Report Date: December 11, 2023
Company: Ramaco Resources, Inc.
Ticker: METC US, METCB US
Industry: Coal Mining
Stock Price (USD): $16.78
Market Cap (USD, Millions): $869.9M

WOLFPACK RESEARCH

METC: Pumping And Dumping Nearly Worthless Dirt

Shares of Ramaco Resources, Inc. (METC) recently soared following a Wall Street Journal article that hyped its Brook Mine as a potential source of up to $37 billion in rare earth elements (REE). METC has been on a national media blitz as the article sparked excitement across major news outlets and retail shareholders alike.

There's just one problem: There is no way to profitably mine them. In fact, we generously estimate METC would lose ~$88 billion if they were ever able to extract, process and sell $37 billion of REEs from the Brook Mine.

METC claims they discovered a "world-class" accumulation of REEs. What they aren't telling you is that anybody standing on Earth's rocky surface probably has a higher concentration of REEs under their feet than at their Brook Mine. Rare earths aren't rare, and one Wikipedia search is all it takes to learn that Ramaco's REE concentrations are less than the average abundance of the Earth's outer crust.

The CEO has asserted that costs for the project will be low because their REEs are in soft clays instead of in hard rocks. But estimates of processing costs *alone* for peer ionic clay projects range from $7.13 to $11.00/tonne. **This cost is more than twice as much as the $3.59 we estimate METC could extract per tonne of material.** An expert we spoke with said that even if METC could magically levitate REEs out of the ground by waving a wand, the Brook Mine would still be unprofitable.

Curiously, management has omitted mention of a typical PH4 and PH1 test to see what portion of Brook Mine's REEs can be easily extracted. This test can be conducted on site using a beaker and cheap solvents for less than $500 per test. PH4 and PH1 test results can be turned around in weeks, yet METC says it will take years to get answers on extractability.

If this recoverability test is too expensive for METC, we are offering to pay for it ourselves. We believe METC has likely performed these tests and is sitting on disappointing results.

Yorktown Partners, a PE fund that specializes in energy and mining and knows Brook Mine and the management team better than anyone, has sold ~12% of its holdings since November. **Overall, insiders have dumped $96.3 million in stock since the start of November**.[1]

The history of METC's Brook Mine is one of failed ventures: it started with a failure to sell the thermal coal to powerplants or local homeowners,[2] and then pivoted to a failed "coal to cars" initiative[3] led by convicted felon, Charles "Charlie" Atkins,[4] brother of METC's current CEO, Randall Atkins. Now the CEO is trying to convince investors that this failed asset is a world-class[5] rare earth mine.

CEO Randall Atkins also has a troubled history, marred by a $32 million judgment after a federal bankruptcy judge held in 1988 that he was *"guilty of conversion"* for his role in Charlie's tax fraud.[6]

We are short METC and believe the stock is massively overvalued due to its incredulous REE claims.

- Our analysis indicates the concentration of REEs in the Brook Mine are less than the average levels present in Earth's crust. We believe the site has no chance of becoming a rare earth mine. Our assessment has been echoed by a chorus of mining professionals who seem to think that this project is at least extremely problematic, or a hoax.[7]
- METC wants you to believe their project is special because their REEs are in clay and easier to recover but REEs in clay are often unrecoverable. A ~$500 test standard in the industry can tell you if they are or not. METC apparently started testing recoverability 6 months ago and now says it will take another 12-24 months to get answers. It should have only taken them weeks to get critical results. In our analysis, we generously assume METC can get a 60% recovery rate, a better rate than nearly all its ionic clay peers. In reality, we think METC is sitting on bad results.
- We estimate Brook Mine can realize REE revenue of only $3.59/t of clay, *using the most favorable assumptions*. Processing costs for clay REE projects, according to estimates for METC's peers, are ~$7-$11/t.[8] This cost alone makes Brook Mine economically unfeasible, even if all other costs were ***zero***. Adding in mining, capex, and G&A cost, we estimate METC would lose ~$88 billion bringing the REEs to market.
- Three of METC's competitors have concentrations of the four most commercially valuable REEs of these rare earths at 3-15 times higher than METC's concentrations.[9] Yet despite much better prospects than METC, these companies are micro-cap and nano-cap companies.
- METC's stock has soared over 40% in the past month. However, insiders have sold $96.3 million of stock since November 10, indicating they don't believe the hype.
- METC's recent focus on REEs follows its failed "coal-to-carbon fiber" project, which we believe was quashed by its own federally funded research paper in March 2023. Charlie Atkins, a key figure in the failed coal to carbon fiber venture[10] and brother of CEO Randall Atkins, pled guilty to felony tax fraud in 2020.[11] Incredibly, it appears that Charlie was still listed as the Head of Research and Development and principal investor in an application for federal funding for ongoing research *after* his guilty plea.[12]
- This was Charlie's second felony conviction for tax fraud. The first was in 1987 when he was prosecuted for his role in a massive tax fraud scheme involving The Securities Group.[13] Randall, the CEO, was a general partner for The Securities Group, and was found liable for a $32M judgment as part of a bankruptcy proceeding. On appeal to the 11th Circuit, the court affirmed the lower court's findings as to Randall, and wrote:

  "[Randall] Atkins' conduct directly violated his fiduciary duty as a partner of [The Securities Group] and [The Monetary Group] to refrain from personally profiting from the misuse of partnership assets."[14]

The Concentration of Rare Earths in the Brook Mine Is Less Than Is Present in an Average Piece of the Earth's Crust; We Believe This Kills the Project

Despite their name, rare earths are not rare.[15] Precious metals and minerals are spread all throughout the Earth's crust (the rocky outer surface we mine from and build on top of). Mines are built around anomalies, extreme concentrations of valuable elements.

Amidst all the hype over METC's rare earths discovery that management claims "could rank among the more promising rare earth deposits on a worldwide basis", we wonder if anyone bothered to check if the REEs at the Brook Mine are even truly concentrated.

Shockingly, the REEs in METC's Brook Mine occur at a **lower** concentration than the average levels of the Earth's crust. Put another way, the rock beneath your feet is probably more enriched with REEs than METC's self-proclaimed "world-class" discovery.[16]

A quick Wikipedia search shows that the average crustal abundance of the four REEs that drive a project's economics (Nd, Pr, Dy and Tb) is 67 parts per million (PPM).[17] METC's Brook Mine averages only 59 PPM, 12% lower than the average of the Earth's crust:

Element Symbol	Earth's Crust Rare Earth Concentration	Brook Mine's Rare Earth Concentration
Nd	49	41
Pr	10.8	10.8
Dy	6.0	6.2
Tb	1.4	1.1
Total	**67**	**59**

Brook Mine's concentration of critical battery metals is 12% LOWER than the Earth's Crust

Source: Wolfpack Analysis, Appendix A

Average crustal abundance won't support an economic mine, let alone below average. However, METC has a classic stock-promoter spin for their project and claims to have a valuable ace up their sleeve:

> *"Most of our [METC] deposits are found in clay and clay-like structures. … They are easier to process, they are less expensive to process and they are, as a result, more valuable."* – Randall Atkins, May 22nd, 2023 Interview

METC's CEO suggests they have a special process-cost advantage that makes the Brook Mine cost-effective, soft clay. Once again, we wonder if anybody has bothered to check...

