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FAR EAST CAPITAL
The Mining Investment Experts

**Weekly Commentary**

19 March 2022. *Chart comments not updated since 5th March due to travel in the USA* Analyst : Warwick

# Smarter ways of extracting lithium from brines

The volatility in gold, oil and other commodity prices has been as extreme as I have ever seen. While this does provide trading opportunities, you have to be quick. It is like walking through a minefield and it is so scary that many traders are standing aside. Confusion is leading to inaction in many instances.

Putin must now be wondering what he must do to appear a winner. From the Western point of view so far Putin has revealed the ineptitude of his planning and tactics, forcing him to revert to Stalinist methodology in order to deceive the Russian people. How long can he live the lie that he is a liberator? In the event that he does win, what is the prize? How will he be better off? At best it will be an ostracising Pyrrhic victory. For the rest of us, it will be another redefining moment in international politics, economics and business - another changing of the rules.

## *Brines - major contributors to the lithium market*

Around 60% of the world's lithium comes from evaporation ponds in countries such as Argentina, Bolivia and Chile. Orecobre is an example of an ASX-listed company that has successfully commissioned and expanded a brine solar in Argentina. It has a market capitalisation of around A$6bn.

The evaporation ponds, which can have individual areas of 60km$^2$ or more, are filled with lithium-rich brine pumped from underground. The brine is concentrated by evaporation while subsequently removing other salts such as sodium chloride and potash, then it is treated to purge it of other metals, such as sodium and magnesium, and the lithium is precipitated as lithium carbonate. The process production cycle can take us long as two years. The yield from in-situ lithium to saleable product is a paltry 30%, yet the operating companies still earn very strong profits, especially at recent high lithium prices.

As with every other industry the lithium brine industry is always open to technological change in pursuit of greater efficiencies. We have reviewed a Canadian company, E3 Metals Corp (TSX:ETMC), that seems to offer an innovative and more efficient method to extract lithium. Additionally, there are two other initiatives worth mentioning.

## *E3 Metals Corp has a new proprietary process*

E3 Metals was founded in 2016, by its CEO Chris Doornbos, on his return to Canada after working in Brisbane on copper/gold projects in Australia and Sweden. The corporate objective is to commercialise its Ion Exchange process, under the umbrella of Direct Lithium Extraction (DLE) technology as a superior process for the recovery of lithium, aiming to produce lityhium hydroxide for use in lithium-ion batteries.

## *Repurposing Historical Oil Fields to Produce Li*

E3's flagship project, Clearwater, is building on the Leduc Aquifer in Southern Alberta, the location of an historic oilfield that had a production history of 70 years. The economic oil has been exhausted and the asset is now ready to be repurposed for the extraction of lithium bearing brines in the formation water that still saturates the reservoir rocks.

E3 is the beneficiary of copious amounts of geological data obtained in the exploration and development of the historic oil production, now at the end of its life. Almost 4,000 wells support the data base with over 200 of these wells being classified as having produced, currently producing or injecting into the Leduc Formation.

This aquifer is notable for its high porosity and permeability, qualities that will work in favour of brine extraction. There is sufficient pressure for it to be water driven from 2,500m to 1,000m, and pumped the remaining 1,000m to the surface from this level.

## *PEA outlines production plans*

Clearwater is based on an Inferred Mineral Resource expressed as a mass of lithium carbonate equivalent, of 5.5 billion m$^3$ of brine at 74.6 mg/L, totalling 2.2 Mt of LCE using a conversion factor from elemental lithium of 5.323. E3 also has two other areas that the Company plans to develop after the Clearwater, bringing the total to 7Mt across their resource area alone. In addition, two thirds of the Company's mineral permit area is not within this resource area.

Brines will be extracted via vertical or deviated wells from depths of around 2,500m and piped to a Central Processing Facility (CPF), then returned to the aquifer in a closed loop system. There will be no surface mining activity and thus minimal surface disturbance, so the project is viewed as being environmentally elegant. There will be no tailings dams.

Phase 1 of the development involves two production well groups comprising 21 wells at each, located to the north and the south of the CPF. Re-injection wells will be located 15 km away from the production wells. Designed capacity is 140,000 m$^3$/day over a 20 year life to produce 20,000 t p.a. of lithium hydroxide monohydrate (LHM).

