

Battery Metals Index
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Battery Metals Bubble: Does it Exist or Do Current Supply and Demand Fundamentals Justify the Prices?

With the evolution of the lithium-ion battery and pending availability of an affordable electric vehicle, we decided it was a good time to produce a Ubika Battery Metals Index, comprised of 10 lithium and 10 cobalt companies. These metals have been on a strong run over the past year, enriching a lot of capital market activity, and investor interest towards these sectors. In an effort to produce an unbiased piece of research, we attempt to answer the question of whether a lithium/cobalt bubble has formed in the public equity asset class. With recent valuations surging over 100%, on average, we've taken a closer look at the supply/demand fundamentals for the metals, in order to help us answer the controversial question.

Matal Price Charts

Figure 1. Lithium Carbonate Prices YTD

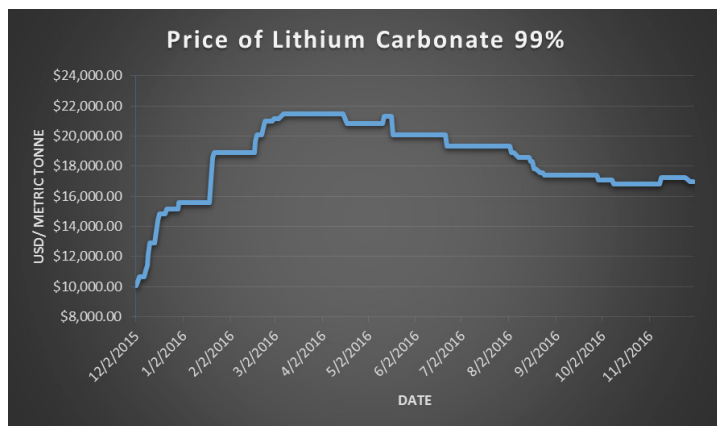


Figure 2. Cobalt Prices YTD

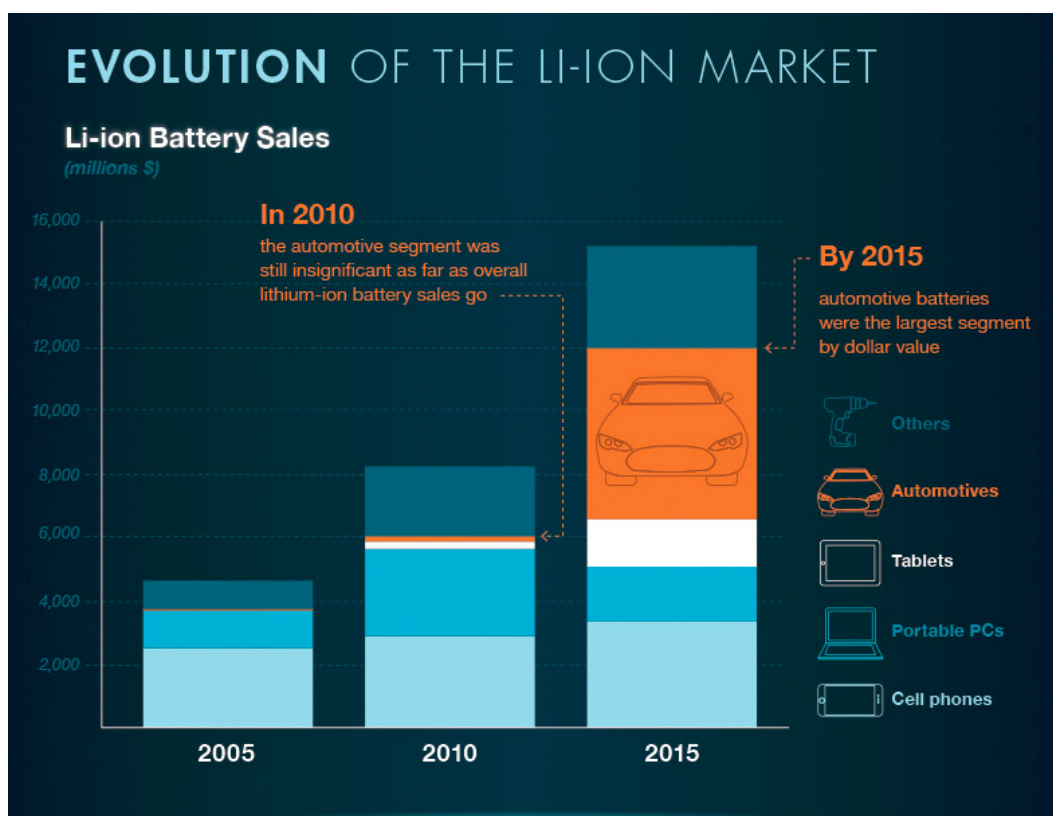


Macroeconomic Drivers

Demand Factors - Lithium

According to the US Geological Survey, as of 2015, the largest source of lithium demand came from battery production, which accounted for 35% of world consumption. That was closely followed by ceramics and glass at 32%, and lubricating greases at 