BATTERY MATERIALS REVIEW

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Market Lithium Commentary Turns Bearish: Should we be worried? No!

It's difficult to read about lithium currently without seeing some negative broker report or other. The bulk of bulge bracket investment banks are negative on the sector and are forecasting a substantial fall in prices next year and into 2024.

Of course, people with long memories will point out that it was exactly the same this time last year when the bulk of bulge bracket banks were negative on lithium and forecasting prices to fall substantially the following year.

Are we worried about lithium in the near-term? No, we really aren't at the moment.

We can point to a number of reasons such as low inventory levels, seasonality in Chinese lithium output, environmental closures of Chinese lepidolite capacity and the fact that the supply chain is normally 6-12 months long, and not as short as most investment banks suggest. Read on for more information…

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Focus…We're not worried about lithium

Bulge brackets negative on lithium

There are so many negative lithium reports coming out of the bulge bracket banks recently that it's difficult to understand why anyone was ever positive on lithium.

Of course, those of us who were positive on lithium were positive (and made money) because we didn't listen to what the bulge bracket investment banks were saying! And we suggest that that will be a good idea again going into next year.

It's not like the bulge brackets have such a great record anyway. Who can forget Goldman Sachs downgrading the US lithium producers with huge fanfare on 14 December last year? Its thinking was that its autos team downgraded its expectations for EV sales on supply chain constraints and potential for higher production.

Hmmm, where have we heard that before? Oh yes, the litany for the bulge bracket seems to be that EV sales won't grow so much next year, and that supply is catching up. The problem is, of course, that they were wrong last year, and we believe that they'll be wrong this year.

Sure, the lithium deficit could very well be smaller in 2023 than in 2022, but we still see a deficit, and prices are unlikely to correct until we see a surplus. Certainly not based on our experience of materials markets over the past 25 years, anyway…

And, of course, that wasn't Goldman's last tilt at the sector. There was the famous GS "downgrade" note from the end of May. Of course, normally a downgrade indicates that you were positive on something, but GS had basically been negative on the sector all the way up!

GS's point in that note was that Chinese supply (primarily from lepidolite) would overwhelm demand. But China only added 67Kt of LCE in 10M/22 and, of that, only 40Kt was battery grade. And, coupled with delays to non-China projects that simply wasn't enough to push the sector into oversupply.

Which led GS to a rather embarrassing recantation of their call in November (9 November) when they ended up raising their 2023 lithium carbonate price forecast by a measly 226% (to US$53.3/kg). But they still have a price forecast of US$11/kg for 2024, implying that prices during that year must fall well-below US$11/kg for the bulk of the period.

That seems quite unlikely, given that GS' own research has established that the marginal cost of production for Chinese lepidolite producers is US$13-17/kg, and these are likely to be the market's marginal producers.

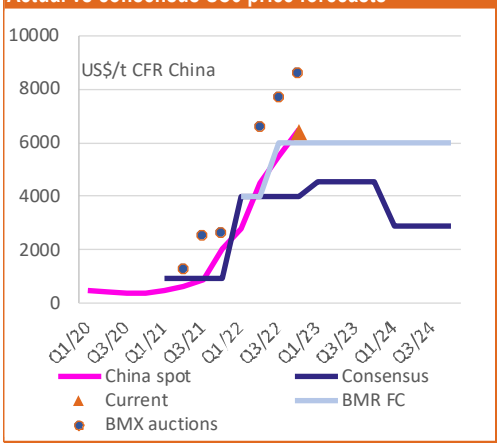
But Goldman Sachs have been by no means the only offender when it comes to getting the call on the industry wrong. Indeed most of the bulge bracket banks persist in treating lithium as a commodity rather than a specialty and most of them are forecasting prices to collapse in coming years.

Morgan Stanley has been one of the permabears; it has been negative on lithium since 2018.

In 2018 it was a great call, in 2019 a reasonable call, in 2020 a bad call, and in 2021 and 2022 a very bad call. Taking the period from 2020 to now, it's been an abysmal call, as even producers have ripped 400-500% and many development stocks have done 1000%+.

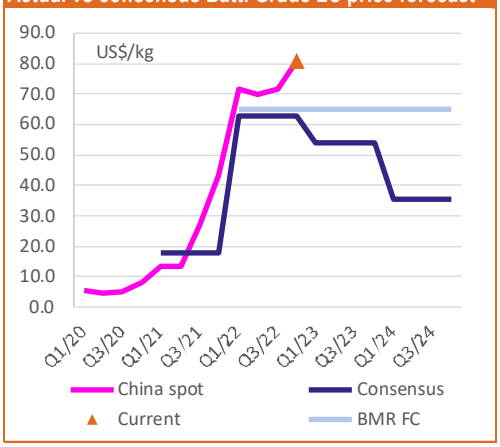
Morgan Stanley also capitulated on its 2023 price forecasts (on 28 November), raising its 2023 price forecast for LC to US$57.5/kg, but still expecting prices to

Actual vs consensus SC6 price forecasts



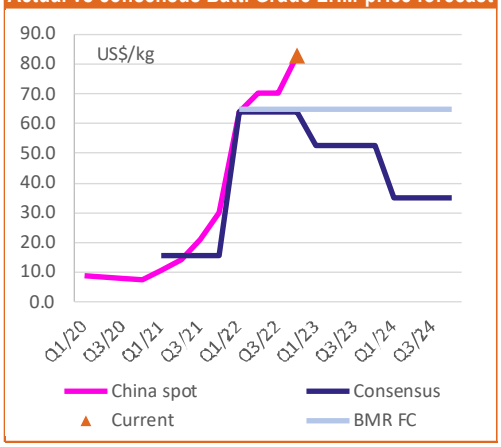
Source: Westbeck Capital, BM Review

Actual vs consensus Batt. Grade LC price forecast



Source: Westbeck Capital, BM Review

Actual vs consensus Batt. Grade LHM price forecast



Source: Westbeck Capital, BM Review

fall to US$27.5/kg in 2024. Their long-term price is now US$12/kg, up 72% from their highly unlikely previous forecast of US$7/kg.

These two bears are joined by JP Morgan and Credit Suisse. And indeed analyst consensus on lithium carbonate is now US$54/kg for 2023 and US$35.6/kg for 2024, some way below the level which we think is realistic.

Don't write off spot pricing; it's important

The spot vs contract conundrum is of great importance in the market at the moment. The bulge brackets cite the spot prices received for Chinese lithium carbonate and lithium hydroxide material and note how it's not indicative of the market as a whole.

We can't help but be reminded of the iron ore market when we read research like that. Sure, that market started off all contract, but within the space of 2-3 years, it was quarterly and spot. The bulge brackets were saying the same thing at that time as well.

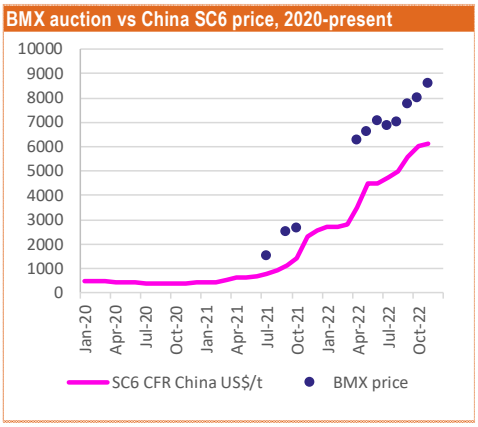
In 2020, we would estimate that spot tonnage in lithium carbonate was less than 5% of the market. We believe it could be as much as 25% now, and quarterly pricing contracts are probably as much as 60%, with long-term pricing less than 15% of the market and falling.

So spot prices are becoming much more indicative and they're an important guide for quarterly contracts, many of which are based on spot prices published by key price providers like Fastmarkets and Benchmark with a one quarter lag.

Spot tonnage has always been a little greater in lithium hydroxide because of the nature of the industry (mostly Chinese converters). The spot proportion is increasing here too, but not as rapidly as in lithium carbonate.

But nevertheless, for investment banks to write spot prices off as non-indicative shows how out of touch they are with the current dynamics of the industry. Spot prices are of great importance to this industry and that's only increasing, not decreasing.

It's also been open season on BMX auctions in sell-side research recently. BMX auctions of course are Pilbara Minerals' way of cashing in on spot demand by auctioning off small 5-10Kt parcels of 5.5% Li2O material. BMX auctions generally lead the price by 2-3 months and hence are a useful indicator of pricing directions.



Source: Pilbara Minerals, BM Review

But they're also useful in other ways; strength in BMX pricing tends to indicate strong demand for lithium units. And, coupled with the 15Kt DSO package that Core Lithium sold in November, that seems to suggest continued desperation to source lithium units, even low grade ones.

For us that's a good indication that demand remains strong so, for the bulge bracket banks to dismiss the BMX auctions as unimportant is frankly daft.

Higher, not lower prices expected

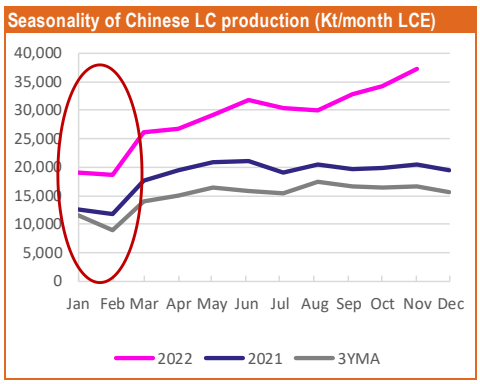
One of the factors that we keep a close eye on, that the sellside doesn't seem to, is inventories.

The collapse in inventories in 2020, and the point of inflection in shipment/inventory ratios for the Australian hard rock producers, was our canary in the coal mine moment in 2020, when we started to be positive on lithium.

Chinese lithium inventories have also been falling in recent months. And, given seasonal issues with Chinese carbonate production and environmental inspections, that makes us positive about the outlook for Chinese lithium prices, not negative.

Let's note firstly that Chinese lithium carbonate production is generally depressed in the first two months of the year. While some might think that's a Chinese New Year impact, it's actually because evaporation rates at Chinese brine operations are low in the winter.

In 2022, depressed production in Jan-Feb took 15Kt out of the market, and it could take 20-30Kt out of the market in 2023, in our view.



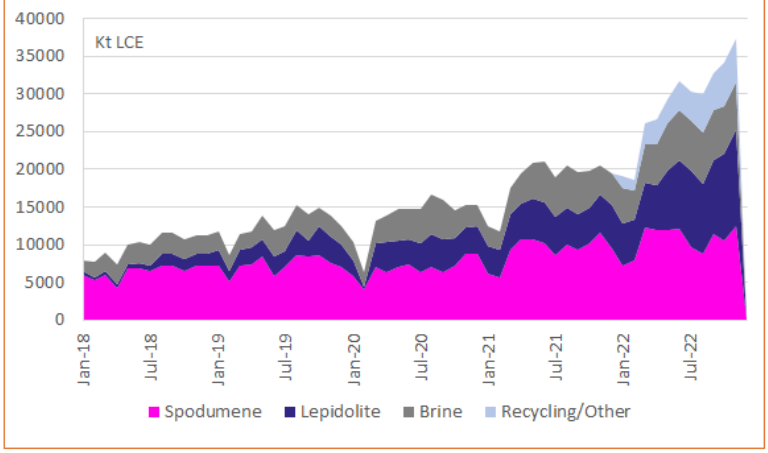
Source: SMM, BM Review, Westbeck Capital

Then, of course, there's environmental inspections at lepidolite production assets. This has caused closure of some capacity. Over the past three months,

Focus...We're not worried about lithium...

33% of China's carbonate production has come from lepidolite sources, although only c.40% of that material is battery grade (the rest needs upgrading). In November China produced c.12Kt of carbonate from lepidolite, so closures could take anywhere from 4-10Kt/month of production out of the market. Which, coupled with the brine issues, could be extremely impactive.

Chinese lithium carbonate production by source



Source: SMM, BM Review, Westbeck Capital

And finally there's inventory levels.

Most China battery material watchers know that lithium hydroxide inventories are depressed. They've fallen from nearly 30Kt of material in May 2021 to 4.5Kt of material in October.

But most battery material watchers disregard the fall in lithium carbonate inventories, because they've only gone from 102Kt in June 2021 to 56Kt in October, and that's still a lot of inventory.

But is it?

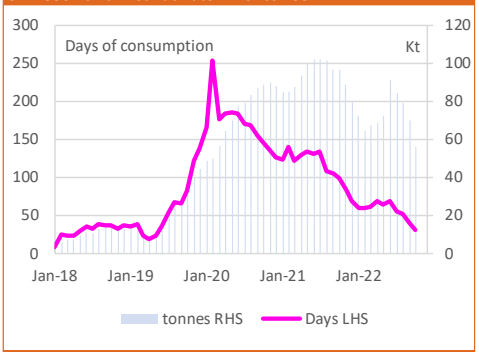
Because China's monthly lithium carbonate demand has risen from 23.5Kt in June 2021 to c.55Kt now. That's nearly a double. So, in days of consumption terms, China's carbonate inventories are now at sub-30 days, and that's the lowest they've been since May 2019, when they were going in the opposite direction.

If you now take 20-30Kt of carbonate out of the market, then you're looking at a huge issue with inventory levels, in our view.

And this highlights another area where the sellside is getting it wrong; in a rapidly-growing market, you've got to think about things in days of consumption terms. Absolute inventory levels don't cut it.

So in your supply/demand model, if you're calculating a 100Kt market surplus for a coming year, that 100Kt market surplus doesn't mean the same if demand is 500Ktpa as it did when demand was 100Ktpa. That still might represent critical inventory levels, but it doesn't if you listen to the sellside.

Chinese lithium carbonate inventories



Source: SMM, BM Review, Westbeck Capital

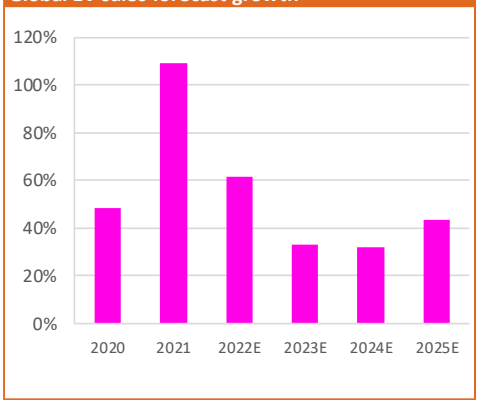
The EV sales growth conundrum

The other reason that the sellside is negative is because it quote-unquote sees EV sales declining next year.

Let's just correct an important bit of English here. They don't forecast **EV sales** to decrease, they forecast **EV sales *growth*** to decrease. And that's an important point.

I don't think any broker out there is forecasting EV sales to fall. That would be politically unacceptable to most governments and if that were to happen in Europe or China, one would expect to see stimulation in this key industry.

Global EV sales forecast growth



Source: BM Review estimates

So, it's the rate of growth which will decrease. And, we agree. We already had a substantial decrease in the rate of growth in our model for 2023.

So that doesn't really worry us.

Supply growth the issue

Really, it's supply where we think that the sellside is most unrealistic. We think GS was unrealistic in its expectations of how fast Chinese lepidolite production could ramp up, and particular in its failure to differentiate between battery grade and non-BG output. We also regard many of its expectations for ex-China supply as unrealistic.

A recurring theme for equity analysts currently is their blind acceptance of management teams' forecasts for production. At the risk of upsetting the

development and production management teams reading this article, we would say that we can count on the fingers of one hand the number of mining projects in our career which have come into production on time. And the number of lithium projects which have is precisely zero. And, in addition to that, projects always take longer to ramp up to design capacity after first production than management teams forecast.

There are factors that generalist sellside analysts looking into the industry struggle with, and one of those is the sheer complexity of the products in this industry. We haven't seen a lithium project yet which has ramped up to production in line with pre-construction management expectations, and we are not sanguine that we *will* see one.

For instance, Australia is on track to manage less than 50% of the capacity additions that GS forecast for 2022 in its May report, and it is the second-most mature lithium production region in the world, and most of the forecast expansions were brownfield ones…

Consequently, we believe that the sellside is substantially overstating supply assumptions and simply pushing delays from this year into next year is shoddy analysis. Analysts should be pushing out project forecasts for 2023 and 2024 as well…

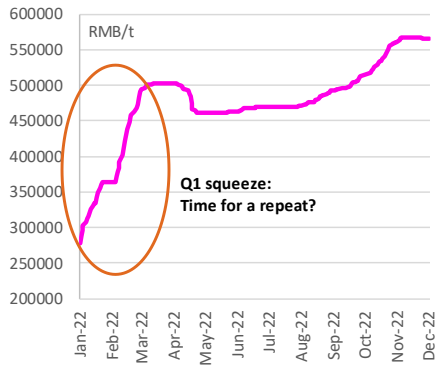
Q1 squeeze on the radar?

Last year we saw a big squeeze in lithium spot prices in the first quarter. Out of all of the factors above, Chinese production seasonality was relevant as well as delays to overseas supply and robust demand.

However, inventories were at elevated levels.

They're not as such elevated levels now (in days of supply terms) and that's why we're expecting another squeeze in Q1/23.

Chinese lithium carbonate spot prices, 2022



Source: Westbeck Capital

With lithium stocks selling off on negative sellside "publicity" we see an excellent buying opportunity ahead of likely strength in lithium prices in Q1.

