

Rare Earth Element Potential from Coal and Coal Ash in the Gulf Coast

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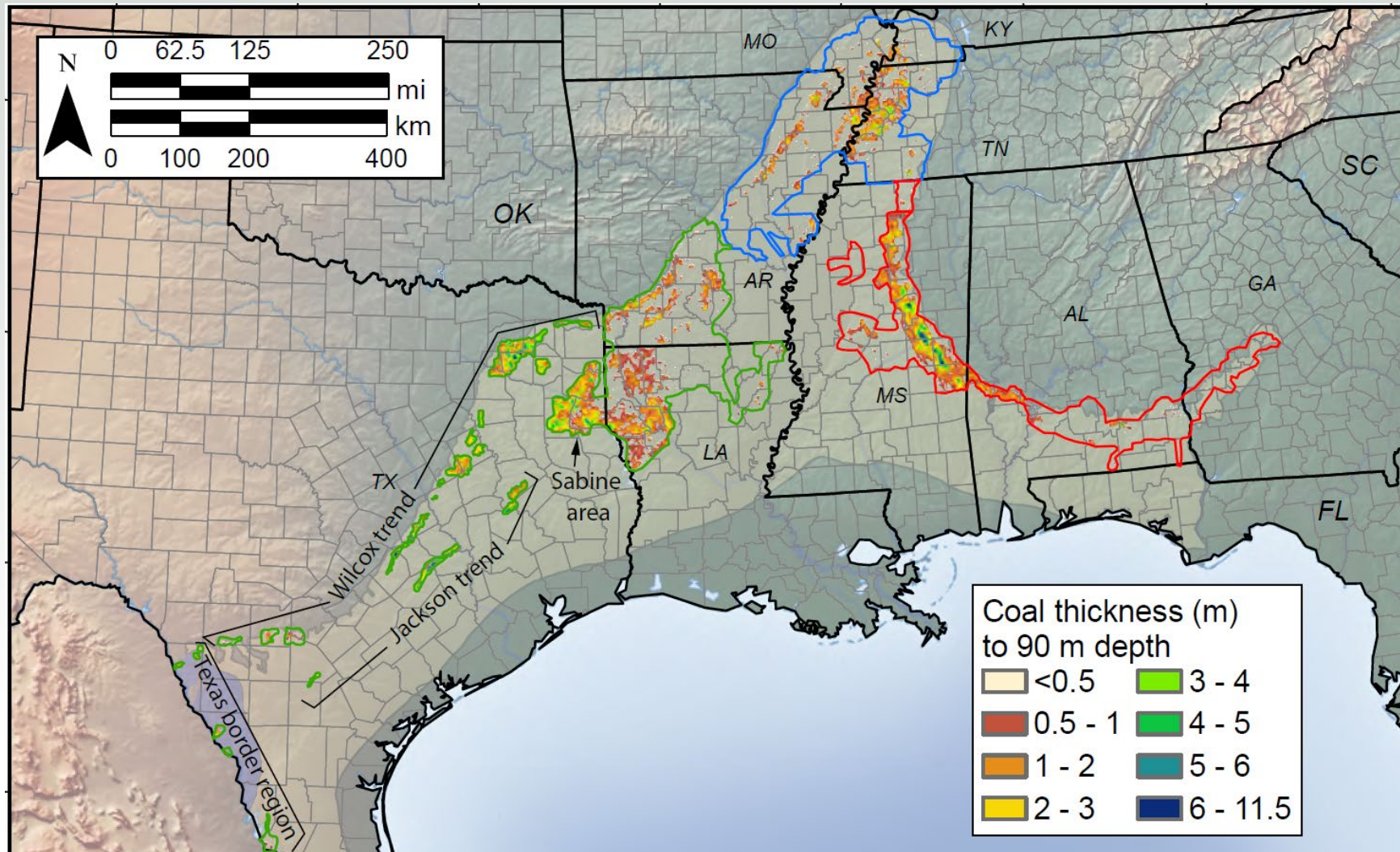
Basic Issue

1. How much **coal** and **coal ash** is available for REE extraction?
2. What is the concentration of **REEs** in coal and coal ash?
3. What are the **tradeoffs** between using coal versus coal ash for REEs?