9%. However, moving forward, that gap will increase as lithium-ion battery demand in the rechargeable batteries market is expected to rise from 33.4% of a USD\$49 billion market to 70% of the estimated USD\$112 billion market size in 2025, according to a presentation by Nevada Energy Metals, eCobalt Solutions Inc., and Great Lake Graphite.

Figure 3: Breakdown of Lithium-Ion Battery Market

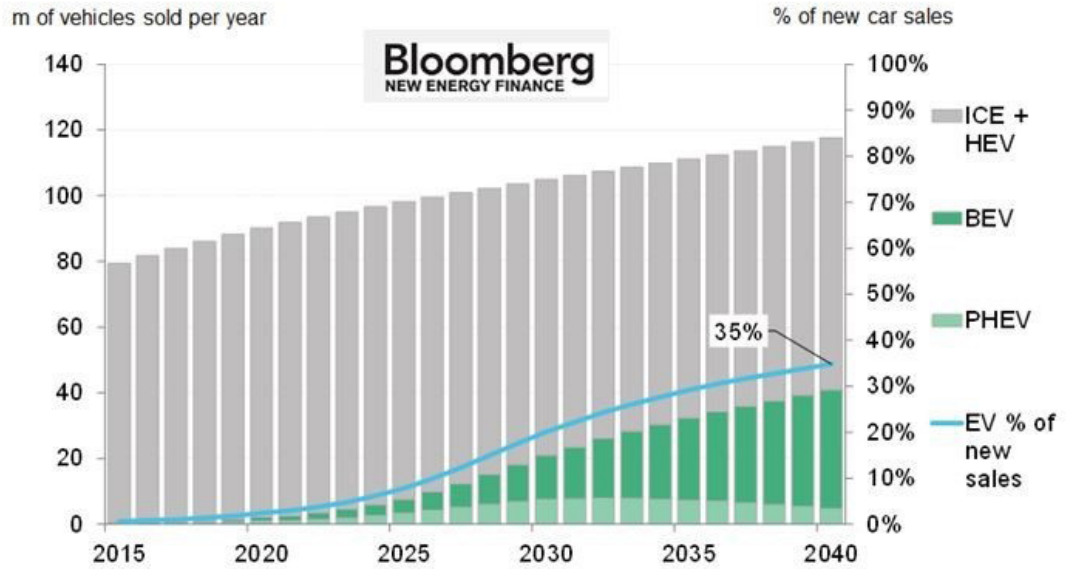


Source: Visual Capitalist

The rise in demand for rechargeable lithium-ion batteries is going to be led by the automotive sector, which accounted for over \$5 billion of the \$16 billion in sales of lithium ion batteries (Figure 3, above). Goldman Sachs estimates that a Tesla Model S 70kwh battery uses approximately 63kg of lithium carbonate equivalent (LCE), and that for every 1% increase in electric vehicle market penetration there is an increase in lithium demand of approximately 70,000 tonnes of LCE/ year. Based on data presented by Bloomberg New Energy Finance, electric vehicles (battery electric or plug-in hybrid) accounted for only 1% of total US vehicle sales in 2015,

however that is expected to rise to 35% by 2040 as is shown in Figure 4, below. This equates to an average increase in market penetration of 1.36% per year, or 95,200 tonnes of LCE of new lithium production per year, and that is just for vehicle batteries.

