COMMODITIES

COMMODITIES VIEWPOINT

Too much hype surrounding copper?

Copper has been discovered by financial practitioners of late. Since early March 2024, the metal has surged in price by over 32% to record levels despite the market being in approximate balance. Financial interest has been driven by the spectre of huge copper supply deficits later in the decade related to the energy transition and constrained supply reflecting declining ore grades and the lengthy lead times for mine development. This the bulls argue will drive copper into the stratosphere. A price of US$15,000/tonne, 50% higher than current levels, is often mentioned in terms of incentivising new copper supply. Significantly, the issues surrounding the long-term outlook for the copper and indeed other critical metals are not new. Furthermore, we believe expectations for an ultra-tight market at least over the balance of the decade could be exaggerated. Our thinking here is that the energy transition at least in terms of automotive may take longer than expected given the slowdown in EV adoption and the potential for metal thrifting. From a supply perspective there is the possibility of stepped-up brownfield mine development and pulled forward major projects to consider. The market looks like being broadly balanced in 2024 and 2025 in the absence of major facility outages.

CME COPPER PRICE ($/lb)

Source: Refinitiv

- **Supply/demand balance 2023:** According to the intergovernmental body, International Copper Study Group (ICSG), the copper market in 2023 was marginally in deficit to the tune of 30,000 tonnes after allowing for Chinese bonded warehouse stock changes. World refined production increased by 5% propelled by an 8% gain in secondary or scrap-based output. Mine output showed slower growth of 2%. Growth was constrained by falling grades, operational outages and weather-related events. World refined usage in 2023 rose by about 5% largely reflecting a rebound in China as the economy recovered from pandemic related restrictions. Demand was soft in the western world.

- **Supply/demand balance 2024:** Based on ICSG data, there was a refined copper market surplus of 231,000 tonnes in the first two months of 2024. The mine production backdrop was more buoyant in early 2024 than in much of 2023 with fewer outages and substantial increases in output in the DRC and Indonesia reflecting new and expanded capacity. Partly offsetting capacity expansion has been the closure of the Mina de Cobre Panama mine in late 2023. The trend in secondary production has remained strongly upward in early 2024. World copper usage in the first two months of 2024 grew year-on-year by about 7% driven by China. Demand in the western world remained weak. The ICSG is looking for a refined copper supply surplus of 162,000 tonnes in 2024.

- **Supply/demand balance 2025:** In 2025 the ICSG is forecasting a modest supply surplus of 94,000 tonnes. Production and usage are both expected to grow moderately at 3.9% and 2.5% respectively. Capacity expansion at the giant Amur Minerals Malmyzhskoye mine in Russia and the phase 3 expansion of the Ivanhoe/Zijin Mining Kamoa-Kakula mine in the DRC should boost production. Usage will probably remain relatively muted according to the ICSG, with growth of 2.5%. As always, the supply-demand balance in 2025 will be greatly influenced by the strength of the world economy and facility outages.

- **Post 2025 outlook:** Looking out to the mid-2030s it is likely that copper demand will grow robustly. Whether it is as robust as some observers such as S&P Global is expecting is questionable. S&P has suggested that demand will approximately double between the mid-2020s and 2035 from around 27m to 54m tonnes. This would imply growth of around 6.5% pa. Note here, we would not only be looking at expansion in upstream but also downstream capacity in the form of rolling and wire drawing mills.

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What are the issues involved in doubling capacity?

Infeasible objective to double copper production capacity-------: To double world copper production capacity upstream and downstream would be a herculean task within ten years and is probably infeasible technically and practically. Even a 20-year lead time would, in our view, be demanding. In this context it needs to be remembered that from initial exploration work through feasibility studies, FEED (front end engineering design) and EPC (engineering procurement construction) a large scale mine and mill producing 0.4m-0.5m tonnes/year of contained copper would take at least 15 years to undertake. This assumes no major technical, political or legal impediments. Based on the experience of recent years with projects such as Anglo American's Quellaveco mine in Peru the capital cost would probably be US$5bn. Interestingly, Rio Tinto's Oyu Tolgoi mine in Mongolia reputedly cost US$10bn.

--------reflecting multiple constraints: There are major constraints on mine development on multiple fronts. These include the length of the technical process itself, the availability of skilled artisanal and professional labour and bottlenecks in the sourcing of specialised machinery and equipment. The question might also be asked as to where the power would be obtained for the proposed vast expansion in mining and processing facilities envisaged, especially if fossil fuel is excluded. Significantly, the issues and constraints on development apply to other critical metals such as rare earths and lithium, given expectations of massive supply deficits over the next ten years assuming consensus demand forecasts.

Energy transition too short in terms of critical materials: The question now arises as to what will happen to the energy transition in the event of constraints on the supply of critical metals, including copper. The answer is that it would have to be extended and/or demand depressed.

New sources of supply

Capacity expansion can possibly keep pace with demand through 2030: Despite the constraints, there are opportunities to expand production near to medium term by virtue of brownfield expansion, debottlenecking of operations and the lagged impact of primary expansion programmes. A key wild card concerns the incidence of weather related and other random events such as strikes and seismic activity which have all acted to depress mine utilisation in recent years. Assuming a reasonably benign backdrop on the utilisation front and bearing in mind that the market is likely to be approximately balanced in 2024/25, we think that supply could roughly keep pace with moderate demand growth over the balance of the decade. We would define moderate here as around 3%% pa. Significantly, based on ICSG data mine capacity is scheduled to increase by 3.4% pa between 2023 and 2027.

Potential for downward trend at world number one producer Codelco to be reversed: A key factor behind the relatively weak trend in copper mine output in recent years has been declining production at the world's leading producer, the Chilean state-owned company Codelco. Historically, Codelco has accounted for about 10% of world mine production. In 2023, production was 1.325m tonnes Cu, down 8% on the prior year and the lowest level in 25 years. Codelco has been plagued by a litany of issues including a trend decline in grades, a pit wall collapse, weather and seismic events and slower than expected new project ramp-ups. Significantly, management has pointed to a modest recovery in output to 1.35m tonnes in 2024 and believes that 1.7m tonnes is feasible by 2030. This would return production approximately to the earlier highs recorded in the mid-2010s.

