February 8, 2019: Post-Indaba Special!

New Year's Animals Part 2:

Ninja Turtle (Hare) & Lithium Bull (Tortoise)

Today's Lithium-ion Bull is an adapted discussion originally composed as an email response in December to a brilliant and ridiculously successful **Aging Skeptic** mining entrepreneur who loves to warn me every few months about how lithium's non-rarity makes it largely an un-investable mineral. But, always a capitalist pig in its purest form, seems genuinely interested in figuring lithium out and identifying which of the ugly duckling lithium development plays will become true swans. I take this as a bullish indicator for 2019.

He forwarded me mining.com's December click-bait suggesting he sees something "disruptive" -- which provided me a good opportunity to re-visit a favorite comparison.

Idioms

Time is Money

+

Put Your Money Where Your Mouth is

=

Put Your Mouth Where Your Time is*

**Please see disclaimer at end of this publication.*

Lithium's in-situ abundance, like oil's in-situ abundance, is a huge positive, not the negative that bears highlight. It means it can be relied upon to fuel the massive and much-faster-than-expected EV and other energy storage adoption rates.

The current "inside baseball" debate over which of lithium-carbonate or lithium-hydroxide is better positioned long-term is an interesting conversation. But more relevant is the fact that with a very high degree of confidence you can bet that future battery technologies will involve lithium, and more of it, because of its abundance, whereas battery scientists may seek to reduce the use of more challenged resources like cobalt.

What is scarce about lithium is chemical processing skills. And low-cost infrastructure, royalties and sovereign risk to support such processing in a consistent, sustainable way that auto OEMs sleep at night.

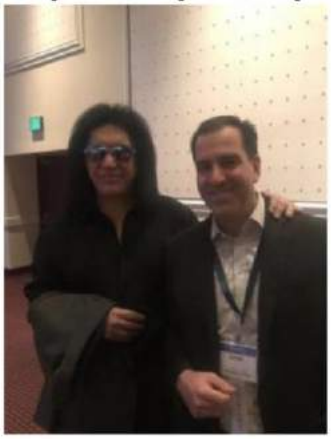
Conventional brines in Chile and Argentina are unpredictable. Rife with technical, environmental and geopolitical risk. Each brine is a unique science project. And those who possess brine chemistry skills are very secretive. Information sharing/skills learning is not as prevalent as in hard rock mining in Australia and carbonate and hydroxide processing in China, and now Australia.

I don't doubt that brines will have a significant role to play in future lithium supply. And one or more black-box technologies like PosLX or Eramet will likely become part of the supply mix in a small way in the distant future. But, on balance, south American brines – using conventional and new technologies - are no longer the lowest cost for the most important, fastest growing, highest priced performance lithium compound, lithium hydroxide: hard rock spodumene feedstock is. And, even carbonate from high quality hard rock will be preferred in many instances, even if slightly higher opex.

Clays have been shown to be doable at pilot stage, but still are unproven at scale and, again, are focused on lower priced, more standardized carbonate, not premium priced hydroxide. Like-wise geo-thermal/petro-lithium projects, which have received excess publicity as 2019 began from those who should know better - click-bait tweets, podcast discussions and FT headlines, only serve to further confuse Jane and Joe Battery Packs who are genuinely attempting to understand the significant mis-pricings right in front of their eyes on the Mr. Market Lithium scoreboard.

From a cost of capital perspective, a higher discount rate must be used when evaluating any brine or any unconventional, high capex "never-been-done-before" project. IMO lithium venture capital of this type requires high public equity market conviction – absent at present - that long-term lithium prices/margins/cashflows will remain high for a long period. My personal preference:

Keep It Simple Stupid



I'm focusing most attention on plain vanilla hard rock spodumene pegmatite projects in investment-friendly OEM jurisdictions. With a great preference for partnering to supply Japan, Korea, US and European demand.

The hard rock lithium world is largely broken down into:

1. Spodumene miners

2. Carbonate and hydroxide “converters” (similar to smelters or refiners), currently in China, that partner through long-term off-takes/JVs with miners of spodumene.

3. Fully integrated mine-to-hydroxide converters (or JVs) - a few are funded and in construction in Western Australia and Quebec.