If lithium prices run, then stocks are almost certain to follow…

LME under attack as nickel contract stumbles

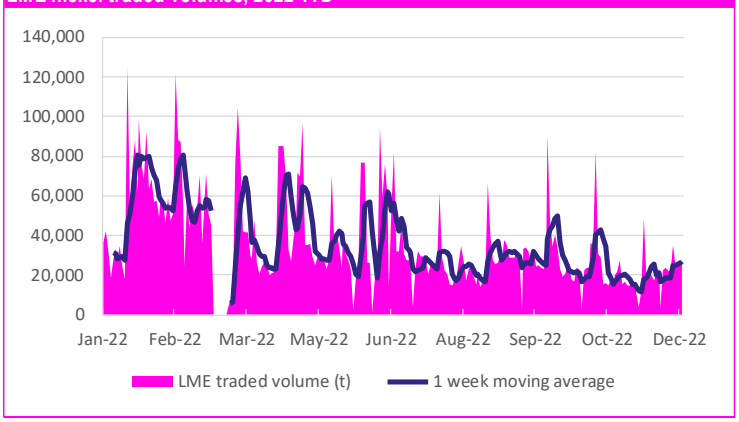
LME Nickel was limit down (15%) in mid-November after rising 40% in just two weeks on volatile and illiquid trading. The LME nickel market has struggled for volume since the fiasco in March and traders continue to bemoan the lack of liquidity.

The LME has defended its decision to cancel billions of dollars of nickel trades in March, saying it was necessary to avoid a US$20bn margin call that would have sent the market into a "death spiral" as at least seven clearing members went into default. The details are included in a document that LME published as part of its defence against law suits by a number of traders and funds.

The news comes as CME is looking to cash in on the LME's woes. It is already doing well on its cash-settled cobalt contract and now there are sustained market rumours that it intends to launch a nickel contract. Volumes have also increased substantially on the Shanghai Metal Exchange nickel contract since the LME debacle.

Sources suggest that CME has attracted major market players to its cobalt contract and that could only be positive if it chooses to head into nickel. It is reported that **Glencore** (LSE:GLEN) uses CME for its cobalt. Open interest on the contract jumped 352% y/y in October.

LME nickel traded volumes, 2022 YTD



Source: Westbeck Capital, BM Review

Canada tells Chinese firms to divest strategic assets

The Canadian government has ordered Chinese investors to divest their stakes in three lithium developers. Shares of **Power Metals** (TSXV:PWM), **Ultra Lithium** (TSXV:ULT) and **Lithium Chile** (TSXV:LITH) all took a tumble on the news. The government chose to target all three juniors even though only PWM and ULT actually have projects in Canada.

The move is not a major surprise, given the fact that Western powers are becoming increasingly concerned about Chinese dominance in the industry. But what is a surprise is that no action has been taken against **Lithium Americas** (TSX:LAC) in which **Ganfeng Lithium** (HKG:1772) has a 20% stake and a 50% stake at the project level in its brine project in Argentina. In addition the acquisition of NeoLithium by **Zijin Mining** (HKG:2899) was approved in February.

If Western powers are going to make these sort of moves, it's important they are consistent, and we're not seeing that at the moment...

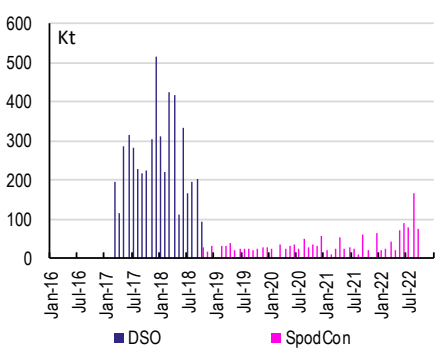
DSO all the rage for SpodCon developers

Spodumene DSO (Direct Shipping Ore) first made an appearance in the 2017-18 cycle, when lithium prices spiked. DSO was predominantly from the Wodgina and Pilgangoora mines which, between March 2017 and October 2018 shipped over 5Mt of material grading c.1.5% Li2O, and also from African projects which shipped smaller amounts of lepidolite and spodumene-rich ore. Then lithium prices passed over their peak and DSO passed out of use.

Now, with lithium prices at all-time highs and demand for lithium units going through the roof, DSO is back. And this time it looks like the DSO market will be bigger.

Core Lithium (ASX:CXO) was the first major DSO tonnage in this cycle with its 15Kt tender for 1.4% Li2O material, which is due to ship by the end of this year. Core reported a US$951/t price on a CIF China basis. Anecdotal reports suggest that material is already being shipped from small mines in Africa and **Shengxin Lithium** (SHE:002240) in China recently announced a plan to purchase 2Mt of DSO at a rate of 500Ktpa.

Port Hedland DSO vs SpodCon shipments



Source: Pilbara Port Authority

At various conferences over the past two weeks, we've spoken with a number of lithium hard rock developers, most of whom flagged the potential to mine DSO for early cash flow. Given that Core is set to receive c.US$13.5m for its DSO shipment, one

can understand the attraction for early-stage developers looking to generate cash flow. And not all DSO has to go to China.

In Canada, developers were flagging the potential to deliver DSO into SpodCon developers such as **Sayona Mining** (ASX:SYA) which were not expected to fully-utilise their plants in the early stage, and, of course, that potential also exists in Australia. Traders are reportedly also active in the DSO market, raising the potential for more developers to access early cashflow.

However, given that it's proven very difficult for concentrators to hit design capacity already in this cycle, we do wonder whether it is viable for such operations to buy large amounts of DSO material which could change the properties of the core material? There has to be a question as to whether putting DSO material from multiple sources through concentrators designed for a certain orebody is going to be viable for the operators?

Could DSO be an issue for supply/demand balances? We don't think so. Even 2Mtpa of DSO would represent only the equivalent of a 300-400Ktpa SpodCon project and that's nowhere near enough to fill the supply/demand gap just yet.

DRC to unwind Chinese mining deals?

There are reports that the DRC government wants to rework the deal it signed with China in 2008 that allowed Chinese companies access to copper and cobalt projects in exchange for infrastructure investment.

China has reportedly spent only US$900m on infrastructure so far, materially short of what was required in the agreement, but operations including the **Sicomines** Cu/Co JV have provided a lot of metal.

Under the deal China was supposed to invest US$3.2bn in mining and US$3bn in infrastructure, but that hasn't happened. This flare up in the DCR/China relationship comes as DRC and China are embroiled in another disagreement over the Tenke Fungurume mine, which is operated by **China Molybdenum** (HKG:3993).

China Inc. has competition for DRC developments. This month **Trafigura** and African banks closed a syndicated US$600m development financing facility with Chemaf Resources for a DRC Cu/Co project.

Some commentators suggest that the recent focus on Chinese deals has come about because of diplomatic pressure on the DRC from the US.

China Moly's Tenke Fungurume mine

Source: Reuters

Raw materials round-up:

Saudi Arabia is reportedly seeking to attract Australian miners to invest in a US$170bn plan to tap into an estimated US$1.3tn worth of mineral deposits in the country, including copper, zinc and phosphates. Saudi's Vision 2030 project is planned to reduce its dependence on fossil fuels.

US Republicans are reportedly keen to use their majority in the House of Representatives to streamline planning processes for mining projects. Let's hope they're successful!

BHP (ASX:BHP) has forecast that nickel demand is likely to rise four times by 2050, driven by the EV sector.

Mexico is looking to encourage US and Canadian companies to invest in its lithium industry. Its move would probably be more successful if it hadn't previously nationalised the industry…

France has called for an international ban on deep sea mining, making it only the most-recent country to be negative. Deep sea mining proponents cite the huge resources of manganese nodules on the sea floor as a reason to develop undersea projects.

Murchison the new play on the nickel block

Murchison Minerals had the stand-out drill hole in November 2022. Its QPM project in Quebec, Canada was initially explored by Falconbridge, before being fully brought inside Murchison in 2019.

The results are from the Barre de Fer prospect, just one of three high priority targets on the licence area. Drilling is ongoing and the company is currently working on a maiden resource for the project.

While **Lunnon Metals** continues to record very high grade intercepts from its Kambalda project in Western Australia, we do have questions about the size of the deposit, which so far have not been answered. While geologically interesting and certainly mineable with current infrastructure in place, we don't currently see the deposit as a company-maker.

In lithium most of the high quality intercepts this month were on known deposits, with only **Lithium Ionic** standing out for its Galvani results. We had the opportunity to catch up with management at a conference recently and Galvani looks like an interesting project, located as it is in a basin with already-producing hard rock mines. We are not so wild about the company's Bandeira project which seems to be producing much thinner intercepts; thin pegmatites raise the potential for dilution and substantially lower recoveries.

Note that there are a number of drill results due for Canadian nickel and lithium projects which are delayed because of congestion at assay labs. Hopefully these may start to trickle through over the next few months.

November 2022 drilling news

Date	Operator	Project	Location	Status	Depth	Key intercept	Hot or not?
Graphite							
14-Nov-22	GreenRoc Mining (AIM:GROC)	Amitsoq	Greenland	PR	139m	15.5m @ 23.5% TGC	
17-Nov-22	Gratomic (TSXV:GRAT)	Aukam	Namibia	PR	81m	1m @ 50% TGC	
28-Nov-22	Lomiko Metals (TSXV:LMR)	La Loutre	QC, Canada	Inf	46.7m	144.3m @ 4.5% TGC	
Lithium							
01-Nov-22	Lithium Energy (ASX:LEL)	Solaroz	Argentina	PR	129.6m	3.5m @ 416mg/l Li	
03-Nov-22	Leo Lithium (ASX:LLL)	Goulamina	Mali	R	48m	118m @ 1.5% Li2O	🔥
08-Nov-22	Green Technology Metals (ASX:GT1)	Seymour	ON, Canada	Inf	13.8m	13.9m @ 1.5% Li2O	
08-Nov-22	FE Battery Metals (CSE:FE)	Augustus	QC, Canada	PR	188.7m	7.3m @ 1.5% Li2O	
09-Nov-22	Arena Minerals (TSXV:AN)	Sal de la Puna	Argentina	PR	365m	255m @ 641mg/l Li	
10-Nov-22	Lithium Ionic (TSXV:LTH)	Galvani	Brazil	PR	Surface	25.6m @ 2% Li2O	🔥
11-Nov-22	Jindalee Resources (ASX:JRL)	McDermitt	Oregon, USA	Inf	Surface	68.6m @ 1669ppm Li	
16-Nov-22	Frontier Lithium (TSXV:FL)	PAK	ON, Canada	R	100m	338m @ 1.6% Li2O	🔥
22-Nov-22	Green Technology Metals (ASX:GT1)	Root	ON, Canada	R	64.6m	2m @ 4.1% Li2O	
22-Nov-22	FE Battery Metals (CSE:FE)	Augustus	QC, Canada	PR	189.6m	5m @ 1.5% Li2O	
23-Nov-22	Pan Asia Metals (ASX:PAN)	Reung Kiet	Thailand	Ext	169.6m	4.5m @ 1.2% Li2O	
24-Nov-22	Jindalee Resources (ASX:JRL)	McDermitt	Oregon, USA	Inf	83.4m	51.8m @ 1787ppm Li	
24-Nov-22	Auroch Minerals (ASX:AOU)	Nepean	W. Australia	PR	198m	2m @ 3.3% Li2O	
29-Nov-22	Atlantic Lithium (AIM:ALL)	Ewoyaa	Ghana, Africa	Inf	14.3m	63.6m @ 1.9% Li2O	🔥
30-Nov-22	Power Metals Corp (TSXV:PWM)	Case Lake	ON, Canada	PR	25m	2m @ 3.1% Li2O, 841ppm Ta	
Nickel							
02-Nov-22	Azure Minerals (ASX:AZS)	Ridgeline	W. Australia	R	434.1m	31.8m @ 1.4% Ni, 0.06% Co, 0.9% Cu	🔥
03-Nov-22	Lunnon Metals (ASX:LM8)	Kambalda	W. Australia	Ext	137.1m	9.5m @ 6.9% Ni, 0.2% Co, 0.7% Cu	🔥🔥
03-Nov-22	Galileo Mining (ASX:GAL)	Callisto	W. Australia	PR	95m	50m @ 0.3% Ni	
09-Nov-22	NiCAN (TSXV:NICN)	Wine	Man, Canada	PR	66.6m	8.6m @ 1.9% Ni, 0.1% Co, 1% Cu	🔥
14-Nov-22	Lunnon Metals (ASX:LM8)	Kambalda	W. Australia	Ext	347m	1.7m @ 4.1% Ni, 0.1% Co, 0.3% Cu	
14-Nov-22	Murchison Minerals (TSXV:MUR)	HPM	QC, Canada	PR	105.9m	8.1m @ 2.7% Ni, 0.2% Co, 0.7% Cu	🔥
14-Nov-22	Flying Nickel Mining (TSXV:FLYN)	Minago	Man, Canada	Ext	149.7m	30.8m @ 0.8% Ni, 0.01% Co, 0.04% Cu	
16-Nov-22	Galileo Mining (ASX:GAL)	Callisto	W. Australia	PR	289m	7m @ 0.4% Ni	
21-Nov-22	Blackstone Minerals (ASX:BSX)	Ta Khoa	Vietnam	R	73m	2m @ 4% Ni, 0.2% Co, 1.2% Cu	
21-Nov-22	Palladium One (TSXV:POM)	Tyko	ON, Canada	PR	186.6m	2.4m @ 3.2% Ni, 0.06% Co, 1% Cu	
22-Nov-22	Aston Minerals (ASX:ASO)	Edleston	ON, Canada	R	26.5m	725.2m @ 0.2% Ni, 0.01% Co	
23-Nov-22	Azure Minerals (ASX:AZS)	Ridgeline	W. Australia	R	508.2m	18.2m @ 1.9% Ni, 0.08% Co, 0.7% Cu	🔥
23-Nov-22	Galileo Mining (ASX:GAL)	Callisto	W. Australia	PR	149m	30m @ 0.3% Ni, 0.4% Cu	
23-Nov-22	Chalice Mining (ASX:CHN)	Julimar	W. Australia	Ext	328m	157m @ 0.2% Ni, 0.02% Co, 0.1% Cu	
24-Nov-22	Lunnon Metals (ASX:LM8)	Kambalda	W. Australia	Ext	415m	4.5m @ 5.7% Ni, 0.1% Co, 0.3% Cu	🔥
27-Nov-22	Power Nickel (TSXV:PNPN)	Nisk	ON, Canada	PR	337.7m	25.9m @ 1.2% Ni, 0.08% Co, 0.8% Cu	🔥
28-Nov-22	Transition Metals Corp (TSXV:XTM)	Maude Lake	ON, Canada	PR	100m	20m @ 0.3% Ni, 0.01% Co, 0.3% Cu	
28-Nov-22	EV Nickel (TSXV:EVNI)	Shaw Dome	ON, Canada	R	10.3m	223.9m @ 0.3% Ni	
28-Nov-22	Metal Energy (TSXV:MERG)	Manibridge	MN, Canada	Ext	268.5m	20m @ 0.8% Ni, 0.02% Co, 0.04% Cu	
29-Nov-22	Palladium One (TSXV:POM)	Tyko	ON, Canada	PR	165.4m	2.3m @ 10.4% Ni, 0.1% Co, 3.4% Cu	🔥
29-Nov-22	Murchison Minerals (TSXV:MUR)	HPM	QC, Canada	PR	123.8m	121.2m @ 1% Ni, 0.07% Co, 0.6% Cu	🔥🔥
REE							
03-Nov-22	E-Tech Resources (TSXV:REE)	Eureka	Namibia	R	83m	3.7m @ 4.7% TREO	
15-Nov-22	Defense Metals (TSXV:DEFN)	Wicheeda	BC, Canada	Inf	93m	111m @ 3.5% TREO	🔥
17-Nov-22	Imperial Mining Group (TSXV:IPG)	Crater Lake	QC, Canada	R	85.8m	115.5m @ 0.3% TREO	
30-Nov-22	RareX (ASX:REE)	Cummins Range	W. Australia	R	14m	373m @ 0.3% TREO, 4% P2O5	

Source: Company data, BM Review. Status: PR: pre-resource; R: resource evaluation; Ext: extensional; Inf: infill

Centaurus increases resource at Jaguar

The standout resource release for the month came from Centaurus Metals'

Last month resource roundup

Date	Company	Ticker	Main commodity	Project	Location	Country	Status	MII Resource Mt	Grade %	By-product
02-Nov-22	Anson Resources	ASX:ASN	Lithium	Paradox	Utah	USA	Upgrade	1Mt LCE	124ppm Li	Br
07-Nov-22	Technology Metals Australia	ASX:TMT	Vanadium	MTMP	W. Australia	Australia	Upgrade	153.7Mt	0.8% V2O5	TiO2
10-Nov-22	Centaurus Metals	ASX:CTM	Nickel	Jaguar	W. Australia	Australia	Upgrade	108Mt	0.87% Ni	
14-Nov-22	FPX Nickel	TSXV:FPX	Nickel	Baptiste	British Columbia	Canada	Upgrade	2.2Mt	0.1% Ni	
17-Nov-22	Rock Tech Lithium	TSXV:RCK	Lithium	Georgia Lake	Ontario	Canada	Update	14.8Mt	0.9% Li2O	
21-Nov-22	Krakatoa Resources	ASX:KTA	REE	Tower	W. Australia	Australia	Maiden	101Mt	840ppm TREO	
21-Nov-22	Widgie Nickel	ASX:WIN	Nickel	Armstrong	W. Australia	Australia	Update	0.6Mt	1.9% Ni	Au, Co, Cu, PGE
23-Nov-22	Abx Group	ASX:ABX	REE	Deep Leads	W. Australia	Australia	Maiden	3.9Mt	918ppm TREO	CeO2

Source: Company data, BM Review

Jaguar project in Brazil where the resource was upgraded to 108Mt at 0.87% Ni.