Chile retains significant capacity expansion potential: Historically, Chile has been the largest producer of mined copper based on the huge porphyry deposits of the Andean Cordillera. Currently it accounts for about 25% of the world total. Reflecting Codelco's weak showing, the trend for Chile in recent years has been lacklustre. Mine output in 2023 of 5.33m tonnes was up about 2.5% on 2022 and broadly unchanged from five years

previously. We believe that the trend over the next few years will strengthen significantly partly due to an expected recovery at Codelco and partly capacity additions elsewhere. These include Teck's large scale QB2 mine which commenced operations in 2023. The Chilean Copper Commission is looking for mine production to climb to 5.5m tonnes in 2024, 5.8m tonnes in 2025 and 7m tonnes by 2030.

Major opportunities for development in Peru and Ecuador----: Elsewhere in the Andean Cordillera there are major opportunities for development in Peru, the world's number two producer in recent years and longer term in Ecuador and possibly Argentina. Peru's production was depressed in 2023 by strikes and disrupted transportation routes by demonstrators opposing mine development. The trend had, in fact, been broadly flat for about five years partly due to the covid pandemic. In the early months of 2024, however, the trend firmed as strikes and demonstrations have abated. According to the Ministry of Mines, Peru mine copper output could increase about 9% in 2024 to around 3.0m tonnes.

-----but opposition to new mines could lead to project cancellations: Peru currently has about ten copper mine projects under appraisal, development or construction. Opposition to mine development, however, has slowed progress and could result in the cancellation of some projects.

Northern Ecuador an emerging copper province: Northern Ecuador is an emerging copper producing province. This reflects the planned commissioning of SolGold's Tier 1 or world class Cascabel mine in 2025. Although the project has successfully gone through the pre-feasibility stage, financing has yet to be secured for the US$1.55bn of pre-mining development costs. There is therefore the possibility of slippage in the start-up date. Significantly, SolGold has recently indicated that it is advanced discussions with counterparties on financing for Cascabel.

US has several mid-tier and brownfield projects plus large-scale Robinson project, permitting delays: The US was once the leading copper producer but now ranks number five with mine production of about 1m tonnes/year. There are several active mid-tier projects in the US plus the large-scale Rio Tinto Robinson project in Arizona. Robinson, however, has encountered a prolonged permitting process and has yet to be subject to a pre-feasibility study. According to reports, Robinson could supply about 25% of US copper consumption. Output from a prospective Robinson mine is unlikely, in our view, before 2030.

DRC production has been growing rapidly driven by Ivanhoe's Kamoa-Kakula mine: The Copperbelt in the DRC's (Democratic Republic of Congo) southern province of Katanga is a well-established source of high-grade mined copper and by-product cobalt. Output here has risen sharply over the past 10 to 15 years. Production in 2023 was 2.5m tonnes, up by about 7X from 2010 and 6% higher than in 2022. This would have implied output close to the number two producer Peru. Rapid growth in recent years has been driven by the Ivanhoe Mines' Kamoa-Kakula mine which came on stream in 2021 and in 2023 produced 393,551 tonnes of contained copper. Recently completed expansion and debottlenecking programmes will take production capacity up to about 650,000 tonnes. This would make Kamoa-Kakula the world's fourth largest copper production complex, according to Ivanhoe.

Newmont and Barrick have major development potential: Elsewhere around the world there are significant copper projects available either as part of brownfield expansions or virgin developments in Canada, Indonesia, Zambia, Pakistan and Russia. Interestingly, the two leading gold producers, Newmont and Barrick Gold have largescale gold/copper projects under appraisal. The former's focused on Canada, Chile and Peru while the latter relate to the Lumwana mine expansion in Zambia and the Reko Diq project in Pakistan.

Barrick's Reko Diq world class project in Pakistan and major Lumwana complex in Zambia: Barrick has referred to Reko Diq as being a 'world class-copper gold mine in the making'. An updated feasibility study for Reko Diq is currently being undertaken. First production is targeted for 2028. In the case of Lumwana, Barrick's planned super-pit and expansion of processing capacity are expected to result in a major copper producing complex. Barrick has suggested a 2028 production start-up. Newmont's copper-gold projects in Canada and Chile are presently at the pre-feasibility or feasibility stage. The company has suggested that mine start-ups are >7 years away.

EVs and copper usage

Automotive is the key driver behind copper demand growth: Electrification, particularly in the automotive sector, is the key driver behind the growth in copper consumption presently. Automotive in the form of light electric vehicles (cars, vans and pickups), according to industry estimates, is currently accounting for around 60% of growth. We believe the electrification trend in automotive will remain the key driver behind copper consumption for the foreseeable future. Added impetus will probably be provided in due course by medium and heavy trucks, although the electrification of this sector will likely be achieved more by hydrogen fuel cell and diesel engines adapted for hydrogen fuel than battery powered propulsion.

Usage per BEV (battery electric light vehicle)

On average BEVs use about 83 kg against 23 kg per ICE powered vehicle: According to industry estimates, battery electric light vehicles (BEV) typically use about 83/kg of copper currently. This is approaching 4x the 23kg used on average by a light vehicle with an internal combustion (ICE)-based powertrain. Conventional hybrid (HEV) and plug-in hybrid electric vehicles (PHEV) have copper contents of around 40kg and 60kg respectively. In the case of medium trucks with gross vehicle weights from 7-15 tonnes, copper content might be 350-400kg.

BEV copper applications batteries, traction motors, DC-AC converters and high voltage cables: ICEs principally use copper in wiring looms, various electric motors, including the starter and the alternator. For BEVs the key copper applications are as follows:

- Batteries where copper foil is used as a current collector at the anode and cathode.
- Traction motors which are used to convert electrical to mechanical energy. All electric motors use copper in the stator while some also use a copper rotor.
- DC-AC converters which converts DC current received from the battery to AC current supplied to the traction motor. The transfer of power is controlled by an electronic control module containing copper components.
- High voltage cables and wiring used to deliver current from the battery to the electronic control systems and the traction motor.

The infrastructural needs of vehicle electrification will also boost copper requirements. This relates to the additional need for power distribution capacity and the installation of charging stations all of which require significant amounts of copper.

Why copper?

Copper offers excellent thermal and electrical conductivity at a competitive price: The use of copper in critical BEV powertrain components principally reflects the metal's excellent properties in terms of electrical and thermal conductivity and its availability at a highly competitive price. Silver, which has only slightly superior conductivity characteristics, sells for about 100X the price of copper/oz. Copper additionally is a highly ductile and malleable metal which makes it amenable for wire drawing purposes and rolling into thin gauge foil. Lastly, copper can be easily recyclable and there is a well-established network for doing so.

