Lifton on the “GLARE” of Technology Materials: Graphite, Lithium and Rare Earths

A New Due Diligence Paradigm for Natural Resource Production

I sincerely hope to offend the bulk of my fellow sector analysts with this essay. I am today going to discuss technology, innovation, and the near-term value of so-called “disruptive technologies.”

Although we all believe that we are able to recognize new technologies, in general, we in fact only see and hear about consumer-product (i.e., mass produced) technologies, because those are the only ones that main stream media journalists understand well enough to notice and report. And more to the point even that small segment of the population with specialized knowledge and experience in “technology” is itself narrowly compartmentalized by “discipline.” I am not qualified, for example, to discuss “advances” in medical technology or in the development of new pharmaceuticals.

Investors should only be concerned with technologies that have an immediate or near-term impact on the economics of the sector in which they exist. In the long term most new technologies, as first presented, fail to achieve permanence. The deciding feature is, as always, economics, but this is rarely discussed other than in the context of “revolutionary” or “game changing” hype.

The exploration for minerals to supply natural resources is a science, exploration geology. Even so, to the public prospectors, as exploration geologists are widely known, are described as grizzled hard drinking old men looking for gold

or, ironically, as male-model resembling young men looking for oil. Mining is seen generally by those who unwittingly bite the hands that feed them as “evil.” Two contemporary popular American television shows well illustrate this point. “American Odyssey” is the story of a courageous female (of course) Army Special Ops team member who has alone survived the murder of her team in Mali (Africa) to help the locals fight terrorism by an American mercenary group employed by a “mining” company in order to maintain its hold on valuable “mining” concessions. The evil mining company, American, of course, has its tentacles throughout the US Government. Its paid “operatives” include a US Senator; a heroic journalist; a high ranking army officer; and, of course, lots of evil mercenaries. The world of science fiction television has “Dark Matters,” a show in which a group of mind-wiped mercenaries in the employ of, you guessed it, an evil interstellar mining company, has had a mysterious epiphany and conversion and they now fight for the beleaguered “local” miners. The last episode was brought to a conclusion by the mercenaries recruiting one evil interstellar mining conglomerate to fight another for the precious “metals” on the embattled plant and the asteroids in its system. I believe that “evil mining” is the first Hollywood trope to go interstellar.

Why has Hollywood decided on mining companies as the evil-doers? Besides the obvious facts that Hollywood businessmen are essentially technological illiterates their choices represent the political correctness and “received wisdom”of the moment. The great tragedy is that these mind-dead imbeciles never give a moment’s thought to how their own critical technologies work much less where the critical materials to manufacture the electronics come from. These morons think that silicon is the name of a valley and germanium is a flower. Creating, manufacturing, and maintaining technologies is for the rubes, right? When I once

complained to a Star Trek author that just lifting into earth orbit the materials and men (people) necessary to construct one Galaxy class starship would exhaust the technological resources of late twentieth century America she laughed and replied “poetic license.”

But the idea of simply replacing established, established paid-for, technologies to refine minerals into metals and alloys is no laughing matter.

Let’s just talk about the technologies now brewing in the Graphite, Lithium, and Rare Earth, GLARE, space.

The most widely used core technologies for producing natural resources are nonetheless remote from common experience and are viewed, more and more in our age of declining general educational standards either as magic by the main stream media or as non-mutable (“standard” or “traditional”) even by most of the specialists including most chemical engineers who should know better. To understand the history of the development of the mining, refining, and fabricating technologies that brought our society to where it is today requires specialized education and an interest in the topic both of which are in short supply in our instant gratification culture. The profound impacts of chemical, metallurgical, and manufacturing engineering on our daily lives is simply unknown and uninteresting to 99.9% of the human race.

The process technologies that underpin the supply chains for the base metals and the common minerals such as fertilizers and fossil fuels have mostly been in place for a long time. For example, an ancient Egyptian gold miner would I think have little trouble following the processing path of the gold from a “modern” mine to its fabrication for jewelry. The process used today to produce 50,000,000 tons per year of aluminum was developed and put into use nearly 150 years ago as was the process used to refine copper for its current production of 25,000,000 tons per year. The most recent innovation in steel

making, the electric-arc furnace, is more than 75 years old. And the currently used processes for separating the rare earth metals from each other and for producing them in metallic forms originated at least 50 years ago.

BUT Just in the last 50 years the fields of chemistry and metallurgy have advanced profoundly and 21st century chemical, metallurgical, and manufacturing engineers are rapidly adapting laboratory discoveries for practical uses. Nowhere has this occurred faster or in more depth than in the United States. (This is an observation not a political or nationalistic statement!)