Clay or No Clay, METC Would Set a World Record for The Most Capital Destructive Mine in History if They Tried to Mine $37 billion of REE's from Brook Mine

Clay REE projects aren't rare either. Many are scattered across numerous micro and nano-cap companies, and the consensus cost of processing them is ~$7-$11/t of clay. In comparison, our calculations show METC's clay, at below average crustal abundance, boasts a pathetic $3.59/t of realizable REE revenue.[18] All-in costs for their clay REE peers average $14.65/t once you add mining and G&A costs on top.

All in all, this suggests that if METC were to mine $37 billion worth of REEs from their Brook Mine, **we estimate they would lose ~$88 billion in the process, which would forever cement METC as the most capital destructive mine in history.[19]**

The Only Thing Unusual About METC's Brook Mine is How Bad it Looks Compared to its Peers.

*Per US$/tonne	Strip Ratio	Mining Costs	Mining Costs Total	Processing Costs	G&A	Total Opex
Meteoric Resources; 2500 ppm cutoff (Caldeira)	0.50	$ 2.00	$ 3.00	$ 11.00	$ 2.00	$ 16.00
Aclara Resources (Penco Module)	0.37	$ 3.11	$ 4.26	$ 7.13	$ 2.20	$ 13.59
Australian Rare Earths (Koppamurra)	0.50	$ 2.50	$ 3.75	$ 8.62	$ 2.00	$ 14.37
Peer Average			$ 3.67	$ 8.92	$ 2.07	$ 14.65

$3.59	**-**	**$14.65**	**=**	**($11.06)**
(value of 1 tonne)		(operating costs per tonne)		(METC loss per tonne of rock processed)

Source: Meteoric Resources, Aclara Resources[20], Australian Rare Earths[21] & Wolfpack Analysis

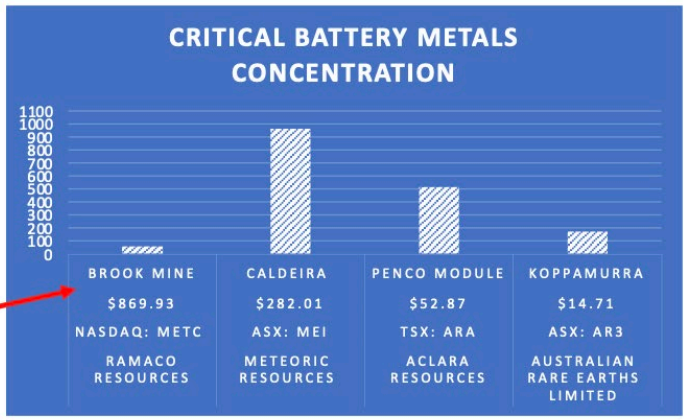
The table above shows METC's peers have an estimated average operating cost of $14.65/t to mine and process their clays. We estimate that METC's clay with its ultra-low REE concentrations could only generate revenues of $3.59/t. This means the company would need their ppm concentrations of REEs to be ~4x higher than what they currently are just to have a chance of breaking even.

Again, breaking news, we need higher than average crustal abundance to make a profitable mine. METC's clay peer group averages concentrations of critical REEs that are **9x** times higher than the Brook Mine. Yet, METC's CEO appears to be telling his investors otherwise:

> *Although the amount of overall REE ppm concentrations are lower than found in "conventional" hard rock minerals, the overall level of concentrations is both consistent as well as higher than ppm concentrations usually found in other "unconventional" deposits" -* ***Randall Atkins, May 4 Shareholder Letter*** [22]

As seen below, Brook Mine does not compare favorably to the other projects—ranking dead last in rare earth concentration.

Brook Mine has the lowest concentration of critical battery metals amongst its clay REE peers.



Source: Appendix C

METC's peers group shown above all have concentrations of critical REEs multiple orders of magnitude higher than the Brook Mine.

METC's Management Has Failed to Conduct a Basic Recoverability Assessment of the Brook Mine

One glaring omission from its technical report is that METC doesn't mention conducting an industry standard test that shows whether you can easily get the REEs out of your clay. These PH4 and PH1 tests cost a mere ~$500 and can be conducted using a simple beaker and stir stick. They inform clay project developers whether their REEs are accessible using mild solvents. METC's peers say this is the first thing you do when looking at a clay REE project. It's a make-or-break test; it's cheap and fast:

> *"Before we even pegged the ground two years ago, me and my co-founder had the materials tested at pH4 and pH1 … to establish whether there were any rare earths coming into solution … We didn't want to waste any of our own money. That was a very cheap, very quick test to do."* ***– Rick Pobjoy, AR3 Founder*** [23]

METC admitted that testing was underway six months ago, acknowledging it was critical to their claims that the Brook Mine will be cheaper and easier to process:

> *"We're doing more testing to determine if these are ionic in character and if they are, then that makes it even easier to process, because then you just do an ion substitution, and the rare earths fall off — that's why it's kind of a big deal to have an ionic deposit because you don't have to go through either a very expensive processing technique"*
> ***– Randall Atkins, May 18th, 2023; mining.com Interview*** [24]

So, will the rare earths just fall off? That's what a PH4 test tells you and it's about as complicated as sticking some clay in a beaker and stirring it around with liquid as acidic as apple juice then sending it to a lab.

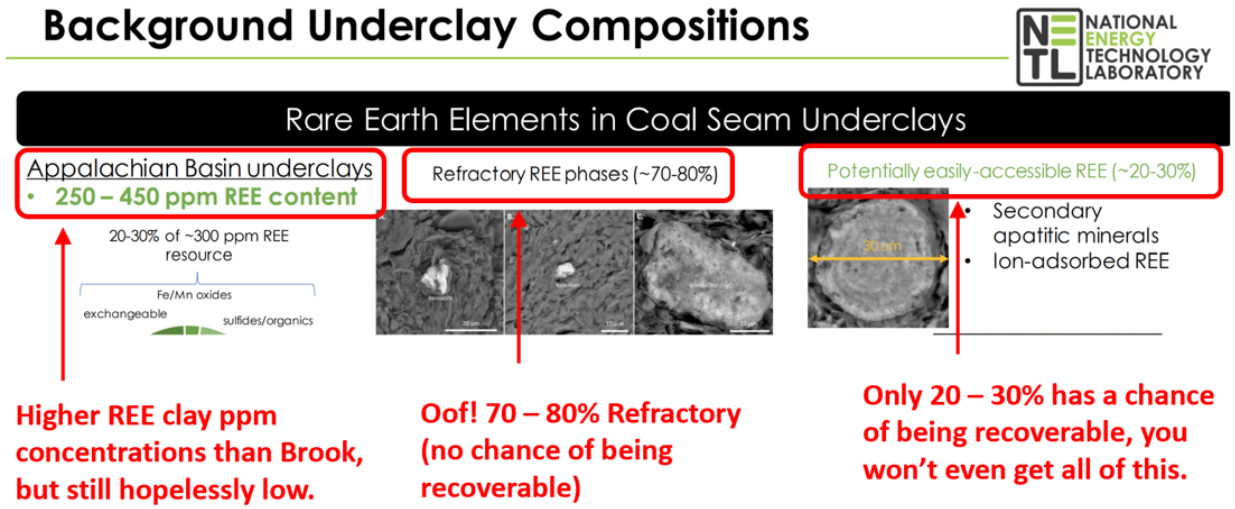
Results from these tests can be turned around in weeks. Now, after 6 months with no results, METC's CEO suggests we may still be waiting years before seeing any recovery data:

