Lifton asks: is scandium the new gold?

Last week's Cleantech Conference in Toronto, organized by **InvestorIntel**, was a "hoot." It was proof to me that in Canada, at least, the Festival of the Rare Earths has been put to rest. Prospector-Geologists with their grab sample based dreams of "pounds in the ground" wishes are simply gone. OK, there is still a whiff of rare-earth – it is in the air as a new crop of niobium juniors list "rare earths" among their "deliverables," if not among their "payables."

But t'was separation technology that slew the rare earth beast, not low prices. Perhaps, in fact, it was the speculatively led attempted market cornering in 2012 that destroyed any hopes in the near term of non Chinese rare earths' production?

Projecting – because assuming made no sense and was just pure ignorance – that sky-high 2012 marginal rare earth prices would last forever, the wise (?) credentialed management boards and the punditocracy aided and abetted Wall Street, Bay Street, and Howe Street financial engineers to take candy from babies and canes and walkers (for resale) from seniors and common sense from everyone in between to enrich themselves.

The story was that because rare earths were "critical" or that, famously, the armies of the west would be helpless without them their prices could not help but defy both the law of gravity and the law of supply and demand. Therefore it was confidently put about that the speculative boom in rare earths prices was just a natural consequence of the revelation that China (the enemy ?) had a monopoly as well as a monopsony of the rare earths; it almost exclusively mined, refined, fabricated, and assembled consumer devices dependent on the rare earths for their operations. We could only buy such items

so long as the wily Chinese deigned to allow us to do so.

Although the Chinese monopoly/monopsony meme was true in the case of the rare earths, it was also true for many equally or even more important technology metals and materials such as tungsten, graphite, germanium, and, interestingly enough, the more mundane magnesium and antimony.

The pirates of Bay Street, weaving their spell that the "price" of a scarce commodity is a measure of its value rather than of the difficulty of obtaining it, used this same story during the rare earth boom. That story was the idea that scandium, which had no commercial demand but many potential proven uses, was a new "gold." This manifested itself in the idea that traces of scandium in rare earth deposits (always there) were "valuable" resources. No one will ever top the story that Molycorp "could/would" produce 50,000 tonnes of light rare earths and in that way also produce "7" tonnes of dysprosium (This would have required 100% extraction and separation capability and capacity at Mountain Pass, which was, and obviously is, impossible, to produce a trace material found in the ore body).

But now the scandium story is entering the hall of shame in preparation for the Memorial Molycorp Puffery, "The trace is the goal" prize of the year.

First some facts; the rare earth story, as is the lithium story, the graphite story, and every other technology metal or material story, was and is an appeal in reality to technology in two ways. First there have to exist "commercial technologies", i.e. mass producible ones, dependent for their operation on a technology metal or material enabler. Then there needs to be a separation and refining technology that can be applied to low as well as high grade ores and residues – first for extraction and then for recycling – in existence and proven to operate economically enough not to disturb the price-so called "disruptive" technology is not so much a

scientific description as that of an economic breakthrough.

The quantitative chemical analysis of scandium is a difficult, so that one must first scrutinize any claims of precision in reports of minerals showing “grades,” for example, of 100 or less PPM of something like scandium.

Although the analytical spectral “lines” of Scandium (i.e. those energies which can be visualized by a spectrograph that are unambiguously caused by scandium) are well known separating them from the background in very small dilute samples is an art form as much as a technology. Forty years ago the same was true of the platinum group metals.

In fact a very scientifically experienced group, of which I am the least educated member, looking to recover technology metals from sea bottom sediments has been studying the credibility of scandium analysis regimens, and I have had the privilege of that information.

But the issues with scandium are:

- What is, if there is, a “scandium deposit”?
- How much scandium must be present in order to recover it “economically”?
- Does the surrounding elemental matrix inhibit or add to the “scandium” value? and, finally,
- Are there today applicable commercial technologies to extract, separate (i.e., refine) and fabricate scandium products for the current market?

First, and perhaps, most controversially, it is my opinion that there are no primary scandium deposits. Where scandium has been proven to be present it always presents at concentrations of no more than 500 ppm in situ. In fact, it is found most prominently as a trace in iron (and niobium) deposits associated with its chemical sister elements, the rare earths and yttrium, which in fact is chemically the nearest to scandium; they are both in, and constitute, a

“column” in the Mendeleev version of the periodic table of the chemical elements.

The scandium in commerce today is produced in China and Russia from past residues, in Russia, and from modern processing, in China. It is unlikely that more than 10 tonnes a year are sold into the global marketplace.

Therefore, due to the tiny supply of scandium, only minimal commercial work has been done on it; mass produced consumer goods with scandium based alloys do not exist. There are some high-end golf clubs and baseball bats produced but these are rich men’s toys (positional goods – the ones that you have and the poorer guys doesn’t, such as an original Picasso).