Vulnerability to thrifting: Although copper is unlikely to be vulnerable to substitution in BEV applications, there is an incentive to undertake thrifting measures both on weight saving and economic grounds. The commodities research consultancy S&P Global has for example suggested that copper usage per BEV will drop to 51-56/kg by 2030 while Goldman Sachs is looking for a decline to 65-66 kg.

Copper usage can be reduced by raising the voltage and reducing powertrain battery size: Keyways in which copper requirements can be reduced are by raising the voltage of the auxiliary battery (used to operate non-powertrain functions such as windscreen wipers) from the typical 12 volt to 48 volts and lowering rechargeable powertrain battery size. The former enables wire gauge and therefore weight to be reduced significantly. Downsizing batteries for propulsion would, however, have negative range implications unless an offset can be achieved by improvements in energy density. There may be the potential to reduce wiring requirements by making batteries more compact and reducing the spacing between cells.

Current and forecast automotive consumption

BEV copper consumption in 2023 was about 1.1m tonnes------Based on global production in 2023 of almost 14m units and 83 kg/vehicle EV related light vehicle copper consumption was around 1.1m tonnes. This represented a still modest 4% of world production. Including ICE light vehicle of around 70m globally, copper consumption would have been around 1.3m tonnes taking the light auto total to 2.5m tonnes for a share of 10%. Using 2024 consensus forecasts for world light vehicle EV production of around 16.5m units copper consumption would rise to approaching 1.4m tonnes. Including ICE powered vehicles, the light vehicle total would be about 3.0m tonnes.

-------and could be 4.2m tonnes in 2030: We believe a plausible scenario for 2030 in the light of prevailing long-term net zero targets is that light vehicle production rises to about 100m units split 50:50 between EVs and ICE powered. Based on current rates of consumption/unit this would imply light vehicle copper usage of 5.4m tonnes of which BEVs might be 4.2m tonnes. Consumption would be significantly lower assuming that thrifting measures are successful in reducing usage per EV as indicated above.

Data centres

Data centres and particularly those focused on artificial intelligence are sizeable users of electrical power. The infrastructural needs of data centres are copper intensive reflecting the use of large quantities of wire and electrical componentry in each facility. In addition, facility air conditioning needs will tend to increase. A prospective expansion of the data centre network has led bullish industry observers to postulate a significant boost to copper consumption as a result. In the period to 2030, forecasts of the incremental impact range made by a range of observers including investment banks range from about 0.2m to 2.0m tonnes. The lower end of range as forecast by the investment bank Macquarie would only imply a modest increase of 0.7% from 2023 levels. The upper end of the range is more significant at about 7%.

Copper prices

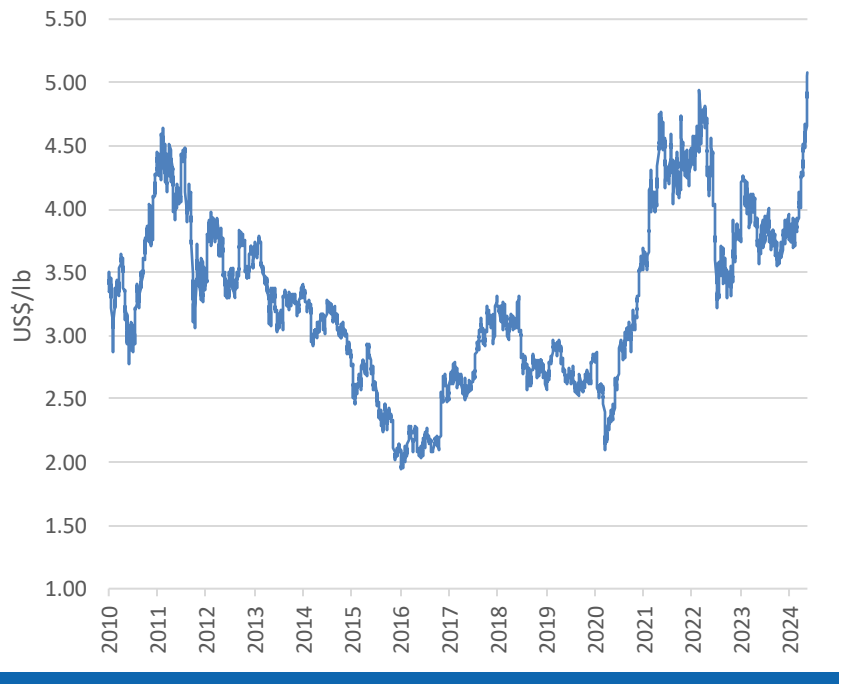
Recent developments

The trend firmed in late Q4 2023---- Sentiment in copper markets firmed in late 2023 driven by a perceived tightening in the supply/demand balance. This followed announcements of the closure of First Quantum's Mina de Cobre in Panama and falling production at Anglo American's operations in Chile. There appeared to be a realisation in market circles that conditions were tighter than expected early in the fourth quarter of 2023. This applied particularly to the availability of concentrate.

------and gained considerable momentum in the YTD 2024 resulting in record levels on the CME of over US$11,000/tonne: Based on CME (Chicago Mercantile Exchange) data, copper cathode ended December 2023 at US$3.89/lb or US$8,577/tonne, up about 4% on late third quarter of 2023 and very close to year earlier levels. The price climbed strongly late in the first quarter of 2024 and at end March was US$4.03/lb. CME copper has remained on an upward trend in the second quarter of 2024 and on May 20 reached a record US$5.06/lb or US$11,157/tonne. The previous record on the CME was US$4.97/lb or US$10,959/tonne recorded in March 2022.

Copper has also been near record levels in real terms: Significantly, copper has also been trading of late at high levels historically in real terms. In the post-war period, the only times when copper has traded significantly higher have been at the height of the China super cycle in 2010/11. In real terms (using early 2024 as a base), the historic highs for copper in real terms have been US$11,000-US$12,000/tonne recorded in 2010/11 and in early 2022. The latter high reflected the backwash of disruptions to supply as the world economy emerged from the covid pandemic.

Exhibit 1: CME copper price trend 2010-24



Source: Refinitiv

Near-term forecast

Upward price trend has been despite a market that is broadly balanced: The surge in copper since end 2023 has been driven by three factors as follows:

- Growing financial sector interest in copper related to the hype surrounding the potential for huge supply deficits in the coming years driven by broad electrification trends and lagging capacity expansion.