Well drilling costs are estimated to be C$3m each and it will take 18-24 months to complete the two groups, totalling 63 wells.

## *The empowering technology*

While the ability to re-purpose an historical oilfield gives tremendous cost advantages, it is the extraction technology that provides the real proprietary technical breakthrough. Once the brines have been pre-treated to remove $H_2S$ tthe plan has it being fed into a counter-current "sorbent-in-pulp" process that absorbs the lithium and rejects the bulk of the impurities. The sorbent is then eluted in a step that concentrates lithium to 870 mg/l Li. E3 Metals has developed its own sorbent for this well-known process that is highly selective for lithium over Ca, Mg, Sr, Mn and B.

The eluatte is further concentrated by reverse osmosis before removing the majority of the remaining divalent ions

(Ca2+ and Mg2+) are removed in the secondary Ion Exchange (IX) circuit. The purified brine, measuring 14,000 mglL Li contains mostly Li+, K+ and Na+ cations. It is suitable for electrolysis and crystallisation to form LiOH.H2O. It is possible to produce Lithium Carbonate $Li_2CO_3$ through crystallisation from the purified lithium concentrate.

### *Key Features of the Direct Extraction technology*

Test results to date indicate that:

- The ion exchange sorbent has high selectivity for lithium over other ions present in significantly higher quantifies in Leduc brine (incl. Na, Mg, Ca). The beads are designed to accept only lithium.
- The absorption reaction kinetics of lithium extraction from brine onto sorbent is particularly rapid and occurs within minutes whereas the stripping of lithium from sorbent into the eluate occurs at a slightly lower rate.
- The ratio of sorbent mass to brine volume is relatively small due to the high lithium loading on the sorbent achieved at lab scale.
- Excellent kinetics with bench scale ion exchange test work has demonstrated lithium recoveries as high as 90% from brine grading 75 mg/L on average, in the first seven minutes of resonance time. Production scale recovery is expected to be 99%.

### *The economics and timing of the project*

Initial capex for the 20,000 tpa facility is estimated at US$602m with an additional C$108m needed in sustaining capital over the 20 year project life. Operating costs are estimated at US$3,656 pt of LHM, offering a very significant profit margin with recent selling prices up around US$50,000 pt. Capex payback is estimated at 3.4 years for a 20 year life project on lower LHM prices.

The PEA assumed an LHM price of only US$14,079 pt to calculate an EBITDA of US$208m p.a. It could be 4-5x this figure if recent prices of US$50,000 are used. So, it would appear that the market capitalisation of around C$120m does not factor in the upside. Perhaps this is due to the US$602m capex hurdle but it could also be due to the perception of technical risk with the new methodology that needs to be proven on a commercial scale.

The PFS will commence in 2022, and be completed in mid 2023. Commercial production is currently expected in 2025/26.

### *Volatile share price movements*

The market capitalisation of E3 is around C$120m with the shares selling at C$2.20, and a cash balance of C$17m. The shares ran from < $1.00 to peak at over $5.00 early in 2021, before falling back to C$1.50 in mid 2021. Thus there has been high volatility in the past and the shares have underperformed relative to other lithium stocks, but more recently there has been a consolidation pattern forming around these levels. Canadian broker, Echelon Securities, released a research note in January 2022, tagging it as a speculative buy with a price target of C$5.00.

### *Upcoming share price catalysts*

Upcoming catalysts in 2022 that could positively impact the E3 share price include;

i) optimisation of its DLE technology including results from ongoing long-run sorbent testing at the Lab-Pilot Prototype and commissioning of its Field-Pilot Prototype;
ii) drilling two to three “virgin” wells in H122 on its Clearwater property which will be pump tested and provide critical dynamic data to better under stand the aquifer response, giving a basis for a resource upgrade from Inferred to Measured and/or Indicated
iii) further flowsheet de-risking following data gathered from the DLE Lab-Pilot and future Field-Pilot; and
iv) initial LHM production expected in prototype mode

### *DLE technology is not quite unique*

While E3’s technology is innovative, it is not quite unique. That observation will help to allay fears regarding technology risk. Standard Lithium (SLI-TSXV, NR) is advancing a similar project in Arkansas, USA. Koch Strategic Platforms (Private) recently provided Standard Lithium with US$100m, sufficient capital to fund its first commercial DLE project. Lake Resources, partnered with Lilac, is a technology peer for E3 on the DLE technology side.