This truly is an exciting project with resources extending from surface and over 500Kt of contained nickel metal within 200m of the surface.

Drilling continues and step out drilling at Jaguar South has encountered further high grade mineralisation.

The project is located within an existing mining province and benefits from strong infrastructure. A DFS is underway.

Development News

Cobalt

Jervois Global (ASX:JRV) announced a FID on the restart of its Sao Miguel Paulista refinery in Sao Paulo, Brazil. It will now cost US$65m to restart the plant to produce 10Ktpa nickel and 2Ktpa cobalt from 2024. The company also initiated a A$231m capital raise.

Jubilee Metals (AIM:JLP) reported that it successfully commissioned its direct leaching and refining circuit, making it one of only a few refineries in Zambia which can commercially produce cobalt materials. Jubilee hopes to produce up to 1.2Ktpa of contained cobalt.

Graphite

Evion (ASX:EVG; formerly BlackEarth) published a positive DFS over its Maniry project in Madagascar which supports a 21 year project producing 39Ktpa of concentrate in Stage 1 followed by a Stage 2 expansion to 56.4Ktpa from year 4. Capex for Stage 1 development is US$79.2m, nearly double that of the estimate in the 2021 scoping study, while development of Stage 2 will require a further US$24.6m investment. It attributed the Stage 1 capex increase to the incorporation of larger process plant equipment. Opex is estimated at US$658/t of concentrate FOB Toliara.

GreenRoc Mining (AIM:GROC) reported that advanced spheronisation testing on material from its Amitsoq project in South Greenland confirmed the suitability of Amitsoq graphite concentrate for micronisation and spheronisation, having achieved a primary concentrate product of at least 95.5% graphite.

Renascor Resources (ASX:RNU) announced the approval of the Program for Environment Protection and Rehabilitation for its Siviour graphite project, part of its BAM project in South Australia. The approval represents the final step in the assessment process and allows RNU to commence the development of the upstream portion of the project.

Lithium

Allkem (ASX:AKE) announced first production of lithium hydroxide utilising Olaroz feedstock at its Naraha plant in Japan. The facility is a 75/25 JV with **Toyota Tsusho Corporation** (TYO:8015) and is expected to reach a 10Ktpa capacity by 2024.

Arcadia Minerals (ASX:AM7) announced that it signed a LOI with **HeBei Xinjian Construction** to negotiate offtake for tantalum and lithium products from its Swanson project in Namibia, as well as funding for the construction of associated concentrator plants.

Critical Elements (TSXV:CRE) announced that it received environmental approval for its Rose project in Quebec, Canada, with the issuance of a certificate of authorization by the Quebec Minister of the Environment.

After announcing plans to develop a lithium project from a kaolin mine in France, **Imerys** (EPA:NK) is now looking to develop a similar operation at its kaolin mine in Cornwall, UK. It has invested in exploration to try to delineate a resource.

Lake Resources (ASX:LKE) resolved its dispute with **Lilac Solutions** over the construction of its pilot plant for the Kachi project in Argentina.

Lepidico (ASX:LPD) provided updated and improved economics for its Phase 1 Karibib concentrator which included revised operating costs comprised of site costs of US$376/t of concentrate (2.5-3.9% Li2O). The Abu Dhabi chemical plant which will produce 4.35Ktpa of LHM will have C1 costs of US$10.3/kg on capex of US$203m for

Allkem's Naraha LHM plant

Source: Allkem

the chemical plant and US$63m for the concentrator.

Lithium Power International (ASX:LPI) reported that lithium carbonate with a 99.92% purity was produced from the test evaporation ponds at its Maricunga project in Argentina.

Pilbara Minerals (ASX:PLS) announced that it entered into a JV agreement with **Calix** (ASX:CXL) for the development of a demonstration plant at its Pilgangoora mine in Western Australia. The JV agreement, which follows on from an earlier MOU, aims to deliver lithium salts via CXL's patented technology in a value added refining process, as well as to commercialise the process.

Pilgan plant at Pilbara's Pilgangoora mine

Source: Pilbara Minerals

Rock Tech Lithium (TSXV:RCK) released a PFS for its Georgia Lake project in northern Ontario, Canada, which supports 100Ktpa of SC production for US$192m of capex and US$98.5m of sustaining capex over LoM at a cost of US$719/t. RCK is exploring refining the output at its proposed converter in Guben, Germany or at a North American converter. Alternatively, it will sell the output to third party refiners. It will now proceed to a FS.

Sayona Mining (ASX:SYA) entered into an earn-in agreement with **Jourdan Resources** (TSXV:JOR) for a JV over the Vallee project in Quebec, Canada. SYA's subsidiary, NAL, will acquire 20 claims outright with the right to earn up to a 51% stake in the remaining 28 claims based on funding milestones. NAL will also acquire 10% of JOR for C$1.5m, with Vallee ore to be fast tracked through NAL's plant.

Sayona also expanded its northern lithium hub in Quebec following an agreement with **Troilus Gold** (TSX:TLG) to acquire an exploration package located near its Moblan project. It will acquire a 100% interest in 1,824 claims covering 985sqkm for C$40m in SYA shares and a C$4.8m cash injection into Troilus.

Sibanye Stillwater (NYSE:SBSW) announced that it will proceed with the construction of the Kokkola refinery at the Keliber project in Finland. SBSW recently increased its interest in the project to 85% and approved the €588m capex.

Sigma Lithium (TSXV:SGML) hopes to complete construction of the first phase of the Grota do Cirilo project in Brazil by the end of the year and is targeting commercial production in April 2023.

St George Mining (ASX:SGQ) executed an MOU with **Shanghai Jayson New Energy Materials** to pursue lithium business opportunities in Western Australia. It will involve SGQ's Mt Alexander project as well as funding to support the acquisition and development of new lithium exploration projects and downstream lithium assets.

Tempest Minerals (ASX:TEM) announced that it plans to demerge its Western Australian lithium assets into a new entity to be named Electra Minerals.

Zimbabwe has announced that **Tsingshan** is to set up lithium mining and processing operations in country. No details were given about the size of the investment, but other Chinese companies including **Zhejiang Huayou Cobalt** (SHA:603799), **Sinomine Resources** and **Chengxin Lithium** have made recent investments in the country.

Nickel

CNGR (SHE:300919) and Indonesian state miner **Aneka Tambang** (IDX:ANTM) signed a framework agreement to build a nickel plant in Indonesia to produce 80Ktpa of nickel sulphate. The facility is expected to begin operations in 2025.

Estrella Resources (ASX:ESR) announced that it entered into an ore processing and offtake agreement with **Glencore**'s (LSE:GLEN) Murrin Murrin mine, for between 2-4Kt of high grade nickel ore from the 5A nickel mine in Western Australia.

Korea Zinc (KRX:010130) and **Trafigura** are reportedly in talks to build a nickel smelter as part of a swap deal that will see Trafigura, **Morgan Stanley** and **Korea Investment** take a US$280m stake in Korea Zinc. The JV would also include a nickel sulphate project.

OZ Minerals (ASX:OZL) published results of a study into production of nickel MHP at its West Musgrave Cu/Ni project using Pressure Oxidation (POX) and precipitation. The project would cost c.A$310m with operating costs of

A$337/t of nickel sulphide concentrate processed. First MHP could be produced in 2027.

Poseidon Nickel (ASX:POS) delivered a BFS over its Black Swan project in Western Australia which will require a capital investment of A$50m to produce 30Kt of nickel over a 4 year LOM. It will continue to progress works on a 2.2Mtpa ore feed FS to produce a rougher concentrate with a lower nickel grade and higher magnesium oxide, with the aim of unlocking more material and higher annual nickel production.

Poseidon Nickel's Black Swan operation

Source: Poseidon Nickel

Queensland Pacific Metals (ASX:QPM) announced that it received environmental approval to build its TECH project in Queensland, Australia. It now awaits approval from the state government and local council.

QPM also published an updated FS for Stage 1 of the project and a scoping study for Stage 2. The capex estimate for Stage 1 is A$2.1bn vs the 2020 PFS estimate of A$650m, although for a 2.7x plant scale increase. Stage 1 has nameplate production of 16Ktpa of nickel in sulphate, 1.75Ktpa of cobalt in sulphate and 4Ktpa of 4N HPA. The scoping study for Stage 2, which is at the same scale as Stage 1, identified a A$350m reduction in capex compared to Stage 1 and opex reductions of 7% to nickel unit costs of A$1.89/lb.

SK On (KRX:096770), **EcoPro** (KRX:086520) and **GEM** (SHE:002340) announced plans to build a new nickel MHP plant at the Morowali industrial park in Indonesia. The plant will produce 30Ktpa of contained nickel with production starting in Q3/24.

Vale (NYSE:VALE) announced that it signed a supply agreement with **General Motors** (NYSE:GM) to provide GM with 25Ktpa of battery grade nickel sulphate from its proposed plant in Becancour, Quebec, Canada. The deal involves enough material for up to 350k EVs a year, starting in H2/26.

Separately, **Vale** broke ground at its Pomala HPAL JV with **Zhejiang Huayou Cobalt** (SHA:603799) with first production expected in 2025. The plant will produce 120Ktpa of nickel in MHP and will cost US$4.29bn.

Other

Alpha HPA (ASX:A4N) signed a MOU with **Orica** (ASX:ORI) to explore the feasibility of establishing a new manufacturing facility in North America to produce HPA products. The facility would be located near Orica's Carseland manufacturing centre in Alberta, Canada. The parties also executed a subscription agreement whereby Orica will acquire a 5% interest in A4N for A$0.44/sh.

Arafura Rare Earths (ASX:ARU) signed a binding offtake agreement with **Hyundai** (KRX:005380) and **Kia** (KRX:000270) to supply NdPr from its Nolans project in Australia's Northern Territory over a 7 year term starting at 0.6Ktpa of NdPr oxide in year one, rising to 1.5Ktpa in years 4-7. Updated project economics consist of pre-production capex of A$1.39bn and opex of A$61.60/kg NdPr to produce 4.4Kt of NdPr over a 38 year LOM. The NT Government approved the Mining Management Plan for the project.

Euro Manganese (TSXV:EMN) reported that it is exploring development of a project in Canada to produce high purity manganese for the North American market. It has commenced a scoping study into a site in Becancour, Quebec, to produce HPMSM and/or HPMSS. The proposed site is close to cathode plants under development as well as planned nickel and cobalt sulphate plants. The study will evaluate the supply of HPEMM from its Chvaletice project in the Czech Republic.

Guizhou Redstar (SHA:600367) is to build a 50Ktpa HPMSM project in Dalong, China. Redstar produced 6.4Kt of HPMSM in Q3/22.

Namibia Critical Metals (TSXV:NMI) published an updated PEA over its Lofdal REE project in Namibia which contemplates the production of 2Ktpa of TREO over a 16 year LOM for initial capex of US$207m. The PEA is based on the mining of 50% of the resource.

RareX (ASX:REE) executed a binding MOU with Ord River District Co-Operative to sell phosphate and by-products from its Cummins Range REE project in Western Australia.

Midstream

Aleees (TWO:5227) will provide its LFP cathode technology to **ICL Group**'s (TLV:ICL) US$400m cathode plant in Missouri, US. ICL's plant, which is expected to come into production in 2024, was awarded US$197m in funding by the US government. Phase 1 of the project will produce 15Ktpa of LFP cathode with phase 2 taking capacity to 30Ktpa by 2025.

BASF (ETR:BAS) expects its Schwarzheide CAM plant to start production at the end of this year.

Enchem plans to double electrolyte production capacity in the US to 300Ktpa by 2026 to meet increased demand. It will increase capacity at its existing plant in Georgia to 140Ktpa by 2024 and add 160Ktpa of capacity in four other states. It has JVs with LGES, GM, SK On, Ford and Volkswagen.

Enerever Battery Solution is due to complete construction at its wet separator plant at Wanju in South Korea by the end of December. The plant will be gradually expanded to reach full production in 2026.

Ford (NYSE:F) is reportedly in talks with **SK On** (KRX:096770) and **EcoPro BM** (KRX:247540) to build a cathode plant in Becancour, Canada at a cost of over US$700m. The plant would supply to JV cell plants in Tennessee and Kentucky.

General Motors (NYSE:GM) and **Microvast** announced a cooperation to develop a battery separator technology for use in a new factory in the US, which Microvast plans to build. The facility will have capacity of 19GWh pa.

LG Chem (KRX:051910) announced it will build a cathode plant in Clarksville, Tennessee at a cost of US$3.2bn. By 2027, the plant will have capacity of 120Ktpa of NCMA CAM. Construction is slated to begin in H2/25.

Separately **LG Chem** inked a MOU with **Korea Zinc** (KSE:010130) for a partnership to secure a stable North American supply chain of EV battery components using Korea Zinc's smelting technology.

Panasonic (TYO:6752) expanded its recycling partnership with **Redwood Materials** to include the supply of cathode materials and copper foils from Redwood for use in its planned Kansas plant.

Posco Chem (KRX:003670) is reportedly considering investing in battery materials plants in the US with **Ford** (NYSE:F), **General Motors** (NYSE:GM) and **Stellantis** (BIT:STLA). The plants would produce cathode and anode materials.

Posco Chem (KRX:003670) has completed construction on the world's largest cathode plant at Gwangyang in Korea, which will produce 90Ktpa of high nickel cathodes. This takes Posco Chem's total cathode production capacity to 105Ktpa. It has a further 120Ktpa of capacity under development.

Sumitomo Metal Mining (TYO:5713) is to increase its NCA cathode production from 60Ktpa to 84Ktpa by March 2026 with a new plant at Niihama in Japan. It plans to reach 180Ktpa by March 2031.

Posco Chem's Gwangyang plant

Source: Posco Chem

Recycling

Botree Cycling intends to build a recycling plant in Guben, Germany. Botree's plant is scheduled to go into operation in 2025.

Altilium Metals is planning a recycling plant in Teesside, UK, to recycle battery waste into CAM for new batteries there.

People Moves

Core Lithium (ASX:CXO) appointed Mike Stone as COO to replace Blair Duncan. Stone recently held the positions of associate director of mining with KPMG, GM of the Oyu Tolgoi operation and chief advisor of productivity within Rio Tinto.

Hastings Technology Metals (ASX:HAS) appointed Alwyn Vorster as Interim CEO. Vorster has held various CEO positions throughout the last decade, including BCI Minerals, Iron Ore Holdings and API Management.

Jindalee Resources (ASX:JRL) appointed Executive Director Lindsay Dudfield as Acting CEO.

Oar Resources (ASX:OAR) appointed Paul Stephen as CEO. Stephen co-founded Crusader Resources, where he oversaw the development and operations of the Posse Iron Ore mine in Brazil.

Paul Burton has stepped down as CEO of vanadium developer **TNG Ltd** (ASX:TNG). It has launched a search process to replace him.

Vital Metals (ASX:VML) appointed John Dorward as its MD. Dorward was previously President and CEO of Roxgold.

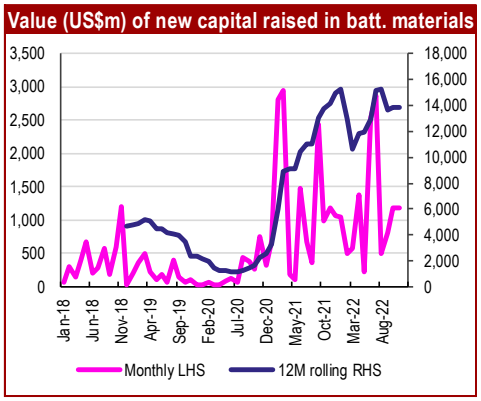
Financing/M&A: News & Analysis

Financing

It was another relatively quiet month for funding in the battery materials sector, with nickel leading the way with US$488m raised, although US$470m of this came from the IPO of China's Lygend Mining. In fact, US$2.3bn of the total US$3.3bn raised in nickel this year has come from Chinese fundraisings with the Western World only managing c.US$1bn raised, in no way enough to catalyse development in the ex-Asian nickel industry.

One does wonder when the shoe will drop for ESG investors that the bulk of carmakers in the world are planning to use extremely dirty nickel produced from Indonesian laterite operations to supply battery materials. It remains a surprise to us that ESG investors do not seem to differentiate between sulphide and laterite nickel sources. After all, they're very happy to differentiate on what the source of cobalt is…

Only US$1.18bn was raised across the battery complex in November, perhaps unsurprising given the equity market volatility, but in no way enough.



Source: Company data, BM Review

At the start of the year, we expected fundraising for 2022 to surpass 2021, but so far it is on track to undershoot 2021 levels and nowhere is this more worrying than in the lithium sector where only US$5.2bn has been raised so far this year, down 40% y/y YTD.

The discovery and development of a world-class lithium hard rock province in Canada should be grounds for excitement but, given the Canadian government's position on Chinese capital and the relatively small amount of funds seemingly prepared to invest in the mining sector, we are wary about how easy it will be to fund many of these exciting projects.