> *"finding it and then involves a lot of subsequent chemically testing to essentially determine how you can separate and extract this … the trick is that you be able to economically separate that and that's the quest we're on right now…but we anticipate probably within* ***the next 12-24 months*** *being in a pretty good position to analyze exactly which extraction techniques may be the right one to deploy" –* ***Randall Atkins, December 6th, 2023 Bloomberg TV Interview*** [25]

We suspect something has gone wrong here and METC is kicking the can down the road. METC's behavior pattern is a common cause of frustration amongst some of METC's more credible peers:

> *"The frustration for us is that there are dozens of explorers who continue to drill, and drill, and release assay results who aren't doing the simple test required to establish whether you can bring rare earths into solution" –* ***Rick Pobjoy, AR3 Founder***

We will not be surprised if the recoverability rate at Brook Mine is far worse than their peers. In 2020, NETL investigated the recoverability from clay underbeds in the Appalachian Basin and the results were awful:



Source: NETL Deck

The Brook Mine's History Indicates That It Is Not Commercially Viable

In WSJ's article discussing Brook Mine, it mentions that Randall Atkins acquired the mine "sight unseen" in 2012 for a paltry $2 million.[26] Our research into what has happened since indicates that Randall likely paid too much.

Despite later statements that "coal is too valuable to burn," reporting on Ramaco in 2017 stated:

> *"locals are skeptical of a company that she said **has gone from proposing a large-scale thermal coal mine to focusing on local sales of coal for home furnaces**."*

We spoke with a representative of the Powder River Basin Resource Council (PRBRC) who confirmed that the company's past attempts at monetizing their thermal coal reserves had failed.

The company decreased the amount it was requesting to mine in its permits from several million tons a year, to 100,000 tons per year initially, ramping up to 500,000 tons according to the PRBRC. For context, "Wyoming's smallest operating coal mine produced 2.1 million tons, and the largest produced 92 million tons in 2016" according to the PRBRC.[27]

When METC went public, management tapped Charlie Atkins, the current CEO's brother and a convicted felon, to spearhead a pivot for the Brook Mine asset. Instead of selling coal for furnaces, they would attempt to convert coal into carbon fiber.

METC's Prior Schtick was "Coal to Cars," Spearheaded in Part by Convicted Felon Charles Atkins, Brother of METC's CEO

This pivot into finding new uses for coal was run by a new private entity, Ramaco Carbon LLC. In a July 2017 pitch deck, Ramaco Carbon's spiel was turning "coal to cars."

This would supposedly be done by converting carbon, the main element in coal, into a material that would act as a "feedstock" for other carbon products such as carbon fiber. Ramaco Carbon claimed it would be able to create the "feedstock" for carbon fiber at lower prices, which would allow carbon fiber to displace steel, aluminum, and other basic materials. The company claimed it was just a matter of time, and then it would be "Game Over."[28]

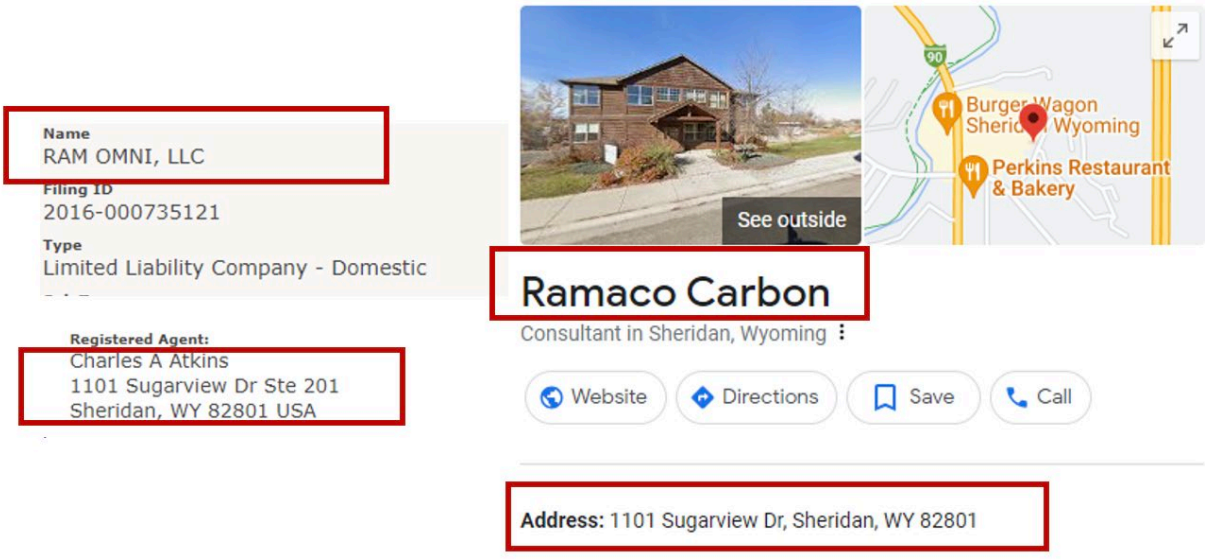
Source: Ramaco Carbon, June 2017 Presentation

METC's CEO Randall Atkins was very gung-ho about this idea, as was his brother Charlie, who also was an executive at the time, serving as the head of Research & Development at Ramaco Carbon. In this article in 2017, Charlie was trumpeting the idea that coal the company had in the Powder River Basin **(the region Brook Mine resides in)** was uniquely suited for the conversion of coal to carbon fiber feedstock.

