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HALLGARTEN & COMPANY

Sector Review

Christopher Ecclestone
cecclestone@hallgartenco.com

Unconventional Lithium

Brine by any other name would smell as sweet?

Company	**Ticker**	**Currency**	**Price**	**Mkt Cap** mn	**Location**	**Mode**
Standard Lithium	SLL.v	CAD	0.60	$56.80	Arkansas, USA	Petroleum brines
Cornish Lithium		UKP	n/a	n/a	Cornwall, UK	Mine water brines
E3 Metals	ETMC.v	CAD	0.255	$8.53	Alberta, CA	Petroleum brines
Vulcan Energy	VUL.ax	AUD	0.20	$10.50	Germany	Geothermal brines
Intl Battery Metals	IBAT.cse	CAD	0.13	$8.21		Extraction Technology

Unconventional Lithium

Eschewing Hard Rock and *Salares*

- \+ Unconventional Lithium sources have gained space as disappointment with the financial woes of spodumene projects and long-lead time of *salares* projects have cast a pall over those modes of production
- \+ Resources, particularly oilfield brines, are potentially enormous
- \+ Most mooted projects are in top-grade jurisdictions
- \+ Technology can overcome low-grade and advance a project over those with higher-grade but in more challenging locations
- \+ Unconventional Lithium projects appear to be more scalable
- ✖ Almost universally the grade of Lithium in the unconventional sources is lower than from the more commonly exploited hard rock and *salar* projects
- ✖ Technologies for extraction of the Lithium are still in evolutionary stages
- ✖ Establishing a resource from the unconventional sources is difficult and that then presents challenges with estimating project economics
- ✖ Mine water sources can be limited in their amount of resource even with replenishment
- ✖ The Lithium price is currently blighted by perceived over-supply and weak EV demand and this is constraining financing of projects of any “style” of mineralisation

Going Unconventional

The bulk of the world’s lithium supply currently originates from two main resources: hard rock and brine deposits form *salares*. Attempts at promoting other non-brine options such as micas/clays have not proven efficient or cost-effective. However in the brine space there are options beyond the tried & true *salares* model as pursued in Argentina, Chile and Nevada.

The unconventional lithium sources we shall look at here are being touted by a small group of players and consist of brines from mine waters, geothermal brines and brines from oil & gas fields.

In this report we shall look at these potential sources and mention in passing the companies that are endeavouring to extract lithium from these “resources”.

Lithium Outlook

Until the latest “virus crisis” we would have posited that there was a good prospect for the recovery in EV demand and thus for Lithium prices. EVs essentially disappointed the much vaunted projections in 2019 due to Chinese demand being flaccid due to the removal of subsidies, disinterest in broader EV uptake by US car buyers and on-going subdued demand in Europe (with a few pockets of exception, like Norway).

Then the crisis hit and we can see no reason to expect China to be any stronger than it was in 2019. Even worse though is that the tumbling oil price has put the low cost of that power source into the balance against the much higher upfront purchase cost of EVs. The “green” alternative has come out lacking. We would thus posit that the crisis and its after effects have put EV adoption maybe 3-5 years behind schedule in Europe and maybe 5-8 years behind schedule in the US. On top of this European governments that might have been expected to offer incentives for adoption, or at least aided in charging infrastructure provision, have seen their budgets blown to smithereens by the effects of the virus crisis and it will be very difficult to demand the level of EV penetration by 2030 that has previously been mooted when surging unemployment and crushed GDP growth are devastating personal incomes.

Thus we do not see a rebound in lithium prices for several years and we see most hard-rock (spodumene) projects being shelved and only very selective development of brine projects. The projects that shall move forward are because they are part of the vertical integration strategies of major players (most notable Japanese and Korean).

With such a scenario evolving there is still scope for new production a few years out and those projects that are scalable should fare better than those that are inflexible in the “bigness”. Spodumene obviously suffers due to its large capex component, while *salares* are amenable to gradual augmentation, the time delay to end-product (through evaporative processes making them less nimble). One option might be brines that are not dependent upon evaporative processes and that can be turned on and off just like one can with an oilfield. These are the unconventional options in lithium production.

In this review we shall look at several modes of unconventional brine extraction and associated technology.

Oilfield Brines

Petrolithium is lithium derived from petroleum brine, the mineral-rich salt solution that is brought to the surface during oil & gas production and exploration.

Oil companies have traditionally managed petroleum brine as a waste product, usually by reinjecting the brine back into the ground for enhanced oil recovery or disposal. A small percentage is also used for "beneficial reuse," which can include production of drilling fluids, irrigation or dust/ice control.