Financing/M&A News

Cobalt

CATL (SHE:300750) announced that it acquired a 25% stake in **CMOC Group** (China Molybdenum; HKG:3993) via a capital boost and stake transfer valued at Rmb26.75bn (US$3.7bn).

Graphite

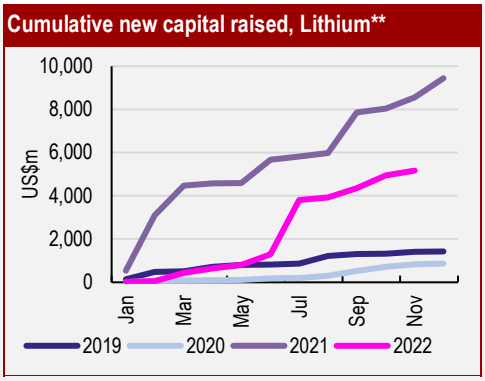
Chase Mining (ASX:CML) completed the acquisition of **Green Critical Minerals** which has the right to earn up to an 80% interest in the McIntosh project in Western Australia. McIntosh has a MRE of 23.8Mt @ 4.5% TGC for 1.1Mt of contained graphite, of which 81% is classified as indicated.

Marula Mining (OFEX:MARU) entered into a binding heads of agreement with **Kusini Gateway Industrial Park**, a Tanzanian miner, to earn into a 73% interest in the Bagamoyo project in Tanzania by conducting an initial exploration programme within three months.

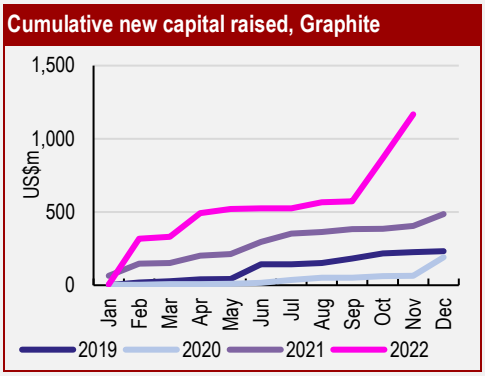
Lithium

Askari Metals (ASX:AS2) acquired the Hillside project in the eastern Pilbara region of Western Australia through a binding SSA to acquire 100% of **Greenstone Lithium**. The project is currently pre-resource.

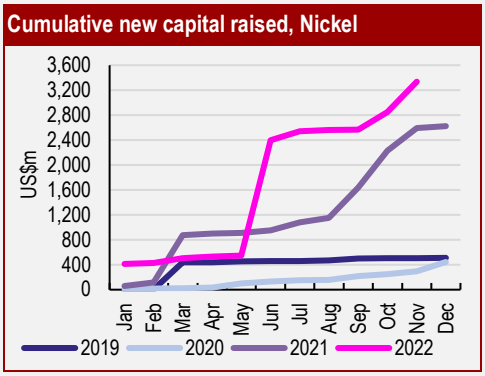
Atlantic Lithium (AIM:ALL) announced that Assore International Holdings increased its stake in the company to 25.1%.



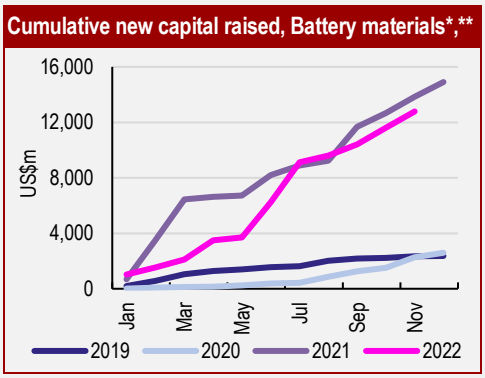
*Source: Company data, BM Review. **Excluding M&A raises*



Source: Company data, BM Review



Source: Company data, BM Review



Source: Company data, BM Review
**Cobalt, Graphite, Lithium, Nickel, REE, Vanadium*
***Excluding M&A raises and re-financings*

Financing/M&A: News & Analysis...

Lithium Americas (NYSE:LAC) announced that it will separate its North American and Argentine businesses into two independent companies. The reorganisation will establish a company focused on the Thacker Pass project in Nevada, USA, and a second company will own the Cauchari-Olaroz project in Argentina.

Pilbara Minerals (ASX:PLS) received loan funding of A$250m to part fund development of its P680 expansion and then its P1000 expansion to get to 1Mtpa of SpodCon. Separately it reported plans to start paying dividends with a ratio of 20-30% of free cash flow, due to the large amounts of cash it's generating.

Nickel

Kedalion Nickel's takeover offer for **Cannon Resources** (ASX:CNR) was declared unconditional. The offer values the company at A$45m and will close on 21 December.

Other

Bushveld Energy, a subsidiary of **Bushveld Minerals** (LON:BMN), restructured its holding in Vanadium Redox Flow Battery Holdings by selling its 50.5% interest to Mustang Energy for US$19.4m. VRFB-H holds a 50% interest in Enerox Holdings which owns an Austria-based VRFB manufacturer. Bushveld will hold 51.5% of Mustang after the deal.

Production News

Albemarle (NYSE:ALB) reported Q3/22 EPS of US$7.50, better than consensus of US$6.99 as lithium sales more than quadrupled to US$1.5bn causing it to raise its profit forecast for the full year. Its Kemerton LHM plant has transitioned to commissioning and it completed the acquisition of the Qinzhou conversion plant in China.

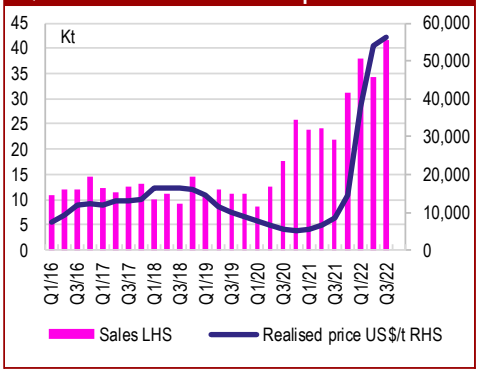
MP Materials (NYSE:MP) reported a 25% y/y increase in revenue during CQ3/22 to US$124m from the sale of 10.7Kt of REO, down 17% y/y. Production volume of REO decreased 9% y/y to 10.9Kt. Adjusted EBITDA grew 34% y/y to US$91.3m on the back of increased realised prices.

Prony Nickel reported that it had to reduce production at the Goro mine because of a leak from its tailings dam following heavy rains. The magnitude of the production impact has not yet been confirmed.

Sherritt (TSX:S) reported a 60% y/y rise in revenue to C$174m during CQ3/22 from its Moa JV in Cuba. Its share of nickel production was up 53% y/y to 4.4Kt, while cobalt production increased 25% y/y to 0.4Kt.

SQM (NYSE:SQM) reported Q3/22 lithium revenues of US$2.3bn, up 1161% y/y, on higher prices and volumes. It reported prices of over US$56/kg and noted that production costs had not increased substantially. It announced plans to use DLE and other techs to improve productivity and minimise environmental impacts at its operations.

SQM lithium sales vs realised prices



Source: Company data, BM Review estimates

It also plans to increase its LHM capacity in Chile from 40Ktpa to 100Ktpa for a cost of US$360m by 2025. It signed an offtake agreement with **SK On** (KRX:096770) to supply up to 57Kt of LHM over five years, starting in 2023.

Albemarle's Kemerton LHM plant under construction

Source: Albemarle

Battery round-up: BYD looking at sodium-ion?

It's rumoured that **BYD** (HKG:1211) is interested in sodium-ion batteries and may initiate production of them from Q2/23 for use in its Qin, Dolphin and Seagull EVs. BYD has denied the rumours. This month it announced another 20GWh cell factory in Zhejiang, China with first production in 2024.

Indonesia's sovereign wealth fund is to set up a US$2bn EV fund with **CATL** (SHE:300750) and **CALB** (HKG:3931) to invest along the EV value chain.

Gotion (SHE:002074) is to build Vietnam's first LFP Gigafactory in a JV with **VinES**. The 5GWh plant is to be sited in Ha Tinh and will cost about US$275m. Production start is expected in late-2024.

Chinese cellmaker **SVOLT** has applied to IPO on the Star Market in China. The cell maker, which was spun out of **Great Wall Motors** (HKG:2333), is looking to raise c.Rmb15bn (US$2.2bn) on a valuation of Rmb60bn. SVOLT is the world's tenth-largest cell maker with 2.6GWh of capacity.

Customcells announced that it is planning at least two more battery cell factories in Germany with a combined production capacity of over 40GWh pa.

Inobat signed declarations of intent with the Serbian government to build an EV battery plant there with an eventual capacity of 32GWh pa. The plant is scheduled to open in 2025 with an initial capacity of 4GWh pa.

Varta (ETR:VAR1) reported that it halted construction of its EV cell plant due to cost pressures. It will continue to operate its pilot plant, with construction of the large plant to resume following binding customer commitments.

Electriq Power, a US home storage firm, is to list on the NYSE via a SPAC listing in H1/23, raising US$125m in cash. The company provides energy storage and management solutions for homes and small businesses.

Zinc storage battery developer **EOS Energy Enterprises** (NASDAQ:EOSE) warned it will fail to meet its US$50m revenue guidance for 2022 and has pushed that target into next year. It expects to make US$17-20m instead.

Hyundai (KRX:005380) is reportedly looking to adopt **CATL**'s (SHE:300750) cell to pack (CTP) technology on its new EVs from next year. CTP puts cells into packs without modules, increasing pack energy density. Hyundai will use CTP for ternary batteries primarily. CATL claims its Gen#3 CTP technology offers 13% more energy density than conventional 4680 batteries.

Hyundai is also reportedly planning a 20GWh pa factory in Georgia, US, with **SK On** (KRX:096770) for a joint investment of US$1.9bn. The plant is expected to start in Q1/26 and will produce high nickel pouch cells. HMC is reported to also be considering another two 35GWh pa factories in Georgia as part of a JV with **LG Energy Solution** (KRX:373220).

Macquarie's Green Investment Group has launched **Eku Energy**, a global platform to develop and own BESS assets. Eku will own GIG's existing 190MWh assets as well as its 3GWh pipeline, which it is looking to expand.

Neoen (EPA:NEOEN) raised its 2022 guidance after its BESS revenues nearly tripled y/y in 9M/22 to €65m. Much of this comes from its earnings from the Victorian Big Battery in Australia.

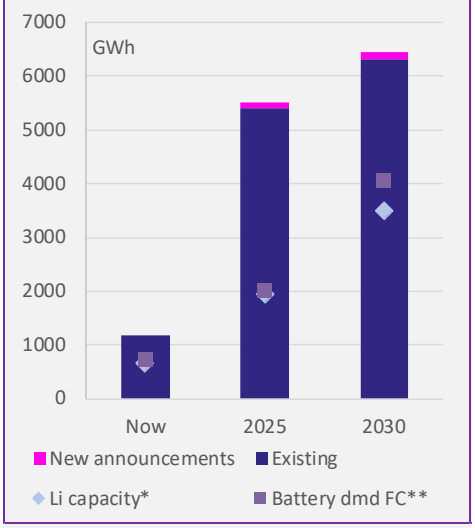
GIGAFACTORY MONITOR

This month's key announcements

Company	Location	Size GWh	Start date
Envision AESC	Cangzhou	30	2024
Envision AESC	Shiyan	40	2024
BYD	Zhejiang	20	2024
Hyundai/SK On	Georgia	20	2026
Hyundai/LGES	Georgia	35	2026

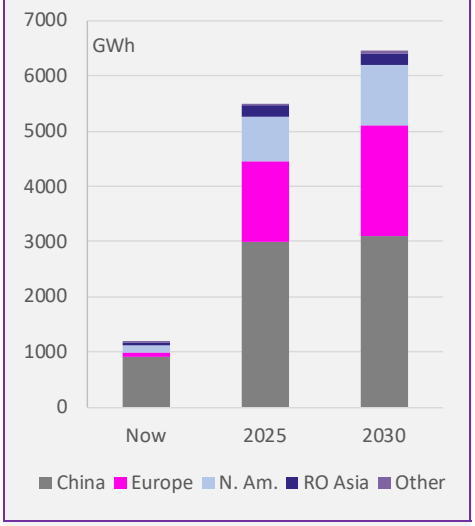
Source: Companies, BMR estimates

Announced gigafactories vs forecast demand



**Lithium to supply batteries on BMR estimates*
***Incl. EVs, other vehicles, cons. Products, ESS*
Source: BNEF, Companies, BM Review estimates

Announced gigafactory capacity by region



Source: BNEF, Companies, BM Review estimates

Volkswagen is reportedly in talks with pre-IPO investors as it seeks to raise funds for its battery unit as it seeks to gauge investor appetites.

Downstream: News and Views...

CellCube is in talks with **North Harbour Clean Energy** (NHCE) to build a 1GW/8GWh cell factory for VRFBs in Australia. The plant could be supplied via a previously signed deal between NHCE and **Australian Vanadium** (ASX:AVL).

Volkswagen to push back Trinity project

Volkswagen (ETR:VOW) has announced that it will have to push back its key Trinity EV project to the end of the decade from 2026 because key software won't be completed in time. As part of that it may shelve plans to build a new €2bn EV factory at Wolfsburg in Germany. The Trinity project is VOW's successor to the ID range of EVs.

The news comes as Volkswagen warned that high energy prices will make European cell manufacturing unviable in the long-term. That does make one wonder if VOW might delay development of its six planned cell factories in Europe?

EV round-up: Renault targeting €10bn valuation for EV business

French OEM **Renault** (EPA:RNO) is reportedly aiming for a €10bn valuation for the carve out of its EV business into a standalone entity. It is considering an IPO for the business, named **Ampere**, next year. Whether Renault will get this valuation, given recent underperformance by EV stocks, remains to be seen.

Mercedes (ETR:MBG) has followed **Tesla** (NASDAQ:TSLA) in cutting prices for its Chinese EVs. Mercedes is struggling to sell models in China and is losing ground to local brands. Likely MBG can afford to make the cuts given the fall in nickel, cobalt and manganese prices in recent months. Interestingly **BYD** (HKG:1211) has raised the prices for some of its models by US$280-840, citing high lithium prices and the phasing out of some EV subsidies.

BNEF reports that automakers are increasingly embracing EVs with 800 volt cell architectures to attract drivers who want shorter charge times. Previously 400 volt systems have been more common. Charging at higher voltage is faster because the lower current reduces energy lost to heat and shrinks component sizes. But the switch will require re-engineering of both vehicles and charging infrastructure.

Japan has approved a ¥70bn (US$493m) subsidy for NEV purchases as part of an extra budget for FY23. Small EVs introduced by Nissan and Mitsubishi have captured substantial market share in Japan in 9M/22.

CATL (SHE:300750) is reportedly to provide Vietnamese EV manufacturer **Vinfast** with a complete EV skateboard chassis. While there is little detail, this seems to be similar to **Volkswagen**'s (ETR:VOW) MEB product, consisting of battery packs, motors and other components. The new chassis will utilise CATL's latest cell-to-pack technology. This should substantially cut down Vinfast's development timeline for its new EV models.

Mazda (TYO:7261) has unveiled plans to spend US$10.6bn on electrification of its range. It's targeting 40% electric sales by 2030, up from its previous 25% target, and is also considering whether to get into cell manufacturing. It has a cell offtake deal with **Envision AESC** for 2025-27 but needs to lock in cell supply beyond that.

The **US** has announced plans to hit zero emission heavy duty truck and bus sales by 2040. Medium and heavy duty vehicles in the US are 10% of road traffic but 26% of emissions

US gives US$350m funding to LDES

The US has announced plans to invest US$350m into long duration energy storage (LDES) demonstration projects as part of its aim to improve its grid by 2035. The Department of Energy will fund as many as eleven pilots focusing on 10-24 hour duration projects.

As we outlined in the last issue, ESS is really starting to gain substantial government support and LDES is likely to be a key component of that. In addition to the packages announced last month, Canada has just introduced a 30% refundable investment tax credit on ESS and the EU continues to make positive noises about ESS, although its planning system is still extremely fraught.

European residential battery demand in Europe on a roll

Residential solar marketplace, **Otovo** (NO:OTOVO), has disclosed that over 70% of the residential solar systems that it sells in Germany and Italy have batteries attached, highlighting the strong demand for residential ESS since the Energy Crisis broke out.

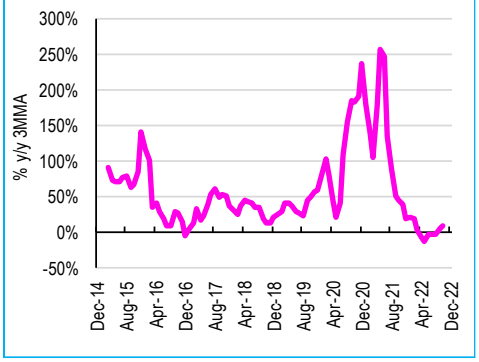
BNEF also highlights strong growth in battery attachment rates for residential solar in Poland, Netherlands and Denmark, and a substantial increase in PV penetration all over Europe. Resi storage installations in Germany are expected to hit 1.1GW/2.1GWh in 2022, up 40% y/y, while Italian installations are expected to rise fourfold to 0.5GW/1.1GWh. With the increase in power prices and energy price volatility, the payback period in Germany for PV and storage has fallen to 10 years from 12 years in 2019.