- Market perception of underlying tightness in the marketplace with supply constraints on concentrate production probably being the key factor. Tightness appears to have been most pronounced on the CME.

- BHP's interest in acquiring Anglo American based on its copper assets. This has supported the thesis concerning the potential for a tightening market and supply deficits.

Demand in the largest market China has been subdued resulting in the elimination of the traditional SHFE premium: Despite all the talk of supply deficits we note that the copper market is likely to be broadly balanced both in 2024 and probably in 2025. Presently demand in China, the largest market for copper, by all accounts is particularly subdued. A manifestation of this is that the traditional SHFE (Shanghai Futures Exchange) premium to the CME has evaporated or even turned negative of late. The greatly ballyhooed copper supply deficits are only likely to emerge late in the decade and may well be less pronounced than expected by consensus opinion. Note, the spot market reflects the supply/demand balance for physical metal rather than future deliveries.

We look for the CME to average US$4.58/lb in 2024-----Assuming, as seems likely, that the copper market remains broadly balanced over the remainder of the year our quarterly CME price scenario (US/lb) for 2024 is as follows: Q1 3.93, Q2 4.90, Q3 4.60, Q4 4.90. The average for the year is US$4.58/lb or US$10,104/tonne, up 18% on a year previously. The key caveat to our forecast is that there are no significant disruptions to output or facility outages at major copper complexes due to such factors as adverse weather conditions, strikes and technical issues. The key near-term downside risk probably concerns the potential for a business slowdown in China. It should be noted that China accounts for about 50% of world copper consumption. The evidence so far in 2024 is that demand in China is far from buoyant.

-------and US$4.95/lb in 2025: Assuming a broadly balanced market in line with our expectations we think copper will average around US$4.95/lb or US$10,914/tonne in 2025. This is consistent with the forward curve.

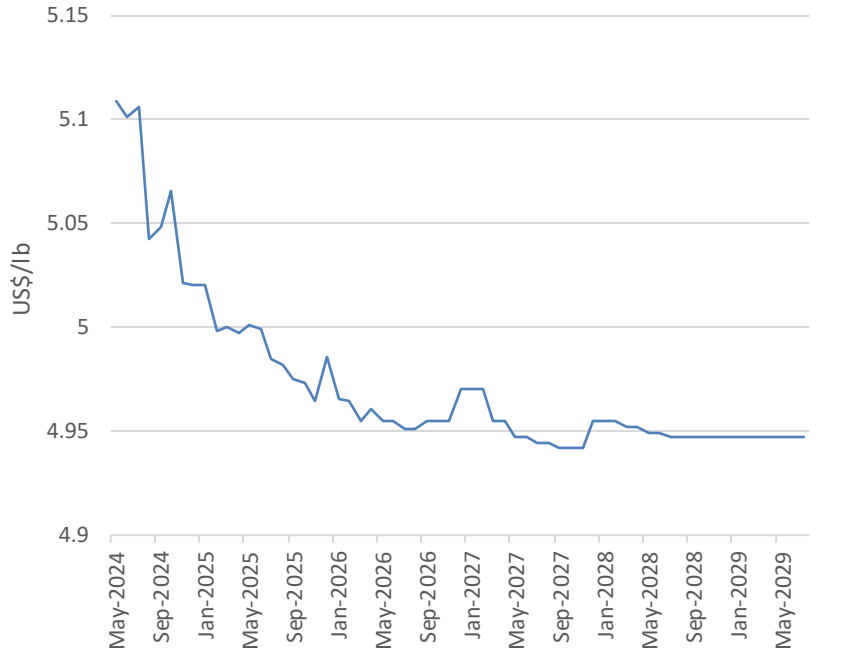
Forward curve

Pronounced front-end backwardation indicating near-term market tightness: Based on Refinitiv data, the front-end of the CME copper cathode forward curve is in pronounced backwardation with prices for the near-term higher than for the forward dates. The spread between spot at around US$5.06/lb and late 2025 delivery dates is about US$0.20/lb. Post late 2025, the curve flattens and terminates at US$4.9/lb in late 2029. Front end backwardation points to a tight CME market currently. The LME (London Metal Exchange) and SHFE (Shanghai Futures Exchange) markets appear less buoyant which suggests that metal could flow into the CME. Given the preponderance, however, of Russian and Chinese metal in LME inventories which are not eligible for CME delivery, the flow might be muted from this source. Large producers of copper in Chile and Peru could decide to divert shipments from China to the CME to capture the price premium.

Post 2025 the curve is flat and reflects subdued price expectations: Interestingly, the copper forward curve which extends to 2029, is not reflecting the expectations of some bullish observers and indeed industry practitioners who are looking for the metal to sell for US$15,000/tonne or US$6.80/lb down the trail. The case for this elevated level is that it will be necessary to incentivise producers to step-up investment to achieve compliance with net zero targets. We believe, however, that the lead time to achieve the energy transition particularly in terms of the availability of critical materials is impractically short.

This applies even if spot price rises to US$15,000/tonne. In practice, demand levels along with the supply deficits being forecast for the late 2020s and early 2030s are implausibly high.

Exhibit 2: CME copper forward curve



Source: Refinitiv

Copper smelter TC/RC charges

Copper produced from sulphide ore obtained by multi-stage processing starting with concentrate: In the case of sulphide ore feedstock (about 80% of the total), copper is produced by a multi-stage beneficiation process starting from mine concentrate obtained by froth flotation. Typically, the concentrate contains 24%-40% copper. Concentrate is firstly treated using a pyrometallurgical process to produce 98% Cu blister. This is then converted to copper anode and refined electrolytically to produce 99.9% copper cathode. The cathode provides the feedstock for downstream products including wire, sheet/foil, plate and tube. While some copper producers have integrated upstream and downstream operations, others depend on third party smelters and refineries for beneficiation.

Concentrate TC/RCs based either on a benchmarking or spot model: Third party treatment (TC) and refining charges (RC) are based either on a benchmarking or a spot market model. Typically, based on industry anecdotes, around 65% of concentrate is treated using benchmarked pricing terms while the spot market is used for the balance. The pattern for benchmarking is usually set in the early part of the fourth quarter and reflects negotiations between major mines and the large Chinese smelters. China, note, hosts around 50% of world smelter capacity. TC/RC contracts typically run for a year. Spot TC/RC's reflect the relationship between third party smelter capacity and the availability of concentrate. A surplus of smelter capacity depresses TC/RC's and vice-versa.