In recent years, several companies have explored technologies to extract the minerals that are found in petroleum brines, including lithium, silicon, magnesium and potassium. Additionally, technologies have evolved to reduce the processing time of such minerals from brine. The improving technology potentially enables profitable lithium production from lower concentration petroleum brines. Capitalizing on advanced filtration technology and existing petroleum well infrastructure, some petroleum-producing geologic formations in North America have come into focus for their lithium production potential.

In the U.S., lithium bearing brines have been identified in Texas, Arkansas, North Dakota, Wyoming, and Oklahoma while in Alberta in Canada is also drawing attention. The highest concentrations have been identified in the Smackover Formation in Arkansas.

Case in Point: Arkansas' Smackover Formation

The Smackover formation in southern Arkansas is one of the largest and the most promising of several unconventional resources in the United States with the potential for economically recovering lithium. The geology and chemistry of the Smackover formation is well-known with sampling data going back decades. Geologically speaking, the region is characterized by an extensive porous and permeable limestone aquifer that hosts large volumes of mineral-rich brines and hydrocarbons. This natural and well-defined porosity allows for the production and re-injection of large volumes of brine. The brine is known to contain significantly elevated levels of lithium, typically ranging from 150 to 500 mg/L.

Southern Arkansas is one of North America's largest brine production and processing regions, according to Arkansas Oil and Gas Commission data. The region has an average annual production of 9.4 billion gallons of brine primarily for the production of bromine. Arkansas is the source of about a quarter of the world's supply. It's produced by two chemical companies, Albemarle (incidentally one of the old Lithium "cartel") and LANXESS (ETR:LXS), in and around the towns of Eldorado and Magnolia.

The source of lithium in the Smackover has yet to be verified. The brine in the Smackover is assumed by some to have originated from seawater that was deposited simultaneously with the sediments. However, in his 1976 paper for the USGS, Collins noted that many ions were either enriched or depleted in the Smackover as would be typical of seawater's natural precipitation and evolution. Thus, considerable alteration in the brine must have occurred.

Collins (1976) proposed that the lithium presence could be a result of the continental drainage of lithium-enriched solutions into the sea. He also proposed that the source of lithium stems from Triassic age volcanic rocks in the Gulf coast: continental water from springs or other hydrothermal fluids along the Mexia-Talco fault system could have leached lithium from Triassic age volcanic rocks. These lithium-enriched fluids then drained into the Smackover Sea and the water was then concentrated by evaporation. This hypothesis is in agreement with the relative decrease in sea level occurring along the Gulf Coast in the late Jurassic period. He also offers that bitterns from the Louann Salt probably mixed with the Smackover brines to create some of the deviations from characteristic seawater.

Research on the Potential

The U.S. Geological Survey National Produced Waters Geochemical Database was utilized in research by Pamela Daitch (at University of Texas – Austin) to identify lithium-rich brine from wells across the U.S. The volume and concentration potential of the most promising lithium-enriched geologic formations were calculated. Historical and current well production data were compiled and used to estimate the expected lithium production for the geologic formation. This data was then applied to a financial model to determine the method of brine production under which extracting lithium from oilfield brine would be profitable.

In her findings, Daitch noted that advanced technology offers the potential for recovering Li from concentrations as low as 70 mg/L. Of the produced water samples, only 344 samples had Li concentrations greater than or equal to 70 mg/L. The majority of the high Li concentration samples were identified in the Smackover Formation. The Smackover was selected to analyse for lithium extraction and production. The Smackover formation has the attraction that Lithium-enriched brine can either be gathered by collecting produced brine from active wells in the formation or by drilling a purpose-designed well to access brine.

Results from the Daitch's financial analysis indicated that the profitability of lithium extraction from Smackover oilfield brine is dependent on the volume of brine that is processed by the facility. Profit can be further enhanced by using economies of scale to increase the brine processing capacity of the facility. In her analysis, drilling a purpose-designed well resulted in the only profitable outcome. When utilizing existing infrastructure to collect brine, the profitability is highly dependent on the number of active wells that produce from the Smackover Formation. This analysis indicates that a standalone lithium extraction company is best positioned to capitalize on lithium extraction from oilfield brine and indeed one of the most prominent Unconventional Lithium plays is focussing on the Smackover.

Geothermal Brines

It is common for geothermal energy producers to experience mineral scaling on the production facilities. Scaling refers to the precipitation of minerals from suspension and their deposition on a surface. Geothermal producers proactively remove minerals from the brine they process to address this problem. One of the potential worthwhile products of this process is Lithium.