EV sales slowing m/m

Global EV sales dropped 10% m/m although they remain robust in y/y terms and are up 61% y/y for the year to date.

European sales activity is quite volatile and was down compared to September, after a strong recovery in that month (due to a large Tesla delivery). However, on a YTD basis, sales are still in positive terms after turning marginally negative in July.

European PEV sales growth



Source: BM Review, EVvolumes.com

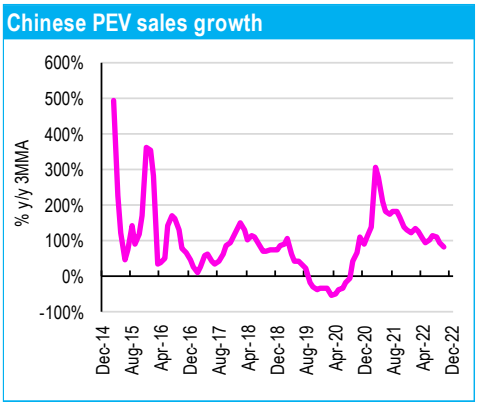
Seasonal trends are normally more positive into the last two months, so we should hopefully see some acceleration in sales activity.

None of Tesla's models made the top ten in October, with the Volkswagen ID.4 and ID.3 dominating the top ten. There were two new entries, the Volvo XC40 BEV and the Polestar 2 BEV, and there was only one PHEV amongst the top 10 models.

In **China**, sales were also down on a m/m basis, and they are now slowing somewhat on a y/y basis, being up a measly 100% for the year to date! There is no doubt that the Covid lockdowns in October (and likely into November) did have an impact and all hopes are now focused on December to see if sales pick up.

Nov-Dec is historically a seasonally strong period for EV sales so a likely slowdown in activity will be negative for sentiment, although we do expect December sales to recover.

Chinese PEV sales growth

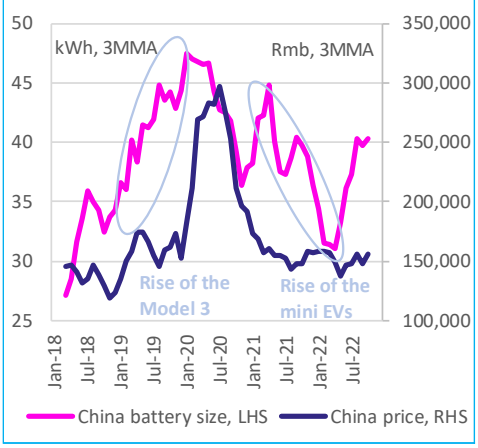


Source: BM Review, EVvolumes.com

Once again, BYD dominated in terms of the top models with seven out of the ten top-selling models in China. Way out in front was the BYD Song PHEV with c.8% market share, although the Wuling HongGuang Mini also returned to the top two with its highest amount of sales since June.

New entrants, the BYD Yuan Plus and Dolphin Hb, both vehicles with smaller batteries, helped push down the average battery size to 39kWh.

Battery size and price of China's top selling EVs

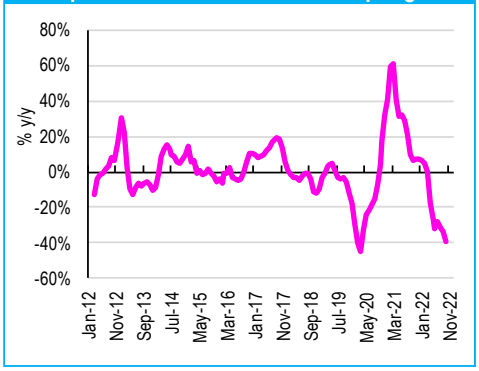


Source: EVvolumes, Westbeck Cap, BM Review

Power tools output collapses

China's power tools output is falling off a cliff, presumably indicative of a fall in demand in the segment which was a key beneficiary of the Pandemic.

China portable electronic device output growth



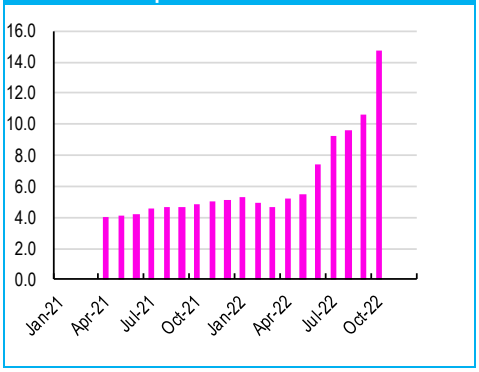
Source: BM Review, China NBS

Mobile phone output has recovered somewhat in y/y terms but wearables demand is still weak suggesting not too much light at the end of the tunnel for consumer battery manufacturers.

China ESS cell production on a roll

Production of cells for Stationary Storage applications seems to be on a roll, even as there is a near-term slowdown in EV cell installations.

China ESS cell production

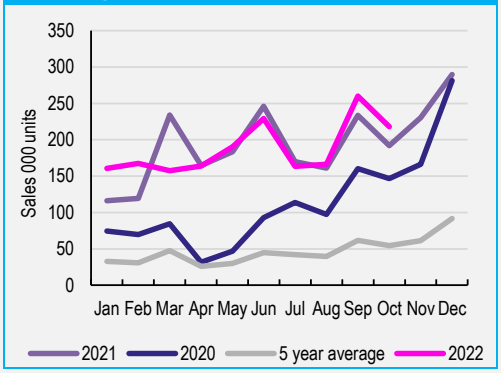


Source: BMR, ICC Sino

ESS cell output was 14.8GWh in October, up over 200% y/y. The bulk of these cells are LFP and due to the less stringent technological requirements of ESS vs EVs, some smaller cell makers are benefiting from demand in this segment.

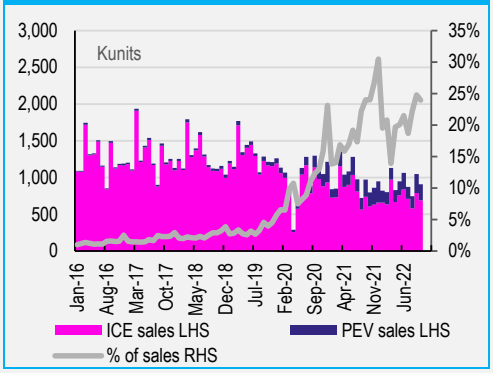
Trade & Demand: End Uses Data Summary

Seasonality of European EV sales



Source: EVvolumes.com, BM Review

European EV new sales penetration



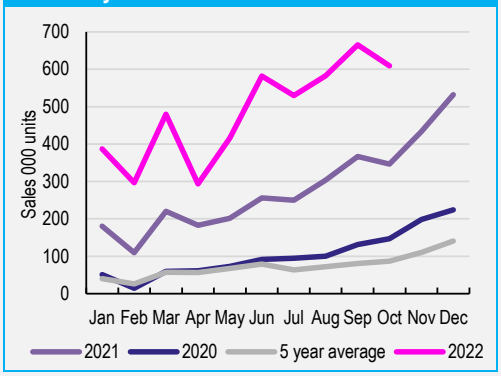
Source: EVvolumes.com, Westbeck Capital, BM Review

Monthly EV sales & battery exports summary

		Oct-22	m/m	y/y	YTD y/y
PEV sales					
Europe	K units	218.1	-16%	14%	3%
China	K units	609.4	-8%	76%	100%
US	K units	95.3	5%	77%	51%
Global	**K units**	**981.5**	**-10%**	**58%**	**61%**
ESS battery production					
China	GWh	14.8	39%	206%	NA
Lithium ion-battery net exports					
China	M units	222.8	-12%	7%	55%
Japan	US$m	51.9	201%	-73%	-54%
Korea	US$m	98.1	-43%	-16%	-31%

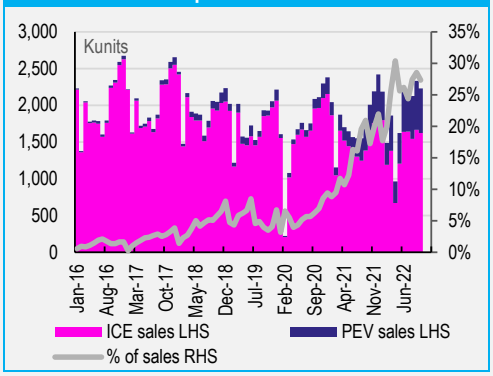
Source: EVvolumes.com, GlobalTradeTracker, BM Review

Seasonality of Chinese EV sales



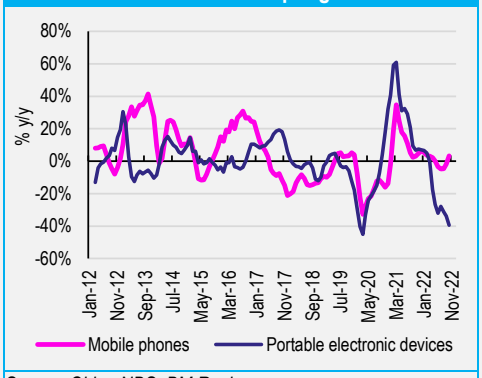
Source: EVvolumes.com, BM Review

China EV new sales penetration



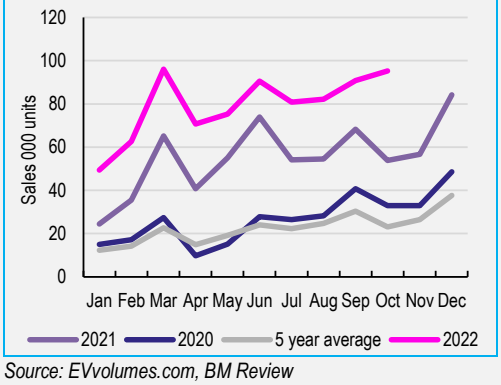
Source: EVvolumes.com, Westbeck Capital, BM Review

Chinese electronic device output growth



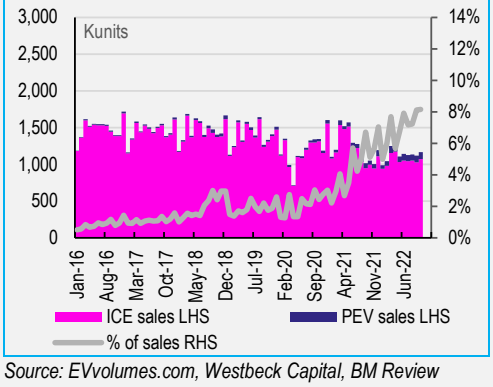
Source: China NBS, BM Review

Seasonality of US EV sales



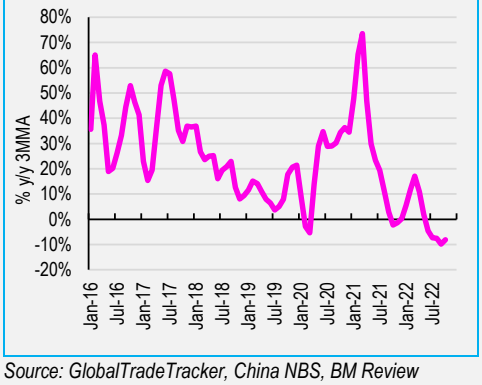
Source: EVvolumes.com, BM Review

US EV new sales penetration



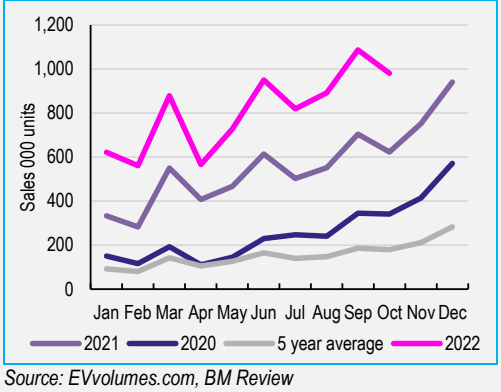
Source: EVvolumes.com, Westbeck Capital, BM Review

Chinese LIB apparent consumption growth



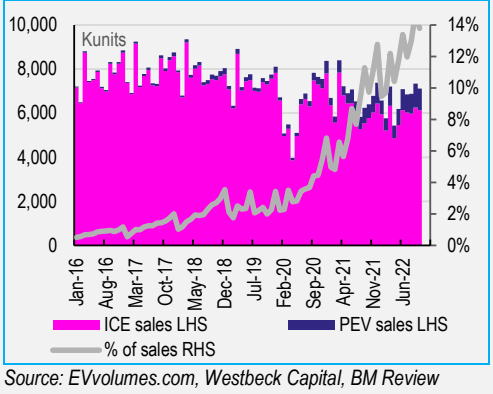
Source: GlobalTradeTracker, China NBS, BM Review

Seasonality of Global EV sales



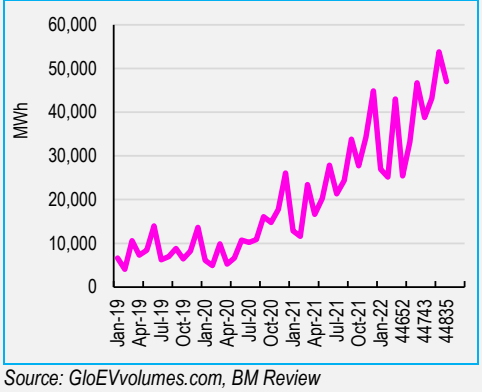
Source: EVvolumes.com, BM Review

Global EV new sales penetration



Source: EVvolumes.com, Westbeck Capital, BM Review

Global Battery Installations



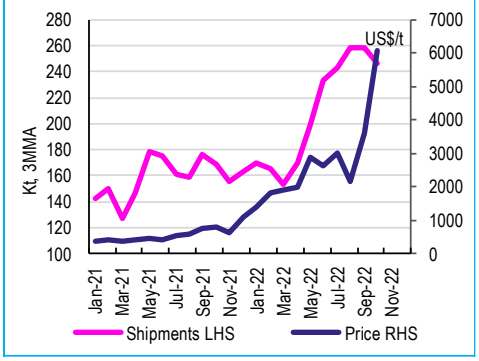
Source: GloEVvolumes.com, BM Review

Aus SpodCon exports down again

Australian spodumene concentrate exports once again failed to kick on in October, falling 35% m/m to 189Kt. It has been a recurring theme so far this year that SpodCon exports have not managed to break materially upwards.

What did manage to break material upwards however, was the realised export price which ticked up to US$6152/t for material bound for China which, when corrected for insurance, freight, demurrage charges and grade, is likely close to US$7000/t. A number of recent notes from bulge bracket banks have questioned the ability of SpodCon prices to break out, but this data suggests that it is now starting to happen, which is likely to be positive for CQ4/22 reporting.

Australian SpodCon exports vs realised prices



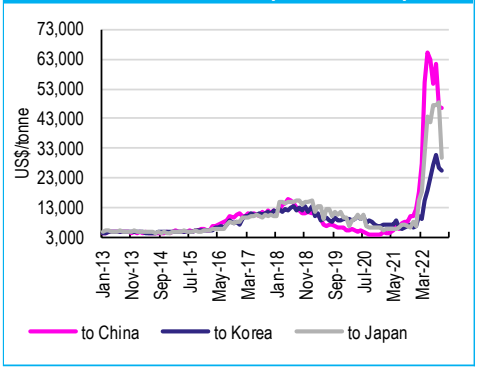
Source: GTT, BM Review

Chile exports also depressed

Another country where exports had been expected to kick on but where they haven't is in Chile. After lithium carbonate exports hit 26.5Kt in May many analysts were suggesting that Chile would flood the market with material.

Unfortunately for Chilean producers, but fortunately for the market, this hasn't been the case and, while Chilean lithium carbonate exports are on track to be up 50% y/y, they are by no means as high as many expected.

Chile Lithium carbonate export realised prices



Source: BM Review, GlobalTradeTracker

One element which continues to concern analysts is price pullback. Obviously we don't know the reason for the price correction, but we would suggest it has to do with low quality material vs higher grade material and with contract tonnage vs spot tonnage.

It seems likely that a large proportion of the exports in May/June may have been inventories of higher grade, non-contract which was sold at spot, whereas now the producers (primarily SQM) are selling contract material. We have also heard transfer pricing being mooted as an explanation and will be doing some more research into that.

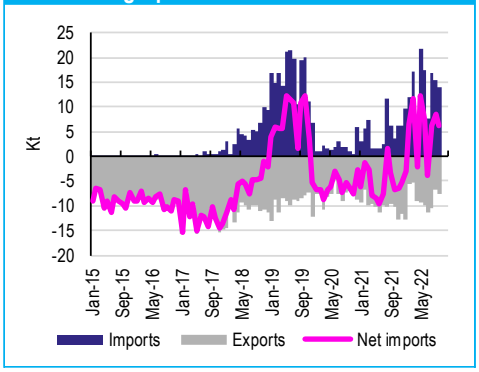
Graphite squeeze

China remains a net importer of flake graphite and has now been a net importer for five out of the last six months.

There was a substantial increase in realized import prices for flake in October with prices for imports from Mozambique up to US$770/t from US$646/t last month and for Madagascar up to US$917/t from US$625/t last month. While we don't know if the make up of the baskets changed, this increase in prices seems to suggest robust demand and potentially a point of inflection in the trading environment.

AAM production continues to accelerate, which seems to suggest that natural graphite demand will continue to grow.