Precipitous fall in TC/RCs since Q4 2023 to an all-time low of US$10/tonne: TC/RCs have fallen precipitously since the fourth quarter of 2023. Establishing the benchmark pattern in November 2023 was the agreement between the Chilean miner Antofagasta and the Chinese smelter Jinchuan. This called for unexceptional TC/RCs of US$80/tonne and 8 cents/lb. Freeport McMoRan and Jiangxi Copper made a similar agreement at about the same time. As of the beginning of the first quarter of 2024, the TC spot price was US$53.5/tonne, a sizeable 33% discount to the benchmark. Over the following two or

three months the trend remained sharply down which has taken TCs to around US$10/tonne or less. This is believed to be an all-time low and clearly unprofitable for the smelters.

--------**reflecting a concentrate deficit:** The collapse in spot TC/RCs reflects an apparent concentrate supply deficit of about 300,000 tonnes, according to industry estimates. This stems in part from constrained availability at the end of 2023 and in part rising smelter capacity especially in China, Indonesia and India. The key question now is what will happen in the autumn when smelters and mines are scheduled to discuss contract terms for 2025, given ultra depressed spot TC/RCs. One solution might be to agree contract terms over an extended period. We would expect the current imbalance between smelter capacity and concentrate availability to lessen over the next few years as unattractive economics constrain further large-scale smelter expansion and possibly trigger production cutbacks.

Cost curve and profitability

Copper cash costs net of by-product credits probably range from zero to US$3.0/lb Cu----: Copper mines often produce significant by-product output typically in the form of gold, silver and molybdenum. Depending on the scale of by-product credits copper cash and all-in sustaining costs can be marginal or in extreme cases negative. Based on data available from the larger producers and S&P Global, cash costs for the bulk of the curve net of by-product credits but including smelter treatment charges range from about zero to US$3.0/lb Cu. Cash costs relating to the production facilities and including treatment charges but excluding by-product credits we believe typically range from US$2.0/lb Cu to US$3.5/lb. On a AISC (all-in sustaining cost) basis net of credits but including maintenance capital expenditure, corporate cost, exploration and royalties/export duties probably have a similar range. Effectively, the by-product credits offset the extra cost.

--------**implying a comfortably profitable industry at current prices:** The above points to a comfortably profitable copper industry at current prices of over US$5.0/lb. For the lower cost producers, the fully accounted margin could be well over US$2/lb. Note, with near record prices for gold and silver, by-product credits are likely to be sizeable for many gold producers currently.

Electrification super cycle?

Electrification copper super cycle but more muted than consensus opinion suggests: We believe a new copper super cycle based on the electrification of the industrial economy and transportation is a possibility starting in the late 2020s and extending into the 2030s. In our view, however, it will be more muted than what is suggested by the massive supply deficits speculated upon by various esteemed forecasting bodies. The key factor to note here is that copper supply cannot technically be increased fast enough to match the demand growth required to comply with the net zero emissions targets ordained by politicians. Lead times will therefore need to become more realistic. As we have noted, longer lead may, in fact, simply be enforced by a lack of supply or prices so high as to sow the seeds of their own destruction probably through triggering a recession.

Despite the above, we nevertheless believe that the copper market will be tight by the late 2020s/early 2030s. To attract investment into expanding capacity sufficient to match even moderate rates of demand growth prices will probably need to rise in real terms. Various industry observers and practitioners have suggested that copper cathode prices will probably need to be sustained at > US$12,500/tonne or even >US$15,000/tonne. This would imply a sizeable margin given the current industry cost curve. In all probability, however, major capital expenditure programmes to raise copper production capacity on the scale envisaged in some quarters will shift the cost curve upwards.

Copper plays

Copper has historically been the province of large capitalisation mining groups. The London market has major exposure to these via Anglo American (LSE: AAL), Antofagasta (LSE: ANTO) and Glencore (LSE: GLEN). Interestingly, Antofagasta, based on its four mines in Chile, is close to being a pure play on copper, a characteristic it shares with the leading listed play in terms of production, Freeport McMoRan (NYSE: FCX).

Outside the majors the London market has exposure to copper via juniors. We have identified four particularly interesting junior plays and have provided brief profiles on each below.

Solgold plc: LSE and TSX: SOLG

Tier 1 Cascabel project in Ecuador: SolGold is arguably the definitive copper-gold exploration junior. The company is focused on its 100% owned Cascabel project in northern Ecuador about 150 km north of the capital Quito and 180 km east of the deepwater port of Esmeraldas. The location is well endowed with modern highway and utility infrastructure. Cascabel is probably the only Tier 1 (world class) copper-gold project not in the hands of the mining majors. By virtue of Cascabel's scale, grade and attractive economics, SolGold has attracted the attention of major mining concerns (ownership shown in parentheses) including BHP, BHP:ASX (10.4%), Newcrest/Newmont, NEM:NYSE (10.3%) and Jiangxi Copper, Shanghai-600362 (6.0%). All have meaningful stakes in the company. The founder and renowned resources entrepreneur, Nick Matther, owns 3.0% directly and a further 1.1% indirectly through the investment vehicle DGR Global Ltd (DGR:ASX).

PFS confirmed attractive Cascabel economics---- In February 2024, SolGold released a pre-feasibility study (PFS) on the Alpala deposit, the primary mineralised zone of the Cascabel porphyry. The PFS included updated NI 43-101 resource and reserve estimates and confirmed the attractive economics of the project. Proven and probable reserves (85% proven) for Alpala are put at 3.2m Cu, 9.4m oz Au and 28.0m oz Ag. On a copper equivalent basis Alpala has measured and indicated resources of 15.6m tonnes with 64% in the former category. The deposit is high-grade for a porphyry with 0.60% Cu, 0.54 g/t Au and 1.6 g/t Ag. Cascabel has considerable exploration upside through the TAM project 3 km north of Alpala. SolGold also possesses 89 other concessions in Ecuador. The initial mine life is expected to be 28 years with an average production rate of 123,000 tpy copper, 277,000 oz/year gold and 794,000 oz/year silver.

------based on conservative commodity price assumptions: The PFS revealed an after tax NPV8 of US$3.2bn and a four-year payback based on commodity price assumptions that are conservative vis-à-vis current levels. Pre-production capital costs were given in the PFS as US$1.55bn.

