EQUITY RESEARCH | October 4, 2018 | 11:33PM BST

Goldman Sachs

Copper

Top Projects

With the ninth iteration of the Copper Top Projects report, we analyse 84 copper projects that are set to form >75% of new copper supply in the near future and account for c.US$150 bn of capex. Our key takeaway: for the first time in four years, the incentive price to bring new projects online has increased dramatically, by c.35% yoy. More than 80% of the unapproved projects we analyse are uneconomic at current prices, which means prices need to climb higher. However, that rise is likely to be slower than we previously expected, owing to higher supply this year and next. We remain confident on demand given our expectation that China's growth will remain strong and EV demand will start to manifest in the next few years. We continue to favour equities that are well positioned to bring new projects online, vs. those that do not have attractive projects and will likely have to engage in M&A.

Deficit delayed, not denied

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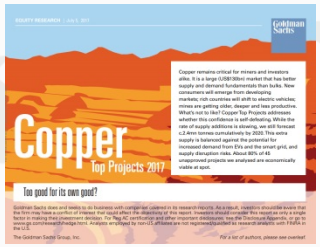
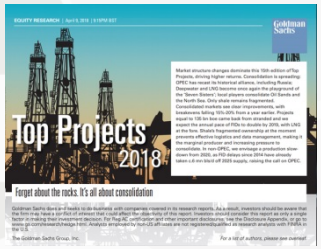
The GS Supply Demand model for copper is a collaboration between our Equity and Commodities analysts. The views expressed outside this analysis are those of the equity analysts.

For more on the Top Project series



[Copper Top Projects 2017: Too good for its own good?]
July 5, 2017



[Top Projects 2018: Forget about the rocks. It's all about consolidation]
April 9, 2018

[Zinc Top Projects Show me the metal]
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COPPER in numbers

Top Projects takeaways

US$7,067 average copper price required to generate a 17% IRR

US$6,799 avg. incentive price for the risked projects under our coverage

US$7,307 avg. incentive price to bring the 51 unapproved projects online

3% average capital intensity of copper equivalent production in the last year

Supply Growth concentrated

50% of the production increase in the next 2 years is coming from 3 mines

40% of the new supply over the next 2 years is coming from 3 companies

Disruptions running low

1.10% YTD rate of disruption vs. 5% through the cycle

Demand

2.90% of demand growth in China pa over 2018-20E

3.50% of demand growth in EMs pa over 2018-20E

0.50% of demand growth in DMs pa over 2018-20E

Electric Vehicles

14% EV/PHEVs as a % of the total fleet

21.8 mn tonnes potential cumulative demand from EVs to 2030

PM Summary: Forecast deficit pushed out again

We update our analysis of the Top Projects: Copper set to come online in the near to medium term. The projects we analyse are set to form >75% of new production. After being a stellar performer for most of 2017 and early 2018, copper has sold off materially as investors have turned bearish on: (1) China demand; (2) EM concerns / stronger dollar and; (3) trade tensions. While prices have come off their peak in May/June this year, they remain strong, in our view. We believe the market continues to underestimate the lack of supply growth in copper, and therefore remain positive on the copper price.

In our 2017 edition, *Copper Top Projects: Too good for its own good*, we argued that the general attractiveness of the metal to all the stakeholders, has resulted in more supply coming online than expected. This has seen previously forecast deficits being pushed out - something which is happening with this report. However, post the work done in this report, we are confident that the lack of investment will see a deficit eventually forming in early 2020s.

On the demand side, we take a more upbeat view on China, and EMs more broadly, vs. the market; we remain confident that demand is likely to continue to grow in the next few years, barring a macro event such as that of 2007-08. Supporting this view is the work we have done with our commodities team on the potential demand from electric vehicles (EVs), which should provide a boost to demand in the early 2020s. While this is likely to be "out of investable time horizon" for some investors, we believe fundamental investors are likely to start to position positively on copper over the next few years given the expected increase in demand.