However, during the last decade or so there has been enough scandium available for serious and fruitful laboratory scale scientific research on light metal structural alloys, which research has borne fruit. It is now clear that alloys with a small “atomic” percentage of scandium in aluminum and magnesium matrices show remarkable resistance to oxidation and exhibit unexpected strength. Therefore, if there were scandium available at a good price then the aircraft, marine, and land transportation industries would buy and use such alloys.

To summarize: scandium is a byproduct at best and in reality found mostly as a trace element in the rare earths. If it were not for the large increase in use of the rare earths since 1980, or so, there would be no sources of recoverable (economical) scandium at all.

Putting the scandium from rare earth occurrences in iron aside, modern analytical chemistry has also found that scandium is frequently (probably always) found as a trace in niobium deposits. Since there are only today three working sources of niobium, two in Brazil and one in Canada, even the presence of scandium traces in those deposits has been of academic interest only until now.

And the proposed development of additional sources of niobium has been used at present to spotlight the fact that, if sufficiently large quantities of niobium are to be recovered, then the possibility of coproducing scandium is also there. The Niocorp deposit in Nebraska (USA) is said to be able to produce 100 tonnes of scandium per year if it is produced as a coproduct/byproduct with 7,500 tonnes of niobium as Ferro Niobium. Note that this will be true only if a proven extraction/separation regime is developed. It turns out that the scandium must be extracted from the mineral mix at the beginning of any process or it will transport to the Ferro Niobium product from which it will not be recoverable economically. However, I am highly confident that the MRT process of IBCAT in Utah can, if placed correctly in the process flow sheet, extract the scandium at an early stage step the in hydrometallurgical treatment of the ore in an efficient and economical fashion.

I have been told by a niobium junior mine promoter that although the million tonnes of rock necessary to crush in order to provide 7,500 tonnes of (ferro?) niobium in Nebraska will provide 100 tonnes of scandium that CBMM with its annual production of some 55,000 tonnes of (ferro?) niobium has no scandium in its ore body. I however believe that it is more than likely that CBMM could produce significant tonnages of scandium (perhaps more than 500 tonnes per year) if its current process regime is amenable to the early removal of the scandium or can be economically modified to do so.

I am also highly confident that there is an anomalous and significant amount of scandium in the seabed sediments in Japanese waters and elsewhere in the South Pacific. And I believe the recovery of that scandium can be done economically with modern ocean floor mining technology.

Notwithstanding all of this, the issue (of course) is what will the future price of scandium be?

The law of supply and demand seems at first look to bode evil on this issue. Yes, in today's market, scandium (as oxide) is selling for USD$1,500-3,000/kg, but what happens (say armchair economists with large and still spreading backsides) when the volume available "jumps" to hundreds of tonnes from tens of tonnes?

The answer is that not only will the current price of scandium hold but it may well increase a bit due to the fact that scandium usage just like that of niobium: that is, very low in any individual product and therefore does not contribute to the cost of that product significantly! The price for scandium does and always will be based on its scarcity and the difficulty of extracting, refining, and fabricating it as a raw material. And just as in the case of niobium and lithium it is in the economic self interest of the very few producers to keep the price stable and this maintain demand!

I note that although scandium metal has been produced "commercially" only by the "Ames Process," and the electrolytic reduction of scandium salts dissolved in molten oxide eutectic, just as have and are the rare earths, it is possible that much better scandium will be able to be made commercially by vapor phase reduction of anhydrous chloride (NSP Corporation (USA)) and, or, by Solid Oxide Membrane Electrolysis (InfiniumInc (USA)). Both of these American high tech companies are located in the Boston area and are affiliated with or derived from the great American technological education complex there.

The scandium story has begun.

2015 – China's Annus Horribilis

For the Japanese, their *anni horribili* at the end of the 1980s are chiefly remembered for overpaying for the Rockefeller Center and golf club acreage. When the Brazilians come a cropper, it's a case of party like its 1959, and return to the basics of fresh air, coconuts and sunshine. But when it comes to *hubris* the Chinese, as in everything, outdo everyone. The new self-proclaimed *Masters of the Universe* have managed to end the year choking themselves, and their economy, to death in a cloud of Purple Fumes (cue the Performer once known as Prince) and shown that as for regulation (and development) of financial markets the Chinese, to put it more politely, could not run a booze-up in a brewery.

The last weeks of 2016 saw several prominent financial market figures disappear and then reappear (including the reputed Chinese version of Warren Buffett), the aforementioned pollution disaster and the start of criminal investigations relating to the FANYA schemozzle. There is an innate tendency for institutions in the capitalist side of the Chinese economy to deteriorate into illegality and irregularity with remarkable speed. In this aspect the Chinese system appears most akin to the rip-roaring US markets of the late 19th century when Robber Barons ruled the roost on Wall Street and established suffocating and anti-competitive cartels/trusts.