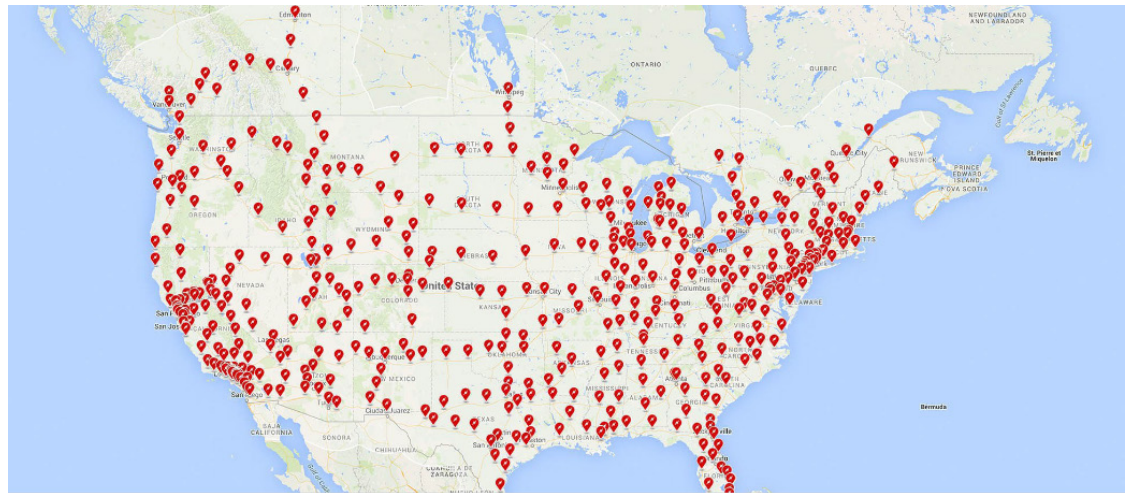
Figure 4: Breakdown of Global Car Sales



Source: Bloomberg New Energy Finance

What is also driving the demand for these cars is the expansion of the supporting infrastructure. One of the biggest downfalls to the first electric vehicles was that they didn't have comparable range to an internal combustion engine, as is evident by the announcement of the 200-mile range, Nissan Leaf being a big step forward for the car. So what was needed to really help make these battery electric vehicles go mainstream was having the infrastructure of charging stations, which thanks to Elon Musk and Tesla, has started to become convenient and substantial. A look at how robust this network of superchargers is can be found in Figure 5 below. This figure represents 751 supercharger stations with over 4,700 superchargers, which can be found on Tesla's website. To give you an idea of how quickly this has developed, just over two years ago, in April 2014, Tesla had opened up its 100th supercharging station in Hamilton, New Jersey.

Figure 5: Map of the Tesla's Network of Supercharging Stations



Source: Tesla

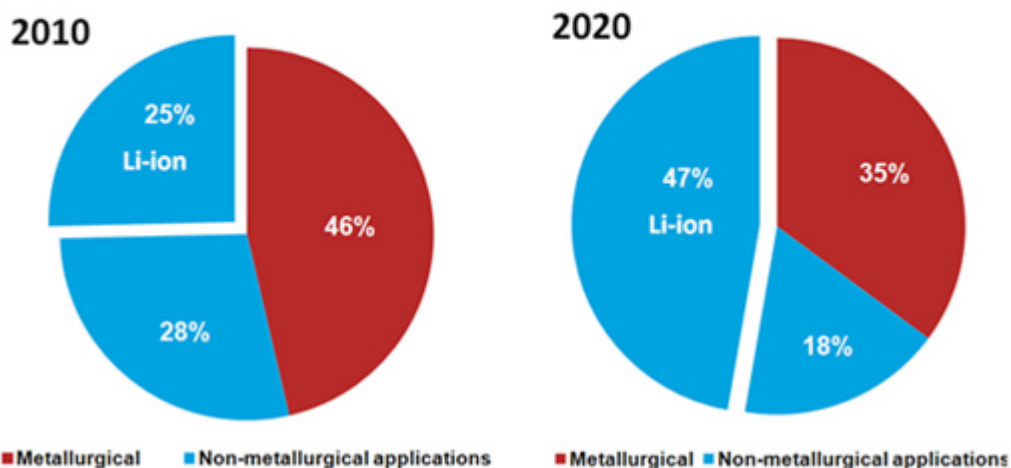
A large driving factor behind this increase in demand is the drop in the cost of production. Back in the 1990s when lithium batteries were first introduced, it costs approximately \$3000 per kwh of energy, which would put the cost of a Tesla Model S 70kwh battery at over \$210,000. Now compare that to Tesla's cost per kilowatt hour of approximately \$190 in 2016, as stated by Tesla's Head of Investor Relations Jeff Evanson. With a target price of \$100kwh in sight, and the current cost per kwh for a lead acid battery at \$150, soon these batteries will become so inexpensive, that the cost of a battery-electric vehicle will rival an internal combustion powered car. The reason for the large drop in price can be attributed to the improvement of the technology and also the scale at which they are now being produced. According to the National Renewable Energy Laboratory, there was a total of 53 gigawatt-hours of lithium ion cell production capacity in 2015, but only 40% of it was utilized. With so much additional room for production growth, we should expect economies of scale to take effect, and lower the cost of the batteries further.