Key takeaways from our copper supply-side work

- **Costs/capex are on the rise**... Costs and capex demonstrated clear evidence of bottoming out in 2017. FY17/1H18 results showed that costs for global copper miners rose anywhere between 3% and 11% yoy, and capex between 3% and 5%. We believe this trend is here to stay.
- **...which has seen the incentive price required for projects increase:** Rising costs/capex, coupled with increasing consumable costs, has led to a rise in incentive prices – the copper price required to bring the projects we have analysed online – for the first time in four years. The incentive price for the 84 projects we have analysed has increased to US$7,067/t, up 33% yoy.
- **Risked projects relatively unchanged**...The parameters of the risked projects that we analyse have remained relatively unchanged, mostly because the majority of the capex for these projects has already been spent. Our analysis of 33 risked projects shows that the required price for the copper projects is c.US$6,799/t, up from US$5,073/t last year.
- **...while the required price for unapproved projects has increased significantly:** Of the 51 unapproved projects we have analysed, the required copper price has climbed to US$7,307/t from US$5,373/t, a yoy increase of 36%. Aside from

cost inflation/higher capex, this has been a function of higher risk, which in our view will lead to companies looking for a higher IRR.

Supply: Entering a period of very low growth on lack of investment over the past few years

- **Capex fell materially in 2015-17...** Investment in mining projects fell materially in 2015-17 as companies struggled to improve their balance sheets, which were highly levered. As the development period of a new mine is 3-5 years, the new mine supply that should have hit in 2018-20 will be pushed out, which means supply growth over the next few years is likely to be the lowest in several years – 2.33% pa over the next three years.
- **Lack of any tangible disruptions has been negative for prices...** One factor that has surprised both us and investors has been the lack of any tangible disruptions despite more than 2 mn tonnes of supply in Chile undergoing wage negotiations. This has been a function of companies reaching common ground with unions to avoid large-scale disruptions such as that of 2017.
- **...unlikely to be a consistent factor:** While the lack of disruptions has been a negative for copper prices, if history is a guide, it is unlikely to persist. Historically, the rate of disruptions has been c.5% of mine supply vs. 1.1% YTD. We believe mean-reversion is likely, which should affect supply from next year onwards.
- **Companies are still not investing in projects...** Despite copper prices having improved materially from the bottom of the cycle in 2016, mining companies are still wary of investing in growth projects. Indeed, the only greenfield project to be approved over the past couple of years has been Quellevaco (by Anglo American). We believe this is because: (1) companies remain wary of the volatility in commodity prices; and (2) investors are looking for enhanced returns and are still cautious on companies making large investments.
- **...which likely means prices need to remain higher for longer:** Given the dampening effect on investment of recent volatility in prices (which is positive for commodity prices in the longer term), we believe that investment will pick up only if prices remain higher for longer. The required copper price for the 84 projects in our analysis has increased for the first time in more than four years, to US$7,067/t from US$5,324/t last year.

Demand: Concerns around recent events in EM/China overdone; we see growth ahead

- **EM concerns saw the first wave of outflows from copper**... The EM sell-off at the start of 2H18 was the first domino to fall. Synchronous growth had been the keyword at the start of the year, which saw commodities rally. However, as EM growth faltered, investors started taking a bearish view on the long-term growth prospects for these markets.
- ...**China concerns were the second driver:** Soggy China data – FAI data for July/August, credit data and other activity data – was the second domino to fall. Given that China accounts for c.50% of total copper demand, this led to investors

taking an even more bearish view on the commodity. Data has continued to disappoint, but our economists believe it should start to pick up given the recent loosening by the policymakers.