> ***"If you're looking for good value for producing a low-cost precursor for carbon material, I think you'd be hard-pressed to find a better place to do that than the Powder River Basin**," Charlie Atkins said."*

At the time Charlie Atkins was not only spearheading R&D at Ramaco Carbon, but also apparently committing tax fraud using an entity called Ram Omni LLC, which shared office space with Ramaco Carbon, LLC.[29]

> *"According to court documents and statements made in court, Charles Agee Atkins, of Chapel Hill, controlled and operated several risk consulting businesses, including Financial Engineering & Risk Management LLC, Risk Assessment & Management LLC, and **Ram Omni LLC**. From 2011 through 2017, Atkins underreported the income that he received from these businesses on his tax returns, causing a tax loss of more than $380,000 to the IRS. Atkins also admitted that he failed to pay more than $420,000 in taxes he owed to the IRS for several prior years. In total Atkins caused a tax loss of more than $800,000 to the IRS."*[30]



As seen below, Ramaco Carbon listed Charlie Atkins as an executive in a federal grant application[31] to research the usefulness of coal from the Powder River Basin as a feedstock for carbon fiber. This application was filed in October 2020, wherein Charlie is described as the Head of Research and Development and listed as a principal investigator for Ramaco Carbon. We are quite confused to how this happened considering Charlie pled guilty to two federal charges *two months prior*, in August 2020.[32]

Furthermore, we think Charlie's brother, METC CEO Randall Atkins, was aware of these charges as early as 2019 when Charlie's home was subject to a search warrant.[33]

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Ramaco Carbon **Exhibit D** DE-FOA-0001992 Narrative

Funding Opportunity Announcement (FOA) Number: DE-FOA-0001992

Project Narrative

Project Title	Experimental Validation and Continuous Testing of an On-Purpose High-Yield Pitch Synthesis Process for Producing Carbon Fiber from US Domestic Coal

Mr. Charlie Atkins is the Head of Research and Development at Ramaco (b) (6) [redacted]

[redacted]

Department of Energy, Federal Grant No. DE-EE00082803, Consortium for Production of Affordable Carbon Fibers in the U.S., Ramaco is not receiving any support, but is making a $450,000 in-kind contribution to the project, (10/1/2017 – 12/31/20), Person-Months per year 0.56 PI: Charles A. Atkins

The Coal to Carbon Initiative Is Exposed as a Waste of Time and Money

A technical report submitted by Ramaco Carbon in March 2023 to a Department of Energy lab revealed that its ongoing science experiment, converting coal to carbon fiber, was largely a failure.[34] Per the technical report, Powder River Basin coal does not appear suitable for producing carbon fiber:

> *"Evaluation of the char was not within the scope of the project; however,* ***it is considered to be unlikely to have such high value when produced from a non-coking coal such as the Powder River Basin (PRB) coal used in this study.*** *The pyrolysis tars that were recovered (MUSCL Oil) did not display a propensity to form mesophase with a thermal treatment and also had a low yield. The resulting upgraded isotropic pitches had very low spinnability and only a small amount of fiber was able to be produced.* ***This fiber contained many defects and only one fiber survived the mounting process to produce a mechanical test result that was very low compared to the target values for structural applications****."*

It does not shock us that the findings in Ramaco Carbon's technical report are yet to be widely disclosed to METC investors. After the report was released, METC's CEO Randall Atkins informed sell side analysts on the company's 1Q23 earnings call that their coal to carbon fiber initiative would "*probably*" have "*meaningful commercial possibilities*" within the next year.[35]

We think this improbable given the technical report reveals a small-scale operation[36] would yield a negative net present value and acknowledges that the *"char product is likely not sellable for appreciable revenue."*[37] Per the report, **a positive net present value of $940k** would be achieved on a large-scale operation[38] requiring nearly $70 million in startup costs, **only if the char can be sold for more than $250/ton.**[39] In our opinion, *Ramaco Carbon's report itself dispels coal to carbon fibers economic viability* as it directly admits this Powder River Basin char is "unlikely to have such a high value." We believe Ramaco Carbon's coal to carbon initiative is a glorified science experiment, designed by METC's management as a promotional point to dupe credulous investors.

Randall Atkins Involvement in "One of the Largest Tax Frauds Cases Ever Filed"[40]

In 1987, Charlie Atkins was convicted and later sentenced for his involvement in a massive tax fraud scheme involving The Securities Group that became national news. He was sentenced to two years in prison, and four years of probation.

Randall, the current CEO of METC, was not brought up on any criminal charges, but he was a general partner in The Securities Group, which sought bankruptcy protection after Charlie's fraud was exposed. After a trial by a bankruptcy court, Randall and another partner were found "guilty of conversion, unauthorized use of partnership funds for non-partnership purposes, usurping a partnership opportunity and of violating their fiduciary responsibilities to the partnerships."[41]

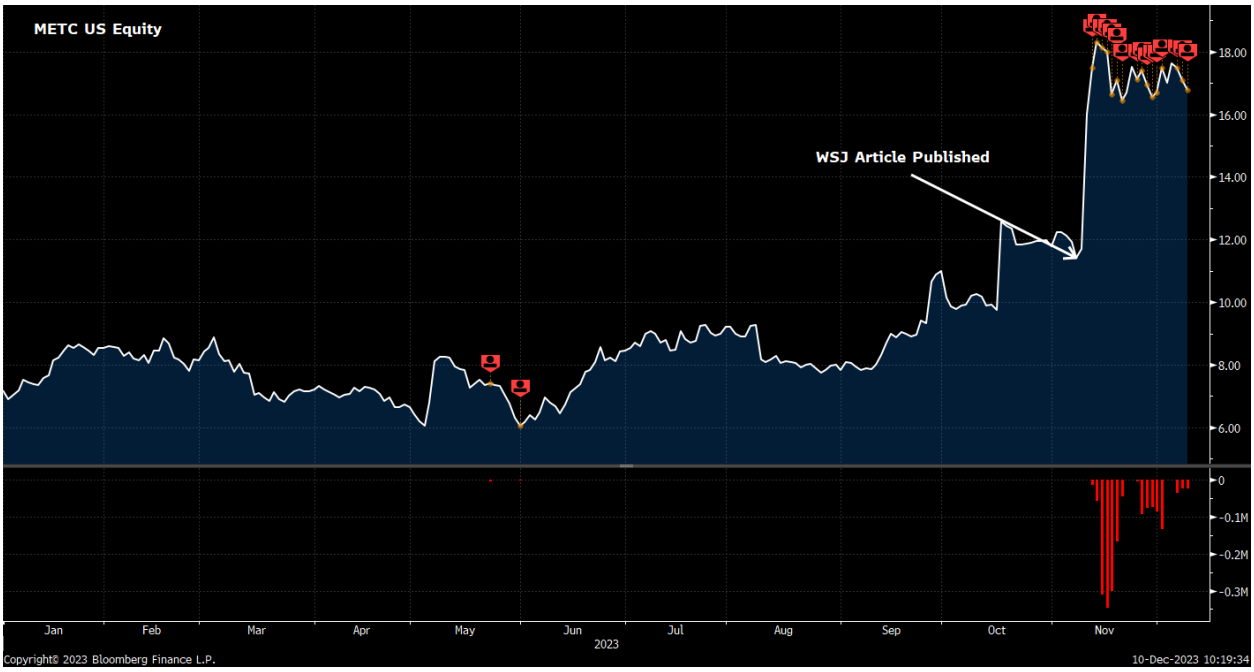
Randall and his partner appealed this ruling to the 11th circuit. The court reversed the judgment as to the other partner but affirmed the decision concerning Randall. This is because, according to the decision rendered by the 11th Circuit, there was a suspect real estate transaction where Randall acted as the general partner for The Securities Group, special counsel for another entity involved in the transaction, and was the escrow agent for the transaction.