FANYA

For the mining community the most important thing about China is the demand aspect as this has driven so much of the global mining industry's thought process over the past 20 years, however for the

The establishment of the FANYA Exchange with its focus on

specialty metals seemed like a logical and inevitable evolution of the Chinese dominance of the production of (many) specialty metals and the substantial position it also held as a processor and end-user. FANYA initially started out with specialty metals and then diversified into fixed income products. The problems in the Bismuth, Indium and Antimony trading by the exchange's investor base are well documented now.

In mid-July Metal Bulletin reported that the Fanya Metal Exchange had suspended accepting applications from companies to sell Indium, Germanium and Bismuth on the exchange between June 23 and August 31. An official from Fanya, who refused to be named, cited "Liquidity-related problems" were the major reason for the decision. That there should be "liquidity problems" in trading notoriously illiquid metals in the pre-FANYA era, comes as no surprise to participants in the global market for specialty metals.

While FANYA has been most (in)famous its metals trading, it has also had a fixed-income element, which not unsurprisingly has reputedly also gone bad. The Financial Times reported in September that "hundreds of well-heeled urban professionals who had purchased high-interest rate products from the Fanya Metal Exchange united with distribution agents who sold them in an unusual protest….in the financial heart of Beijing".

The FT captured the moment at which the head of FANYA, Shan Juiliang was manhandled by a crowd in Shanghai. They dragged him off to the police to have him arrested. Whether his potential fate at the hands of the crowd or in the Chinese legal system will be a better one will remain to be seen.

The big question, as everyone knew six months ago that FANYA was going down in a welter of financial irregularities, is why did it take so long to look into the matter? Obviously people

in high places wanted to cover their behinds (and unwind positions) before the Great Unwashed cottoned on. However, the public are now so far ahead of the authorities in catching a whiff of scandal that the Powers that Be are last to know.

Chinese "Statistics"

Time and again we have seen the Chinese "issue" with deceptive practices on bonded warehouses and the collateralization and double-counting of fictitious or "massaged" inventories. It is very easy to create theoretical liquidity by miscounting (read exaggerating) warehouse numbers then creating paper instruments based on the bogus holdings, trade them fast and furiously and voila, liquidity. The whole scheme (never let the word "Ponzi" cross our lips) comes apart at the seams when someone wants physical delivery and then the game is over. In China of course the small and medium sized investor can be stalled for a while, while the big fish exit their positions and when the curtain is eventually pulled back to reveal that the "cupboard is bare" then the recriminations start flying. A few random death sentences may be meted out (involuntary organ donations, anyone?) and the matter is regarded as swept under the rug until the next time.

The result though is that China has blown up chances of being taken seriously as a locale for trading of commodities due to this repeated flaunting of warehouse statistics which are at the root of the credibility of any market in the metals trading world.

Bubbles

The Chinese cannot be criticized for having "bubbles" in their stock exchange(s) for the US is a repeat offender in this regard, with Alan Greenspan being a notorious bubble-blower with a goodly part of the US economy and the High Net Worth sector regularly refilling their coffers through repeated pump and dumps on a truly grand scale. However in the case of China

a casino-ish atmosphere has not only existed, but been encouraged. The closest that the US has come to this was the dot-com era market of 1998-2000, which was mainly tech/media/telecoms (rather than a whole market) and 1929, which was a very long time ago and before hardly any legislation governed markets.

While regulators in the West, in the wake of a market bust, go into a frenzy of reregulating and attempting to close the gate after the horse has bolted, the Chinese on the other hand are quite shameless with the goal being to reinflate the bubble as fast as possible. Investors in the West go into soul-searching wondering why they were suckered or why they suckered themselves, whilst in China introspection seemingly has no place and mass amnesia is seen as the cure for all ills.

Robber Barons

China looks like the US in the Age of the Robber Barons in the late 1800s. The trouble for China is that we are talking about 130 years ago. It is not that hard in this day and age to be up to date in regulatory and supervisory matters and systems. If you can have stock tickers wrapped around office blocks then why can't you buy in some skillsets on market regulation? The answer is largely because the authorities don't want to appear to be taking advice from the *Gwai Lo*. Frankly they could save themselves (and everyone else) a lot of grief is they forsook the financial Wild West (East?) and got their house in order in 2016.

Riding the S-Curve

Or we could less charitably say going down the S-bend! We found an interesting thesis, posited by a Charles Hugh Smith, that tallied with our own view that China is following a well-trodden path down which Japan, Taiwan and South Korea have already travelled. China would like to think it is different and heading down some Middle Kingdom version of the Thousand

Year Reich (oops!) when in fact it is just doing what all economies have done since the dawn of time, and that is pursuing an S-shaped trajectory.