I don’t believe there are “disruptive” projects in lithium, though I believe very strongly in disruptive geopolitical risk. Much of today's lithium industry production is in Emerging Market, heavy State influenced Chile, China and macro-politically volatile Argentina. The world’s most well-known and prestigious consumer brands, VW/Audi/Porsche, Mercedes, GM, Ford, Tesla, Apple, Samsung, LG, Nissan, Panasonic take “sustainability" very seriously. Few of these companies worry about where their copper comes from. But are scared about Security of Supply of critical minerals lithium and cobalt and where they come from.

I believe that Africa is the least preferred place to develop lithium assets. China may do some small deals (we’ll see if non-binding MOU announced between **General Lithium** and **Birimian** comes to anything), but I see Africa spodumene as likely to mirror the unrealized African iron ore dreams, while Western Australia chugs along. Oz-like sovereign risk jurisdictions - Canada, USA, Europe, Minas Gerais, Brazil -- will be preferred and attract premium valuations.

In evaluating a lithium project I would strongly suggest a focus on #3 above, which was **Softbank**’s approach with their $100M for **Nemaska** - low-end of the cost curve, vertically integrated, clean and green spodumene to hydro-powered hydroxide. French Canadian National Industrial Champion.

Beast and the Beauty

Over the past year, it has become consensus view that more long-term margin will be in lithium carbonate and hydroxide processing ($12-16kt long-term forecast), rather than spodumene mining (forecast price $500-750/t, ~8 tons spodumene for 1 ton LCE). Especially for hydroxide. This is why sizable, integrated hydroxide plants are being built in Western Australia and why Albemarle, the biggest lithium producer in the world, is writing a $1.15B + $800M check for 50% investment with Mineral Resources' Wodgina project in the Pilbara. 45% EBITDA margins, according to ALB. **50-100kt for 30+ years. Long-term. Sustainable. Security of Supply.**

And why I believe Quebec and North Carolina hard rocks will develop significantly. Albemarle has described their past producing King's Mountain mine as second highest grade in the world after Greenbushes in Western Australia. USGS and their consultants have estimated the North Carolina Tin Spodumene Belt to have similar potential tonnage as in Manono in DRC (excerpts below).

A lithium sweet spot is integrated spodumene-to-hydroxide projects that can meet a threshold of 20,000 tons for 20 years and ~$400-$500M capex ($100-150M mine/concentrator, $300-350M hydroxide plant). Additionally, it is likely that new hydroxide processing plants outside ChinAustralia will develop to process spodumene ores from other geographies (eg, South America, Europe). This is the **Beauty Piedmont Lithium** thesis.

I see **Beast Monster Manono AVZ** as the Simandou of Lithium, not Escondida. That is to say, a stunningly huge and high-grade deposit that will unlikely ever get built due to sovereign and logistical issues.

AVZ's business plan is largely focused on #1, mining spodumene. Downstream hydroxide processing is virtually impossible due to lack of skills (chemical engineer professionals, even Chinese, are unlikely to choose to live in DRC over Australia, Canada, USA or stay in China), and would very likely be uneconomic due to infrastructure considerations (power, reagents etc). I see no future "Lithium Valley, DRC".

I affix a 33% chance that a zero-cost-of-capital China Belt and Road mentality could finance Manono spodumene into production for converters in China, but I doubt this project will be for non-China EV players. And I affix only a 5-10% probability that a minority shareholder in AVZ will reap the reward - if it's built, China/DRC will likely arrange to keep the spoils. 40% of Manono is already owned by who-the-hell-knows in DRC and I've heard there are still some legal questions by those they took the project from. If Manono does progress, it will be fantastic news for long-term lithium chemical prices as Manono spodumene concentrate would be relatively high cost (2nd or 3rd quartile on the spodumene cost curve). And if this project is economic it will be because EV demand is far surpassing today's projections, lithium remains super tight and prices stronger for longer.

Manono's biggest problem, aside from the very-substantial-never-never-never-under-estimate non-Democratic Republic of Congo risk, is transport. From Manono to Africa port is >2,000 km on poor roads, barges and trains. And from Africa port to China is far more expensive than Port Hedland or other WA ports to China**. Not Sustainable.**

AVZ's PEA envisions spodumene production at a cost of ~$300t FOB Dar es Salaam which compares, for example, to Pilbara or Altura at $200-300M FOB Port Hedland.