### *The key takeaways*

- Inferred resource of 7 Mt, the 7th largest in the world
- Phase 1 production of 20,000 tpa of LCH for 20 years, but potential to lift to 150,000 tpa which can run for for 35 years
- The quick turnaround of the brines - being above ground for only 60 minutes - obviates the need for the huge evaporation ponds that are the most visible features of the lithium projects in Argentine, Bolivia and Chile
- Also obviated is the lengthy commissioning period that these South American projects entail, and the typical two year period of evaporation needed to achieve viable solution grades.
- the DLE process has worked well at bench scale but it needs to be proven at commercial scale. Pilot scale operations will commence in 2022.
- favourable environmental considerations due to minimal surface impact and the absence of tailings dams

### *Difference between lithium carbonate and hydroxide*

Lithium carbonate is a lithium compound which associates with carbonates to become a salt. Lithium carbonate is mainly produced by extracting it from underground brine pools, using precipitation, extraction of other undesired compounds, and addition of sodium carbonate. Its main industrial use is to produce rechargeable batteries, by using lithium carbonate as a primary compound which is converted into those which serve as a cathode and electrode.

Lithium hydroxide is a lithium-based compound with a crucial distinctive property compared to lithium carbonate: it decomposes at a lower temperature, allowing the process of producing battery cathodes to be more sustainable and the final product to be long lasting. For this reason, lithium hydroxide is preferred in the battery manufacturing industries, especially in the EV (electric vehicles) production. It increases the performance of the battery, allowing EVs to have a higher usability range before needing a recharge.

The cost of producing lithium hydroxide from brine is higher than extracting lithium carbonate, but newer technologies - such as E3’s DLE process - allows it to be processed more directly, increasing its competitiveness in the industrial market.

Lithium carbonate has traditionally sold at a premium to hydroxide product, with carbonates recently selling at around US$60,000 pt and hydroxides at US$50,000 pt.

### *Comparing Clearwater with spodumene lithium mines*

The average spodumene mine has a capacity of around 30,000 spa of LHM. Spodumene mines produce a concentrate that currently sells for around US$2,790/tonne. This is about 6-7% $LiO_2$, where as E3's DLE concentrate is 60-70% Li.

### *EnergyX - a polymer membrane*

An American company, EnergyX, plans to extract lithium directly from brine using a polymer membrane. It is planning a containerised pilot plant that processes millions of litres a day, achieving an impressive 90% yield.

The technology relies on the structure of protein channels that control the flow of metal ions in and out of biological cells. Modern imaging tools and supercomputers have enabled these channels to be copied. A membrane pierced by nanometre-sized pores made from rings of carbon and oxygen atoms precisely arranged to let lithium ions through while slowing the passage of others, such as sodium. At the early R&D stage of process development, these membranes will enrich a brine's lithium levels before it enters the evaporation ponds ponds. The objective is to replace the ponds entirely by generating a pure and concentrated solution of lithium hydroxide suitable for immediate industrial use.

### *Improving evaporation efficiency*

A second initiative to improve the efficiency of the pond process aims to use solar energy more efficiently to accelerate evaporation rates by covering the pond surface with a porous material that quickly converts light to heat. Research is still being conducted to select the best material but most recently charcoal seems to work well. The technology offers potential beyond lithium extraction, where faster evaporation would be advantageous e.g. waste water ponds from fracking and mining tailings dams. Maybe it could also be used to recover fresh water from salt water.

The current low-tech process of extracting lithium from brines requires vast expanses of land that are not available in many places due to competing land usages. These newer technologies could open up development opportunities in alternative locations around the globe, such as southern California.