We have seen this process described as being somewhat akin to a rocket's trajectory with an ignition phase as the fuel of financialization and untapped productive capacity is ignited. The high growth rate of credit and production overwhelms all other factors, as rising profits and production increases wages which then support further expansion of credit and consumption which then supports more production (or excess-capacity).

After this the thrust that comes from "financialisation" is exhausted, and the previously fast-growing economy moves forward on momentum alone. As the economy weakens, this momentum is to the downside. This is where we find ourselves now in the China cycle as everything that worked in the boost phase reverses, as nothing works any more. Investors in China's "markets" lose every bet and officialdom's efforts to reverse the decline end in repeated failure.

Conclusion

While many in Western markets (and particularly in the US) are used to complaints that the system is rigged against the investor class by the Powers that Be, the complaints are usually just hyperbole and blame-searching after the one a decade meltdowns that we have become inured to. In China though, like all casinos, the House always ends up winning and the punters, by and large, end up going home without their shirts. The markets in the West may end up occasionally ripping off investors whereas in China they seem to be set up with the explicit purpose of fleecing the lambs. The results is that the middle and lower middle classes keep having their savings confiscated for the greater good of those higher up

the totem pole that mastermind, tolerate, encourage and then cover-up the scams. It is like China is in the grip of a horde of Bernie Madoff clones.

If 2015 was bad then 2016 has got off to an even worse start with two suspensions of trading on the Stock Exchange in the first few days of the New Year. This was followed by the same old intervention which obviously failed in the first instance because it had to be applied again a few days later. The "Street cred" of the Chinese "powers that be" that pull the financial levers is totally shot. Major figures on the financial stage appear and disappear like characters in a Feydeau farce. Re-education used to involve years in the paddy-fields and now consists of a weekend of being brow-beaten in a board room at the Ministry of Finance. Maybe the old ways were better!

Once a soap bubble is burst there is no reinflating it. The Chinese should face the fact and move on. They are now in a new place that the rest of us in the Western economies have been in all too frequently in recent decades and they may care to learn from it… even if it means having to lose a little face.

FANYA – Good Girl Gone Bad

As we have written in the past the Chinese are not as infallible as they would like everyone to believe. Economic booms of the intensity of that which the Chinese have experienced over the last 15 years can bring the tendency to become self-declared Masters of the Universe. Look at the Japanese in the late 1980s, where pride definitely came before a fall and a long and depressing two lost decades for the

Japanese economy. One could also say that the Vietnam War was the Waterloo of the US dominance after twenty years of post-War economic mastery over the global economy. That war saw the baton of net savings/wealth pass to the oil states of the Middle East and to the Japanese.

One of the attributes of these periods of fleeting dominance is an attitude *internally* of superiority over other economic systems (particularly over that of the displaced power). Then the attitude is manifested *externally* with criticisms about how other economies, have become fat or lazy or decadent.

FANYA – Good Girl Gone Bad

The establishment of the FANYA Exchange with its focus on specialty metals would seem a logical and inevitable evolution of the Chinese dominance of the production of (many) specialty metals and the substantial position it also held as a processor and end-user. Alas though there is an innate tendency for institutions in the capitalist side of the Chinese economy to deteriorate into illegality and irregularity with remarkable speed. In this aspect the Chinese system appears most akin to the rip-roaring US markets of the late 19^{th} century when Robber Barons ruled the roost on Wall Street via massive cartels/trusts and rampant stock market manipulation schemes.

FANYA initially started out with specialty metals and then diversified into fixed income products. The problems in the Bismuth, Indium and Antimony trading by the exchange's investor base are well documented now. In mid-July Metal Bulletin reported that the Fanya Metal Exchange had suspended accepting applications from companies to sell Indium, Germanium and Bismuth on the exchange between June 23 and August 31. An official from FANYA, who refused to be named, cited "Liquidity-related problems" were the major reason for the decision. That there should be "liquidity problems" in trading what were regarded as notoriously illiquid metals in

the pre-FANYA era, comes as no surprise to participants in the global market for specialty metals.

Once again we have seen the Chinese “issue” with deceptive practices on bonded warehouses and the collateralization and double-counting of fictitious or “massaged” inventories. It is very easy to create theoretical liquidity by miscounting (read exaggerating) warehouse numbers then creating paper instruments based on the bogus holdings, trade them fast and furiously and, voila, liquidity. The whole scheme (never let the word “Ponzi” cross our lips) comes apart at the seams when someone wants physical delivery and then the game is over. In China of course the small and medium sized investor can be stalled for a while, while the big fish exit their positions and when the curtain is eventually pulled back to reveal that the “cupboard is bare” then the recriminations start flying. A few random death sentences may be meted out (involuntary organ donations, anyone?) and the matter is regarded as swept under the rug until the next time.