China flake graphite trade balance

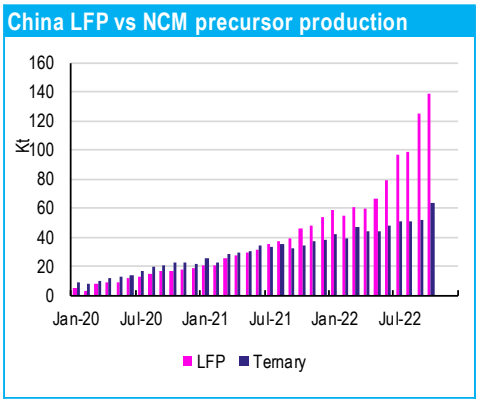


Source: BM Review, GlobalTradeTracker

LFP continues to outperform ternary

LFP precursor production continues to exceed ternary precursor production by quite some distance in the second half of the year.

China LFP vs NCM precursor production

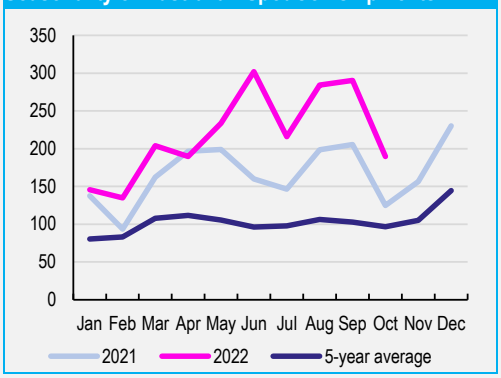


Source: ICCSino

There is concern in some circles that LFP may be moving into overcapacity and there simply won't be enough demand to fill all the new capacity. However, given the rapid expansion of ESS cell capacity and demand, it's possible that the LFP overcapacity may not be as bad as many commentators suggest.

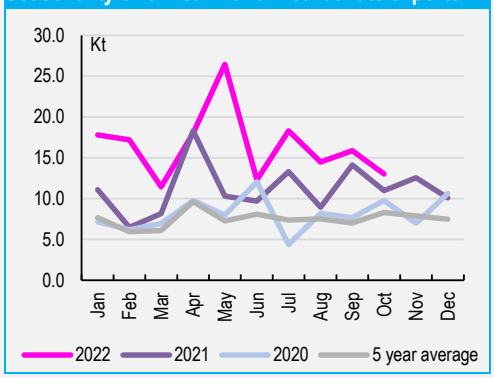
Trade & Demand: Materials Data Summary

Seasonality of Australian SpodCon shipments



Source: GlobalTradeTracker, BM Review

Seasonality of Chilean lithium carbonate exports



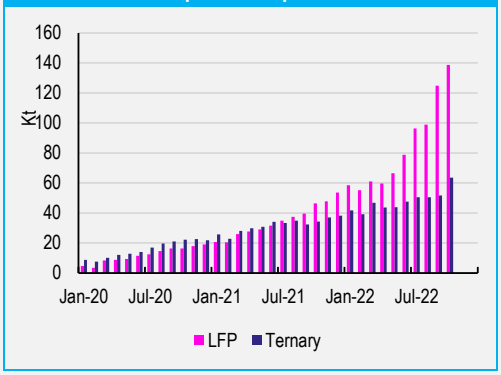
Source: GlobalTradeTracker, BM Review

Monthly trade summary

		Oct-22	m/m	y/y	YTD y/y
Trade data					
China					
Net imports					
Cobalt ores & conc.	Kt	0.0	-100%	-100%	42%
Lithium carbonate	Kt	7.7	-34%	-22%	66%
Nickel metal & alloys	Kt	23.3	35%	-66%	-42%
Flake graphite	Kt	6.3	-27%	95%	296%
Net exports					
Spherical graphite	Kt	4.7	-25%	21%	4%
Lithium hydroxide	Kt	9.5	27%	76%	28%
Exports					
Rare Earths	Kt	3.6	-17%	-17%	4%
Japan					
Net imports					
Lithium carbonate	Kt	2.0	-10%	6%	41%
Lithium hydroxide	Kt	0.1	-4%	-76%	-42%
Korea					
Net imports					
Lithium carbonate	Kt	3.3	-5%	-20%	12%
Lithium hydroxide	Kt	7.5	35%	70%	36%

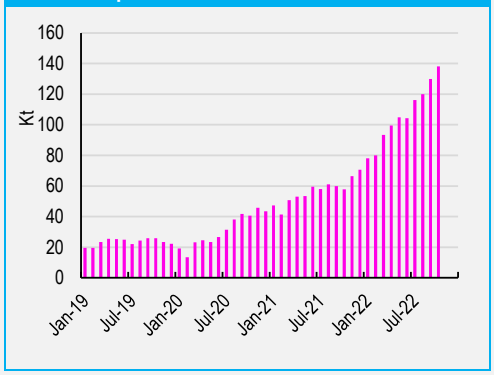
Source: GlobalTradeTracker, BM Review

China LFP vs NCM precursor production



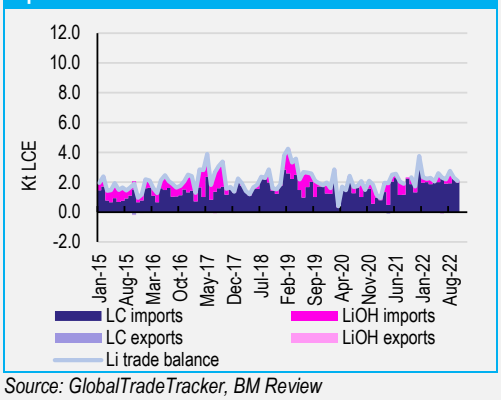
Source: ICCSino, BM Review

China AAM production



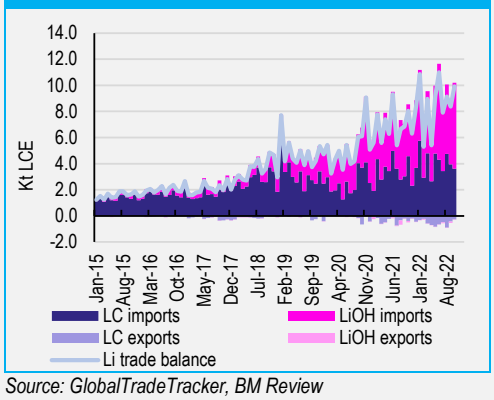
Source: ICCSino, BM Review

Japan lithium trade balance



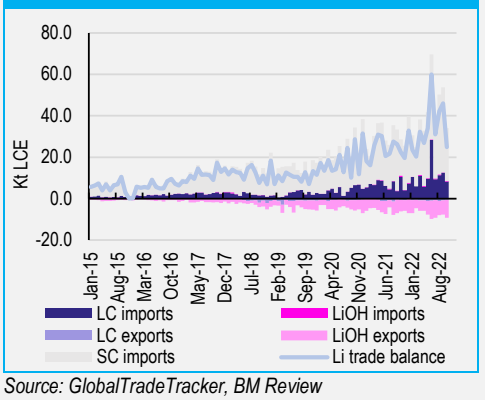
Source: GlobalTradeTracker, BM Review

Korea lithium trade balance



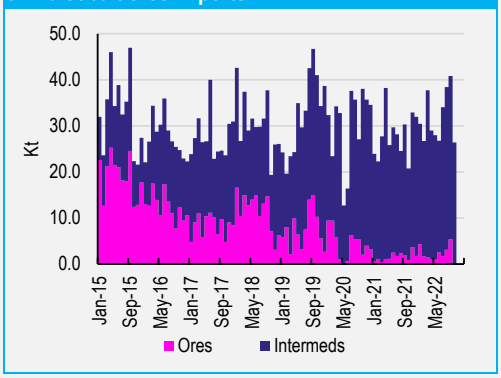
Source: GlobalTradeTracker, BM Review

China lithium trade balance



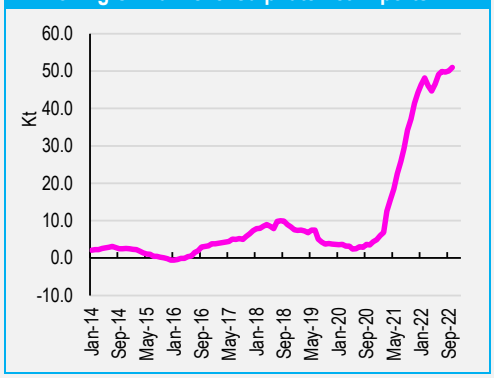
Source: GlobalTradeTracker, BM Review

China cobalt ores imports



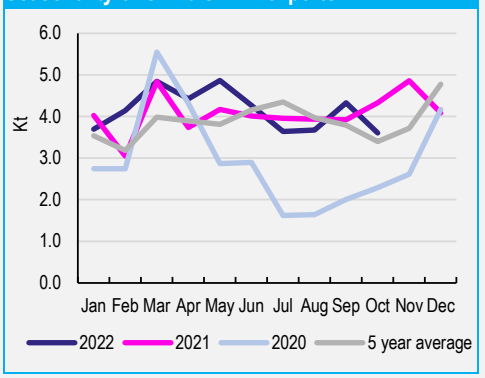
Source: GlobalTradeTracker, BM Review

12M rolling China nickel sulphate net imports



Source: GlobalTradeTracker, BM Review

Seasonality of China's REE exports



Source: GlobalTradeTracker, Westbeck, BM Review

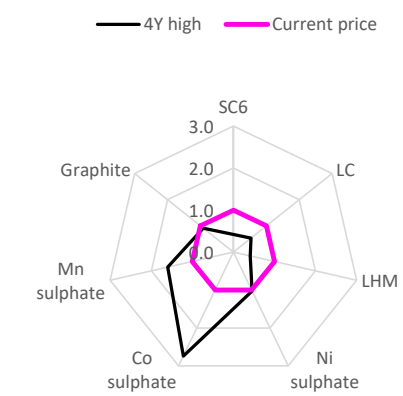
Macro and Material Prices

Monthly performance of key battery materials, November 2022

US$		Nov-22	1M	3M	12M	YTD
Raw Materials						
Spodumene concentrate (CIF China)	US$/t	6,110	2%	22%	165%	139%
Lithium carbonate China (99% del)	US$/kg	81.5	5%	14%	161%	86%
Lithium hydroxide China (96% del)	US$/kg	79.9	7%	15%	179%	144%
Nickel, LME	US$/t	26,892	24%	26%	34%	29%
Nickel sulphate China (21-22.5% ExW)	US$/t	5,747	2%	1%	4%	8%
Cobalt LME	US$/t	51,498	0%	0%	-21%	-27%
Cobalt sulphate China (20% Del)	US$/kg	7.9	-7%	-9%	-45%	-50%
Manganese sulphate	US$/t	973	3%	0%	-37%	-38%
Graphite, China flake 190	US$/t	557	3%	18%	29%	14%
Vanadium pentoxide, China 98% FOB	US$/lb	7.9	2%	8%	-12%	-13%
NdPr oxide, Shanghai	US$/kg	92.9	4%	2%	-31%	-30%
Aluminium, LME	US$/t	2,448	10%	3%	-7%	-13%
Copper, LME	US$/t	8,227	9%	5%	-14%	-16%
Lead, LME	US$/t	2,182	10%	12%	-6%	-7%
Zinc, LME	US$/t	3,050	12%	-14%	-7%	-15%
Intermediate Materials						
NCM 523 precursor	US$/kg	15.2	-1%	-5%	-26%	-27%
NCM523 cathode material	US$/kg	49.7	3%	10%	41%	28%
NCM 622 cathode material	US$/kg	52.5	3%	9%	37%	25%
LFP precursor	US$/kg	23.9	2%	6%	78%	56%
China SPG 99.95% 17 micron ExW	US$/kg	3.2	4%	3%	20%	10%

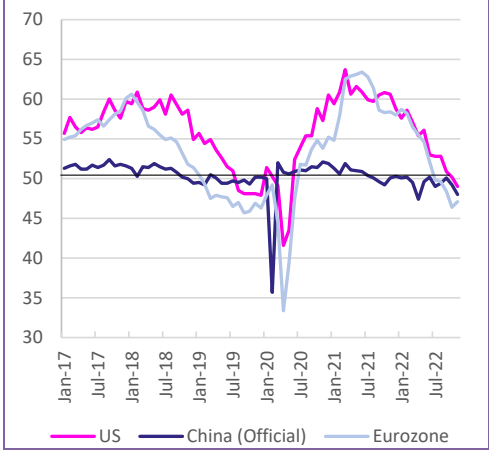
Source: Westbeck Capital, BM Review

China LIB material prices* vs 4-year high (US$/t)



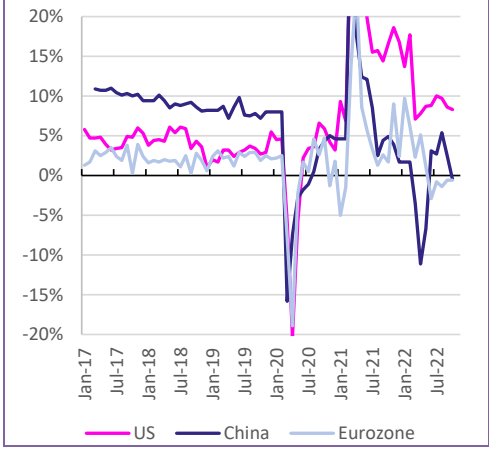
*Source: BM Review. *Spot prices, indexed to 3Y high*

Global manufacturing PMIs*



Source: BM Review. +50 is expansion, -50 contraction

Global retail sales growth



Source: Company data, BM Review

Big squeeze in LME nickel

It was quite a reasonable month for battery raw materials in November, with most materials in the black, apart from cobalt sulphate where prices took a 7% dive.

It was lithium and nickel which dominated the column inches however. The LME's nickel contract is becoming increasingly volatile and market participants are starting to investigate other futures markets such as Shanghai and Chicago.

In lithium there were a number of negative sell-side notes (the usual suspects; see Focus article) but Chinese prices continued to inch up. We regard the volatility on the Wuxi futures exchange as noise in this market; the exchange accounts for volumes of much less than 1% of the market…

Macro: how far are we from the bottom?

That is very much the question that is now starting to dominate, but unfortunately we feel it will be some time before we reach the bottom of the macroeconomic cycle.

All key regions are now in manufacturing contraction and retail sales growth remains negative in the Eurozone and has gone negative in China. Only the US consumer seems to be keeping its head above water.

We are concerned about the potential for a material business inventory destocking event which could lead to a further downturn in demand for metals (not battery materials, it must be said) which could lead to weaker copper and nickel prices (after the bounce which accompanies China reopening excitement). We still expect battery materials to outperform, however.

We still prefer Lithium

Given our comments on Lithium in the Feature article, it's perhaps not a major surprise that we continue to prefer **Lithium** this month.

Even though there has been negative momentum due to tax loss selling in North America and various negative broker reports, we continue to prefer lithium within the context of the overall battery materials universe, and we continue to prefer explorers and developers over producers within that.

As expected, **Copper** equities had a strong bounce in November, but we remain wary about the global macro situation and would not be chasing those stocks.

The big surprise for the month was **Graphite** (at last)! While the basket performance doesn't fully redress considerable underperformance of the equities compared to the material during the year, it does go some way towards doing so. We hope for more.

It was also good to see **REE** becoming better-bid after a material sell-down, which we don't believe is warranted.