- **EM sell-off and a stronger USD have been a headwind too:** A stronger dollar, implying a move to risk-off assets, has been another drag on copper prices.
- **We remain confident on demand growth despite recent weakness**: Despite the recent weakness, we remain confident on demand, with our commodities team forecasting demand growth of c.2% pa over the next three years. Our view is based on: (1) EM growth not being affected to the extent that the market appears to believe; we forecast EM copper demand growth of 3.5% over 2018-20; (2) China growth that is likely to remain strong – policymakers have started loosening by cutting onshore rates and by reducing restrictions on lending, which should be supportive of growth; and (3) DMs are expected to remain broadly flat – our commodities team forecasts growth of c.0.5% pa in DM copper demand over the next 3-4 years.
- **EVs likely to offer a material fillip to demand from the early 2020s:** China accounts for half of all global electric vehicle (EV) sales and continues to be the fastest-growing EV market. Even under relatively conservative assumptions, we estimate that copper consumption will increase 700ktpa from 2018 to 2025 on rising EV production, roughly half of which will come from China.

Equities: See pockets where valuation looks undemanding

- **Equities have had a choppy year...** Copper mining equities have had a volatile year after a very strong 2016/17. We believe the underperformance of equities vs. copper reflects an unwillingness by investors to pay high multiples given the lack of confidence in commodity prices.
- **Remain positive on copper prices albeit a more tempered view:** We remain positive on copper prices, albeit our commodities team now forecast a 12-month copper price of US$6,885/t, down from their previous forecast of US$8000/t by end-2019 given the recent hiccups in demand from EMs/China.
- **We expect capex and M&A to increase**: We believe capex is set to rise further, a trend already in evidence with miners across the size spectrum increasing both sustaining and growth capex. Another trend to watch is the rising tide of M&A, where we believe the companies that do not have attractive copper projects are likely to buy projects sitting with companies that do not have the resources to build them.
- **Favour equities that have strongly positioned projects**: Our preferred equities are those that have strong growth projects (i.e. that are well positioned in terms of jurisdiction and required copper price) and catalysts ahead. ***Reflecting these themes, our top picks with the highest exposure to copper remain GLEN, FM, FCX, MMG and Zijin while we downgrade Antofagasta to Sell.***