Not just Metals

Like any good scheme, over-reaching (mission-creep?) sets in. While FANYA has been most famous its metals trading, it has also had a fixed-income element, which not unsurprisingly has reputedly also gone bad. The Financial Times reported this week that earlier this week “hundreds of well-heeled urban professionals who had purchased high-interest rate products from the Fanya Metal Exchange united with distribution agents who sold them in an unusual protest….in the financial heart of Beijing”.

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legal system will be a better one will remain to be seen.

Conclusion

The collateral damage to the metals markets has been brutal but hopefully short-lived. Antimony and Bismuth have seen large amounts of product tipped out into markets that are illiquid at the best of times with particularly damaging effects for Antimony that has gone from $9,000 per tonne down to $6,000 in a the space of a few months.

While the FANYA bust-up looks like a Chinese Madoff-like moment that will pass quickly, we doubt it. China was well positioned five years ago to have the Shanghai Metals Exchange become the leading global market for metals. Repeated scandals (most notably the copper inventory scam that caught Standard Chartered and Citibank amongst others) mean that the SME's warehouses have zero credibility. The LME has shown through its long existence that credibility is everything and the SME had a chance to grab some of that credibility for itself. It should take at least ten years to rebuild that trust, but maybe the moment has been lost.

As for FANYA, there is no chance of redemption. China's own position as the dominant force in the specialty metals world is slipping away due to over-exploitation and erratic export/import duties and other examples of unreliability. FANYA's arrival meant there was a chance to create a legacy overlordship by creating a financial dominance, even as a role as a leading producer leaked away (much as Britain did with the LME). Instead the sleazy operators at the FANYA put on their suicide vest and blew up any chance of China controlling the "trade" in specialty metals. In a world of increasing "discovery" in both price and volumes in so many products, the Chinese authorities let some cowboys essentially create a noxious fog of misinformation which has choked a large group of investors and justified Western observers' growing belief that there are "lies, damned lies and Chinese inventory

statistics”.

Beryllium – Where the USA Dominates

In recent years the panicked cry has gone up about US dependence upon foreigners for supply of the most strategic metals used in high tech and/or defence applications. However there is one metal that the US has a stranglehold on and it is Beryllium. When panic merchants begin their jeremiads, there is nary a mention of this metal. But it is the metal in which the US has most of the rest of the world at its mercy. This dominance should be a model for other metals but the doomsters in Washington would be unlikely to know that the US has this advantage.

Some Chemistry

Beryllium is the chemical element with the symbol Be and atomic number 4. It is a relatively rare element in both the universe and in the crust of the Earth. It is an element which occurs naturally only in combination with other elements in minerals. As a free element it is a steel-gray, strong, lightweight and brittle alkaline earth metal.

Beryllium increases hardness and resistance to corrosion when alloyed with aluminium, cobalt, copper (notably beryllium copper), iron and nickel. In structural applications, high flexural rigidity, thermal stability, thermal conductivity and low density (1.85 times that of water) make beryllium a sought-after aerospace material for high-speed aircraft, missiles, spacecraft, and communication satellites. Because of its low density and atomic mass, beryllium is relatively

transparent to X-rays and other forms of ionizing radiation; therefore, it is the most common window material for X-ray equipment and in particle physics experiments. The high thermal conductivities of beryllium and beryllium oxide have led to their use in heat transport and heat sinking applications.

The main negative is that inhalation of beryllium particulates may cause a potential health risk for a lung disease, Chronic Beryllium Disease, but reasonable industrial control practices can easily protect workers.

Production Metrics

In 2011, the world beryllium production reached more than 260.4 tonnes. In 2012, the global production of beryllium registered a 12.3% YoY decrease, declining to approximately 228.41 tonnes. The US is an unrivalled leader in the world beryllium market, with more than 87% share of the world beryllium output. Other important beryllium producing countries in the world include China, Mozambique, Brazil and Madagascar.

Currently, a new player is deepening its footprint in the global beryllium marketplace. In December 2011, Russia reopened its unique emerald-beryllium Malyshevsky mine in the Sverdlovsk region (the volumes of non-gem grade emerald that could be available for beryllium production will not be significant). The country is also increasing investments in its other mining and refining complexes.

The overall beryllium production in the USA might manage to pass the 300 tonnes of contained beryllium threshold by 2017. Some other estimates expect demand to grow to 425 tpa by 2020 and to over 450 tpa by 2030, driven by such applications as the construction of the ITER fusion reactor. Another independent source, Merchant Research & Consulting, London 2013 in their Beryllium Market Review 2012, indicate that

global beryllium production and usage will grow from 432 tpa in 2012 to 465 tpa by 2016.

