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.

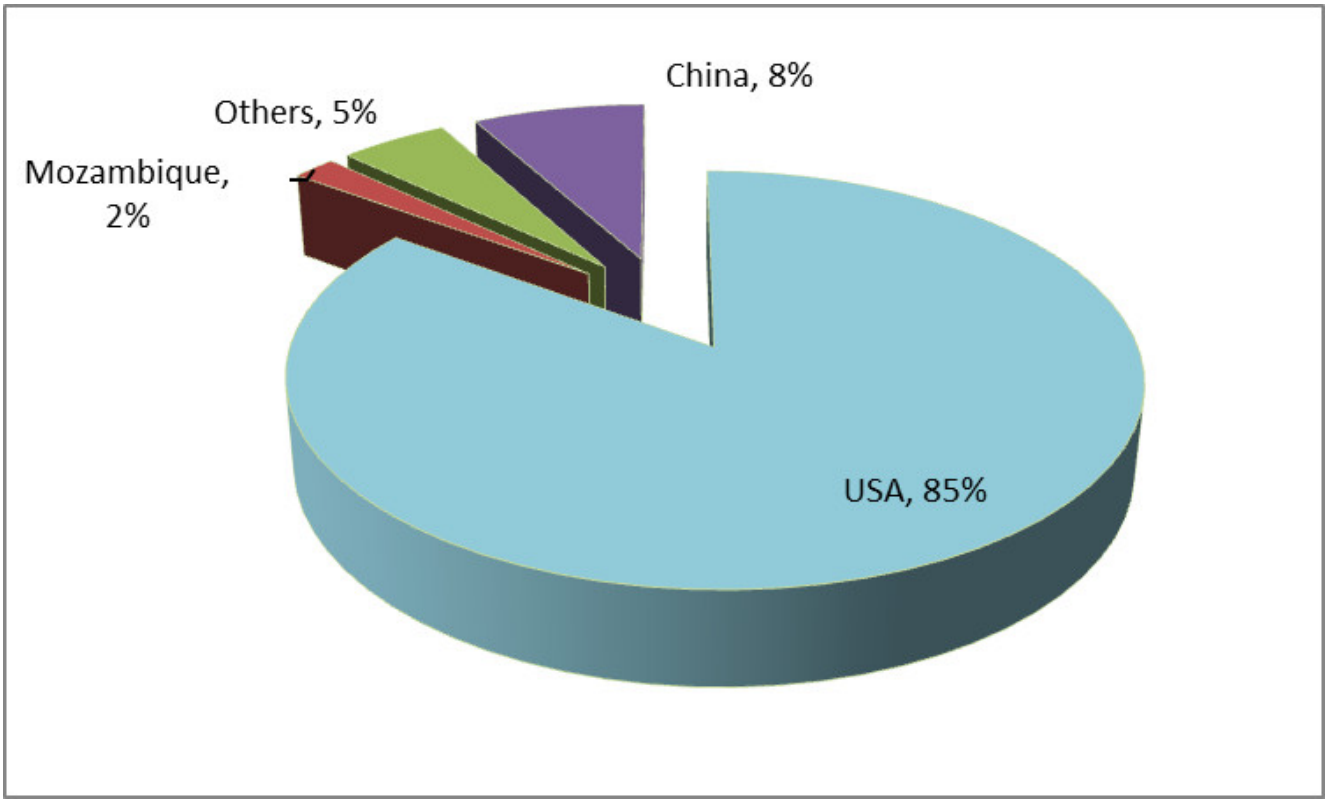
Demand fluctuates as we have seen as the level of US government stockpiling is a key swing factor. We would expect an uptrend though over coming years with rising consumption

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.

2011 All in Kg	TOTAL Beryllium produced in 2011 by each region in kg			
	USA, Japan & Kazakhstan (a)	China (b)	Others (b)	TOTAL
Beryllium contained in metal > 60% Be Produced	43,000	5,000	1,500	49,500
Be contained in Alloys < 60% Be content	283,000	59,000	5,000	347,000
Be contained in BeO Ceramics	2,500	1,000	0	3,500
Total Be converted and sold as commercial products	328,500	65,000	6,500	400,000

(a) Total aggregated by an independent auditor from data provided by BeST members.
(b) Estimates.