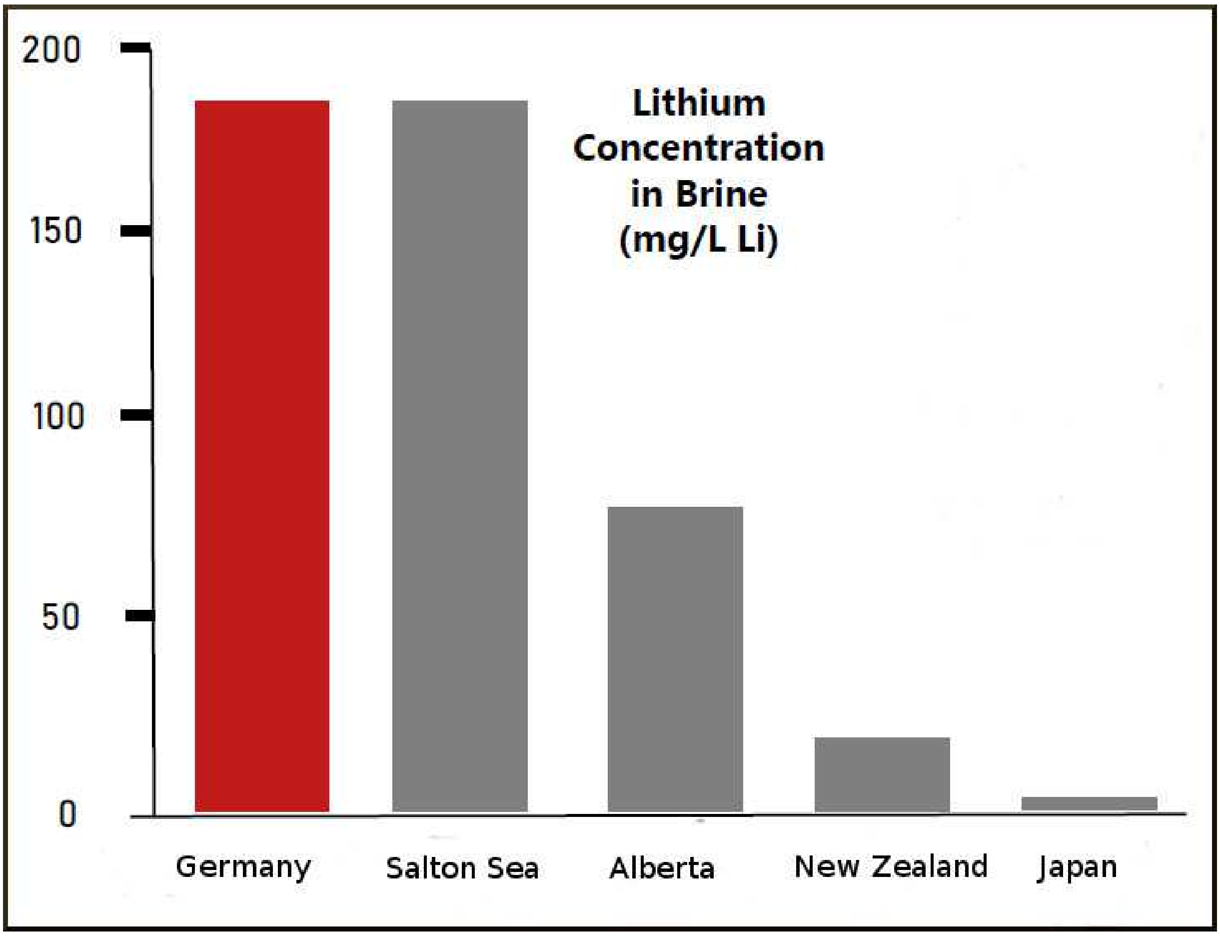
The lithium chemical production process begins with contacting the geothermal brine with a selective medium which adsorbs lithium chloride (LiCl) from the brine and leaves all the other salts in solution. The lithium chloride is then eluted into pure water or acid at a higher concentration compared to the geothermal brine and with very low quantities of impurities.

There are a number of technology companies which market the ability to perform DLE with high lithium recovery including Lilac Solutions, Tenova Advanced Technologies, Adionics, EnergySource Minerals, and others, some of which will work well for geothermal-lithium projects.