## Detailed Chart Comments

*NB. Only the bold comments have been updated. Comments in grey type are from previous weeks and will be less relevant. Please note that this list is a cross section of the market. It IS NOT a list of recommendations.*

| **Indices** | **Code** | | **Trend Comment** | |
|---|---|---|---|---|
| All Ordinaries | XAO | | still in downtrend | |
| Metals and Mining | XMM | | testing downtrend | |
| Energy | XEJ | | punched higher, above uptrend channel | |
| Information Technology | XIJ | | rallying | |
| **Stocks** | **Code** | | **Trend Comment (updated comments in bold)** | **Main Interest** |
| Alpha HPA | A4N | | pullback | HPA |
| Adriatic Resources | ADT | | continuing down | zinc, polymetallic |
| Alkane Resources | ALK | | stronger | gold |
| Alicanto Minerals | AQI | | downtrend | base metals, silver, gold |
| Altech Chemical | ATC | | down | HPA, anodes |
| Alto Metals | AME | | sideways | gold exploration |
| American Borates | ABR | | recapturing uptrend | borate |
| American Rare Earths (was BPL) | ARR | | off its highs | rare earths |
| Antilles Gold | AAU | | testing downtrend | gold |
| Arafura Resources | ARU | | rising | rare earths |
| Ardea Resources | ARL | | pullback | nickel |
| Aurelia Metals | AMI | | new uptrend | gold + base metals |

| | | | | |
|---|---|---|---|---|
| Australian Potash | APC | | heavy fall | potash |
| Australian Rare Earths | AR3 | | down | rare earths |
| Auteco Minerals | AUT | | rallying | gold exploration |
| Azure Minerals | AZS | | on support line | nickel exploration |
| BHP | BHP | | breeched uptrend | diversified, iron ore |
| Beach Energy | BPT | | new uptrend confirmed | oil and gas |
| Bellevue Gold | BGL | | down | gold exploration |
| Benz Mining | BNZ | | new low | gold |
| Blue Star Helium | BNL | | down | gas, helium |
| BMG Resources | BMG | | new low | gold exploration |
| Boab Metals | BML | | in a secondary downtrend | silver/lead |
| Breaker Resources | BRB | | heavy fall from highs | gold exploration |
| Buru Energy | BRU | | testing uptrend | oil |
| Calidus Resources | CAI | | on support line | gold |
| Capricorn Metals | CMM | | surge to new high | gold |
| Caravel Minerals | CVV | | slump | copper |
| Celsius Resources | CLA | | testing short-term uptrend | copper |
| Chalice Mining | CHN | | down | nickel, copper, PGMs, gold exploration |
| Chesser Resources | CHZ | | rallied off lows | gold exploration |
| Cobalt Blue | COB | | surge to new high | cobalt |
| Cyprium Metals | CYM | | rallied to meet resistance line | copper |
| Danakali | DNK | | downtrend accelerating | potash |
| De Grey | DEG | | on support line | gold |
| E2 Metals | E2M | | down | gold exploration |
| Ecograf | EGR | | down | graphite |
| Element 25 | E25 | | down | manganese |
| Emerald Resources | EMR | | rising again | gold |
| Empire Energy | EEG | | holding uptrend | gas |
| Euro Manganese | EMN | | down | manganese |
| Evolution Mining | EVN | | breached uptrend | gold |
| Firefinch | FFX | | breached uptrend | gold |
| First Graphene | FGR | | testing uptrend | graphene |
| Fortescue Metals | FMG | | testing uptrend | iron ore |
| FYI Resources | FYI | | down | HPA |
| Galena Mining | G1A | | still down | lead |
| Galilee Energy | GLL | | down | oil and gas, CBM |
| Genesis Minerals | GMD | | surged higher after consolidation | gold |
| Genmin | GEN | | new uptrend | iron ore |
| Global Energy Ventures | GEV | | testing downtrend | hydrogen |
| Gold Road | GOR | | testing downtrend | gold |
| Great Boulder Resources | GBR | | rising | gold exploration |
| Hastings Technology Metals | HAS | | testing uptrend | rare earths |
| Hazer Group | HZR | | bounce back to resistance line | hydrogen |
| Highfield Resources | HFR | | back to resistance line | potash |