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:

2006	2007	2008	2009	2010
$128	$144	$159	$154	$230
Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2011				

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.

Orbite Aluminae solves big

red Problems while treading toward the Future of Mining

The discovery of metals and raw materials and the ways to extract and combine them in alloys is one of the pillars of human evolution, serving as the catalyst to human development. Mining is synonymous with civilization in the same way that is agriculture; together these disciplines have built empires and civilizations. Mining has also built financial empires and in most of the world's markets, mining firms continue to be among the main drivers of stock indices in all continents. Mining and the extraction of raw materials has typically relied on geology as its core science, guiding the prospecting and extraction activities. However, as concerns over environmental degradation – from mining byproducts or tailings – have intensified in the past decades, rightfully or opportunistically exploited by social and environmental groups in developed and developing countries, the mining industry has gathered many detractors. Regardless of the validity of the detractors' claims, mining as an activity requires considerable capital and companies are under pressure from investors to deliver.

The gambling and pioneer spirit element that led to the gold rush in the Americas and the massive colonial mines of Africa in the 19th century have long lost their viability and practicability. In response, mining has become ever more scientific, combining efforts with other disciplines such as chemistry to maximize yields, grades, purities while reducing environmental impact. Moreover, because of the costs involved in brining a mining project to production, it has become more desirable to develop multiple, rather than single,

commodities. Projects that can for example lead to the production of phosphate, uranium and rare earths are more attractive than a solely focused uranium property; similarly, projects that focus on aluminum are much more efficient when they can offer by-products from bauxite.

Chemistry offers more solutions than geology in this regard and Orbite Aluminae is one of the pace setters in this emerging evolution of mining itself. Orbite will produce a series of market ready metals from the treatment of red mud- the highly toxic waste that results from the production of alumina. Apart from the promising commercial applications that can be achieved through this method, perhaps more importantly, the treatment of red mud solves the major problem of dealing with this extremely toxic material. Such is the environmental potential that last February the French group Veolia signed a partnership with Orbite that will lead to the first treatment plant red mud. In the world there is no less than 3 billion tons of red mud; industrial states have no idea what to do with it and how to deal with it. Enter Orbite, the metal industry's equivalent of Quentin Tarantino's 'Pulp Fiction' character of 'Mr. Wolf' and Mr. Wolf "solves problems".

Orbite and Veolia, an environmental technology giant with over 300,000 employees worldwide, have come together to solve the red mud problem. The solution rests in processing, and developing valuable resources hidden in the red mud. The first commercial results of this collaboration are expected to be released in the third quarter of 2013. Orbite has developed a patented process, which thanks to the ability to control acidity, or Ph, using a sort of 'acidity cruise control' treats the red mud with hydrochloric acid solution. This allows for the separation of various metals non-leachable elements such as silica or titanium oxide, recovered as chlorides and then easily separated, guaranteeing enough purity to be brought to market. In view of rising global demand for aluminum, Veolia and Orbite believe that this

process should experience strong growth. Alumina, until recently, has been extracted from bauxite using the Bayer process. This method certainly yields aluminum but it leaves behind large and ever more unsustainable quantities of red mud in a ratio of 2:1 in the best of cases: a ton of alumina generates two tons of red mud. Countries like China faced with the need to store large amounts of red mud have already shown interest in the technology and Orbite has earned patents in China and Russia for its process. Evidently, Canada, the United States, Brazil, Germany and Australia are also candidates. Orbite has access to bauxite and its own aluminous clay deposits and its process extracts alumina and rare earths and it is able to generate various rare earth elements – as well as alumina from the aluminous clay and bauxite essentially resulting far more efficient and economical than the Bayer method.

Last August, Orbite Aluminae already managed to extract samples for commercially valuable heavy rare earth oxides, gallium and scandium from its Grande-Vallee aluminous deposits in Quebec using its patented technologies. Orbite observed a 22% proportion of heavy rare earths in the total amount of rare earth elements from its Grande-Vallee aluminous sludge, also noting the presence of scandium-highly in demand in the aerospace sector. Orbite is confident that its rare earth extraction process has considerable commercial potential and that it would likely be the first such method used in North America whereby aluminum production can take place in parallel to the extraction and separation of heavy rare earths.