- AVZ's PEA economics are suspect:
  - Presumes a **highly aggressive $920t spodumene price** (based on spot at time of PEA) while forecasts are in the $500-750t range medium term. Piedmont and others used a more realistic, detailed consensus $685t in their PEA, a level that would reduce Manono NPV to $600M, net to AVZ, not $1B headline cited in PEA.
  - Presented pre-tax not industry best practice net-tax.
  - Presented pre-royalty.
    - while lithium was spared "critical mineral" tax for now, I'd affix a high probability such regime will change if/when lithium production happens.
  - 10% nominal discount rate for DRC is too low for the risk, shaving $600M NPV further
- The stock, even with its 80%+ fall in 2018 and further drop on proposed $5-15M retail raise, remains expensive relative to peers.

Hello Dr. Lithium. Goodbye Dr. Copper?

Dismal scientists like **Paul Gait** at think tank **Alliance Bernstein** and other Air Supply lovers generally take an ivory tower economic theory approach to lithium. They conduct little or inadequate project by project bottom up supply analysis. Other generalists like Morgan Stanley put a megaphone to, but don't look critically enough, at SQM's fake news utterances. They are **wrong.**

I recall Paul Gait's near certainty 5 years ago over 90 pages that copper would already be at $10,000. Copper has been lower nearly every day since he wrote that note ranging from ~$4,500-7,200. His "Big Short" Lithium, recently re-iterated, is a history repeat. **Artificial Intelligence**.

Lithium is a niche, specialty chemicals industry filled with lots of nuance. Talk to more true experts, and, think chemicals, not mining. FMC's spinoff of their lithium division into Livent in an October IPO has resulted in many more, and more credible, investment banks having done their lithium homework. Have a read through IPO syndicate members **Goldman (This Time is Different, Unprecedented Commodity Cycle)** as well as **CS, Nomura and Bank of America** notes, which are neither overly bullish nor bearish.

As far as economic theory goes, **PPP** is highly relevant for lithium. North Carolina, USA = 40 years **P**roven **P**egmatite **P**roduction. And, like almost any cost in USA vs. other geographies outside China, lower cost on a USD and **P**urchasing **P**ower **P**arity basis.

Piedmont's $50M market cap = ~5% the $888M NPV laid out in its greatly detailed and credible Scoping Study for an integrated spodumene-to-22.7kta hydroxide project. **(Not Advice. DYOR. Read Disclaimer)**

Piedmont raised AUD12M in December for a significant drill campaign aimed at expanding mine life. Lithium, as everyone seems to know, is not rare. Judge for yourself the likelihood of exploration success.

Some excerpts and links below to US Geological Survey analysis from 1989 and 2008 about the Carolina Tin Spodumene Belt, the Charlotte Quadrangle.

Charlotte Quadrangle Trumps Lithium Triangle

USGS, 1989, citing Keith Evans

nism of lithium enrichment but unlikely because of the great volume of parent magma needed to produce even a small fraction of residual liquid having the appropriate composition.

A mechanism for lithium enrichment that has not been considered previously is liquid-state fractionation, as in the convection-aided "thermogravitational diffusion" model of Shaw and others (1976) and Hildreth (1979). Granitic magmas in the roof zones and margins of magma chambers can be enriched 10 to 20 times in rare lithophile elements over the bulk of the same granite and can already be sufficiently fractionated to crystallize lithium aluminosilicates, micas, or phosphates (D. London, written commun., 1982). Liquid-state fractionation supplemented by a separation of aqueous and silicate phases, as discussed by Jahns and Burnham (1969), is a viable alternative to the anatectic and simple fractional crystallization models.

The spodumene pegmatites were mined sporadically for cassiterite from 1903 until 1937, but total production probably did not exceed 110 short tons of metallic tin (Kesler, 1942). A USGS strategic minerals investigation begun in 1938 (Kesler, 1942) revealed that spodumene was potentially more important than cassiterite. The Solvay Process Company operated an open-pit spodumene mine and flotation plant 3 km southwest of the town of Kings Mountain, N.C., in the early 1940's (Kesler, 1961). This mine was inactive from 1945 until 1951, when Foote Mineral Company opened a still-active pit on the same property (Kesler, 1961). In 1955, the Lithium Corporation of America opened a lithium chemicals plant at Bessemer City, N.C., and began mining at the now inactive Murphy-Houser and Indian Creek mines near Lincolnton, N.C. Their present open pit, the Hallman-Beam mine 7 km northwest of Bessemer City, has been active since 1968 (Singleton, 1979). Total production in the area through 1978 is equivalent to 58,500 short tons of lithium metal (J.H. DeYoung, Jr., 1982, oral commun.).