| | | | | |
|---|---|---|---|---|
| Hillgrove Resources | HGO | | long term uptrend | copper |
| Iluka Resources | ILU | | breached downtrend, back to highs | mineral sands |
| Image Resources | IMA | | new uptrend | mineral sands |
| Independence Group | IGO | | new high | gold |
| ioneer (was Global Geoscience) | INR | | slump | lithium |
| Ionic Rare Earths (Oro Verde) | IXR | | recovering long term uptrend | rare earths |
| Jervois Mining | JVR | | shallower uptrend | nickel/cobalt |
| Jindalee Resources | JRL | | strong rally | lithium |
| Kingston Resources | KSN | | rallying | gold |
| Kingwest Resources | KWR | | breached uptrend sideways | gold |
| Legend Mining | LEG | | down | nickel exploration |
| Lepidico | LPD | | testing steepest uptrend | lithium |
| Lindian Resources | LIN | | surge higher | bauxite |
| Lion One Metals | LLO | | spike higher | gold |
| Los Cerros | LCL | | rallied to hit resistance line | gold exploration |
| Lotus Resources | LOT | | holding long term uptrend | uranium |
| Lucapa Diamond | LOM | | shallow downtrend | diamonds |
| Lynas Corp. | LYC | | sharp pullback | rare earths |
| Magnetic Resources | MAU | | shallow downtrend | gold exploration |
| Mako Gold | MKG | | breaching support | gold exploration |
| Marmota | MEU | | sideways | gold exploration |
| Marvel Gold | MVL | | breached uptrend | gold exploration |
| Matador Mining | MZZ | | rallied to hit resistance line | gold exploration |
| Mayur Resources | MRL | | slump to new low | renewables, cement |
| Meeka Gold | MEK | | strong rise but still LT downtrend | gold |
| Megado Gold | MEG | | new low | gold exploration |
| Meteoric Resources | MEI | | still falling | gold exploration |
| MetalsX | MLX | | new high | tin, nickel |
| Metro Mining | MMI | | new uptrend confirmed | bauxite |
| Mincor Resources | MCR | | new high | gold/nickel |
| Mithril Resources | MTH | | down | gold/silver |
| Musgrave Minerals | MGV | | testing downtrend | gold exploration |
| Neometals | NMT | | testing uptrend | lithium |
| Northern Minerals | NTU | | rising | REE |
| Northern Star Res. | NST | | breached downtrend | gold |
| Nova Minerals | NVA | | heavy slump | gold exploration |
| Oceana Gold | OGC | | breaching downtrend | gold |
| Oklo Resources | OKU | | down | gold expl. |
| Orecorp | ORR | | down | gold development |
| Oz Minerals | OZL | | back to support line | copper |
| Pacific American | PAK | | back to lows | coking coal |
| Pantoro | PNR | | surge higher | gold |
| Panoramic Res | PAN | | on support line | nickel |
| Peak Minerals | PUA | | new low | copper exploration |

