



TECHNOLOGY ASSESSMENT AND FIELD DEVELOPMENT PLAN

Speaker
Date

James Patten

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FOUR KEY QUESTIONS

- What kind of REE resource can be significant?
REE Concentrations, Specific Composition, Total REE Resource Size, Carbon Ore Potential for Non-Fuel High Value Byproducts...?
- Where might it be found with respect to infrastructure?
- What would be required to produce this resource?
- How can carbon management and environmental safeguard imperatives be met?



WHAT KIND OF RESOURCE CAN BE SIGNIFICANT?

- Attractive REE concentrations in directly mineable or easily separable form.
- REE elemental composition concentrated on valuable components.
- REE targets in accessible mineralogy for separation.
- Surface mineable.
- Can the resource significantly contribute to early startup of U. S. production of critical goods.



CURRENT MARKET PRICE MAY NOT BE THE IMPORTANT METRIC

- One electric vehicle contains 2 pounds of REE. 1000 vehicles/ton of REE.
- One F35 strike fighter contains 920 pounds of REE. Two state-of-the-art fighters/ton of REE.
- One Virginia class submarine requires 4 ½ tons of REE.
- Importance/value to U. S. economic and military security, in the event of interruption/suspension of foreign supply may be the important metric.



TECHNOLOGY NEED DRIVERS

- Resource location - Remote locations will require energy independence and local reduction of ore mass to high REE concentrations. Locations near energy and transportation infrastructure will have less intense needs in this regard.
- Localized high REE concentrations in or adjacent to carbon ore.
- Minerology containing high concentrations of REE in dense minerals will indicate potential for density based separation technology.
- Mineral host phase chemistry will dictate REE extraction technology.



RESOURCE LOCATION

- Remote locations will require self contained heat and power generation. Electrification of all mobile and semi mobile equipment would also eliminate equipment fuel transportation requirements and improve energy efficiency (reduce CO2 emissions). Also, if there is an opportunity for CO2 storage, there would be an opportunity for CO2 separation at the power generation facility.
- There is a potential opportunity to collaborate with another DOE Alaska program focused on CHP.
- One of our partners (North American Coal) is preparing a technology strategy related to energy efficiency improvement (CO2 reduction), including mine electrification.
- Remote locations will also require transportation technology/infrastructure for very concentrated REE ores or extracts.
- All REE resources would benefit from colocation of deep un-mineable coal beds, suitable for CO2 storage. The potential for CO2 storage business related to Q45 credits is being investigated.



REE LOCAL CONCENTRATIONS

- Interlayered REE rich zones within or adjacent to carbon rich zones in the carbon ore deposit will require selective mining and separation of REE rich mineral phases. Two of our partners are expert in precision surface mining (Vermeer surface miner provider and North American Coal surface miner operator).
- If the REE rich minerals are more broadly distributed in the carbon ore, more emphasis will be placed on the importance of mineral phase separation. One of our partners is an expert in density based separation in coal mines (FGX density separation equipment provider).



MINERAL HOST OF REE

- REE concentrated in dense minerals will indicate potential for density based separation technology.
- Bastinite specific gravity is about 5. Monzanite specific gravity is about 4.6 to 5.7. Ewaldite specific gravity is about 4 to 5.
- Chemical properties of mineralogy, and complexity (multiple minerals) of mineralogy will indicate potential pathways to extract REE from mineral phases, and potential solvent management technology and waste stream management technology.
- Potential presence of other valuable critical minerals may also indicate additional separation and related technology.



POTENTIAL FOR HIGH VALUE CARBON BASED NONFUEL BYPRODUCTS

- Earlier work on another DOE Alaska project shows potential for nitrogen containing high value liquid products from Alaska (Usibelli) coal , including chemical process feed stocks, from low temperature pyrolysis.
- Work at other CORE-CM centers will be monitored for potential technology application to Alaska coals.
- As an example, the University of Utah CORE-CM program has robust efforts with respect to resins, carbon fiber, carbon quantum dots, coal-derived supercapacitor and battery components, graphene and graphene oxide, and BTX compounds. Interaction is supported by a collaboration agreement between centers.



CARBON MANAGEMENT AND ENVIRONMENTAL SAFEGUARD IMPERATIVES

- Maximizing energy efficiency (minimizing CO₂ production) will be the base measure to manage carbon (CO₂) emissions. As discussed earlier, technology is available for application in Alaska that can address this aspect.
- Also as discussed earlier, There are well documented opportunities to store CO₂ at several coal deposit locations. This will be investigated for practical application opportunities.
- New technology has been identified that involves filtration with graphene membranes. This technology appears to be capable of targeting specific impurities (or valuable dilute constituents) for removal from waste and process waters. Both removal and elemental separation of REE is potentially feasible, with low energy cost. Removal of other potentially harmful impurities might also be feasible.



FIELD DEVELOPMENT

- Field development will be site specific.
- Initial strategy development will be targeted to the Usibelli coal operation, as a surrogate for resources on or near critical infrastructure.
- A second strategy exercise, for remote sites, will be chosen when a remote resource with high potential is identified





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