SolGold is engaged in detailed discussions with capital providers: An important development of late relates to the potential provision of Cascabel project finance. SolGold has indicated that it is in 'detailed discussions with capital providers who have shown a strong interest in committing to a robust, longer-term financing package for the Cascade Project. The proposed financing is projected to cover a significant portion of the estimated initial capital development costs of the project'. Additionally, SolGold has recently secured a US$10m loan facility. This will be used for general corporate purposes and will provide liquidity while long-term project financing arrangements are finalised. Given the often-challenging backdrop for financing resource projects, the apparently serious interest being shown by capital providers in Cascabel lends credence to the project.

Assuming a DFS required unlikely that a Cascabel can be on-stream before late this decade: It is not clear what the next stage will be in the development of Cascabel. We suspect that it will probably be undertaking a definitive feasibility study (DFS) and the FEED (front end engineering design) for the mine and mill. This will refine the analysis contained

in the PFS and include detailed engineering and design work. We believe a DFS and FEED will take comfortably over a year and possibly nearer two years to complete. This would suggest that a Cascabel mine/mill is unlikely to be on-stream before late this decade.

Investment view

Surprisingly perhaps, SolGold's announcement on May 14 concerning the potential availability of project finance failed to generate any excitement in the stock. In our view, the news on the financing front enhances what is a modestly valued advanced stage Tier 1 copper mine development play. With an enterprise value of U$479m, based on Refinitiv data, SolGold is selling on US$31/tonne Cu/eq of indicated and measured resources. According to SolGold, M&A transactions in this field are more like US$130/tonne. SolGold's market capitalisation of US$335m is only 1.1x book value of US$292m, a very modest premium given that the project has been derisked technically and subjected to a PFS.

Exhibit 3: SolGold share 2-year price history

Source: Refinitiv

Phoenix Copper plc: AIM: PXC; OTCQX: PXCLY

Flagship polymetallic Empire mine in Idaho: Phoenix Copper is a base and precious metals explorer and potentially producer focused on projects in the pro-mining US state of Idaho. Its flagship project is the 80% owned polymetallic Empire open pit mine located in the historic Alder Creek mining district near the small town of Mackay. This is about 100 miles east of the Idaho state capital of Boise. The historic Empire underground mine produced very high-grade copper (6%-8% Cu), gold (6.6 g/t Au) and silver from sulphide ore between 1901 and 1942.

Shallow oxide ore open-pit, flotation heap leaching SX-EW processing: Phoenix Copper's plan for a new Empire mine involves mining the relatively shallow oxide ore and processing using flotation and heap leaching SX-EW (solvent extraction-electrowinning) technology to produce copper cathode. The status of the project is advanced development. Considerable drilling has been carried out across the property involving 445 holes. A significant resource and reserve base has been established. Metallurgical testing has been undertaken and yielded encouraging results in that copper, gold and silver can be recovered efficiently.

Proven and probable reserves 66,467 tonnes Cu eq, sulphide ore exploration upside: Empire's proven and probable reserves currently stand at 49,654 tonnes Cu, 104,000 oz Au and 4,654,000 oz Ag. On a copper equivalent basis reserves are 66,467 tonnes. This implies modest production potential at this stage. The copper equivalent grade of 0.66% is superior to many porphyry projects. Significantly, 76% of reserves are in the proven category. Appraisal work and drilling on the Empire property suggests that there is scope for exploration upside. In the last drilling programme, the deeper sulphide zone was targeted. The results were positive revealing evidence of high-grade mineralisation including an intercept grading 8.38% copper. We believe Empire could possibly evolve as part of a larger porphyry play. Clearly, this would point to the potential for a major mining operation.

Empire largely de-risked from geological and metallurgical perspectives: Phoenix would now appear to have largely de-risked Empire from geological and metallurgical processing perspectives as far as the oxide ores are concerned. A pre-feasibility study for Empire is underway and scheduled for release in the second quarter of 2024. In late January 2024 Phoenix raised £2.7m in equity to for general corporate purposes and to finance the purchase of two pre-owned ball mills. The consideration of US$1.1m implies an astute purchase given that new equipment would have cost US$7-8m with a delivery lead time of 12 months. Importantly, Phoenix has indicated that the mills have been thoroughly inspected while the motors have been tested and the components catalogued.

Private equity house NIU Invest has subscribed to US$80m of bonds to finance Empire development: To finance mine development Phoenix announced in September 2023 a US$300m corporate copper bond. In a major announcement on May 15, 2024, Phoenix reported that the Berlin-based private equity concern NIU Invest SE had subscribed to U$80m of the bonds. This will enable the first phase of the Empire open-pit mine and mill to be financed. The bonds will be drawn down in tranches according to an agreed schedule between late May and the first half of 2025. A floating rate coupon will be payable between 8.5% and 20.0%. The rate will be calculated as to the higher of a copper price coupon linked to the copper price on the LME or an interest rate coupon liked to the US Discount Rate. The bond will be secured against Phoenix's open-pit mining claims and have a maturity date of 10 years. The bonds are not convertible but NIU will become entitled to warrants during the drawdown process. Based on the terms of the drawdown and the current issued share capital, NIU will have the right to accumulate up to a 25% interest in Phoenix over a five-year period.

Navarre Creek precious metals and Red Star silver-lead exploration projects in vicinity of Empire: In addition to Empire, the broader district includes historic underground mines

producing base and precious metals. About 5km west of Empire lies the Navarre Creek precious metals project. Here a 28-hole RC drilling programme was undertaken in the third quarter of 2023. Assay results pointed to low-grade mineralisation. Phoenix has indicated that exploration will continue at Navarre in 2024. About 330m northwest of the Empire Mine lies the Red Star silver-lead discovery. A drilling programme conducted in 2022 appears to have yielded encouraging intersect results. Exploration work is scheduled to continue in 2024. Phoenix also has two early-stage cobalt projects 100 miles north of Empire in an area that has attracted the attention of Canadian juniors.

Investment view

The Phoenix news flow has been positive of late on both the technical and financial fronts. In addition, the commodity market backdrop in terms of copper, gold and silver has been propitious for a company approaching mine development. The stock has reacted positively to the news flow. At the May 17 close of 20.0p/share Phoenix was trading 86% above the recent March low. From a longer-term perspective, however, the stock is still trading at a depressed level which is possibly a reflection of the long lead times and financing risks associated with mine development. As of mid-May 2024, Phoenix with a market capitalisation of US29.8m was trading at 20% discount to book value of US$37.2m. We regard this as decidedly undemanding given the advanced development status of the Empire mine. The copper equivalent valuation however is relatively high at US$560/tonne. Exploration upside particularly regarding the Empire sulphide ores could bring the valuation down significantly on this parameter.