The court held that “Atkins actively participated in the purchase of the property” and “facilitated the transfer of the "security deposit."” The court also held that “Atkins enjoyed a personal windfall from the transactions.” Finally, the court concluded:

> *“Based on his involvement in the transactions, Atkins clearly was aware of the nature of the transactions. Atkins cannot now credibly claim that he was neither aware of, nor participated in, the misappropriation of plaintiffs' property. Under the circumstances,* ***Atkins' conduct directly violated his fiduciary duty as a partner of TSG and TMG to refrain from personally profiting from the misuse of partnership assets.*** *We therefore conclude that the record amply supports the bankruptcy court's factual finding that Atkins wrongfully participated in the transaction.”*[42]

METC's Largest Shareholder, Yorktown, Is Selling Brook Mine's Hype as Meaningful Dilution Looms

Insiders have used METC's recent rise in its share price as an opportunity to cash out. Over the past month, insiders have dumped $96.3 million worth of stock—*more than 10% of METC's current market cap*. As seen below, insiders are having a fire sale:



Source: METC Graph Insider Transactions, Accessed via Bloomberg, LP

Leading the pack of insider selling is METC's largest shareholder, Yorktown Partners, which has sold more than 12% of their stake in the company since November. We think if the Brook Mine or Ramaco Carbon had any substantial value, Yorktown along with members of METC's Board wouldn't be selling. It's that simple: ***if Yorktown and METC's insiders actually believe the Brook Mine is worth anywhere near $37 billion then why are they selling so many of their shares at a sub $1 billion valuation?***

In our opinion, an existing $400 million shelf offering is cause for alarm. METC's recent run-up in share price, coupled with newfound love for the stock from retail due to the **flurry of media attention** and promotional television appearances are tell-tale signs dilution is coming soon. We expect METC to use the shelf at today's inflated prices. A $400 million equity offering at METC's current valuation equates to ~45% dilution for current shareholders.

Appendix A: Brook Mine's REE Concentration Compared to Earth's Crust

Below is a step-by-step process on how we calculated that Brook Mine has a lesser concentration of REEs than the Earth's Crust. For brevity, we refer to each column by the letter listed in the top row.

A	B	C	D	E	F	G
Element Symbol	REE Avg. PPM In Earth's Crust	REE to REO Conversion Factor	REO Avg. PPM In Earth's Crust	Brook Mine REO Concentration %	REO Midpoint Avg. PPM In Brook Mine	Brook Mine REO Concentration As % of Earth's Crust REO Concentration
Nd	41.5	1.17	48.555	15.84%	40.63	84%
Pr	9.2	1.17	10.764	4.22%	10.82	101%
Dy	5.2	1.15	5.98	2.42%	6.21	104%
Tb	1.2	1.15	1.38	0.42%	1.08	78%
					Total	**92%**

1. Brook Mine's technical report states the REEs of most interest to METC are the Primary Magnetic REEs given their commercial significance. These elements are Neodymium (Nd), Praseodymium (Pr), Dysprosium (Dy), and Terbium (Tb).[43] Given their significance and usage in batteries, we refer to this group as "critical battery elements" in our report. Column A, we list each of these element's symbol.
    a. Note: There are three other REE's (Sm, Gd, and Ho), labeled as Secondary Magnetic REEs which we think do not have a material impact on the valuation of Brook Mine.[44]
2. Column B is the average ppm in earth's crust of each respectively listed REE in the column "element symbol." The crustal abundance of each REE can be found here.
3. To compare REEs found in the earth's crust to the Brook Mine, we must convert each REE's ppm crustal abundance to REO. Brook Mine's technical report lists conversion factors for converting REE to REO—we list the appropriate ones in the above chart under Column C. Column D is derived by multiplying each REE's Column B & Column C together.
4. Brook Mine's REO concentrations are sourced directly from METC's website. Below is a screenshot of the image we're referencing for Brook Mine's REOs.

Brook Mine ICP Analysis	
Primary Magnetic REOs	
Neodymium (Nd2O3)	15.84%
Praseodymium (Pr6O11	4.22%
Dysprosium (Dy2O3)	2.42%
Terbium (Tb4O7)	0.42%
% of Primary Total	**22.90%**
Secondary Magnetic REOs	
Samarium (Sm2O3)	3.06%
Gadolinium (Gd2O3)	2.78%
Holmium (Ho2O3)	0.48%
% of Secondary Total	**6.32%**
% of All Magentic Total	**29.23%**
Other REOs	70.78%
Brook REO Basket	**100%**

Source: Brook Mine ICP Analysis of REOs – Source: Weir International, Inc.

5. Column F was derived from data published in Brook Mine's technical report on p. 41, Figure 7.6-1 Estimated TREO Grade Distribution. A discussion of how we determine our estimated TREO PPM midpoint value of 256.5 ppm can be found in Appendix B
6. Multiplying each respective REE's Column E by our calculated TREO PPM of 256.5, we can reasonably estimate the values found in Column F.
7. Column G is calculated by dividing Column F by Column D.

Appendix B: Brook Mine's Realizable REE Revenue Per Tonne

Our realizable REE revenue per tonne is calculated as follows: [In Situ Value ($8.55) * Recoverability Rate (60%) * Payability Rate (70%)].

In Situ Value	$ 8.55
60% Recoverability Rate	$ 5.13
70% Payability Rate	$ 3.59
REE Revenue Per Tonne	**$ 3.59**

A mining expert we consulted claims it'd be generous to assume METC could generate a 50% recovery rate with a best-in-class recovery rate at 60%. Sprott's estimates historical recoverability rates at 44-68% for clay hosted deposits.[45] METC's rare earth peers, Aclara Resources and Ionic Rare Earths, respectively have recoverability rates of 18% and 53%.[46]

Assuming Brook Mine has an ace 60% recoverability rate, we believe Brook Mine will only yield $5.13 per tonne. However, Brook Mine is then paid a percentage value (payability rate) of its REEs from their rare earth processor. Macquarie recently estimated a clay REE project in Brazil would have a 70% payability rate.

Brook Mine In Situ Value

We calculated Brook Mine's in situ value per tonne by taking each respective REE's column B/1000*Column C. Column C data was sourced each REE listed below from Macquarie's 2023 estimated REOs pricing table on p. 3 of this report.

A	B	C	D
Element Symbol	REO Midpoint Avg. PPM In Brook Mine	REO $/kg	In Situ Value
Nd	40.63	$ 91.59	$ 3.72
Pr	10.82	$ 91.59	$ 0.99
Dy	6.21	$ 320.35	$ 1.99
Tb	1.08	$ 1,713.71	$ 1.85
		In Situ Value	**$ 8.55**
		Recoverability 60%	$ 5.13
		Payability 70%	$ 3.59

Estimated TREO PPM Calculation

Figure 7.6-1 Estimated TREO Grade Distribution shows only 3.3% of Brook Mine's distribution having an estimate greater than 300+ ppm. We assigned the average grade of this 300+ ppm distribution at 325 ppm. We believe this is a fair estimate considering the range cited on p. 40 in Table 7.6-3 was 245-307 ppm. Other values in column "Average PPM" were found by taking the

average of the low and high number in column “PPM Range.” Given Figure 7.6-1 discloses the distribution of PPM ranges, we were able to back into an estimated TREO PPM of 256.5 as seen in the chart below.

