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Donna Castro
CEO & Partner at PMO Virginia,
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E-mail: info@pmovirginia.com

INDUSTRY DIRECTIONS

Industrial value of critical minerals and graphite in coal refuse deposits

It's no secret that the coal industry has been suffering challenging times. Even though the demand for burning carbon energy has diminished, revolutionary ways of repurposing it are continuously being discovered. The U.S. Department of Energy (DOE), the Department of Defense (DOD) as well as the private industry sector unanimously agree that an uninterrupted supply chain for both rare earth elements (REE's) and 35 critical minerals (CM's) are crucial for the safety and vital economic stability of the United States. Fossil fuel-producing communities across the country support the research and production of these vital materials for manufacturing of magnets, batteries, and countless indispensable products. The European Union has identified 30 raw materials critical for industrial production. Their supply chain is endangered by trade monopolies, conflict, and lax regulations which are commonly practiced in China.

Over the last several decades, China has successfully become the world's dominant supplier of both REE's and CM's. They currently control at least 85% of the world market at such a low cost of production that it is challenging for most industrial nations to effectively compete with.

Despite the toxic and detrimental environmental impact of China's routine extraction and separation technology, industrial nations by and large turn a blind eye due to their cut-rate market pricing. However, earlier this week G-7 leaders declared a tough, united front on China's human labor practices in their quest to maintain global domination in this arena. Nonetheless, the outcome of their stance remains to be seen. China is known to have no bounds in its relentless pursuit of REE and CM production regardless of human and environmental cost; which begs the question: how can we hope to compete?

Over the last decade, close collaboration between the scientific community and private sector have created a synergistic effect. The government has provided millions of dollars of accessible grant money to support the advancement of this crucial industry. Pilot plants established around the country have prioritized their focus on environmentally responsible and economically viable methods of separation and extraction of these essential REE.

REE's are remarkably similar to one another on a molecular level, which is why separating and extracting them in an environmentally friendly way is so challenging. As opposed to REE's, CM's are much more easily distinguishable from one another. They are readily processed using standard industrial methods .This makes their identification, separation, and extraction a less challenging endeavor. When these steps are simplified in an ethically responsible way, even feedstock sources with lower ppm concentrations suddenly become much more fiscally attractive. The U.S. has a voracious appetite for these materials, and coal refuse feedstock is yet another modality with which we can provide our own independent U.S. supply chain requirements.

No single mining site, regardless of its magnitude can possibly accomplish the job alone. According to (1) Pini Althaus, CEO of USA Rare Earth, "As big as Round Top is, and as much as it will be producing, it will be a fraction of what is required for the U.S. supply chain.

When you hear companies make claims to be able to provide all materials for the U.S. supply chain, its absolute nonsense. It will take many projects and many decades to be able to provide the materials across the supply chain." This fact is both humbling and honest.

One may ask what could be considered alternative sources? We have the answer. Scientific research has demonstrated that some of these "coal refuse sites" contain significant levels of valuable, indispensable critical materials in industrial quantities. Most of these coal refuse ponds have sat idle, untouched over the last century. Considered

"waste materials," they have been mixed with various concentrations of clay and rock after being abandoned and exposed to the surrounding environment. Over time, this natural environmental process has resulted in a chemical incubation phenomenon of minerals that we must take advantage of. When analyzed, this "waste" contains significant concentrations of valuable, industrially viable elements.

The scientific community (2) has studied various coal refuse deposits, particularly in the Appalachian region as it's known for high concentrations of minerals. They have struggled for years with several key questions. Knowing that these complex coal refuse ponds consist of various substances, including coal products, clay, and rock, a piece of the puzzle remains: WHERE are the elements found? Are they contained in the clay, the rocks, or the coal? Have they been percolating through the coal fines and passing through in the acid mine drain (AMD) waters? The fundamental question of "why" and "where" these elements are found is unfortunately simple to answer. The hard truth is: there is no recent unanimously accepted consensus.

Recent and thorough scientific analysis of an Appalachian coal refuse deposit in Virginia seems to have answered the vital question as to WHERE these valuable industrial elements are being contained. Scientists and University lab technicians have determined that CM's are present in all materials mentioned, including the clay, coal, and rock. Both REE's and many valuable CM's have been found in the combined coal, clay, rock, and AMD. The washed coal refuse which was University tested contained 22% ash, while the combined coal, clay and rock mixture which was tested displayed a 70% ash content. Even more intriguing, some REE's and CM's were also noted in the AMD.

It is well known that when coal is burned, the residue, ("ash") is discarded; however, ash is also known to hold significant quantities of both REE's and CM's.

Further analysis of these finely ground (500 mesh) samples by multiple well known scientific coal lab centers (2) (3) (4) (5) have found an average concentration ratio of 1000:1 between many valuable CM's and REE's. The relative high concentration of some valuable CM's in these coal refuse deposits combined with a much lower cost of extraction by the above methodology will render these endeavors economically viable. Of course, some metals, such as Scandium, Vanadium and Lithium may still be found profitable to extract from coal refuse since their process of separation and extraction are known to be simpler. Additionally, following the extraction of these metals, the residual carbon may be transformed into industrial nano-graphite or activated carbon; another of the 35 CM's considered industrially valuable.

With continued participation from capital investors in addition to millions of dollars in accessible grant money; not only do we find shovel ready sources of CM's and REE's, but we have a "clean green" path to environmental restoration which provides countless job opportunities for communities that have been abandoned.

References

(1) Pini Althaus, CEO & Director of USA Rare Earth.

(2) Sarma Pisupati, Professor of Energy & Mineral Engineering, Director of Center for Critical Minerals PENN State University.

(3) Rick Honaker, Chair and Professor University of Kentucky, Department of Mining Engineering.

(4) Dr. Wencai Zhang, Assistant Professor Virginia Tech University, Dept. of Mining & Minerals Engineering.

(5) Rodney Campbell, Mineral Labs, Inc., ISO/IEC 17025: Accredited. Kentucky.