Exhibit 4: Phoenix Copper 2-year price history

Source: Refinitiv

Arc Minerals plc: AIM: ARCM

JV with Anglo American on the Zambia Copper project in NW Zambia: Arc Minerals in recent months has emerged as an exciting copper exploration play. The key factor here was the conclusion in November 2023 of a joint-venture deal with Anglo American to explore Arc's Zambia Copper Project (ZCP) in the Northwestern Province of the country. Importantly, the deal struck between Arc and Anglo American was via an earn-in arrangement which could result in the latter taking a 70% stake in ZCP. To do this Anglo will need to spend US$88.5m for exploration with staged payments in three phases covering up to 7½ years. Assuming this to be the case, Arc would own 20% of ZCP given that its original interest in the licence holder, Unico Minerals Ltd, was 67%. Following the joint-venture agreement Anglo is the operator of the ZCP project.

Arc free carried on US$88.5m of exploration expenditure: It should be noted that Arc is free carried on ZCP exploration which eliminates financial risk. This is a very positive arrangement for Arc bearing in mind that financial constraints usually impose a major constraint on juniors in undertaking exploration and subsequent development.

Project located towards the western margin of the Zambian Copperbelt in the vicinity of major Barrick and First Quantum mines: The ZCP properties cover a large area of 870km^{2}in what is known as the Domes region of the Zambian Copperbelt about 900km north of the Zambian capital Lusaka. The ZCP project lies towards the western margin of the Copperbelt in the general vicinity of Barrick Gold's Lumwana and First Quantum's Sentinel and Kansanshi mines. The Zambian Copperbelt has been a major copper producing province for almost 100 years and the bulk of the production has been obtained from the Domes region. Until the 1950s/60s the Zambian Copperbelt was, in fact, the world's largest source of copper. Geologically, copper deposits are large scale and high grade (~1% Cu) and are based on mineralised stratabound sedimentary sulphide rock formations. Significantly, Arc believes that ZCP offers one of the few remaining copper play zones with large scale resource potential in the Domes region.

Anglo well acquainted with Zambia Copperbelt: Importantly, Anglo American is familiar with both Zambian Copperbelt and the ZCP project area. Anglo and its affiliates have been producers in the Copperbelt at various times since the inception of mining in 1928 but are not present currently. The Executive Chairman of Arc, Nick von Schirnding, has been a senior executive with Anglo American and De Beers.

Work programme commenced: At the beginning of May 2024 Arc announced that Anglo has commenced its work programme on the ZCP project. The work programme includes the following:

- A LIDAR (laser imaging, detection and ranging) survey.
- Detailed geological mapping.
- Core diamond drilling in prospective zones.
- Ground-based geophysical studies.

The question arises as to what a success case would look like in terms of scale of resource at ZCP. We believe Anglo American would be looking for >1m tonnes of contained copper. For perspective, Barrick Gold reported in a 2014 technical report proven and probable reserves for its Luwana mine of 3.0m tonnes contained Cu.

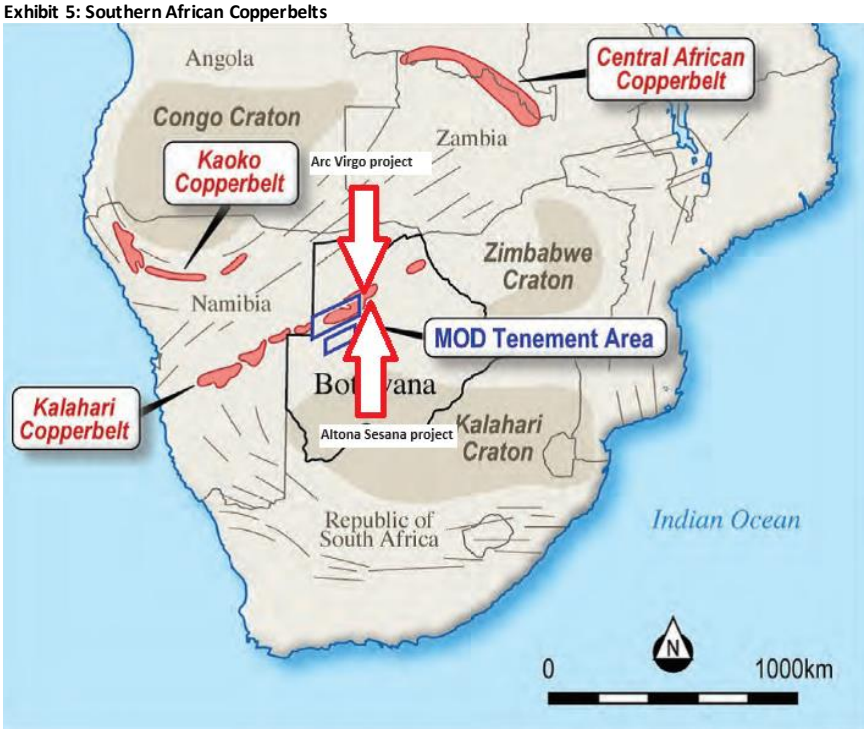
Arc also has interests in two prospecting licences in the Kalahari Copperbelt: In addition to the ZCP project, Arc has a 75% interest in two early-stage prospecting licences in the Botswana Kalahari Copperbelt (KCB). Collectively the licences are referred to as the Virgo project and are also prospective for gold and silver. Arc's interest is held indirectly through a local company, Alvis-Crest (Proprietary) Ltd. The KCB is a southwest-northeast sedimentary/metavolcanic trend stretching for about 1,000 km from central Namibia to northeastern Botswana and is about 250 km wide.

KCB has similar geological setting to the ZCB: Broadly speaking, the geological setting of the KCB with its sediment-hosted copper deposits are analogous to the ZCB. Concentrations of copper stem from oxidised hydrothermal fluids derived from source rocks which have subsequently been subject to reductants to form sulphates. Copper is typically found in the contact zone between the D'Kar (DFK) and Ngwako Pan (NPF) formations. Historically, the KCB has been overlooked due to overlying sand up to 100m deep and the KCB's remoteness. The challenges have been overcome in part by the application of airborne electromagnetic surveys.