The supply situations for each of the GLARE technology materials are now being caught in the innovation" and "disruptive technologies" maelstrom. They all share a common theme: It is that the technologies for the extraction, separation, purification and fabrication of end-user products of each of them, including the individual rare earths, have evolved rapidly in the just the last few years to the point where prior analyses of the feasibility and bankability of such projects must now be rechecked and recalculated so that they will be up-to-date rather than obsolete.

The core financial issue, whether or not new production of a GLARE material can be done at less cost than existing production, is still, of course, valid as the defining metric for choosing to go with a new process technology. Additionally it is critical to examine where in the individual supply chains for the GLARE materials the venture undergoing due diligence plans to enter the market. This additional issue has been overlooked, sometimes purposefully; sometimes due to ignorance by almost all of the GLARE ventures now seeking capital to go into or remain in development. Many previously prohibitive costs of entry due to traditional processing for traditional markets and forms must now be urgently re-visited as new technologies rapidly move from bench scale to pilot plant testing and in doing so are on the verge of replacing

other, older although proven in use, technologies. It seems to have been conveniently forgotten by many promoters that although it seems that only less expensive (in the sense of CAPEX/OPEX) technologies can replace existing ones this conclusion cannot be reached without examining the individual costs in each segment of the supply chain, as well as of the processing chain, as they are affected by the "new" technology, that the venture wishes to include before entering the market.

In the case of the rare earths the "new" technologies may in fact include just updates of the traditional ones. And the recent commentary upon the current low discounts (against the prices of the individual separated elements) offered for "mixed concentrates of the SEG and HREEs should cause every rare earth junior to carefully examine the urgency of in-house separation all the way to individual elements. The most promising "new" selective separation technologies now being adapted for rare earth separation and purification, MRT and CIC/CIX, are in fact already proven at scale with other technology meatls and materials, uranium, phosphates, the platinum group metals, and base metal purification, for example. The application of these technologies to the rare earths is now aborning as pilot plants are ready to begin or already in construction. For the production of rare earth metals and alloys there are also some new technologies being tested at bench scale with one "improvement" on the current, traditional process, being touted as ready for prime time. Economics and the appetite of the market for risk will sort this out.

For lithium juniors dramatic new hydrometallurgies have opened up the processing of previously (economically) unattractive minerals. For example a Canadian venture in Australia is claiming "all in" costs of only $2000/tonne for lithium carbonate produced from a well-known mica mineral which assays at 0.49% Li. This is a significant cost improvement over the

extraction and separation of lithium from brines that begins with material that assays 0.17% and which process takes up to 18 months and has all in costs at least 50% higher than those of the “new” process. The processing of brines itself displaced most of the hard rock (spodumene) sourced lithium that was standard just a generation ago, and was mostly replaced by brine processing due to costs.

Lithium production is almost a poster-child for the time it takes for “new” technologies to become “standard.” And in case you didn’t notice all of this has been driven by an increase in demand.

Graphite has also undergone a true revolution in utility in just the last generation. Because it is already produced at a level of more than 1,000,000 tons per year it is not defined (by me anyway) as a rare technology material, but in fact technology has turned this definition on its head. I am now naming graphene, a form of graphite, as a rare technology material. The race to produce graphene from natural graphite has accelerated just in the last two years as more and more high tech applications (electronics, structural materials, and chemical catalysis, for example) have been shown to be possible and extremely beneficial) Overlooked by investors, who rarely examine the impact of technologies on the demand for technology metals and materials, as they relate to the production of metals and materials are the huge 21st century increases in global steel production and in global aluminum production, just to name the two largest sources of demand for graphite (as electrodes and crucibles), have increased the demand for natural graphite dramatically. The newest uses for graphite in nuclear reactor construction call for extremely pure graphite, and the purification of graphite for that purpose has allowed the development of techniques for the mass production of graphene. This is a rare case where the availability of a former laboratory material has opened up mass producible end uses that present dramatic opportunities

to improve existing technologies in electronics, energy storage, and structural materials.

I have come to the conclusion that the new process technologies are best utilized for new production. From new mines or from recycling. Existing producers of base metals and even of technology metals and materials have far too much invested in current technology to just discard one that works and replace it with a different technology. This is a question of capital allocation. There is not an infinite amount of capital and the markets will tell us when one technology has replaced another not promoters screaming about “disruptive technologies.”

Junior technology metals and materials ventures that have not begun to produce now have an opportunity to separate themselves from the herd. They can adopt new or newly applied technologies to reduce the overall costs of the supply chain for delivering end-use products. When they achieve overall costs less than those from supply chains using traditional technologies that is the time to buy the juniors and sell the seniors.