Demand Factors - Cobalt

Just as with lithium, the largest single demand factor for cobalt is its use in batteries. In 2015, 40% of cobalt is used to make rechargeable batteries, according to the presentation by Nevada Energy Metals, eCobalt Solutions Inc., and Great Lake Graphite. This number is expected to grow to approximately 47% by the year 2020. Figure 6, breaks down the shift in demand usage of cobalt from 2010 to 2020.

Figure 6: Break Down of the Shift in Demand for Cobalt

Li-ion battery growth is shifting global cobalt demand towards the non-metallurgical sector



Source: CRU

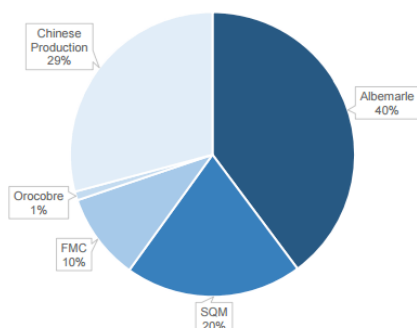
According to the Cobalt Development Institute, in 2015 the world consumed approximately 87,000 tonnes of cobalt. Dr. Edward Spencer of the CRU Group expects that number to increase to 100,000 tonnes in 2017, and reach 150,000 tonnes by 2025, of which approximately 80,000 tonnes will be used specifically for lithium-ion batteries. At a 40% consumption rate for 2015 (34,800 tonnes), that equals a 129% increase in demand for the metal in only one of its uses.

With Tesla aiming to produce 500,000 Model 3s by 2018 that represents an increase in demand of approximately 7,500 tonnes at an estimate weight of 15kg of cobalt per battery. That doesn't include the demand for the Nissan Leaf, with a 60kWh battery expected on the market in the next couple of years as well.

Supply Factors - Lithium

When looking at the supply of lithium to the market place, it is truly dominated by three major companies, Sociedad Quimica y Minera de Chile ("SQM") (NYSE:SQM), FMC Corp. (NYSE:FMC), and Rockwood Lithium, which is owned by Albemarle Corporation (NYSE:ALB), who collectively supply 70% of the world's lithium as is shown in Figure 7. In addition, a majority of the globally-known deposits of lithium are concentrated in what has become known as the lithium triangle, with Argentina, Bolivia, and Chile boasting 75% of the world's deposits in the lithium-rich salars of the high Andes.

Figure 7: % of Global Lithium Production by Company 2015



Source: CRU

Australia is currently the largest producer of lithium in the world, producing 71,631 tonnes of LCE per annum (USGS) (Figure 8, below) and is one of the best-positioned countries to take advantage of the global supply chain. Although most of its deposits are hard-rock formations, which tend to be more costly to extract, the country's proximity to Asia gives it an advantage as the Asian market is the largest consumer of lithium for industrial purposes and battery production.

2015 Rock Production LCE				
Company	Operation	Location		2015
Albemarle (49%) & Tianqi (51%)	Greenbushes	Australia	Production (t of LCE)	71,631
			% global Share	41%
			Capacity Utilization	65%
Albemarle	King's Mountain	U.S.A	Production (t of LCE)	5,000
			% global Share	3%
			Capacity Utilization	45%
China-various	China-various	China	Production (t of LCE)	10,000
			% global Share	6%
			Capacity Utilization	-
2015 Brine Production				
Company	Operation	Location		2015
Albemarle	Salar de Atacama	Chile	Production (t of LCE)	25,200
			% Global Share	14%
			Capacity Utilization	50%
	Silver Peak	USA	Production	5,000
			% Global Share	3%
			Capacity Utilization	88%
SQM	Salar de Atacama/ Salar del Carmen	Chile	Production (t of LCE)	35,473
			% Global Share	20%
			Capacity Utilization	74%
FMC	Salar de Hombre Muerto	Argentina	Production (t of LCE)	17,460
			% Global Share	10%
			Capacity Utilization	87%
Orocobre	Olaroz Stage 1	Argentina	Production (t of LCE)	1,762
			% Global Share	1%
			Capacity Utilization	10%
China- Various	Various	China	Production (t of LCE)	5,000
			% Global Share	2%
			Capacity Utilization	14%