Coal Resources

- Cumulative coal thickness in Gulf Coast based on ~31,200 drill holes and other data points.
- Total coal resources ~ 83 billion metric tons in upper 90 m (~300 ft)
- TX: 40% of total, MS, 24%, LA: 14%, TN 10%, AR, 6%

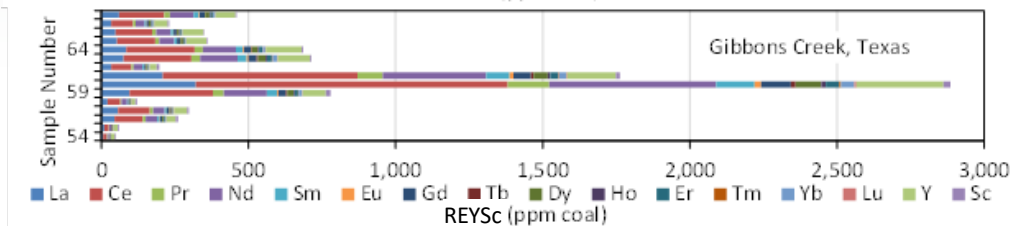
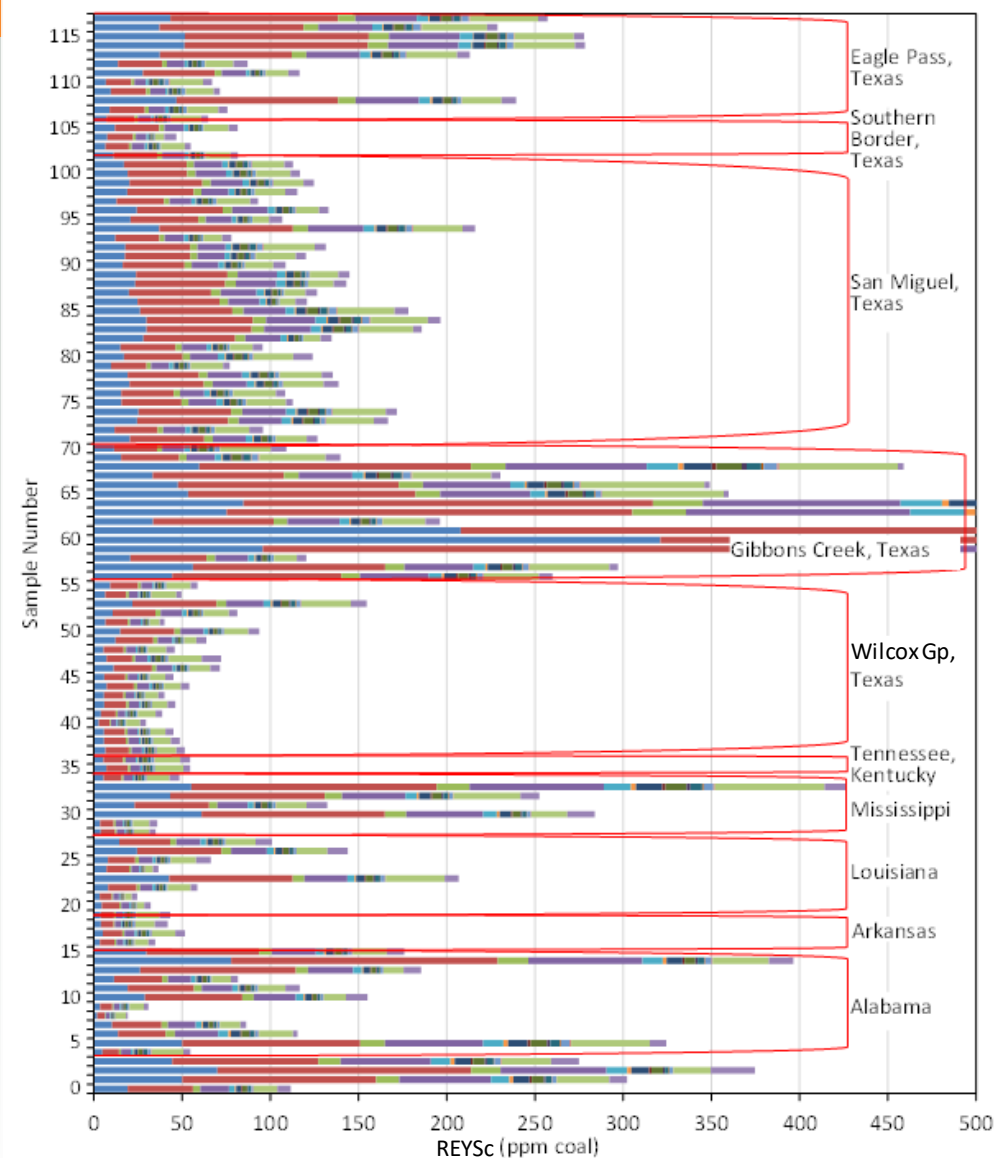
Coal Thickness in Upper 90 m (100 ft)