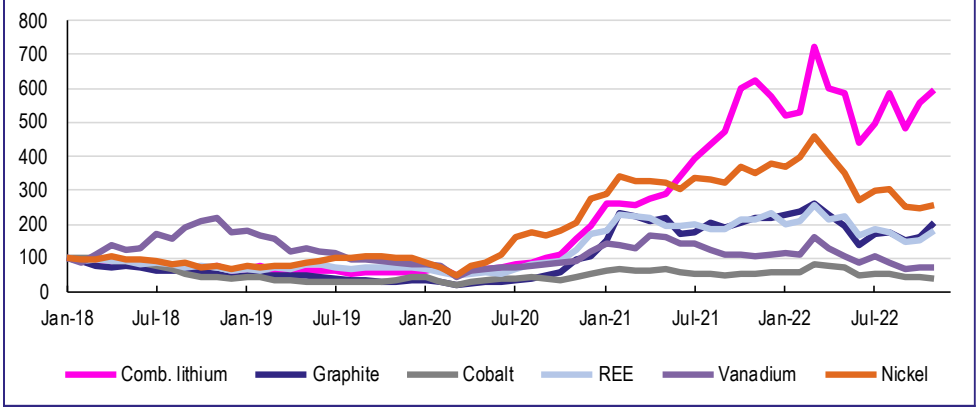
Our preferences are thus **Lithium Explorers & Developers, REE, Graphite.**

On the downside, **EV makers** continue to suffer, and we would remain wary about this segment with continuing erosion of consumer demand in the Western World. **Cell makers** are managing to outperform, and perhaps it's time to turn neutral on them, although maintaining our negative stance on EV manufacturers

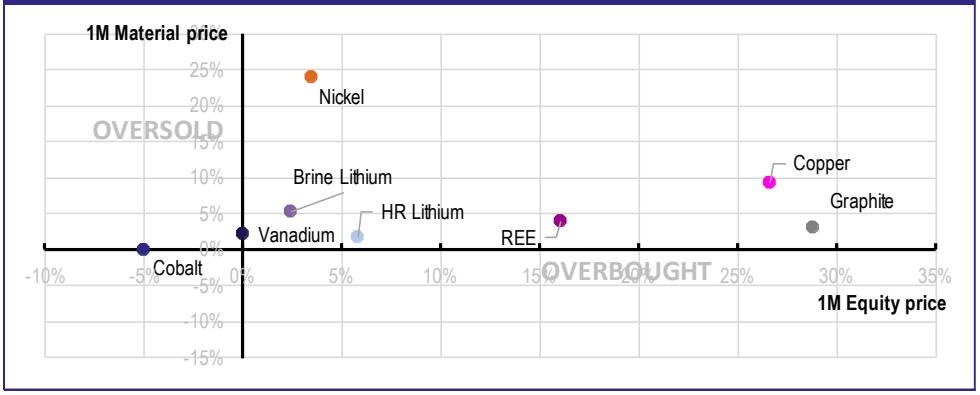
November 2022 performance of key indices and BM Review equity baskets

US$	Current	1M	3M	12M	YTD
BMR Raw & Intermediate Materials equity baskets					
Cobalt	42	-5%	-23%	-20%	-27%
Copper	132	27%	23%	-7%	-13%
Graphite	208	29%	16%	-5%	-6%
HR Lithium	1021	6%	5%	14%	24%
Brine Lithium	376	2%	-1%	-13%	-20%
Li - producers	328	8%	3%	-8%	4%
Li - developers	915	1%	-8%	-16%	-16%
Li - explorers	278	24%	34%	105%	70%
Manganese	179	5%	3%	-30%	-30%
Nickel	255	4%	-16%	-27%	-33%
Ni - explorers/developers	253	4%	-8%	-30%	-31%
REE	180	16%	3%	-16%	-23%
Vanadium	72	0%	-18%	-31%	-35%
Midstream	290	10%	4%	-20%	-17%
Recycling	107	-1%	-27%	-33%	-35%
BMR Downstream equity baskets					
Cellmakers	238	9%	-17%	-42%	-36%
EV Makers	197	-8%	-30%	-59%	-54%
Indices & sector ETFs					
S&P Global 1200 index	3014	8%	4%	-11%	-15%
S&P Global 1200 Materials index	3393	15%	11%	-3%	-9%
Global X Lithium & Battery Tech ETF	69.5	4%	-6%	-25%	-18%
Solactive Battery Value-Chain index	462.5	11%	7%	-5%	-7%

BMR Equity basket performance (US$), Jan 2018-present



Equity vs Material price performance, last month



Source: BM Review, Westbeck Capital

Equity Valuations – Lithium

Lithium company EV/resource valuation tracker

Ticker	Company	Mkt cap US$m	Project	Type	Product	Stage	Li2O grade %	Li mg/l	Contained LCE Mt	Mkt cap/ Resource US$/t LCE	Prodn EV/ Resource US$/t LCE
EARLY STAGE											
ESS AU	Essential Metals	77	Dome North, WA	Rock	SC6	MRE	1.2%		0.3	230	NA*
GL1 AU	Global Lithium	404	Marble Bar, WA	Rock	SC6	MRE	1.1%		0.5	750	NA*
GT1 AU	Green Technology Metals	168	Seymour, ON	Rock	SC6	MRE	1.0%		0.3	661	NA*
PAM AU	Pan Asia Metals	43	Reung Ket, Thailand	Rock	Integ	MRE	0.4%		0.1	384	NA*
LITM US	Snow Lake Lithium	54	Thompson Bros, MN	Rock	SC6	MRE	1.0%		0.3	195	NA*
GLN AU	Galan Lithium	290	HMW, Argentina	Salar brine	LC	PEA		866	5.8	50	95
LIS CN	Lithium South Developme	35	HMN, Argentina	Salar brine	LC	MRE		756	0.6	61	NA*
LI CN	American Lithium	318	TLC, NV	Sedimentary	LHM	Evaluation		1,672	11.9	27	NA*
AM7 AU	Arcadia Minerals	15	Eden Pan, Namibia	Sedimentary	LC	Evaluation		633	0.3	52	NA*
AZL AU	Arizona Lithium	123	Big Sandy, AZ	Sedimentary	LC	Evaluation		1,850	0.3	384	NA*
CYP CN	Cypress Development	112	Clayton Valley, NV	Sedimentary	LC	PFS		958	7.7	15	76
JRL AU	Jindalee Resources	82	McDermitt, Oregon	Sedimentary	LC	Evaluation		1,370	13.3	6	NA*
NRM CN	Noram Ventures	49	Zeus, NV	Sedimentary	LC	Evaluation		897	5.7	9	NA*
SPMT CN	Spearmint Resources	11	McGee, NV	Sedimentary	LC	Evaluation		823	2.1	5	NA*
ALLI CN	Alpha Lithium	108	Tolillar, Argentina	Salar/DLE brine	LC	MRE		224	3.3	33	NA*
ASN AU	Anson Resources	172	Paradox Basin, UT	Salar/DLE brine	LC	Evaluation		187	0.8	218	438
ETL CN	E3 Lithium	115	Leduc, Alberta	DLE brine	LC	Evaluation		72	7.0	16	NA*
GRD CN	Grounded Lithium	15	Kindersley, Saskatchewan	DLE brine	LC	MRE		74	2.9	5	NA*
HAM CN	Highwood Asset Manager	22	Drumheller, Alberta	DLE brine	LC	MRE		48	18.1	1	NA*
LBNK CN	LithiumBank Resources	20	Boardwalk, Alberta	DLE brine	LC	MRE		67	6.0	3	NA*
PE CN	Pure Energy Minerals	13	Clayton Valley, NV	Salar/DLE brine	LC	PEA		123	0.2	61	1,424
EVALUATION											
ALL LN	Atlantic Lithium	325	Cape Coast, Ghana	Rock	SC6	PEA	1.3%		0.9	347	329
AVZ AU	AVZ Minerals	1,955	Manono, DRC	Rock	SC6	DFS	1.7%		16.4	119	150
CRE CN	Critical Elements	333	Rose, QC	Rock	SC5.5	FS	0.9%		0.8	438	855
EMH AU	European Metals Hldgs	95	Cinovec, Czech Rep	Rock	Integ. LHM	PFS	0.4%		7.4	13	77
EUR AU	European Lithium	80	Wolfsberg, Austria	Rock	Integ. LHM	PFS	1.0%		0.3	250	1,397
FL CN	Frontier Lithium	347	PAK, ON	Rock	Integ. LHM	PEA	1.5%		1.6	218	649
INF AU	Infinity Lithium	53	San Jose, Spain	Rock	Integ. LHM	PFS	0.6%		1.7	32	209
KOD LN	Kodal Minerals	57	Bougouni, Mali	Rock	SC6	FS	1.1%		0.6	97	324
PLL US	Piedmont Lithium	1,090	Carolina, US	Rock	Integ. LHM	PFS	1.1%		1.2	923	1,515
RCK CN	Rock Tech Lithium	181	Georgia Lake, ON	Rock	Integ. LHM	PEA	1.1%		0.4	507	1,373
SAV LN	Savannah Resources	55	Mina do Barroso, Portugal	Rock	SC6	PEA	1.1%		0.7	78	207
SYA AU	Sayona Mining	1,358	Authier, QC	Rock	SC6	DFS	1.1%		3.7	372	368
ZNWD LN	Zinnwald Lithium	27	Zinnwald, Germany	Rock	SC6	DFS	0.6%		1.0	26	208
LPI AU	Lithium Power Int.	140	Maricunga, Chile	Salar brine	LC	DFS		953	2.3	62	309
INR AU	Ioneer	885	Rhyolite Ridge, NV	Sedimentary	LC, LHM	DFS		1,600	1.2	709	1,263
LKE AU	Lake Resources	946	Kachi, Argentina	Salar/DLE brine	LC	PFS		228	4.4	215	311
SLI CN	Standard Lithium	709	Lanxess, AK	DLE brine	LC, LHM	PEA		168	3.1	226	333
VUL AU	Vulcan Energy Res.	717	Zero Carbon Li, Germany	DLE brine	LHM			181	15.9	45	74
FINANCED/CONSTRUCTION											
CXO AU	Core Lithium	1,638	Finniss, Northern Territory	Rock	SC6	U/C	1.3%		0.6	2,655	2,605
LLL AU	Leo Lithium	448	Goulamina, Mali	Rock	SC6	FID	1.5%		3.9	231	232
LTR AU	Liontown Resources	3,032	Kathleen Valley, WA	Rock	SC6	FID	1.4%		5.2	582	566
SGML CN	Sigma Lithium	3,530	Grota do Cirilo, Brazil	Rock	SC6	FS	1.4%		3.0	1,163	1,155
AGY AU	Argosy Minerals	626	Rincon, Argentina	Salar brine	LC	PEA		325	0.2	2,552	3,059
LAC CN	Lithium Americas	3,425	Various, Arg, US	Salar brine, sed	LC	U/C		1,179	32.9	104	122
PRODUCTION											
PLS AU	Pilbara Minerals	9,389	Pilgangoora, WA	Rock	SC6	Production	1.2%		6.6	1,419	1,406
ALB US	Albemarle	33,304	Various, Chile, Australia	Integrated	SC6, LC, LHM	Production			21.4	1,557	1,691
AKE AU	Allkem	6,119	Various, WA & Argentina	Rock, brine	SC6, LC	Production			24.2	253	254

*Source: Company data, BM Review estimates. Based on MII resources. *No capex estimates. Prodn EV = EV + Capex remaining to production.* As at 05-Dec-22.

Equity Valuations – Graphite / Manganese

Upstream Graphite company EV/resource valuation tracker

Ticker	Company	Mkt cap US$m	Project	Type	Stage	MII Resource Mt	TGC grade %	Cont'd graphite Mt	Mkt cap/ Resource US$/t	Prodn EV/ Resource US$/t
EVALUATION										
AFRICA										
ACP LN	Armadale Capital	13.7	Mahenge Liandu, Tanzania	Concentrate	DFS	59.5	9.8%	5.8	2.3	9.0
BAT AU	Battery Minerals	8.0	Montepuez, Mozambique	Concentrate	DFS	135.7	8.4%	11.3	0.7	6.6
BKT AU	Black Rock Mining	106.9	Mahenge, Tanzania	Concentrate	DFS	213.1	7.8%	16.7	6.4	12.8
BRES LN	Blencowe Resources	13.9	Orom-Cross, Uganda	Concentrate	PEA	24.5	6.0%	1.5	9.4	63.8
EVG AU	Evion Group	17.5	Maniry, Madagascar	Concentrate	PEA	40.0	6.5%	2.6	6.7	21.0
EV1 AU	Evolution Energy Minerals	33.1	Chilalo, Tanzania	Concentrate	DFS	67.3	5.4%	3.6	9.1	32.1
NEXT CN	NextSource Materials	249.6	Molo, Madagascar	Concentrate	U/C	141.3	6.1%	8.7	28.8	34.0
SVM AU	Sovereign Metals	140.9	Malingunde, Malawi	Concentrate	PFS	65.0	7.2%	4.7	30.1	37.7
SRG CN	SRG Mining	55.1	Lola, Guinea	Concentrate	FS	50.3	4.1%	2.0	27.0	87.0
TON AU	Triton Minerals	32.0	Ancuabe, Mozambique	Concentrate	DFS	46.1	6.6%	3.0	10.5	45.7
VRC AU	Volt Resources	42.2	Bunyu, Tanzania	Concentrate	FS	461.0	5.0%	22.8	1.8	3.2
WKT AU	Walkabout Resources	43.1	Lindi Jumbo, Tanzania	Concentrate	DFS	41.8	10.7%	4.5	9.6	15.7
AMERICAS										
FMS CN	Focus Graphite	16.6	Lac Knife, QC	Concentrate	FS	12.7	14.4%	1.8	9.1	91.9
GPH CN	Graphite One	95.3	Graphite Creek, AL	Concentrate	PFS	102.8	8.0%	8.2	11.6	39.3
GROC LN	GreenRoc Mining	7.3	Amitsoq, Newf'land	Concentrate	MRE	8.3	19.8%	1.6	4.5	NA*
LMR CN	Lomiko Metals	5.3	La Loutre, QC	Concentrate	PEA	70.0	4.3%	3.0	1.8	63.6
LLG CN	Mason Graphite	19.3	Lac Guéret, QC	Concentrate	FS	83.2	17.2%	14.3	1.3	14.6
NGC CN	Northern Graphite	45.1	Bissett Creek, ON	Concentrate	FS	94.0	1.7%	1.6	28.0	78.7
STS CN	South Star Battery Metals	12.0	Santa Cruz, Brazil	Concentrate	PFS	22.8	2.3%	0.5	23.0	84.6
EUROPE										
BEM LN	Beowulf Mining	55.2	Aitolampi, Finland	Concentrate	MRE	26.7	4.8%	1.3	43.1	NA*
INTEGRATED										
EGR AU	Ecograf Resources	84.2	Epanko, Tanzania	Integrated	BFS	30.7	9.9%	3.0	27.7	47.9
NOU CN	Nouveau Monde Graphite	270.8	Matawinie, QC	Integrated	FS	124.8	4.3%	5.3	50.8	150.4
RNU AU	Renascor Resources	493.4	Siviour, SA	Integrated	DFS	93.5	7.3%	6.8	72.3	87.6
TLG AU	Talga Resources	343.3	Vittangi, Sweden	Integrated	FS	23.9	23.4%	5.6	61.3	154.3
PRODUCTION										
GW1 AU	Greenwing Resources	25.3	Graphmada, Madagascar	Concentrate	Production	61.9	4.5%	2.8	9.1	13.2
SYR AU	Syrah Resources	1144.7	Balama, Mozambique	Integrated	Production	1,423.3	10.3%	146.7	7.8	9.3
TGR LN	Tirupati Graphite	38.5	Various, Madagascar	Concentrate	Production	25.5	4.4%	1.1	34.0	70.2

*Source: Company data, BM Review estimates. Based on MII resources. Prodn EV = EV + Capex remaining to production. *No capex estimates* As at: 05-Dec-22.

High Purity Manganese company EV/resource valuation tracker

Ticker	Company	Mkt cap US$m	Project	Mineralisation	Product	Stage	MII Resource Mt	Mn grade %	Contained Mn Mt	Mkt cap/ resource US$/t	Prodn EV/ resource US$/t
E25 AU	Element 25	141.9	Butcherbird, WA	Oxide	HPMSM	PEA	263.0	10.0%	26.3	5	NA*
EMN CN	Euro Manganese	86.6	Chvaletice, Czech Republic	Carbonate	HPMSM, HPEMM	FS	27.0	7.3%	2.0	44	415
EMM CN	Giyani Metals	23.6	K. Hill, Botswana	Oxide	HPMSM	PEA	1.7	19.9%	0.3	70	398
MN CN	Manganese X Energy	18.9	Battery Hill, NB	Oxide	HPMSM	Evaluation	60.8	6.5%	4.0	5	NA*

*Source: Company data, BM Review estimates. Based on MII resources. *No capex estimates. Prodn EV = EV + Capex remaining to production* As at: 05-Dec-22.