| | | | | |
|---|---|---|---|---|
| Peak Resources | PEK | | broken down through support line, but rebound | rare earths |
| Peel Mining | PEX | | down | copper |
| Peninsula Energy | PEN | | on support line | uranium |
| Poseidon Nickel | POS | | sideways | nickel |
| Perseus Mining | PRU | | good bounce | gold |
| PVW Resources | PVW | | steep rise | rare earths |
| Queensland Pacific Metals | QPM | | down | nickel/cobalt/HPA |
| Red River Resources | RVR | | still down | zinc |
| Regis Resources | RRL | | out of downtrend | gold |
| Renergen | RLT | | on support line | gas, helium |
| RIO | RIO | | new uptrend | diversified, iron ore |
| Rumble Resources | RTR | | breached downtrend | gold exploration |
| S2 Resources | S2R | | consolidating after steep rise | gold exploration |
| St Barbara | SBM | | testing downtrend | gold |
| Sandfire Resources | SFR | | breached uptrend | copper |
| Santos | STO | | breached downtrend | oil/gas |
| Saturn Metals | STN | | breached ST downtrend, but still in LT one | gold exploration |
| Silex Systems | SLX | | sideways through downtrend | uranium enrichment technology |
| Silver Mines | SVL | | sideways | silver |
| South Harz Potash | SHP | | slump | potash |
| Stanmore Coal | SMR | | hitting resistance line | coal |
| Strandline Resources | STA | | slump | mineral sands |
| Sunstone Metals | STM | | downtrend | exploration |
| Talga Resources | TLG | | still down | graphite |
| Technology Metals | TMT | | down | vanadium |
| Tesoro Resources | TSO | | new low | gold exploration |
| Theta Gold Mines | TGM | | down | gold |
| Thor Mining | THR | | downtrend breached | gold exploration |
| Tietto Minerals | TIE | | strong rise | gold |
| Titan Minerals | TTM | | breached downtrend | gold |
| Turaco Gold | TCG | | downtrend | gold exploration |
| Vanadium Resources | VR8 | | back to highs | vanadium |
| Vimy Resources | VMY | | testing downtrend | uranium |
| West African Resources | WAF | | new high | gold |
| Westgold Resources | WGX | | new uptrend being tested | gold |
| West Wits Mining | WWI | | risen to meet resistance line | gold |
| Whitehaven Coal | WHC | | secondary uptrend | coal |
| Wiluna Mining | WMC | | breached uptrend | gold |
| Yandal Resources | YRL | | breached uptrend | gold exploration |
| Zenith Minerals | ZNC | | surge to new high | gold exploration |
| Zinc Mines of Ireland | ZMI | | sideways | zinc |
| Totals | 34% | 48 | Uptrend | |
| | 38% | 53 | Downtrend | |
| | | 141 | Total | |

**Guides to Chart Interpretations**

- Charts usually go pass from one trend (up or down) into the other via a period of indecision and uncertainty during which the trend can either recover or change. This period is signified by the orange colour. The orange represent both the greatest risk and greatest reward possibilities.
- Once a chart is in confirmed up or downtrends it is not uncommon for 10-20% of that trend to have already transpired.
- There are trends within trends. The focus of this chart review is the immediate trend that affects the sentiment i.e. it can be a downtrend within a long-term uptrend.
- Not every chart warrants a new comment every week. The new comments are in bold type. Grey type comments may be dated.
- Individual charts provide a single view. It is valuable to look at charts of other companies in similar commodities, and the overall sentiment is also very valuable. Not many stocks can swim against the tide.
- We periodically add or delete charts, some times for obscure reasons. If a chart consistent gives poor signals or is very erratic, we may delete it. Sometimes we add a chart because we want to see what all the fuss is about. We do have a preference for charting stocks that we cover in our research as well.
- Errors and omissions may occur from time to time, especially in fast moving markets.

Amber Lights in Tables: Just a reminder if when the amber light is used in the table – it is when the charts are ambiguous or when there is a change of trend taking place. If a chart is breaching a downtrend it can either be a positive sign or a trap. Only once it has done more work can it be confirmed as a new uptrend. Maybe it is a new uptrend (or conversely a new downtrend); the risk takers can decide to jump on board early (or sell). They will maximise their profits (or minimise their losses if indeed it is the start of the new uptrend (downtrend). More risk-averse investors should wait a little longer, being prepared to give up some of the gains in return for greater certainty.

**Weightings of Sectors Represented in the Company Charts**

| Sector | No. of Companies | Weighting | |
|---|---|---|---|
| Gold | 31 | 22.0% | |
| Gold Exploration | 24 | 17.0% | |
| Nickel | 11 | 7.8% | |
| Copper | 10 | 7.1% | |
| Rare Earths | 9 | 6.4% | |
| Oil/Gas | 7 | 5.0% | |
| Iron Ore/Manganese | 6 | 4.3% | |
| Lithium | 4 | 2.8% | |
| Potash/Phosphate | 5 | 3.5% | |
| Graphite/graphene | 4 | 2.8% | |
| Uranium | 4 | 2.8% | |
| Zinc/Lead | 4 | 2.8% | |
| Mineral Sands | 3 | 2.1% | |
| Silver | 3 | 2.1% | |
| Coal | 3 | 2.1% | |
| Bauxite | 2 | 1.4% | |
| Cobalt | 1 | 0.7% | |
| Tin | 1 | 0.7% | |
| Diamonds | 1 | 0.7% | |

| | | | |
|---|---|---|---|
| Other | **8** | | |
| Total | **141** | | |

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