PPM Range	Average PPM	PPM Range Percentage		
300+	325		3.3%	10.7
250-299.99	274.995		63.7%	175.2
200-249.99	224.995		26.7%	60.1
150-199.99	174.995		5.6%	9.8
100-149.99	124.995		0.4%	0.5
50-99.99	74.995		0.3%	0.2
		Estimated TREO PPM —>		**256.5**

Source: Wolfpack Analysis, Brook Mine Technical Report p. 41

Appendix C: Critical Battery Metals Concentration

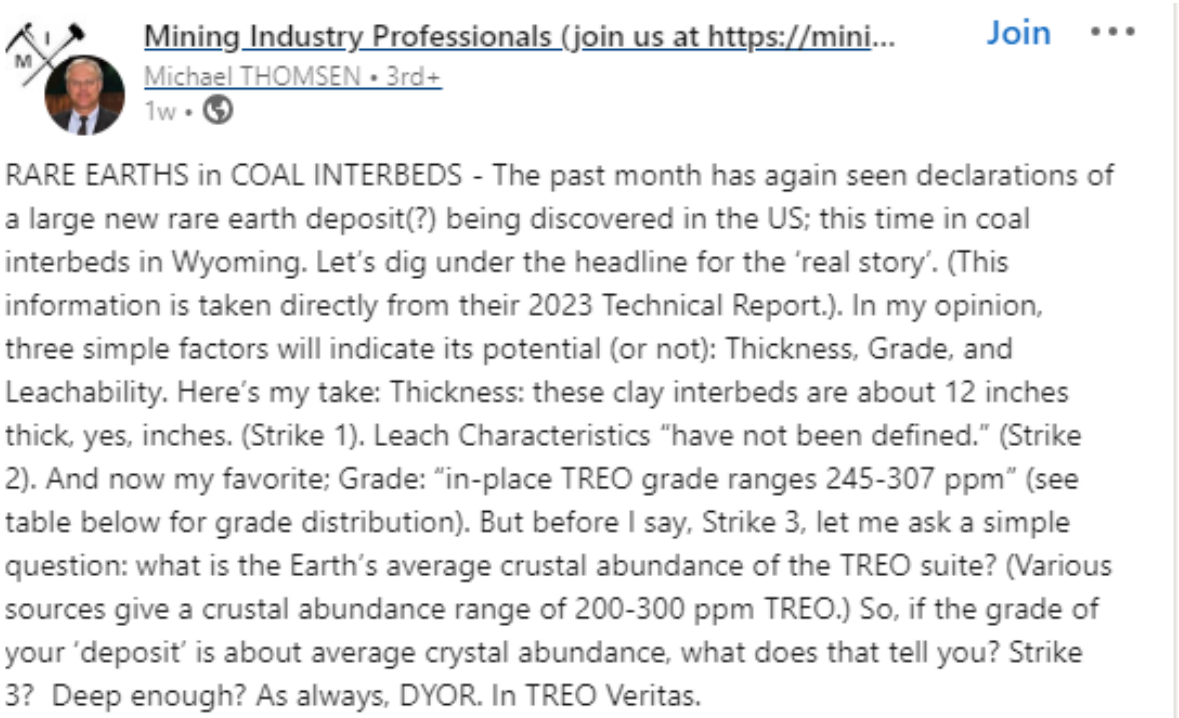
The chart in our report references the total resource ppm of the critical battery elements. Conversion factors were used from Brook Mine's technical report (p. 38) to convert each project's REEs to rare earth oxides (REOs). The following reports were used for each respective company to determine the REO amount of critical battery elements for each project:

1. Aclara (Penco Module)
2. Australian Rare Earths (Koppamurra)
3. Meteoric Resources (Caldeira)
4. Ramaco Resources (Brook Mine)

Total Resource In PPM	Nd	Pr	Dy	Tb	Total
Aclara Resources (Penco Module)	349	90	67	9	515
Australian Rare Earths (Koppamurra)	122	32	18	3	175
Meteoric Resources; 2500 ppm cutoff (Caldeira)	688	235	34	7	964
Ramaco Resources (Brook Mine)	41	11	6	1	59

Appendix D: A Chorus of Mining Experts Are Trashing This Project:

The Chairman of North American Strategic Minerals Inc, dismantled METC's claims in a short linked-in post for mining industry professionals, which simply pointed out that the average crustal abundance is about the same as the "deposit."