Equity Valuations – Nickel-Cobalt

In situ resource valuation comparison for key Ni/Co developers and producers

Ticker	Company	Mkt cap US$m	Project	Type	Stage	MII Resource Mt	Ni grade %	Ni eq grade %	Mkt cap/ resource US$/Kt Ni-eq	Prodn EV/ resource US$/Kt Ni-eq
EARLY STAGE										
SUB-1% Ni-eq										
GAL AU	Galileo Mining	137.1	Various, WA	Laterite	MRE	25.1	0.5%	0.7%	0.79	NA*
G88 AU	Golden Mile Resources	3.9	Quicksilver, WA	Laterite	MRE	26.3	0.6%	0.7%	0.02	3.88
AMC LN	Amur Minerals	22.2	Kun-Manie, Russia	Sulphide	PFS	174.3	0.8%	0.8%	0.02	0.40
CNC CN	Canada Nickel	116.2	Crawford, ON	Sulphide	PEA	2,095.2	0.2%	0.3%	0.02	0.24
CHN AU	Chalice Mining	1489.5	Julimar, WA	Sulphide	PEA	350.0	0.2%	0.2%	1.97	NA*
CZN AU	Corazon Mining	7.3	Lynn Lake, Manitoba	Sulphide	MRE	16.3	0.7%	0.9%	0.05	NA*
GIGA CN	GigaMetals	21.9	Turnagain, BC	Sulphide	PEA	2741.3	0.2%	0.2%	0.00	0.22
GRDM CN	Grid Metals	18.9	Makwa Mayville, Manitoba	Sulphide	MRE	39.6	0.3%	0.4%	0.13	NA*
NCP CN	Nickel Creek Platinum	16.2	Nickel Shaw, Yukon	Sulphide	MRE	431.5	0.3%	0.3%	0.01	NA*
NNX CN	Nickel North Exploration	2.6	Hawk Ridge, QC	Sulphide	MRE	34.7	0.2%	0.4%	0.02	NA*
NNL AU	Nordic Nickel	15.7	Pulju, Finland	Sulphide	MRE	133.6	0.2%	0.2%	0.05	NA*
SME CN	Sama Resources	21.3	Samapleu, Guinea	Sulphide	PFS	51.0	0.2%	0.2%	0.18	2.54
ABOVE-1% Ni-eq										
AOU AU	Auroch Minerals	13.4	Various, WA	Sulphide	MRE	0.9	2.3%	2.5%	0.59	NA*
AZS AU	Azure Minerals	54.1	Andover, WA	Sulphide	MRE	4.6	1.1%	1.3%	0.88	NA*
CNR AU	Cannon Resources	28.0	Fisher East, WA	Sulphide	MRE	7.5	1.8%	1.8%	0.21	NA*
DKM AU	Duketon Mining	32.8	Rosie, WA	Sulphide	MRE	2.6	1.9%	2.1%	0.60	NA*
ESR AU	Estrella Resources	13.1	Rosie, WA	Sulphide	MRE	1.0	0.9%	1.0%	1.38	NA*
LM8 AU	Lunnon Metals	106.1	Foster, WA	Sulphide	MRE	1.7	2.9%	2.9%	2.22	NA*
PNPN CN	Power Nickel	11.6	NISK, QC	Sulphide	MRE	4.0	0.7%	0.9%	0.31	NA*
PNRL CN	Premium Nickel	142.5	Selebi, Botswana	Sulphide	MRE	15.9	1.0%	1.5%	0.60	NA*
TN CN	Tartisan Nickel	22.2	Kenbridge, ON	Sulphide	PEA	4.5	1.1%	1.3%	0.39	2.06
WIN AU	Widgie Nickel	87.9	Mt Edwards, WA	Sulphide	MRE	10.7	1.6%	1.6%	0.51	NA*
EVALUATION										
ARL AU	Ardea Resources	105.6	Kalgoorlie, WA	Laterite	PFS	830.0	0.7%	0.8%	0.02	0.08
AUZ AU	Australian Mines	20.2	Sconi, Queensland	Laterite	BFS	89.9	0.6%	0.7%	0.03	1.48
GME AU	GME Resources	41.9	NiWest, WA	Laterite	PFS	85.2	1.0%	1.1%	0.04	0.78
GSR AU	Greenstone Resources	24.1	Mt Thirsty, WA	Laterite	PFS	36.7	0.5%	0.7%	0.09	1.04
MLX AU	Metals X	175.9	Central Musgrave, WA	Laterite	FS	215.8	0.9%	1.0%	0.08	0.83
SRL AU	Sunrise Energy Metals	126.2	Sunrise, NSW	Laterite	FS	183.7	0.5%	0.7%	0.10	1.58
BSX AU	Blackstone Minerals	53.1	Ta Khoa, Vietnam	Sulphide	PEA	130.0	0.4%	0.4%	0.10	0.66
CTM AU	Centaurus Minerals	348.6	Jaguar, Brazil	Sulphide	PEA	80.6	0.9%	1.0%	0.44	0.66
TLO CN	Talon Metals	278.7	Tamarack MN, US	Sulphide	PEA	17.0	1.3%	1.5%	1.10	2.56
CONSTRUCTION & PRODUCTION										
HZM CN	Horizonte Minerals	415.7	Various, Brazil	Laterite	U/C	354.0	1.2%	1.3%	0.09	0.28
S CN	Sherritt International	159.7	Moa, Cuba	Laterite	Production	190.6	1.0%	1.2%	0.07	0.18
MCR AU	Mincor Resources	554.3	Various, WA	Sulphide	U/C	5.2	3.8%	3.8%	2.80	2.98
PAN AU	Panoramic Resources	292.9	Savannah, WA	Sulphide	U/C	13.5	1.6%	1.9%	1.12	1.41
POS AU	Poseidon Nickel	77.1	Black Swan, WA	Sulphide	FS	43.1	0.9%	1.0%	0.18	0.24

*Source: Company data, BM Review estimates. Based on MII resources. Ni-equivalent calculated on spot prices. Prodn EV = EV + Capex remaining to production. *No capex estimates* As at: 05-Dec-22.

Equity Valuations – REE / Vanadium

In situ resource valuation comparison for key REE developers and producers

Ticker	Company	Mkt cap US$m	Project	Stage	MII Resource Mt	NdPr grade %	NdPr-eq grade %	Mkt cap/ resource US$/Kt NdPr-eq	Prodn EV/ resource US$/Kt NdPr-eq
EVALUATION									
AFRICA									
MKA CN	Mkango Resources	40	Songwe Hill, Malawi	PFS	48.5	0.29%	0.40%	0.29	1.31
NMI CN	Namibia Critical Metals	22	Lofdal, Namibia	Evaluation	48.7	0.02%	0.09%	2.58	NA*
PEK AU	Peak Resources	65	Ngualla, Tanzania	BFS	214.4	0.45%	0.50%	0.07	0.24
PRE LN	Pensana Metals	146	Longonjo, Angola	PFS	313.0	0.35%	0.44%	0.13	0.26
RBW LN	Rainbow Rare Earths	65	Gakara, Burundi	Evaluation	1.2	0.54%	0.61%	9.88	NA*
AMERICAS									
ARR AU	American Rare Earths	73	La Paz, AZ	MRE	128.2	0.01%	0.01%	7.84	NA*
AVL CN	Avalon Advanced Materials	37	Nechalacho, NWT	FS	269.4	0.37%	0.66%	0.04	0.91
CCE CN	Commerce Resources	10	Ashram, QC	PEA	249.1	0.40%	0.49%	0.01	0.63
DEFN CN	Defense Metals	29	Wicheda, BC	Evaluation	17.0	0.43%	0.43%	0.40	NA*
REEMF US	Rare Element Resources	91	Bear Lodge, WY	PFS	18.0	0.63%	0.79%	0.80	2.51
UCU CN	Ucore Rare Metals	28	Bokan-Dotson, AL	PEA	5.8	0.12%	0.32%	4.14	13.19
AUSTRALIA									
ARU AU	Arafura Resources	488	Nolan's, NT	DFS	56.0	0.68%	0.78%	1.27	2.85
HAS AU	Hastings Technology Metals	335	Yangibana, WA	DFS	21.7	0.40%	0.47%	3.87	4.77
NTU AU	Northern Minerals	145	Browns Range, WA	DFS	10.8	0.03%	0.47%	38.69	7.69
REE AU	Rarex	19	Cummins Range, WA	Evaluation	18.8	0.23%	0.29%	0.45	NA*
CLAY PROJECTS									
ARA CN	Aclara	35	Penco, Chile	Evaluation	22.8	0.05%	0.10%	3.28	3.34
AR3 AU	Australian Rare Earths	30	Koppamura, WA	Exploration	39.9	0.02%	0.03%	4.77	NA*
IXR AU	Ionic Rare Earths	102	Makuutu, Uganda	PEA	315.0	0.01%	0.03%	2.31	2.17
PRODUCTION									
LYC AU	Lynas Corp	5,318	Mt Weld, WA	Production	35.3	2.00%	2.30%	7.53	5.88
MP US	MP Materials	5,992	Mountain Pass, CA	Production	55.4	1.05%	1.14%	10.35	9.64

Prodn EV = EV + Capex remaining to production.

*Source: Company data, BM Review estimates. Based on MII resources. NdPr-equiv based on spot prices. NdPr-equiv excludes Ce/La. *No capex estimates.* As at: 05-Dec-22.

In situ resource valuation comparison for key Vanadium producers and developers

Ticker	Company	Mkt cap US$m	Project	Stage	MII Resource Mt	V2O5 grade %	V2O5 eq grade %	Mkt cap/ resource US$/t V2O5-eq	Prodn EV/ resource US$/t V2O5-eq
EVALUATION									
AVL AU	Australian Vanadium	72.5	AVL, WA	PFS	208	0.74%	1.2%	47.1	185.5
PHNM CN	Phenom Resources	24.5	Carlin, NV	Evaluation	32	0.59%	0.6%	129.8	NA*
TMT AU	Technology Metals Australia	48.5	Gabanintha, WA	DFS	137	0.82%	1.3%	43.1	196.4
TNG AU	TNG Ltd	86.9	Mount Peake, NT	FEED	160	0.28%	0.6%	193.9	808.6
VONE CN	Vanadium One	6.9	Mont Sourcier, QC	PEA	1067	0.20%	0.3%	3.2	101.6
VR8 AU	Vanadium Resources	19.8	SPD, South Africa	PFS	612	0.78%	0.9%	5.6	86.9
VRB CN	VanadiumCorp Resource	2.3	Lac Doré	Evaluation	302	0.40%	0.7%	1.9	NA*
PRODUCTION									
BMN LN	Bushveld Minerals	79.8	Various, South Africa	Production	549	0.83%	0.8%	27.6	58.9
LGO CN	Largo Resources	350.3	Maracas Menchen, Brazil	Production	49	0.99%	1.0%	718.1	582.3

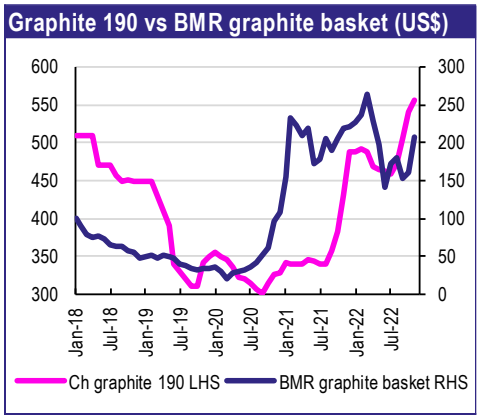
Prodn EV = EV + Capex remaining to production.

*Source: Company data, BM Review estimates. Based on MII resources. V2O5-equivalent calculated on spot prices. *No capex estimates* As at: 05-Dec-22.*

Graphite the top-performing basket

You have no idea how long we've been waiting to write that headline! Over the past 12 months our graphite basket has given up 5% and graphite prices have appreciated 29%. This seems to be the only material where equity performance is completely at odds with performance of the underlying material.

The major strength for November continued to be in the Australian-listed stocks, with **Renascor Resources** (ASX:RNU) leading the way, up 73% off the back of its PEPR approval for the Siviour project. **Talga Group** (ASX:TLG; up 25%) also gets an honourable mention.



Source: BM Review, Westbeck Capital

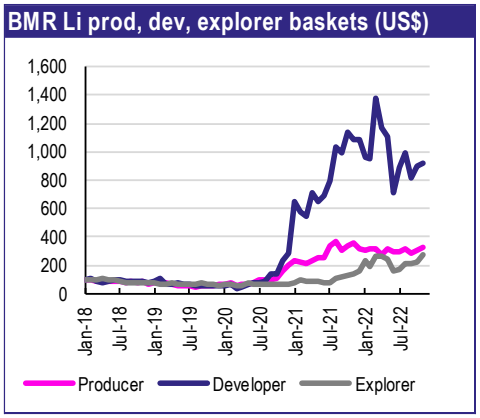
The Canadian-listed graphite developers continue to underperform, perhaps opening up an arbitrage opportunity…

Lithium explorers also on a roll

It was also a strong month for our Lithium Explorer basket, which rose 24% as explorers were well-bid.

The big winner was **Winsome Resources** (ASX:WR1) which rose 151% in US$ terms for the month as it raised A$6.8m in equity issuance and appointed outgoing **Core Lithium** (ASX:CXO) MD Stephen Biggins as Chairman. Management has also been highly active in marketing the stock ahead of expected drill results which seem to be stuck in the Canadian assay bottleneck.

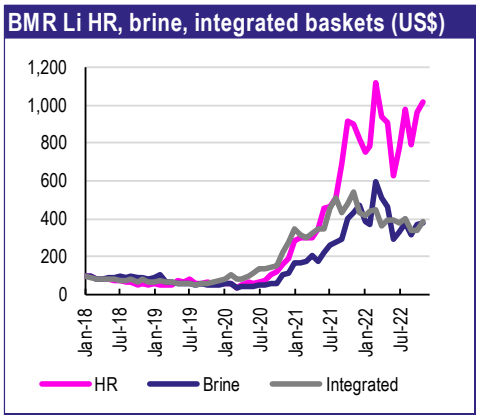
An honourable mention must go to small-cap **FE Battery Metals** (TSXV:FE), which is also exploring in Quebec, and released drill results. It managed 117% for the month.



Source: BM Review, Westbeck Capital

Hard Rock outperforms brine

While it was explorers which took the plaudits in November, in Producer and Developer land, our Hard Rock basket was back to outperforming in November, managing 6% for the month.



Source: BM Review, Westbeck Capital

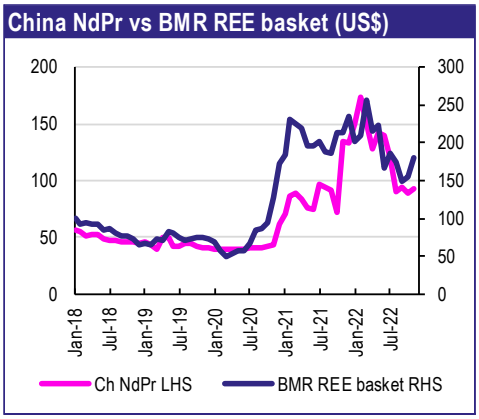
It was definitely the developer end of the market which outperformed though with producer **Pilbara Minerals** (ASX:PLS) in negative territory for the month while **Critical Elements** (TSXV:CRE) was November's best performer.

In brine land it was also a mixed month but again developers outperformed producers. **Livent** (NYSE:LTHM) was down 11%, while **Argosy Minerals** (ASX:AGY) managed +30% on its positive development update.

REE bounce

After a pretty torrid few months which as seen Shanghai NdPr prices give up much of their gains, REE equities finally bounced in November.

The best performer was **Arafura** (ASX:ARU; up 64%) which benefited from a considerable amount of corporate newsflow including its offtake with Hyundai and Kia and updated economics for the Nolans project.



Source: BM Review, Westbeck Capital

There are signs that NdPr prices may have bottomed out in China which makes us more positive on the REE space in the near-term.

Midstream on a roll

Our Midstream basket also managed double-digit returns in November as warm weather in the northern hemisphere meant that power demand remained depressed and gas prices remained low.

Unfortunately, that looks set to change in December, with cold weather likely

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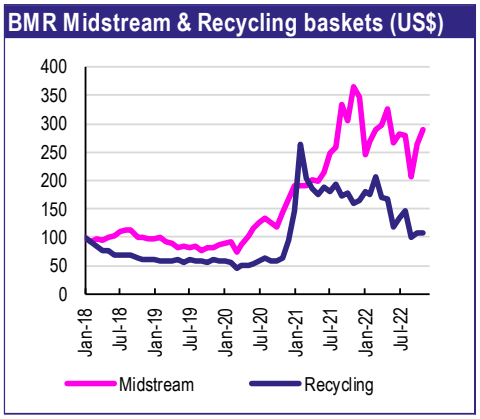
to boost power demand and raise power prices. That could have flow-through impacts on profitability for both anode and cathode makers.



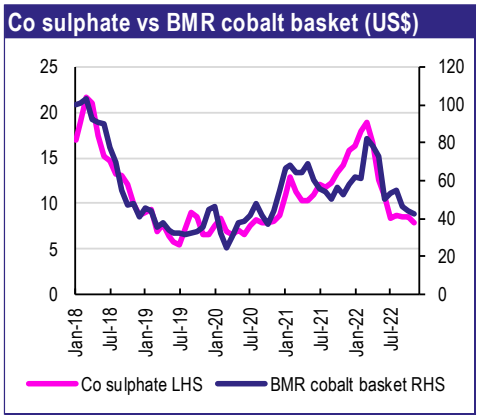
Source: BM Review, Westbeck Capital

The big winner for the month was **SK IE Technology** (KRX:361610; up 37%) which rose for the first time since May in m/m terms after a truly horrendous run which has seen it fall 77% from September 2021 to October 2022.

Anode and cathode maker **Posco Chem** (KRX:003670) also had a good month on newsflow, up 18%.

Watch out for cobalt on weak fundamentals

Our Cobalt basket continues to drift off, and was down 5% for the month. Cobalt sulphate prices were weak in November and continue to be weak in early-November as cobalt production has ramped up in DRC and demand for cobalt for EVs falls as 5-series and 6-series batteries are replaced by higher nickel cells.

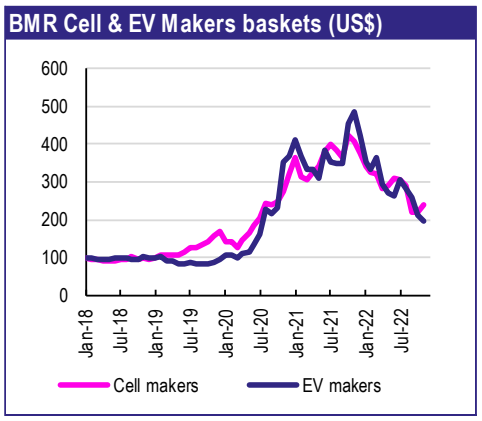


Source: BM Review, Westbeck Capital

This suggests that cobalt equity performance could continue to drift although cobalt sulphate prices are now pretty close to multi-year lows. Cobalt metal prices are still above those levels but there seem to be pretty weak fundamentals which suggest downside risk for cobalt metal.

EV makers to remain weak

EV makers were our weakest basket in November and it remains very difficult to get excited about this segment going forward.



Source: BM Review, Westbeck Capital

They remain stuck between the rock of higher raw material prices and the hard case of a weakening consumer and it's difficult to see them getting out of that situation any time soon.

While Chinese EV makers may outperform on Covid loosening measures, the situation looks tough for Western World EV makers and particularly those OEMs which are in the midst of their EV transformation. We would be particularly wary of European car makers given potential for power prices and shortages to disrupt production.