As the alkali metal of lowest atomic weight, lithium is the metal of lowest density and is the most electrochemically reactive. Lithium compounds are used in aluminum reduction cells, in ceramics and glasses to improve thermal shock resistance, in lubricating greases effective over a wide range of temperatures, in refrigerants for air conditioning, in pharmaceuticals, and as a catalyst in the manufacture of synthetic rubber (Singleton, 1979). Lithium and its compounds also are used in nonrechargeable batteries. Spodumene is used directly in the manufacture of some glasses and ceramics. Potential new uses for lithium in rechargeable batteries and in the development of nuclear fusion as an energy source may greatly increase its consumption in the future (Hammond, 1976).

The major byproduct of spodumene mining in North Carolina is a feldspathic sand that contains 2 parts sodic feldspar and 1 part quartz; it contains some lithium and is used in the ceramic and glass industries (Singleton, 1979). Muscovite is a current byproduct, and quartz and feldspar have also been recovered. Amphibolite host rock from both mines is crushed as a byproduct by Martin Marietta Corporation for roadbase material. The pegmatites contain low-grade resources of beryllium (Griffitts, 1954), and a pilot plant was temporarily operated by the U.S. Bureau of Mines to test the recovery of beryl as a byproduct (Browning, 1961).

DESCRIPTIVE MODEL

Size and grade of spodumene pegmatites

Length: Dikes range from a few centimeters to almost 1,000 m in length; they are generally less than 250 m long. They occur chiefly in a zone about 40 km long. Additional dikes occur at Gaffney, S.C., 19 km southwest of the main pegmatite field.

Width: Dikes range from a few centimeters to about 90 m in width; they are generally less than 10 m wide. The pegmatite field is 1 to 3 km wide.

Depth: Drilling deeper than 200 m has encountered no change in pegmatite composition (Kesler, 1976). The deepest spodumene pegmatite confirmed by drilling was at 274 m (Engineering and Mining Journal, 1952).

Volume (tonnage): In 1976, after 16 years of mining, Foote Mineral Company announced proved reserves of 38 million short tons of spodumene pegmatite over approximately one-half of its property (Kunasz, 1976). Reserves on the remaining half were reportedly unknown. In the same year, the Lithium Corporation of America reported proved and probable reserves of 30.5 million short tons of spodumene pegmatite grading 1.5 percent Li_2O and 27.5 million short tons recoverable by open-pit mining (Kunasz, 1976). These known reserves total 68.5 million short tons of spodumene-pegmatite ore having an average grade of about 1.5 percent Li_2O. This is equivalent to 1,027,500 short tons of Li_2O or 477,000 short tons of lithium. A more recent assessment by the National Research Council (Evans, 1978) indicates 56.0 million short tons of proved or measured reserves and 9.3 million short tons of probable reserves of ore-grade spodumene pegmatite, mostly at the two active mines. Additional resources of ore-grade pegmatite outside of currently envisaged mining limits and in undeveloped parts of the spodumene-pegmatite belt to a depth of 1,500 m were statistically estimated at 795.5 million short tons (Evans, 1978).

Charlotte. American Girl

V COUNTRY REVIEW

(a) The United States

Pegmatites:

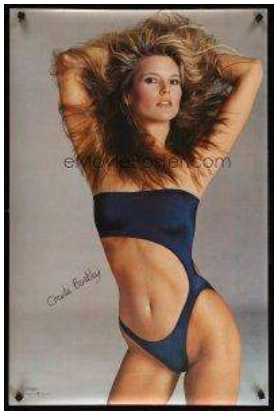
The two North Carolina operations closed with the development of lower cost sources in Chile but could, should a massive demand materialize and prices rise as a result, be reactivated.

Based on figures used in the Lithium Panel report and later reserve data it is estimated, very approximately, that the FMC and former Foote operations contained reserves of 80,000 and 150,000 tonnes Li respectively at the time both operations were closed.

The Panel, based principally on Kesler's very extensive work along the 48km long belt estimated a potential recoverable resource down to a depth of 1,500 metres of 375 million tonnes of ore at a grade typical of the area thus containing 2.6 million tonnes Li.

TABLE I PEGMATITES

Pegmatites:	Tonnes Li
North Carolina Former operations	230,000
North Carolina Undeveloped	2,600,000 *
Barraute, Quebec	90,000
Bernic Lake, Manitoba	18,600
Others, Canada	147,000
Bikita, Zimbabwe	56,700 *
Manono, Zaire	2,300,000 *



Beauty. Uptown Girl

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