Demand fluctuates as we have seen as the level of US government stockpiling is a key swing factor. We would expect an uptrend though over coming years with rising consumption from the telecommunications, automotive electronics and computer industries. Some prognosticate a considerable increase in beryllium consumption in Latin America and Asia in the upcoming years. On the technological side the applications employing beryllium-containing alloys could make a significant contribution to the world beryllium market growth.

The US is forecast to remain the dominant market player in both consumption and production. The United States is the world's leading source of beryllium. The Spor Mountain mine in Utah produced more than 85% of the 230 tpa of beryllium mined worldwide. The production of beryllium in the US registered a 14.9% YoY decline in 2012 and decreased to 200 tonnes, compared to 235 tonnes in 2011.

China produced most of the remainder, and less than 2% came from Mozambique and other countries. Madagascar used to be an important producer in the 1990s but that has largely disappeared as a force.

Global Beryllium production by country, 2012

National stockpiles also provide significant amounts of beryllium for processing.

Total world reserves of beryllium ore are estimated to be greater than 400,000 tonnes.

Consumption

The domestic consumption for 2012 was estimated at around 220 tonnes. In the same year, the consumer electronics and

telecommunications industries were the major beryllium end users, accounting for over 40% of the beryllium consumption volume in the US.

Three countries (China, Kazakhstan, and the United States) process beryllium ore. In 2005, the U.S. Department of Defense began a partnership with Materion to build a new processing facility in Ohio to produce high-purity beryllium metal. The processing facility was completed in 2011, and up to two-thirds of its output was to be allocated for defense and other government-related end uses.

The United States imported approximately 34% of the beryllium raw materials it used in 2011, including beryllium metal and other processed beryllium materials used in manufacturing; two-thirds of this material came from Russia and Kazakhstan.

The trend (at least up until 2010) reported by the USGS indicated strong demand. In the first half of 2010, Materion reported a 62% increase in shipments of bulk beryllium-copper alloy products, compared to the first half of 2009. Beryllium product sales in the key markets of aerospace, automotive electronics, ceramics, computers and telecommunications were substantially higher than the previous year. Recently though the demand has levelled off with sale revenues essentially flat from 2010 to 2012.

Pricing

Pricing is usually set between the mine and the production facility based on the usual factors of supply and demand. Increased demand led to increasing prices for beryllium over the last decade. Based on the beryllium content in imported beryllium-copper master alloy, an alloy for which there is a reliable reported price, the USGS estimated the average annual unit value of contained beryllium in beryllium-copper master alloy US$/lb as:

The Players

The names to conjure with in the mining and processing of Beryllium are Materion (Ohio/Utah), IBC Advanced Alloys Corp. (Canada but plants in US), Belmont Metals (New York), Applied Materials, NGK Metals Corporation (Tennessee), American Beryllia (New Jersey), Esmeralda de Conquista Ltda (in Brazil), Ningxia Orient Tantalum Industry Co (China), Fuyun Hengsheng Beryllium Industry Co (China), and Grizzly Mining Limited (a Zambian gem miner). Some of these are not much more though than aggregators of artisanal mining output from their region.

Materion (MTRN)

The 800-lb gorilla in the Beryllium space (not to mention being the “anointed” of the Pentagon) is Materion, the specialty metals processor which also owns the aforementioned Spor Mountain Mine. As such it is the world’s only integrated “mine-to-mill” supplier of beryllium-based products. The company used to be known more prosaically as Brush-Wellman (before that the Brush Beryllium Company).

While being the owner of the important mine it is mainly a producer of beryllium-sourced products. These include precious and non-precious specialty metals, precision optical filters, inorganic chemicals and powders, specialty coatings and engineered clad and plated metal systems.

The strategic importance of Beryllium is evidenced by some of the high tech output of Materion as evidenced by sophisticated thin film coatings for hard disk drives, specialty inorganic chemicals for solar energy panels, bio-compatible materials for implantable medical devices, specialty alloys for miniature consumer electronics components, optical filters for thermal imaging, critical components for infrared sensing technology and special materials for LEDs. It’s worth noting that Materion is a supplier to the Defense Logistic Agency

(DLA) stockpile.

The Beryllium deposit at Spor Mountain was initially mined by Brush Wellman beginning around 1970. The company is thought to mine 1% grade BeO ore at Spor Mountain (and reports 75 years of reserves at current mining rate). Ore is mined from linear open pits that follow the strike of the tilted ore-bearing tuff. Deposits are mined to shallow depths (very approximately, 30-50 m). Depth is limited by the cost of stripping hard rhyolite caprock.

The techniques used for mining beryllium-bearing ore from this property are considered unique, because of the requirements that must be met to identify the ore body and the rock materials overlying the ore. The beryllium mineralization contained within the tuff member produces no visible physical characteristics which aid in identifying the presence of mineralization as the beryllium mineralization is colorless and its crystal structure is too small for recognition by the naked eye.