One of the areas that is a hotbed (pardon the pun) of geothermal brine theorising is the Salton Sea in California. The Salton brines are renowned for their elevated levels of lithium and other minerals and, according to some pundits, represent one of the largest untapped sources of lithium in the world. As of 2010, Simbol, Inc. has been producing lithium from geothermal brine in California's Salton Sea as an intentional by-product, along with manganese and zinc minerals. Fortune magazine reported that, in 2014, Tesla CEO Elon Musk offered $325mn to buy Simbol Materials, but the deal fell through.

A number of other developers are also working on building geothermal-lithium plants in the Salton Sea including greenfield play Controlled Thermal Resources. Others have expressed interest in integrating geothermal plants including EnergySource, Berkshire Hathaway Energy, and Ormat Nevada.

The primary value of geothermal brines is the contained heat which can be converted into mechanical energy (Bradley et al., 2017). The geothermal plant can produce all of the power and heat required from the geothermal brine to drive the process. This gives geothermal-lithium projects a low carbon footprint.

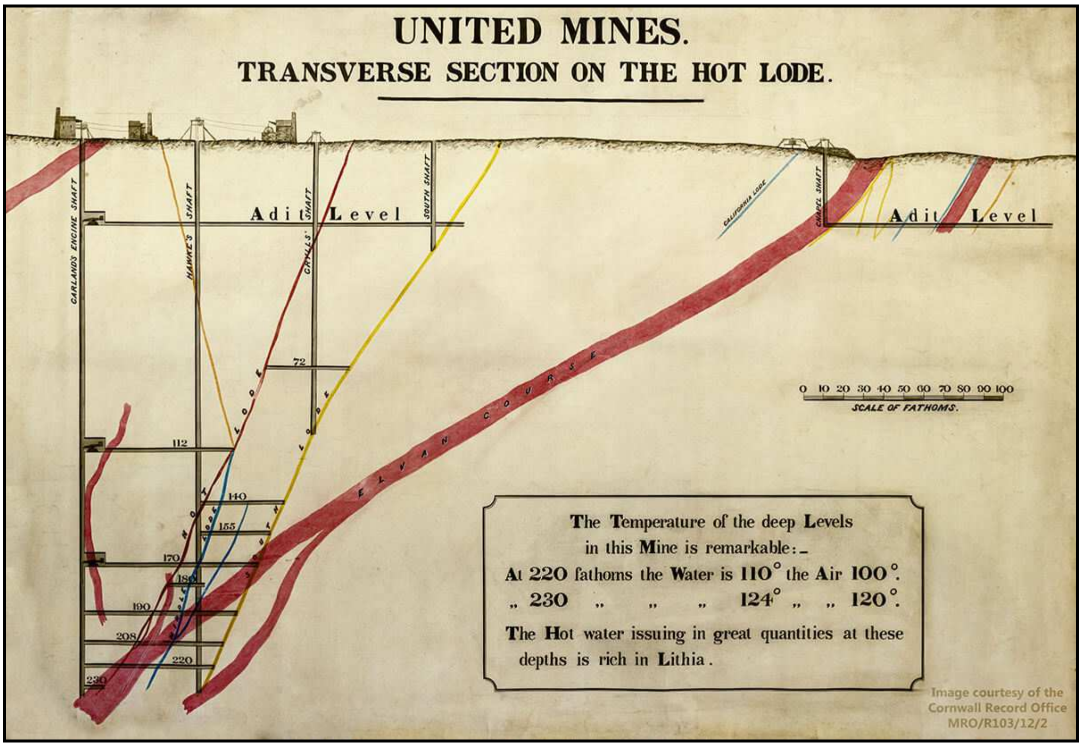


Source: Vulcan Energy

Mine Water Brines

Abandoned underground mines and water are almost synonymous. It is only a short leap of the thought process to gather that mine waters might hold in solution the minerals (or by-product minerals) that were originally mined on site. With Tin-Tantalum-Lithium being a classical mineralogical pairing, then old mines with these metals should have mine water with (potentially) Lithium in solution.

That was the thesis of a group that decided to seek Lithium in Cornwall, which is probably the longest mined area for tin in the world with a history going back to Phoenician times. The presence of lithium in hot spring brines in Cornwall has been known since the mid-1800s but this was regarded as a curiosity, given there was no developed market for the metal at that time.



The old cross section above shows the temperature of the mine waters at varying levels of depth.

The presence of high levels of lithium in hot spring brines is believed to be due to the interaction between highly saline water from a nearby sedimentary basin and the granite under Cornwall. Some of the granite rocks in Cornwall are enriched in lithium and, over millions of years, this lithium appears to have become dissolved in highly saline waters which have interacted with the granite.