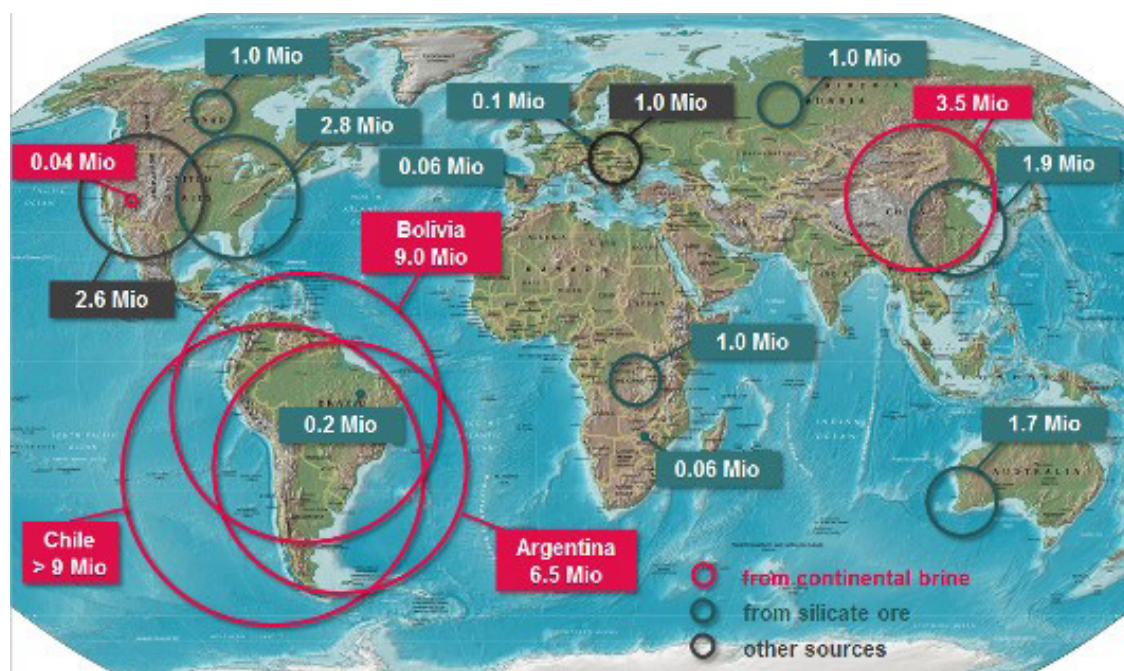
Supply Factors - Cobalt

The supply chain for cobalt metal is extremely concentrated, with approximately 51% (63,000 tonnes) of the entire global supply of the metal being produced in the Democratic Republic of Congo, according to the USGS, followed by China and Canada at 6% and 5%, respectively. Currently the top producing regions are Africa, estimated at 60% of global production, with 11% from the Americas, and 10% from Asia.

Predominately mined as a by-product of copper and nickel, cobalt's supply is tied to the prices of both copper and nickel in the market. According to the Cobalt Development Institute, approximately 50% of cobalt is produced through the nickel industry, 44% through copper and other industries, and only 6% is from primary cobalt operations.

Global production of cobalt was approximately 124,000 tonnes in 2015 according to the USGS, however a large amount of production is at risk, which will be discussed later on. As demand was estimated at 87,000 tonnes in 2015 by the Cobalt Development Institute there is still a buffer however, with the growth in demand of cobalt for batteries, and the concentration and nature of production, the supply of cobalt is in a much more fragile state.

Figure 8: The Geography of Lithium



Source: Energy & Capital

Types of Lithium

Brine

Lithium Brine refers to lithium that is dissolved in saline water with high concentrations of salts. There are three types of lithium brines that exist on earth: continental, geothermal and oil field, which account for approximately 66% of global lithium reserves. Brines are defined as a concentration and use a parts per million (ppm) to describe the quantity of a certain substance within.

Continental brines are found on saline desert basins, known as salt flats or salars, which are the deposits that characterize the landscape in Argentina, Bolivia, and Chile. The largest known salar in the world is the Salar de Uyuni in Bolivia, which reportedly contains approximately 50% of the known world reserves in an almost 10,600km² salt flat, according to the Salar's website.

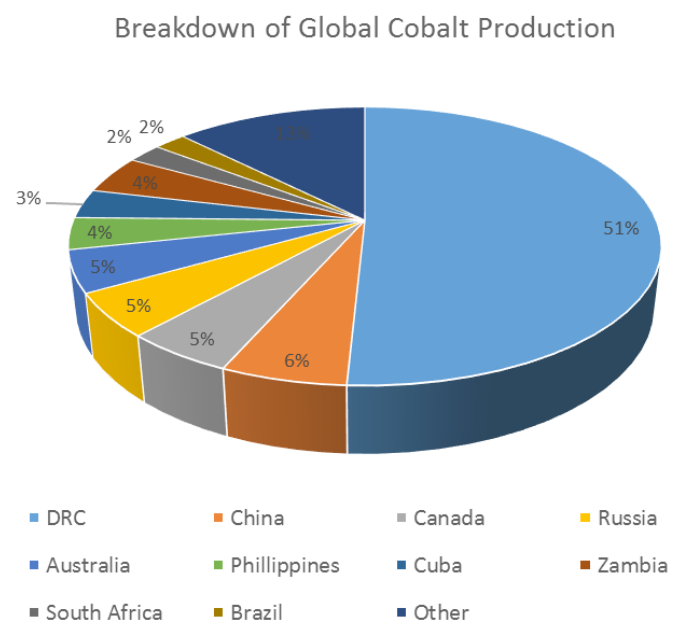
Brines are more economical than hard-rock to process, as the process is based on evaporation technology to concentrate the saline water to a concentration of between a couple hundred ppm to 7000ppm, according to Terence Bell, President and Founder of Strategic Metal Investments Inc.