A detailed mining operation is employed utilising procedures to follow in survey control, use of cross sections, structure contour maps, and field berylometer. The beryllium ore is mined from selected or predetermined areas of the ore body, placed in the stockpile in layers as blocks on top of each other. This method has been successful in producing a homogeneous blend acceptable as mill feed.

When it recently announced its 1Q14 results it also confirmed its earnings guidance for the full-year 2014 of $1.75 to $1.95 per share.

Texas Rare Earths – Beryllium Plug & Play

Texas Rare Earths (OTCQX: TRER) is the owner of the Round Top Mine in Texas which is a wunder-mine that is all things to all investors. It has Rare Earths, Flourite, Lithium and Uranium. However it was originally developed as a Beryllium deposit.

Most of the work on this score was done in the past by Cabot Corp and Cyprus Minerals.

The current situation at Round Top is the efforts of Cabot and Cyprus left not only a data-set on the deposit but also physical infrastructure in the form of a “starter mine” (still usable and pictured below) consisting of a 867 ft long, 10ft x 10ft decline with vent fan & services in place.

The Cyprus mine plan dating from 1988 is in the possession of TRER. Round Top represents a high grade mineralization – 300,000 tons at 2% BeO (not NI 43-101 compliant). The latest PEA envisages 36 tpa of BeO production. This would represent 7.4% of global production. Before one dismisses the relative puny size of this production one should note that the metal is currently trading of the Shanghai Metals Exchange at $374,000 per tonne.

Beryllium represents an interesting Phase Two (or Three) exercise for TRER.

IBC Advanced Alloys

IBC Advanced Alloys (TSXV: IB | OTCQX: IAALF) is a rare metals advanced alloys developer and manufacturer of beryllium copper, chrome zirconium copper, chromium copper alloys, nickel aluminum bronze, copper rod, and other alloys of copper. It also makes high-performance beryllium aluminum castings. These high technology products are used in a broad range of market sectors including nuclear power, automotive, oil and gas, electronics and aerospace. The company also undertakes R&D initiatives focused on enhancing and supporting IBC’s growing US manufacturing base.

It has several mining properties it has explored in Utah (adjacent to Spor Mountain), Colorado (includes the Boomer Mine – second-largest historical beryllium mine in the US) and

also in Brazil (Minas Gerais). Most effort has been expended on the 7,500 acres it staked at Spor Mountain. The last major work there was in 2011 when the company undertook a program that consisted of 35 reverse circulation holes. The company reported that no ore-grade BeO was encountered. This was a blow which seemingly sent the company's Be exploration efforts into hibernation but we are surprised that the more prospective Boomer property has not been subject to exploration work. The Boomer mine produced a majority of the beryllium ore mined in Colorado from 1948 until 1969 and over 50% of the total US production during that period according to the U.S. Bureau of Mines Minerals Yearbooks. Mining operations were discontinued in the early 1970s due to a legal dispute between the operating partners.

BE Resources

This is more a case of what might have been. BE Resources (TSXV: BE) is a mineral exploration company incorporated in 2007 to explore and evaluate a significant beryllium target in New Mexico, USA. It secured a 100% interest in the Warm Springs property in Socorro County which comprises about 520 acres. In addition to Warm Springs, the company also obtained three other state leases and over 1200 mining claims in Socorro and Sierra Counties. Together with the Warm Springs property, it accumulated an interest in an area of about 25,000 acres (10,000 hectares). The website of the company is seemingly moribund and there were some announcements about heading towards graphite in Quebec in January of this year. So it is unclear if the Beryllium interest has gone out the window in a focus-shift.

Avalon Rare Metals – Oops, missed

We might also note in passing that Avalon Rare Metals (TSX: AVL | NYSE MKT: AVL) holds territory at Spor Mountain where drilling in 2012 found nothing of interest.

Conclusion

The dominance of the US in Beryllium is a good thing. This could be further accentuated by development of a second mine, Round Top, owned by TRER. Maybe life could be breathed back into the Bommer Mine. The US is clearly the axe in this metal but still remains dependent upon imports for too much of its industrial conversion. One could look at the US and Beryllium as somewhat like the Japanese and Rare Earths. In Japan there is a heavy concentration of the conversion of these REE oxides into end-use products. The US, by dominating Be mining, has managed to still retain an overwhelming role as the "go-to-guys" for Beryllium oxides and other by-products. The fact that the US stockpiles this product when it has let its grasp slip on so many others is rather telling.

The potential is clearly good here for the US and the "industrial-military complex" to maintain and build upon this dominance. And maybe it should be lesson in what might be done with other metals, such as REEs, Gallium, Tellurium and Germanium.