Mining Industry Professionals (join us at https://mini... Join

Michael THOMSEN • 3rd+

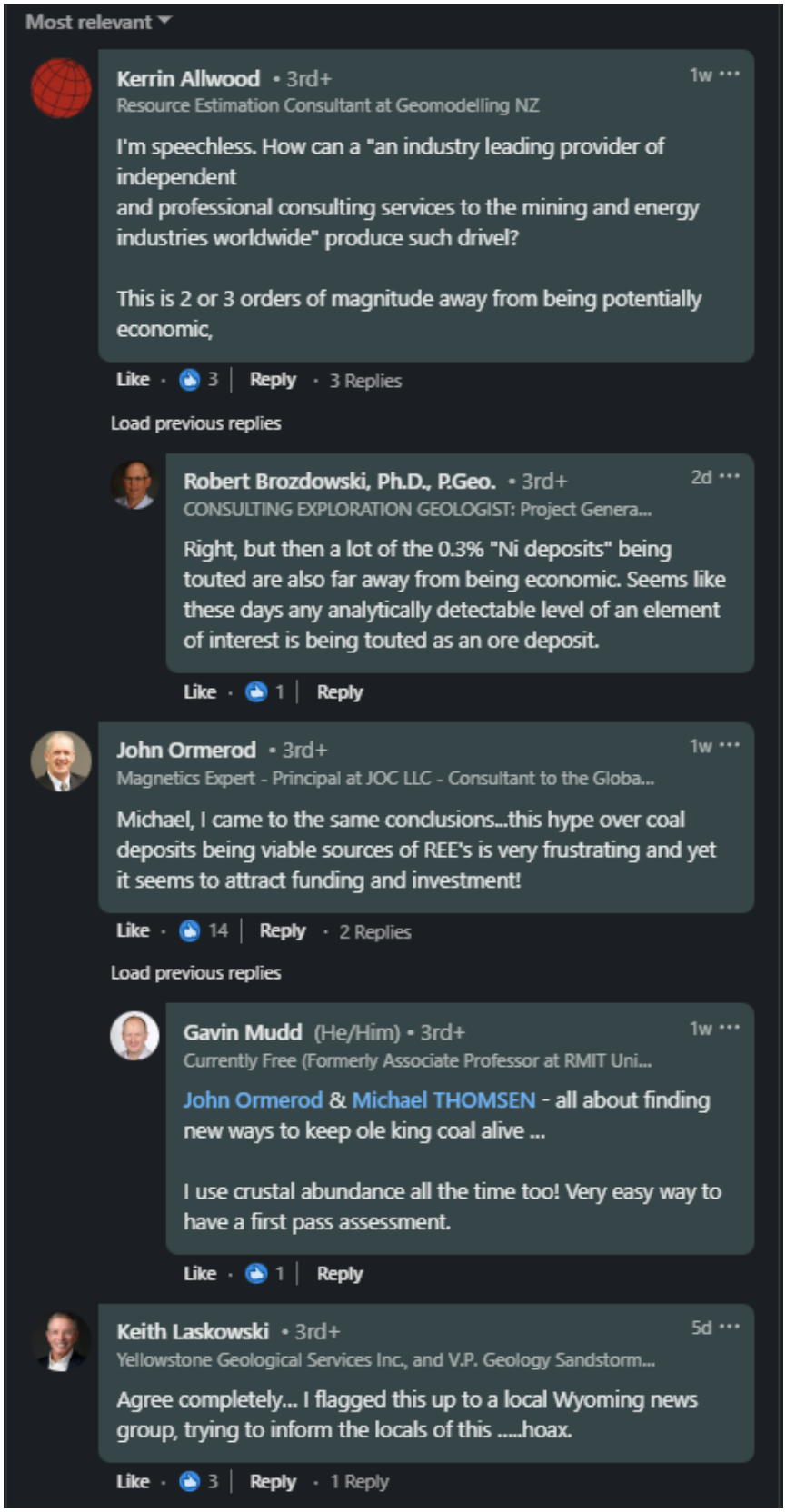
1w •

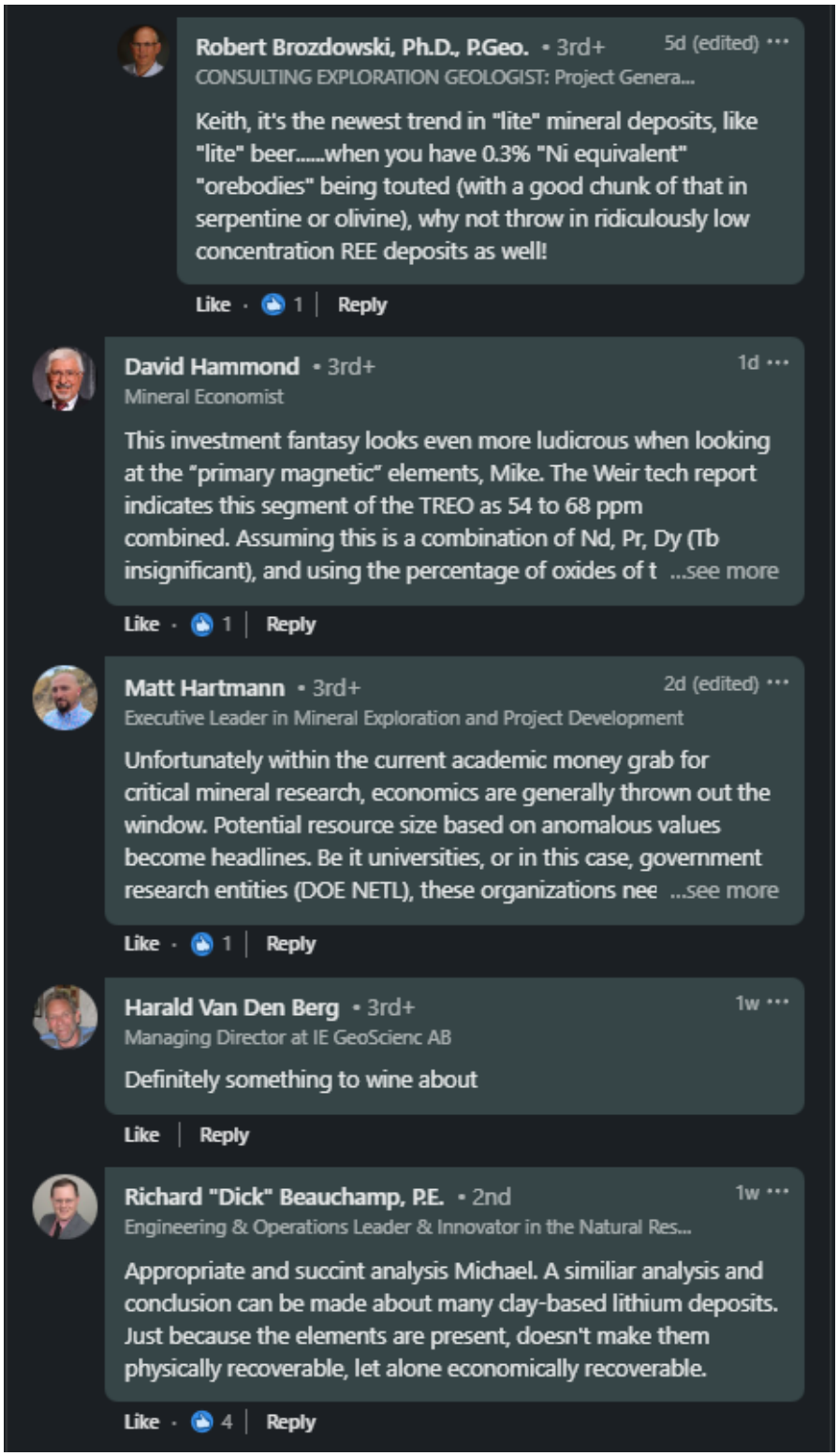
RARE EARTHS in COAL INTERBEDS - The past month has again seen declarations of a large new rare earth deposit(?) being discovered in the US; this time in coal interbeds in Wyoming. Let's dig under the headline for the 'real story'. (This information is taken directly from their 2023 Technical Report.). In my opinion, three simple factors will indicate its potential (or not): Thickness, Grade, and Leachability. Here's my take: Thickness: these clay interbeds are about 12 inches thick, yes, inches. (Strike 1). Leach Characteristics "have not been defined." (Strike 2). And now my favorite; Grade: "in-place TREO grade ranges 245-307 ppm" (see table below for grade distribution). But before I say, Strike 3, let me ask a simple question: what is the Earth's average crustal abundance of the TREO suite? (Various sources give a crustal abundance range of 200-300 ppm TREO.) So, if the grade of your 'deposit' is about average crystal abundance, what does that tell you? Strike 3? Deep enough? As always, DYOR. In TREO Veritas.

Table 7.6-4 TREO Distribution by Lithology Group

TREO Concentration (ppm)	Estimated Distribution (% TREO)			
	Clay/Silt	Coal	Other	Total
<50	0.01	0.03	0.00	0.04
50-99	0.08	0.21	0.02	0.31
100-149	0.22	0.15	0.02	0.39
150-199	2.78	1.50	1.35	5.64
200-249	17.58	2.00	7.12	26.70
250-299	42.97	5.62	15.07	63.66
300+	1.87	0.37	1.01	3.26
Total	65.51	9.89	24.60	

The comments attached to this article were both funny and informative, as you can see below:





Robert Brozdowski, Ph.D., P.Geo. • 3rd+ 5d (edited) ···
CONSULTING EXPLORATION GEOLOGIST: Project Genera...