Hardrock Deposits

Lithium can also be found in hardrock deposits of pegmatite or sedimentary rock. Although more expensive than lithium brines to extract, its processing is less time consuming as the evaporation of brines can take up to 9 to 12 months, according to Peter Epstein of MiningFeeds.com.

Pegmatite is a hard igneous rock and is the type of deposit that characterizes Talison Lithium's Greenbushes deposit in Western Australia, and the ore is defined in its grade referring to a percentage, which could be approximately 3-5%. Pegmatite deposits account for approximately 26% of the known global lithium resources, while sedimentary rock deposits account for approximately 8% of globally-known lithium deposits.

Figure 8: The Geography of Cobalt



Source: USGS

Threats to Lithium Supply

The largest supply risk is that 75% of the world’s economically accessible reserves are concentrated in three countries, but Logan Goldie-Scot, head of Energy Storage Analysis at Bloomberg New Energy Finance, does not think that this represents a significant risk, because of differing political agendas. That being said, there still are a number of concerns for the unimpeded supply coming from these countries as the region is still political unstable (SQM’s Atacama core asset is under threat of arbitration as the lessor is seeking early termination), as well the production and transportation of the high-altitude deposits can be subject to weather patterns.

An example is that in 2015, production in Chile was disrupted when areas in the Atacama Desert received rain for the first time in 80 years, causing massive flooding. SQM’s lithium plant in Northern Chile, which is responsible for nearly 30% of the world’s lithium chemical production, was closed down for a short period of time and created fears of supply shortages, according to an article by Benchmark Mineral Intelligence. Although only short-term delays occurred, which limited the long-term impact, it proved how easily operations could be disrupted. Also remember that the west coast of South America lies on a volatile fault line, which could also disrupt production and shipments. This is highlighted by the fact that just over a year ago, a powerful 8.3 magnitude earthquake hit Chile, and more recently on December 1st, a 6.3 magnitude earthquake struck Chile’s northern neighbor Peru, 43 km Northeast of Huarichancara.

Threats to Cobalt Supply

As stated earlier, cobalt is mined as a by-product of copper and nickel as it is a relatively abundant mineral (No.33 in the world) but is found on average in relatively-low concentrations. This creates a large supply chain risk and somewhat of an inverse relationship between the price of cobalt to the price of copper and nickel. As prices for copper and nickel fall, output is curtailed as mines close down and their extraction becomes uneconomical, but as this happens, the supply of cobalt will also decrease, which will push its price up further.

For example, in Q1 2016, vs. Q1 of 2015, Congolese cobalt production fell 19% to 16,396 tonnes, which tracks the fall in copper production of 22% over the same period. In addition, the DRC is entering a tense time politically as President Joseph Kabila and the government has delayed the elections that were to take place this year, which will push President Kabila past the DRC's constitutional limit of two terms in power, set to expire in December 2016.

In the Philippines, the government has already closed 10 mines and has threatened the suspension of 20 more due to environmental concerns raised after an audit was completed in August, so a large percentage of nickel and consequently cobalt is at risk of coming off the market. The Philippines is the largest supplier of nickel in the world and the 6th largest supplier of cobalt.

Although there is an apparent supply glut (124,000 tonnes produced in 2015 vs. 87,000 tonnes consumed), with the drastic shift in demand for EV's, the threat of production cutting in The DRC and the Philippines due to environmental issues, there are more constraints on the supply of cobalt, which make it a more vulnerable material in the battery mix. These types of risk create the potential for the largest bottlenecks in the battery production cycle.

Additional Considerations for Battery Metals

One other thing that hangs over the economics and reliability of the supply of these battery metals is that the majority of them come from poor, disadvantaged countries. The DRC is one of the worst countries for human rights violations and war, and the OECD rates it a 7 out of 7 as having the highest country risk in trade and Argentina, a large supplier of lithium is rated as a 6 out of 7 risk.

