓ Mine Equipment Dealerships
  ✓ Process Equipment Vendors
  ✓ Transportation Firms
  ✓ Engineering Firms
  ✓ Fabrication Shops
  ✓ Environmental Firms
  ✓ Geology Firms
  ✓ Law Firms
  ✓ Maintenance Contractors
  ✓ The Lunch Truck

Examples of Supply Chain Operations

• Where do Unconventional Resources Plug in?
• Where are the Gaps?
• How can New Production Processes Fill the Gaps?
If the Goal is Integrating New Production into Existing Supply Chains:

Things that can Contribute:

• Finding Resources
  – Geosciences
  – Mineralogy

• Process Design
  – Mining Engineering
  – Mineral Processing
  – Extractive Metallurgy

• Good Financial Models

• Where do Unconventional Resources Plug in?
• Where are the Gaps?
• How can New Production Processes Fill the Gaps?
• It Needs to be Economic
The Opportunities:

Multiple Unconventional Critical Mineral Resources are in Appalachia
Industries in the Region

• Metallurgy (Critical Minerals)
• Carbon Products
• Manufacturing

• Where do Unconventional Resources Plug in?
• Where are the Gaps?
• How can New Production Processes Fill the Gaps?
• It Needs to be Economic
• A Good Start