Addressing critical material and rare earth demand; the case of First European Minerals

First European Minerals Ltd. (FEM), a British company headquartered in London has launched a Rare Earths and Strategic (or critical) Metals storage program in cooperation with German companies. FEM identifies prospective areas and

then works in conjunction with established mining firms to share its expertise in order to develop mining projects. It is not a stand-alone miner; rather, it offers support for early-stage mining project, contributing to resource localization, sample analysis and economic viability studies.

Both private and institutional buyers have the option of buying, storing and managing these rare elements, in accordance to German Industrial Standards. The Company has found an opportunity in the fact that more than 90% of rare earths are still being produced in the People's Republic of China. These elements are crucial in the production of the newer high-performance electric motors, semiconductors, photovoltaic systems, fiber optic cables, lasers and LEDs.

While Chinese growth projections have dropped in the past year, and as it constrains rare earth production through consolidation and regulation, there is a risk to Western industry that China will be restricting exports of these critical metals in order to address internal demand exclusively – relying on 100% of production by 2020. Recycling of rare earths is unrealistic and, perhaps, if research continue in a linear fashion, some 30 % of the demand by 2020 will be recovered through recycling in the most optimistic of cases while it is far more realistic to expect that new resources will be needed to address some 50% of demand.

This scenario risks producing a supply shortage, which will need fresh funding and new resources. The latter will have to confront what are, typically, extremely long exploration and production times, given the processing requirements and mineralization analysis while separating rare earths from its ore can be a very complicated affair, given both the difficulty of identifying the right ore and the need to increasingly confront environmental issues and restrictions. The latter will have to confront what are, typically, extremely long exploration and production times, given the processing requirements and mineralization analysis while

separating rare earths from its ore can be a very complicated affair, given both the difficulty of identifying the right ore and the need to increasingly confront environmental issues and restrictions.

First European Minerals has heard the urgent call to action while International, and domestic, politics has led to debates discussing whether governments should play a role in producing or, perhaps, accumulating critical metals. Nevertheless, the current economic thinking in the EU is not to interfere with industry through regulation, even as it has to deal with the impending shortage. Meanwhile, the European demand for rare earths is huge and it continues to grow. First European Minerals has been looking for partners to push its project. One of these is Frankfurt based Tradium, one of the largest rare earths and metals in Europe. Tradium is ISO 9001 certified and it has gained a reputation for consistent quality. Metlock is another such company based in Frankfurt. To address this need, First European Minerals, has used an old air raid shelter from the Second World War, converting it to a security storage area to ensure German rare earth needs are met in consultation with advice and support from the Dusseldorf based Institute of Rare Earths and Metals.

First European Minerals processes demand and supply information about Rare Earths and their availability and requirements for the near future, filling the ‘baskets’ accordingly. More specifically, FEM aims to fill the baskets with dysprosium, gallium, germanium, indium and terbium. These five elements have one thing in common, they are rare and they have typically suffered from supply shortages. Dysprosium is mainly used in high-power electric motors; because it helps to maintain magnetic pull even at very high temperatures, their magnetic effect, yet annual production of dysprosium is 500 tons – worldwide. Gallium is used in semiconductors, solar panels, electronics and LED industry. Worldwide increasing use of LED, a rapidly growing photovoltaic industry and the

rapidly growing demand for mobile devices such as smartphones , tablet computers and game consoles have caused gallium demand to rise. Gallium is very rare today, given that the current global consumption of 280 tons derives from actual mining production (78 tons), recycling operations (90 tons) and reserves (112 tons).

Germanium is one of the rarest metals on earth. Without germanium, there can be no fiber optic cables or infrared optics. The annual production of germanium is only 140 tons per year, 70% of which comes from China. At the same time, the Fraunhofer Institute has predicted that there will be an eight-fold increase in demand for germanium by 2030, in response to fiber optic cable usage. Indium is used in display technology and thin-film photovoltaic technology. At present, 1,000 tons of indium are produced annually, half of which half comes from recycling operations much of the rest from China. The EU Commission has set indium supply shortages as a critical issue in the technology metals space. Terbium is used in semiconductors and as an activator for fluorescent phosphors. The U.S. Department of Energy has predicted a terbium supply gap in medium term.

Accordingly, FEM arranges for the purchase and storage, on contract, of the requisite amounts of rare earths in the Tradium market in Frankfurt, which then brings the goods to be stored in the high- security Metlock storage facility, also in Frankfurt. After a minimum holding period of two years, the metals can be stored, sold or picked up. In 2013, FEM, for example, announced a Product sharing agreement (PSA) with the Suhut chrome mine in the south of Turkey at a 90:10 profit distribution agreement, whereby FEM would get 90% of eventual sale of the materials. The mine is said to have a capacity of 8,000 tons/month and reserves of 650,000 MT in Phase I.