In the view of at least one UK company new technologies now offer the potential to extract lithium from these hot spring brines. We would note however that while the world has many flooded underground workings we would posit that those with potential for this type of extraction of mine water brines is limited to (some) past-producing Tin or Lithium mines.

Technologies

The subject of technology adoption in the mining industry is a chequered one but with special challenges in the Lithium space (and brine extraction being more like chemistry than quarrying) the race has been on to find new techniques. There is no “tried & true” in Lithium extraction, it’s more like “tried & was frustrated” or “tried & made do”. The challenge is to short-cut long processing times dependent upon evaporating at high-altitude *salares*. However a bigger problem is in locations where evaporation is not so guaranteed and where weather conditions (i.e. rainfall) can reverse the progress of evaporation. All the oilfield brines in consideration are in locations unsuited to the utilisation of evaporation ponds, as are also the mine brines. Only those geothermal brines with electricity generating potential can hope to mobilise that factor to create carbon-neutral (and non-evaporative) separation/concentration processes.

The magic bullet that many are seizing upon is Direct Lithium Extraction (DLE).

Direct Lithium Extraction

The DLE process is currently used by multiple commercially operating projects to extract Lithium from brines. It is not just unconventional modes that are adopters as the broader Lithium industry is shifting to DLE because:

- Lithium extraction in hours instead of months
- Not weather-dependent like evaporation, in increasingly unstable climate
- Ability to produce consistent chemical product for battery industry
- Spent brine re-injected into reservoir with no evaporation losses.
- No water stress unlike some *salares* projects

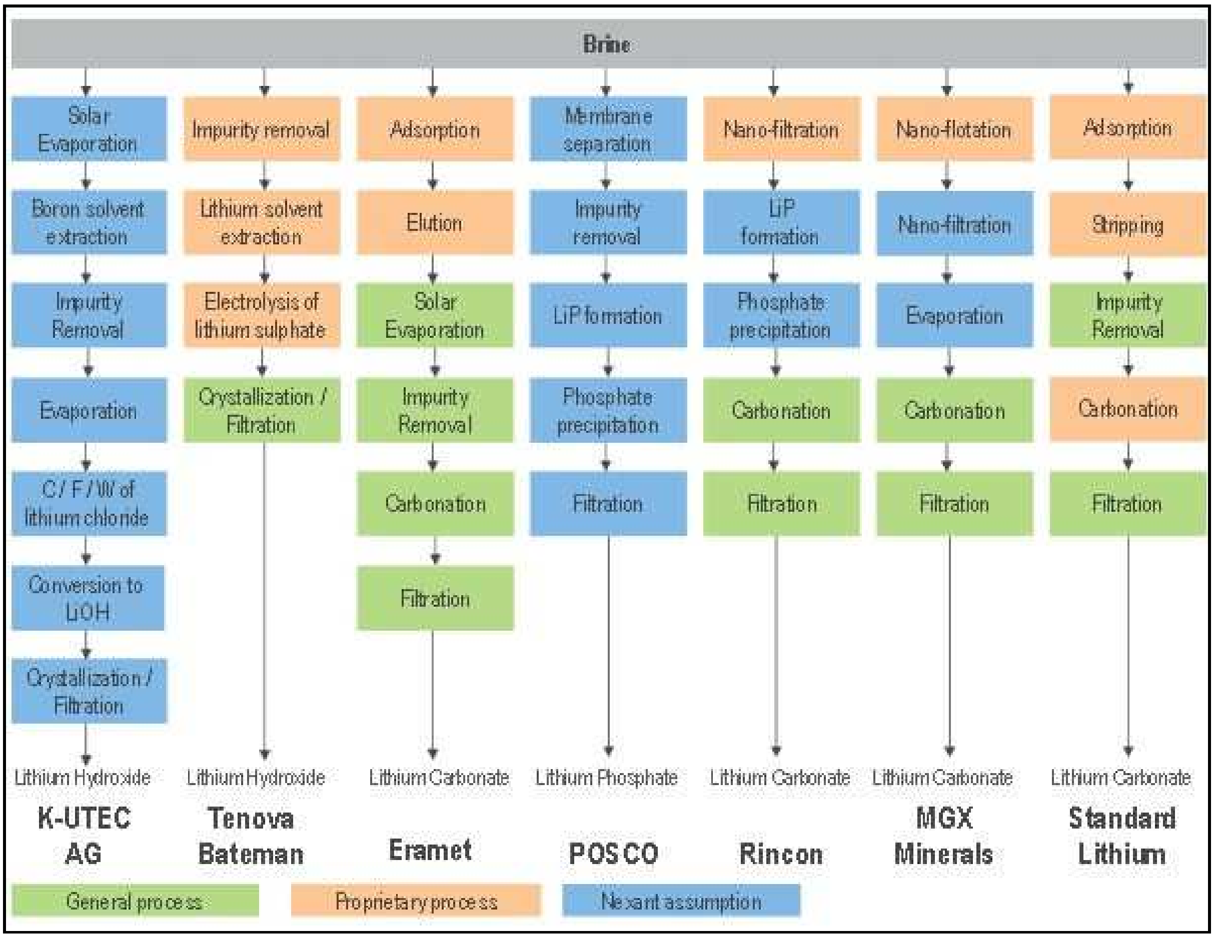
The list of things that DLE solves is exactly those things that currently ail the brine space (though one could add financing and isolated locations as problems the no technology will solve for the *salares*).