REEs in Coal in the Gulf Coast

- Total REEs + Yttrium (REY) (dry coal basis) similar to concentrations in upper continental crust (UCC) with localized hotspots ($\leq 2,860$ ppm, Gibbons Creek, TX)
- REY to UCC ratios: 2 – 307 (median: 11)
- REE extractability from lignites is high (63 – 93%) using weak acids
- Median price of REY + Sc = \$10/tonne of coal assuming 50% extraction
- Only 5 active mines produced 260 million tonnes in 2023
- REE production from coal would require co-products (e.g., activated carbon, humic acids) for economic viability

REEs in Coal in the Gulf Coast



Coal Ash Resources in the US

- 52 billion metric tons coal produced in US (1950 – 2021)
- Coal ash ~ 10% of coal production (5.3 billion metric tons)
- ~70% of coal ash potentially accessible for REE extraction (1985 – 2021)
- Median REEs Appalachian ash (431 mg/kg), Illinois Basin (282 mg/kg), Powder River Basin (264 mg/kg)
- Considering market value of REO, extractability of REEs (30% Appalachia and Illinois, 70% Powder River Basin) estimated \$8.4 billion value for REEs

Rare Earth Element Potential in Gulf Coast Coal & Ash

Mines

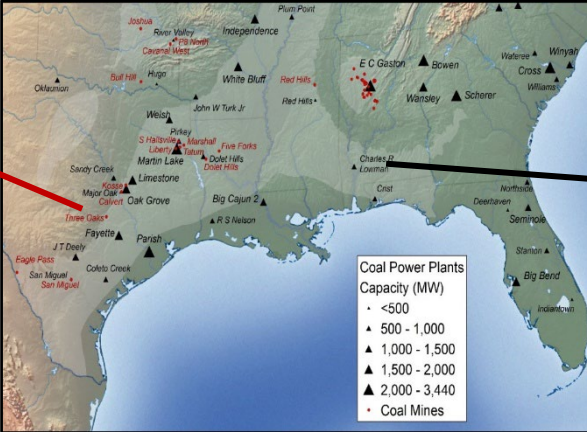


Coal



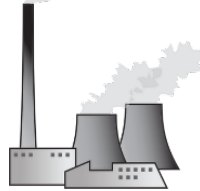
Coal and Ash

Coal from
mines
Fly ash
Bottom ash



Gulf Coast Region

Power Plants



Ash



Analyses

Coal samples
REE & CM levels
Ash % → REE + CM in ash
Extractability of REEs

Results

1. REE levels in coal similar to crustal values with localized hotspots
2. Median REE levels in ash = 3× levels in coal
3. REE extractability from lignite is high (~60 – 90%) with weak acid
4. REE extractability from ash is low ~30%)

Implications

1. Tradeoffs between REE concentrations and extractability between coal and ash
2. REE production from coal would need carbon co-products for economics
3. REE production from ash could offset remediation costs of ash ponds near power plants
4. Carbon coproducts or societal benefits required for socio-economic viability