These ratings are based on convertibility risk and the risk of force majeure. Convertibility risk refers to the risk of a government imposing capital or exchange controls that prevent the movement of currency out of the country, and force majeure refers to the risk of war, expropriation, revolution, civil disobedience, floods or earthquakes.

With regards to the DRC, UNICEF estimates that there are approximately 40,000 children as young as eight working in cobalt mines in the DRC. It is a sad reality but it is big business, accounting for between 10 to 25 percent of global cobalt production. This creates a large risk to a company's corporate social responsibility as large consumers of lithium-ion batteries, such as Tesla or Apple, could take a large hit to their image if the cobalt they used was traced back to child labor.

Introducing the Lithium Index

Identifier	Company Name	Company Market Cap (Millions, CAD)	Revenue (LTM, CAD, Millions)	Cash and Short Term Investments (FQO, CAD, Millions)	Total Liabilities (LTM, CAD, Millions)	Year to Date PCT Change	P/NAV*	Ev/EBITDA (2017)*	Resource	Lithium Resources**
ALB.N	Albermarle Corp	\$12,825.16	\$3,865.64	\$306.65	\$8,102.33	52.90%		11x	27 years worth of production	10.9 mm tonnes of LCE
SQMa.SN	Sociedad Quimica y Minera de Chile SA	\$10,278.89	\$2,259.43	\$757.89	\$2,493.84	11.80%		10.75x	30 years worth of production	8.5 mm tonnes of LCE
FMC.N	FMC Corp	\$10,038.64	\$4,390.72	\$171.57	\$5,721.67	44%		10.8x	75 years worth of production	6.9mm tonnes of LCE
ORE.AX	Orocobre Ltd	\$932.09	\$20.59	\$46.31	\$32.41	95.20%	0.6x	-	Volume- 1.75km2 @690mg/L	7.2mm tonnes LCE
GXY.AX	Galaxy Resources Ltd	\$859.17	\$4.30	\$7.88	\$43.46	313%	0.7x		48.6m tonnes, 2.2km3	7.75mm tonnes LCE
PLS.AX	Pilbara Minerals Ltd	\$745.91	\$0.00	\$96.32	\$4.14	87.50%	1.0x		128.6mmt (@1.22% li20 and 138ppm Tantalum) (1.57mm tonne li, and 39.17Mlb Tantalum)	3.38mm tonne LCE
NMCTO	Nemaska Lithium Inc	\$381.41	\$0.00	\$78.25	\$19.23	179.50%	0.6x	-	32.5@1.53%li for 0.5mm	1.26mm tonnes LCE
LACTO	Lithium Americas Corp	\$245.14	\$0.82	\$13.14	\$3.20	124.70%	0.3x	-	92.5mm tonnes @0.38% for 7.7mm tonnes of	7.7mm tonnes LCE
NMT.AX	Neometals Ltd	\$188.94	\$0.00	\$70.50	\$5.94	124%	0.2x		77.8mm tonnes @1.37% Li20 for 1.1mm tonnes and 1.09% Fe for 848,020lbs	2.36mm tonnes LCE
AJMAX	Altura Mining Ltd	\$170.21	\$5.93	\$21.36	\$20.82	154.40%	0.54x		39.2mm tonnes @1.02% Li20 for 0.4mm tonnes	0.8612mm tonnes of LCE

*Estimates from brokerage houses

** Calculated using a Li20 to LCE conversion factor of 2.153, or a Li metal to LCE conversion ratio of 5.3. These conversion factors were taken from An article by Terrence Bell, President and Founder of Strategic Metal Investments Ltd., and a report issued by European Metals Holdings LTD

A large area of interest within the lithium space is whether or not there is a bubble surrounding the material. There are a number of new entrants who have seen exponential stock-price growth in a very short time period. One that comes to mind is Millennial Lithium Corp (CVE:ML), which has seen a YTD return of 1,566%, but when you look at the more established companies the story is different.

When analyzing companies on a Price to Net Asset Value (P/NAV) basis, there does not appear to be any blatant overvaluation, with the exception of Pilbara Minerals, which is just above the industry standard 0.7x and is valued at a 1.0x multiple. The reason for the standard being placed at 0.7x is that rarely do companies obtain all of the economic value that is calculated in the economic assessments of the projects. From this standpoint it actually appears that a number of companies are slightly undervalued, with the exception of Neometals Ltd., which is severely underpriced with a P/NAV of just 0.2x, which could be a sign of a potential correction to better match the combined NPV's of its two economically-assessed projects.