The other issue pending in the brine is the plethora of different weightings of minerals in the brines, running the whole gamut from borates to magnesium. The latter in particular is a particular problem with deposits like the Salar de Uyuni in Bolivia having that as its main challenge. Although it is the biggest lithium resource in the world, the Salar de Uyuni has a high content of magnesium making it uneconomic to extract by current methods.

Therefore technology to process brines with a high ratio of magnesium or other impurities to lithium are somewhat of a *Holy Grail* in the battery metals space. Using current processing technology for these brines, lithium yields at Uyuni would be low from solar evaporation and operating costs from reagent use would be very high.

On the following page can be seen a graphic that shows just a few of the principal technologies for DLE under development. At the bottom can be seen the main parties either developing the technologies or showcasing it in their projects.

In the first column is the technology of K-UEC. In April 2018, the Bolivian government took the decision to advance the development of the deposit by reaching a deal with ACI Systems and K-UTEC Salt Technologies. If it is proven technically and economically feasible, the exploitation of the Salar de Uyuni would add a significant supply of lithium to the world markets and upset various other applecarts.



Source: Nexant

The DLE Process

The pure lithium chloride stream produced by the DLE process needs to be purified and concentrated to produce lithium chemical products like lithium hydroxide. For the purification process, a number of inputs are needed including chemical reagents like soda ash (Na_2CO_3), caustic soda (NaOH), and sulfuric acid (H_2SO_4).

One disadvantage compared to evaporative techniques is that electricity is also required to run pumps and filtration systems. For the concentration process, a significant quantity of electricity and heat is required to remove water from the lithium chloride stream for recycling and to crystallise battery quality lithium hydroxide.

Ion Exchange

At least one company is employing Ion Exchange for its Lithium separation process from oilfield brines, in that case in Alberta. The company has been undertaking extraction tests. The tests achieved demonstrated lithium recoveries greater than 99%, averaging 90%, and volume reductions up to 20 times while consistently removing 99% of metal impurities. The extraction testing produced lithium-enriched brines with up to 1498 mg/L lithium from an original raw brine concentration of 72 mg/L. The average concentration factor across the tests was 18 times with an average increase in concentration to 1308 mg/L.

This work was conducted at GreenCentre Canada and demonstrated the enhancement of the ion-exchange sorbent developed in collaboration with the University of Alberta, funded through Alberta Innovates. The company claims that the important differentiator of its proprietary technology is that it concentrates and purifies Alberta petro-brine feedstock in a single step, producing a highly concentrated lithium feedstock for further purification and refinement into battery-grade lithium products. The technology is also designed to be proficient at processing raw brines at high brine flow rates.

Standard Lithium (TSXV:SLL,OTCQX:STLHF)

This company is in the oilfield brine space. It has partnered with the German specialty chemical company LANXESS on a 150,000-acre project in the Smackover Formation to prove the commercial viability of producing battery-grade lithium from the brine stream by-product of the aforementioned LANXESS' three existing bromine production facilities. On average, LANXESS processes about 126 million barrels of brine each year. Adjacent to the project, Standard Lithium holds an option agreement with TETRA Technologies (NYSE:TTI) on 30,000 acres of additional brine leases, including hundreds of historical oil and gas exploration and production wells. A sampling program conducted in 3Q18 yielded lithium grades ranging from 347 to 461 mg/L.

The partners have developed a lithium extraction process for selectively recovering lithium from brine that eliminates the need for evaporation ponds and significantly reduces the average production time typical for conventional lithium from brine projects (several months to years) to a matter of hours.