Keith, it's the newest trend in "lite" mineral deposits, like "lite" beer.....when you have 0.3% "Ni equivalent" "orebodies" being touted (with a good chunk of that in serpentine or olivine), why not throw in ridiculously low concentration REE deposits as well!

Like · 1 | Reply

David Hammond • 3rd+ 1d ···
Mineral Economist

This investment fantasy looks even more ludicrous when looking at the "primary magnetic" elements, Mike. The Weir tech report indicates this segment of the TREO as 54 to 68 ppm combined. Assuming this is a combination of Nd, Pr, Dy (Tb insignificant), and using the percentage of oxides of t ...see more

Like · 1 | Reply

Matt Hartmann • 3rd+ 2d (edited) ···
Executive Leader in Mineral Exploration and Project Development

Unfortunately within the current academic money grab for critical mineral research, economics are generally thrown out the window. Potential resource size based on anomalous values become headlines. Be it universities, or in this case, government research entities (DOE NETL), these organizations nee ...see more

Like · 1 | Reply

Harald Van Den Berg • 3rd+ 1w ···
Managing Director at IE GeoScienc AB

Definitely something to wine about

Like | Reply

Richard "Dick" Beauchamp, P.E. • 2nd 1w ···
Engineering & Operations Leader & Innovator in the Natural Res...

Appropriate and succint analysis Michael. A similiar analysis and conclusion can be made about many clay-based lithium deposits. Just because the elements are present, doesn't make them physically recoverable, let alone economically recoverable.

Like · 4 | Reply

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Sources and Citations:

[1] METC Form 4s filed between 11/10/2023 and 12/06/2023.
[2] Ramaco is discussed in a 2017 article "Ramaco to spin coal into carbon fiber for met coal margins without volatility" where a representative of the Powder River Basin Resource Council (PRBRC) is quoted:

> *"locals are skeptical of a company that she said* ***has gone from proposing a large-scale thermal coal mine to focusing on local sales of coal for home furnaces****."*

We spoke with a representative and these statements were based on documents revealed as part of discovery in an administrative hearing concerning the company's blasting permit.
[3] We believe this initiative was a failure based on, Coal to Carbon Fiber – A Novel Supercritical CO_2 Solvated Process; Final Technical report, p. 59-60. The conclusion stated in part concerning the carbon fiber created:

> *This fiber contained many defects and only one fiber survived the mounting process to produce a mechanical test result that was very low compared to the target values…*

[4] DOJ, North Carolina Risk Consultant Sentenced to Prison for Tax Fraud and Illegally Possessing a Firearm, May 14, 2021.
[5] METC Shareholder Letter, p. 33
[6] In Re the Monetary Group, 11th Circuit, 1993, decision available via Justia
[7] *See* Appendix D
[8] See infra, *"The Only Thing Unusual About METC's Brook Mine is How Bad it Looks Compared to its Peers"*
[9] Ibid.
[10] Charlie Atkins was called the Head of Research and Development at Ramaco in a request for federal funding and was the principal investigator; he helped organize a conference on new uses for coal, made comments to the press concerning the project for this article, and a google cache version of the company's presentation on its coal-to-products initiative, has his name on patent applications, and coauthored at least five different papers submitted to NETL.
[11] DOJ, North Carolina Risk Consultant Pleads Guilty to Tax Fraud and Illegally Possessing a Firearm, August 21, 2020
[12] *See* request for federal funding supra, the document was filed in October, 2020.
[13] See, SHELTER ADVISER CONVICTED IN TAX FRAUD CASE, The Washington Post, Dec. 11, 1987
[14] U.S. Court of Appeals for the Eleventh Circuit - 2 F.3d 1098 (11th Cir. 1993), 10, available on Justia
[15] Science History: "What are the Rare Earth Elements…"
[16] METC Press Release May 3rd, 2023
[17] Wikipedia: "Rare-earth element"
[18] *See* Appendix B
[19] (Brook Mine's supposed $37bn "value"/$3.59 [Wolfpack's REE Revenue/t est.]) * Wolfpack est. net loss ($3.59-$12.13 [est. sum of lowest mining cost total, processing cost, and G&A of the three respective peers we covered])
[20] Aclara December 2021 PEA, p. 32-33 assumed "Base Case"
[21] Strip ratio based off comparable Caldeira project. Mining, processing, and G&A based off comparable clay REE projects & Sprott's Initiation Coverage
[22] METC May 3, 2023 Shareholder Letter p.3
[23] Stockhead: "Not all ionic clay rare earths deposits are created equal…"
[24] Mining.com, Randall Atkins Interview
[25] Bloomberg Markets: The Close, "Wyoming Coal Mine Could Hold $37 Billion Treasure"
[26] WSJ, The $2 Million Coal Mine That Might Hold a $37 Billion Treasure, Nov, 9, 2023.
[27] Ramaco By the Numbers, October 2018, Powder River Basin Resource Council.
[28] Ramaco July 2017 presentation, slide 20.
[29] U.S. Department of Justice, Office of Public Affairs: "North Carolina Risk Consultant Sentenced to Prison…" Address of Ram Omni screenshotted from Wyoming Secretary of State website. Ramaco Coal, LLC, Ramaco Carbon, LLC, and Ramaco Royalty, LLC, all shared the same address in 2017. The screenshotted picture of the building was the google search result for the address.
[30] Department of Justice, "North Carolina Risk Consultant Sentenced to Prison for Tax Fraud and Illegally Possessing a Firearm"
[31] Screenshots of the funding application were taken from Funding Opportunity Announcement, linked here: Ramaco Carbon

[32] DOJ, North Carolina Risk Consultant Pleads Guilty to Tax Fraud and Illegally Possessing a Firearm, August 21, 2020
[33] Department of Justice, "North Carolina Risk Consultant Sentenced to Prison for Tax Fraud and Illegally Possessing a Firearm"
[34] Coal to Carbon Fiber – A Novel Supercritical CO_2 Solvated Process; Final Technical report, 59-60
[35] METC 1Q23 Earnings Transcript
[36] Coal to Carbon Fiber – A Novel Supercritical CO_2 Solvated Process; 1 tpd batch system
[37] Coal to Carbon Fiber – A Novel Supercritical CO_2 Solvated Process; Final Technical report, 56
[38] Coal to Carbon Fiber – A Novel Supercritical CO_2 Solvated Process; 100 tpd continuous
[39] Ibid, 58.
[40] NYT, Article available here.
[41] In Re the Monetary Group, 11th Circuit, 1993, decision available via Justia, (quoting the lower court).
[42] In Re the Monetary Group, 11th Circuit, 1993, decision available via Justia
[43] Brook Mine Technical Report p. 38
[44] We estimate the cumulative in situ value of Secondary Magnetic REOs at less than $0.60 per tonne; after factoring in aggressive recovery and payability ratios, REE *(revenue) would be <$0.25/tonne
[45] Sprott: Australian Rare Earths p. 2
[46] Aclara PEA December 2021 & Sprott: Ionic Rare Earths p. 12 (53% excludes cerium)