Even the three largest corporations currently involved in the production of lithium (FMC, SQM and Albemarle) all seemed to be reasonably priced. As these three companies are all large, diversified chemical manufacturing companies involved in the extraction of lithium, a P/NAV can't be used to appropriately evaluate. According to a report issued by BMO Capital markets, the average EV/EBITDA multiple for chemical companies comparable to these three has been 11x over the last decade. As all three companies are currently trading at an EV/Forward EBITDA either on, or slightly below, the 11x multiple, there is no indication of a valuation bubble.

Furthermore, considering that future demand is expected to outstrip supply beyond 2018, lithium could still be a strong investment choice. That being said, if you are patient and wait until Q2 to Q3 of 2017, you may just see a larger return. We have indicated there is extra supply coming online during the year, which will lead to a short-term surplus and time period of depressed prices, which would produce a favorable time period for entrance.

Cobalt Index

Identifier	Company Name	Price Close (CAD)	Market Capitalization (CAD, Millions)	YTD Price PCT Change	P/NAV*	Cobalt resources**
LUN.TO	Lundin Mining Corp	6.91	4,940.34	81.8%	1.04x	27.7mm lbs
IGO.AX	Independence Group NL	4.33	2,503.76	72.8%	1.3x	24.3mm lbs
LML.L	Lonmin PLC	2.40	781.99	71.6%	1.4X	
ALS.TO	Altius Minerals Corp	12.38	544.30	22.2%	1.25x	
S.TO	Sherritt International Corp	1.24	396.75	69.9%	0.7x	339.5mm lbs
KAT.TO	Katanga Mining Ltd	0.14	266.61	-3.6%	0.1x	388.7mm lbs
TGS.AX	Tiger Resources	0.04	72.00	-22.0%	0.2x	111mm lbs
ECS.TO	Ecobalt Solutions Inc	0.59	61.85	413.0%	0.5x	35.7mm lbs
HIG.AX	Highlands Pacific Ltd	0.06	52.36	-13.4%	0.4x	25mm lbs
FT.TO	Fortune Minerals Ltd	0.11	31.13	425.0%	0.1x	69.5mm lbs

*Estimates from brokerage houses and calculations taken from Technical Reports

**Taken from resource tables and direct contact with company Investor Relations Personnel

Similar to the companies seen on our lithium index, the valuations of many of the company that produce cobalt do not seem inflated, with expectation of the larger players on the list. However, when reviewing the smaller, more-cobalt focused companies there appears to be a trend of undervaluation. The larger players (the Top-5 companies on the list) all conduct business operations outside of mining cobalt and it comes more as a by-product of their operations than the sole reliance, and so its other operations could account for the higher valuation.

The most interesting companies on the list today are in the bottom half though. All are quite undervalued compared to their NI 43-101 report NPVs, but only two in particular, ECobalt and Fortune Minerals, have seen substantial growth in their stock value this year. This is because these two companies are developing fairly new projects and have not yet generated any profits

or revenues from their projects, and so the market could be waiting to see if once operations are up and running, they realize the predicted cash flows. According to the Fortune Minerals technical report, by the end of fiscal 2017, the Company should be on the verge of generating positive cash flow, and be out of the red by 2018. If the Company can realize these cash flows, we believe that the stock value will jump to more closely reflect the actual NPV of its NICO Cobalt-Gold-Bismuth-Copper Project. As a junior miner, we believe the stock is still being very heavily discounted because of the unknown of whether or not the Company will realize positive cash flows.

The reason for caution when looking to invest in a company that has a low P/NAV is that when analyzing Katanga Mining, it is apparent that its valuation has been brought on by underperformance. After an independent technical report (NI 43-101) was released in 2012 on behalf of Katanga, the assessors found that the Company had a NPV of over \$5 billion in its assets and would be cash-flow positive by 2013, and would remain so over the life of the mines. Unfortunately, Katanga was unable to realize the calculated economic value and so the low valuation is justified.

Conclusion

Based upon the research conducted and our findings, it is easy to say that there is certainly no bubble in either lithium or cobalt. As a majority of the companies we observed have low P/NAV, with the exception of the larger, more-diversified firms, we feel the valuations are justified and there is more potential to see an upside as the new mining projects become operational.

Furthermore, after analyzing the supply and demand dynamics of each metal, it is our conclusion that demand will continue to put pressure on the supply, with the exception of lithium during 2017, which will ultimately push the price up and make the smaller players more valuable. Cobalt is certainly the more at-risk metal in the battery mix, as a large majority of it is concentrated in a very unstable part of the world. All eyes in the battery metal sector will be on President Joseph Kabila and what unfolds over the next year. If the population grows weary of his continued stay in power, the potential of violence erupting is very real, which would certainly have an impact on operations within the country, and the global supply of cobalt.

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