Mounted in stirred-tank reactors, the technology involves the use of solid ceramic absorbent material with a crystal lattice capable of selectively pulling lithium ions from brine and then releasing those ions for recovery. Because the brine leaves the bromine extraction process heated to approximately 70°C, minimal additional energy is required for the lithium extraction process, dramatically reducing the production time and costs associated with producing high-purity lithium carbonate solution from traditional evaporation pools.

In December of 2019 the company completed an industrial-scale Direct Lithium Extraction Demonstration Plant at Lanxess' South Plant facility in southern Arkansas. It also installed a site office/control room, the lithium-specific analytical laboratory, and a steel-framed, all-weather structure that allows year-round operation. Commissioning is on-going with completion of all utility/service connections, as well as brine and reagent supply and disposal lines.

The venture's proprietary LiSTR Direct Lithium Extraction technology will be used to extract lithium from waste brine (tail brine) that is a by-product of existing bromine production facilities run by Lanxess. The industrial-scale pre-commercial plant is designed to continuously process an input tail brine flow of 50 gallons per minute (gpm or 11.4 m^3/hr) from the Lanxess South Plant, which is equivalent to an annual production of between 100-150 tonnes per annum of Lithium Carbonate.

The company sees little in the way of hindrance to its development as Arkansas has a well-established permitting process for brine projects, extensive industry-related infrastructure including extraction, transport and reinjection systems, as well as utilities, rail and easy access to the Gulf of Mexico and a workforce skilled in brine handling and processing.

E3 Metals (ETMC.to)

This company is focussed on petroleum brines and has secured the lithium and other mineral rights to more than 1.3 million acres in the Leduc Reservoir region in Alberta, hoping to ultimately construct a commercial extraction and processing facility within the province. To this end the company has a Joint Development Agreement with Lithium major, Livent Corporation (NYSE: LTHM).

The JV's technical team is working on what it calls the Ion Exchange (IX) Project. This project aims to test the commercial readiness of the DLE ion exchange sorbent to produce a high purity lithium concentrate from its Alberta brines. The project test work involves a program focused on optimizing the performance of the process. Next steps will be a shift towards a Pilot Plant Project to test the IX Process and evaluate the production of concentrate at a larger scale. All brine tested for this program is sourced directly from the Leduc Reservoir.

In 2020, the company will conduct well testing, including brine sampling and reservoir pressure testing with a goal of improving the reservoir model, collecting information about lithium concentrations outside of oil & gas accumulations and updating the brine delivery plan in its resource area.

The company is getting the province on board as the evolution of a lithium industry in Alberta could provide employment for laid-off oil & gas workers. E3 Metals estimates that when operating it could create 300 to 500 full-time jobs. The company hopes to be in production by 2023, producing 20,000 tonnes of Lithium Carbonate Equivalent (LCE) per annum, with the ability to scale up.

Cornish Lithium

This company is on a likely path towards a UK listing. It has the distinction of being the mining company that has raised most (GBP1.4mn) from crowdfunding in the UK. Its legal agreements encompass a large area centred around the area of Camborne, Redruth and St Day, but also cover other areas of Cornwall that it believes may be prospective for geothermal hot spring brines.

Records from Cornwall's 19th century heyday as a producer of tin and copper show that lithium was encountered in hot springs, which were intercepted as the mines got deeper. These 'geothermal' waters are now understood to circulate through natural permeable structures which act as pathways through the otherwise impermeable rock.

To this end, the company has entered into definitive mineral rights agreements with Strongbow Exploration (TSX-V: SBW – which holds the rights over the storied South Crofty Mine) and Mineral Exploration Limited, and has signed a Heads of Agreement with Tregothnan Estates, to carry out exploration for, and development of, lithium in hot spring brines within the majority of the mineral rights held by these entities.

Vulcan Energy (VUL.ax)

This Australian-listed company is focussed on geothermal brines as a source of Lithium. Its portfolio is comprised of five separate and non-contiguous Exploration Licences within the Upper Rhine Valley of southwest Germany that include: Mannheim, Ludwig, Taro, Rheinaue and Ortenau.

In February of 2020 the company published a scoping study on what it terms its "Zero Carbon Lithium Project". This, it claims, has shown potential for a combined operation producing lithium hydroxide and renewable energy, with a net-zero carbon footprint.