Burgeoning interest in KCB: In recent years, interest in the KCB has burgeoned in an approximately 11km section towards the north of the trend. Mid-tier miners, notably, Hong Kong-listed MMG Ltd (1208: HK) and Sandfire Resources (SFR:ASX) have established sizeable mining/mill operations. The former has world class potential at its Khoemacau mine. Exploration interests have also been established by the juniors Galileo Resources (GLR.AIM) and most recently Altona Rare Earths (REEA.L).

Virgo project contains highly prospective acreage in the DFK-NPF contact zone: The Virgo project covers a sizeable 210km² in the highly prospective Central Structural Corridor which contains the MMG Khoemacau and the Sandfire Motheo mines. The Virgo licences are located in close proximity to these two mines. So far two copper-nickel prospects have been identified on the licences. Significantly, the larger of the two on PL135/2017 overlays an interpreted DFK-NPF contact zone. Recently Arc announced a c. 35km IP (induced polarisation) survey over the prospective zone of the licence. This will be followed by a 10-hole 2,000m reverse circulation (RC) drilling programme to test the generated anomalies. The programme is expected to commence in the second quarter of 2024 and take about a month to complete. Financing for the current exploration programme is underpinned by the equity raise earlier in 2024.

Exhibit 5: Southern African Copperbelts



Source: Company

Investment view

Arc Minerals as of mid-May was trading at 1.8p/share, close to a five-year low. The market capitalisation at this price is £26m. Arguably, the lacklustre trend in the share

price is a surprising result given the prospectivity of Arc's projects, the free-carry financing provided by Anglo American on the ZCP project and generally bullish market perceptions concerning the outlook for copper long term. We believe ARC is undiscovered and a potential beneficiary of positive news flow emanating from the imminent drilling programmes at ZCP and Virgo.

Exhibit 6: Arc Minerals 2-year share price history

Source: Refinitiv

Altona Rare Earths plc: REEA.L*

Monte Muambe rare earths project in Mozambique at the PFS stage: Altona was originally a pure rare earths play based on its 51% owned Monte Muambe project in northwestern Mozambique. Monte Muambe has shown considerable promise and was partially de-risked in 2023. During the year a maiden JORC resource was announced of 13.6m tonnes at 2.42% TREO, a scoping study pointing to viability was successfully completed and a Competent Person Report was published. The company has moved into the Pre-feasibility Study (PFS) phase and has been undertaking metallurgical testing. Interestingly the results of flotation testing are imminent. Progress in undertaking the PFS, however, is being constrained by a lack of finance. We believe that Monte Muambe has the potential to evolve as a mid-tier, high-grade rare earths mine and processor.

Objective is to produce a rare earths carbonate: Long-term Altona is looking to process concentrate through a hydrometallurgical plant to produce a mixed rare earths carbonate. This would then be exported to an element separation plant. The value added under this strategy would be significantly higher than selling concentrate.

Recent strategic move into copper exploration in the Kalahari and Zambia Copperbelts: In late March and early April 2024, it announced a strategic move into copper exploration in the Kalahari and Zambian Copperbelts for little cash consideration. This involved two deals. Firstly, an option agreement to acquire up to an 85% interest in the KCB Sesana Tenement. The consideration was US$110,000 in cash and 250,000 in shares payable in three tranches over four years. In a separate agreement, Altona acquired 100% of the Kabompo South Tenement in the Mufumbe District of Zambia's Northwestern Province towards the western margin of the ZCB. The consideration was US$40,000 in cash on completion and US$150,000 in shares payable 12 months after completion.

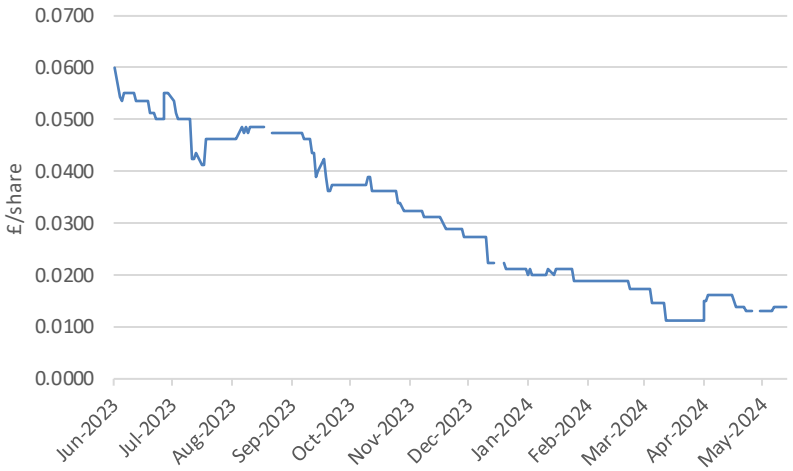
Highly prospective Sesana project in the KCB lies over the DFK-NPF contact zone: Sesana is located in the heart of the KCB development zone 25km south of MMG's Khoemacau mine. Regional airborne magnetic data reveals that a c.10km long section of contact between DFK and NPF formations pass through the northern part of the Sesana tenement, along the eastern margin of the fold structure. According to Altona, this is 'a perfect setting for copper-silver mineralisation'. We believe drilling is possible at Sesana by early 2025 subject to finance being available.

Kabompo South project in NW Zambia contains a large Cu-Au-Ag silver anomaly: The Kabompo South licence interests were owned by Freeport McMoran until April 2020 when a strategic decision was made to exit Zambia. The licence area is a significant 616km² and has been subject to some early-stage exploration involving 4,000-line kilometres of magnetometer surveys and a partial leach soil survey. A large copper-gold-silver anomaly has been identified in the northeastern part of the Tenement. The work programme is focussed on reprocessing the magnetometer and leach soil surveys. This could lead to drilling targets.

Investment view

Altona undoubtedly has highly interesting exploration and development potential for key critical metals in the form of rare earths and copper. The company, however, is confronted by a financial constraint which is slowing project development. A short-term palliative has been provided by a £0.25m credit facility with a 20% pa coupon and a maturity date of December 20, 2024. Repayment in shares is a possibility. With a market capitalisation of only about £1.1m investors are clearly aware of the challenging financial situation.

Exhibit 7: Altona Rare Earths* share price history



Source: Refinitiv. * Allenby Capital acts as Joint Broker to Altona Rare Earth plc

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