The scoping study is based on a staged expansion plan for the project, with the Stage One production plant comprised of a direct extraction and lithium plant, to be located at the Insheim geothermal power plant. Stage One would commence a year prior to the larger Stage Two, which is dependent on the company being able to permit and drill its own geothermal production wells. Stage Two consists of two larger production plants that would require drilling a total of ten new geothermal production wells and constructing a new combined geothermal, direct lithium extraction and lithium hydroxide plant at the Ortenau licence.

The scoping study indicated that the project has the potential to be the first negative carbon lithium project in the world. Vulcan claims the project's carbon dioxide emissions would be offset through the co-generation of geothermal energy.

The study is based on the mineral resource estimate for the project, comprising a total of 13.95 million tonnes of lithium carbonate equivalent.

MGX Minerals (CNSX:XMG)

This company was ahead of the pack on focussing on oilfield brines but has such a plethora of other associated, and unassociated, technologies and interests in battery metals that it cannot really be regarded as central to the unconventional space anymore.

Risks

The potential risks are:

- Delay in EV adoption, beyond China, due to recessionary conditions in the post-Virus world
- That Lithium prices remain in the doldrums
- Over-production at uneconomic levels by existing players so as to just stay in the game
- Ongoing tough financing conditions

Lithium prices are captive to sentiments regarding EVs and as the rest of the world largely eschews EVs at this time, thus the price is indirectly linked to Chinese policy on the promotion (or not) of this new means of locomotion.

As mentioned earlier in this piece we see European ambitions for EV adoption being setback by the current virus crisis by several years at least and for the US we predict adoption to be delayed by over half a decade and maybe even longer depending on how oil prices evolve. EVs are a luxury, and have now become a luxury that battered consumers can ill afford. It's not that they will buy ICE vehicles instead of EVs, rather that they will stick with the automobiles they currently have until their buying power is restored to pre-2020 levels. Some may never see that restored depending on how things pan out.

Lithium prices are depressed yet could go lower on excess supply or, more likely, weak demand in the EV space.

There are many wannabes and a few producers in the Lithium space. Before 2010 there were only three players and fairly disciplined cartel. Now that discipline has broken down on the price front. The only discipline operating is the rule of prices. As prices look unattractive capital markets restrict funding and that in turn restricts projects moving forward. Now the only projects advancing are those with guaranteed offtakers further down the OEM supply chain. This means those players will tend to match production from their facilities to their supply chain needs. However the non-supply chain players will produce whatever they need or want to produce with the goal being producing income to service their debt, if they have any. This produces a rogue unknown that is not driven purely by supply/demand.

Financing will be available if prices start to rise. There is no sign of that so far. As per our previous point the offtakers will mainly be in the OEM "trade" and thus very hardnosed as funds at their disposal are not in superabundance.

Conclusion

There is a fine line between the various lithium-rich brine manifestations that we have looked at here. Most *salares* have similar characteristics and chemical components but in varying percentages (for instance the Bolivian *salares* being strongly weighted towards magnesium). However the alternative brines tend to take on the composition of the circumstances in which they are found. Mine brines are weighted towards the metals which the mine used to exploit (tin in the case of Cornish mines) and elements of hydrocarbons in the case of petroleum brines.

There are two key considerations with regard to the unconventional brines, grade and cost of processing. A low grade can be compensated for by inexpensive processing. One might sweepingly dismiss the unconventional brines as low-grade and, on average, they are much lower grade than the conventional alternatives, but they do come with advantages. All of those discussed here are in mainstream jurisdictions, where surprises are (in theory) less likely to take place. They are also closer to end markets than most of the brine or spodumene projects extant or planned. They have less exposure to criticisms about using up scarce water resources (which has become an issue in Chile, for example).

The chief unknown is the effectiveness of the technologies being contemplated. The hunt has been on for a few years now to come up with processing means that shortcut the evaporative process which involves extensive ponds and long processing times. If techniques like DLE or ion-exchange work then it shall put all the unconventional projects cited in a prime position to challenge the "tried & true" technologies.

Another issue to be pondered is the question of resource at these projects. Theoretically the resources could be well-nigh infinite. How much lithium is in mine-water when the water just keeps coming and is bringing in minerals in suspension from over an unknown expanse of mineralisation? Ditto for the oilfield brines, and the geothermal brines can be arising from thousands of metres below the surface. We are less worried by this consideration, as infinite and unlimited resources sound good to us ….. less so to regulators and exchanges.

Unconventional Lithium has the potential to become conventional, and in a big way. It might even drive a number of second-rate conventional projects to fundamentally implausible status. The grades may not be astonishing but the potential size of the brines to be harvested from the projects more than compensate for this. The key decider now will whether the technology can deliver more for less.

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