Exhibit 1: Summary financial metrics for global copper equities

Company	Share price Ccy	Last Close	Rating New	Rating Old	12m PT PT	12m PT Old	Return (%)	P/E 2018E	P/E 2019E	P/E 2020E	EV/EBITDA 2018E	EV/EBITDA 2019E	EV/EBITDA 2020E	Net debt/EBITDA 2018E	Net debt/EBITDA 2019E	Net debt/EBITDA 2020E	FCF Yield(%) 2018E	FCF Yield(%) 2019E	FCF Yield(%) 2020E	Dividend Yield(%) 2018E	Dividend Yield(%) 2019E	Dividend Yield(%) 2020E
Diversifieds																						
BHP - LSE	GBP	1,692.00	Buy	Buy	1,950	2,000	15%	15.76x	15.48x	17.63x	5.45x	5.64x	6.04x	0.40x	0.33x	0.24x	8.1%	7.0%	6.7%	5.0%	4.3%	3.9%
BHP - ASX	AUD	35.41	Buy	Buy	40.0	42.0	13%	18.15x	17.82x	20.30x	5.92x	6.06x	6.42x	0.40x	0.33x	0.24x	7.4%	6.5%	6.3%	4.4%	3.8%	3.4%
Rio -LSE	GBP	3,917.50	Neutral	Neutral	4,000	4,000	2%	9.77x	10.54x	11.84x	5.49x	5.56x	5.97x	0.02x	0.19x	0.32x	6.3%	6.4%	4.8%	6.2%	5.6%	5.1%
Rio Tinto - ASX	AUD	79.95	Neutral	Neutral	82.0	84.0	3%	10.97x	11.83x	13.29x	6.04x	6.09x	6.52x	0.02x	0.19x	0.32x	5.7%	5.8%	4.3%	5.5%	5.0%	4.5%
Glencore	GBP	333.55	Buy	Buy	400	375	20%	8.20x	8.45x	10.79x	4.13x	3.87x	4.06x	0.49x	0.31x	0.07x	20.9%	16.3%	16.0%	5.3%	4.2%	5.6%
Anglo American	GBP	1,755.40	Buy*	Buy*	2,200	2,000	25%	10.12x	10.22x	12.90x	4.33x	3.86x	4.48x	0.42x	0.19x	0.21x	8.7%	9.4%	3.8%	4.4%	4.6%	3.7%
Norilsk Nickel	USD	17.20	Buy	Buy	24	25	40%	7.03x	6.75x	7.07x	5.94x	5.32x	5.79x	1.32x	1.14x	1.46x	13.6%	8.0%	7.9%	13.1%	14.4%	13.9%
Teck Resources Ltd.	USD	24.33	Neutral	Neutral	30	28	23%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Teck Resources Ltd.	CAD	31.28	Neutral	Neutral	38	37	21%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Copper																						
Antofagasta	GBP	879.40	Sell	Neutral	725	800	-18%	29.43x	14.30x	12.33x	7.58x	5.61x	5.22x	0.30x	0.16x	0.11x	1.9%	2.5%	3.2%	1.3%	2.6%	3.0%
Boliden	SEK	253.60	Neutral	Neutral	250	250	-1%	9.39x	9.89x	10.59x	4.71x	4.97x	5.02x	0.07x	0.04x	-0.07x	8.5%	6.7%	7.9%	6.4%	6.1%	5.6%
First Quantum Minerals	CAD	14.99	Buy	Buy	18.0	24.0	20%	22.38x	11.69x	7.98x	9.24x	6.44x	4.79x	3.57x	2.41x	1.49x	-3.9%	4.1%	15.7%	0.1%	0.1%	0.2%
Lundin Mining Corp.	SEK	47.34	Neutral	Neutral	50.0	51.0	6%	15.41x	9.19x	7.54x	4.97x	3.94x	3.04x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.0%	1.8%	1.7%	1.7%
Lundin Mining Corp.	CAD	6.67	Neutral	Neutral	7.3	7.5	9%	15.27x	9.10x	7.47x	4.91x	3.90x	3.01x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.1%	1.8%	1.8%	1.8%
KAZ Minerals Plc	GBP	553.60	Neutral	Neutral	575	450	4%	7.67x	9.45x	9.84x	4.66x	5.27x	5.41x	1.90x	2.20x	2.28x	-5.9%	-2.1%	-1.3%	0.3%	0.2%	0.2%
Aurubis AG	EUR	60.60	Neutral	Neutral	60.0	61.0	-1%	12.12x	14.98x	13.02x	5.38x	5.63x	5.01x	-0.53x	-0.96x	-1.04x	14.0%	8.9%	6.0%	3.4%	3.3%	3.5%
KGHM Polska Miedz SA	PLN	90.40	Sell	Sell	89	88	-2%	9.35x	8.15x	11.10x	4.60x	4.35x	4.34x	1.15x	1.01x	0.88x	8.5%	4.3%	5.7%	1.2%	1.0%	0.9%
Freeport-McMoRan Inc.	USD	13.95	Buy	Buy	18.0	19.0	29%	8.79x	18.66x	14.81x	4.43x	7.20x	6.30x	0.93x	1.38x	0.86x	13.4%	4.3%	9.8%	1.4%	1.4%	1.4%
MMG Ltd	HKD	3.95	Buy	Buy	5.80	6.30	47%	14.75x	8.39x	7.44x	6.69x	5.41x	4.72x	3.67x	2.69x	2.06x	16.0%	18.4%	18.7%	0.0%	0.0%	0.0%
Jiangxi Copper	HKD	9.03	Neutral	Neutral	11.5	12.7	27%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Jiangxi Copper	CNY	14.47	Neutral	Neutral	17.10	18.80	18%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Zijin Mining	HKD	3.03	Buy	Buy	3.8	3.9	25%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%
Zijin Mining	CNY	3.57	Buy	Buy	4.80	4.90	34%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%

** Denotes member of our Pan Europe Conviction Investment List*

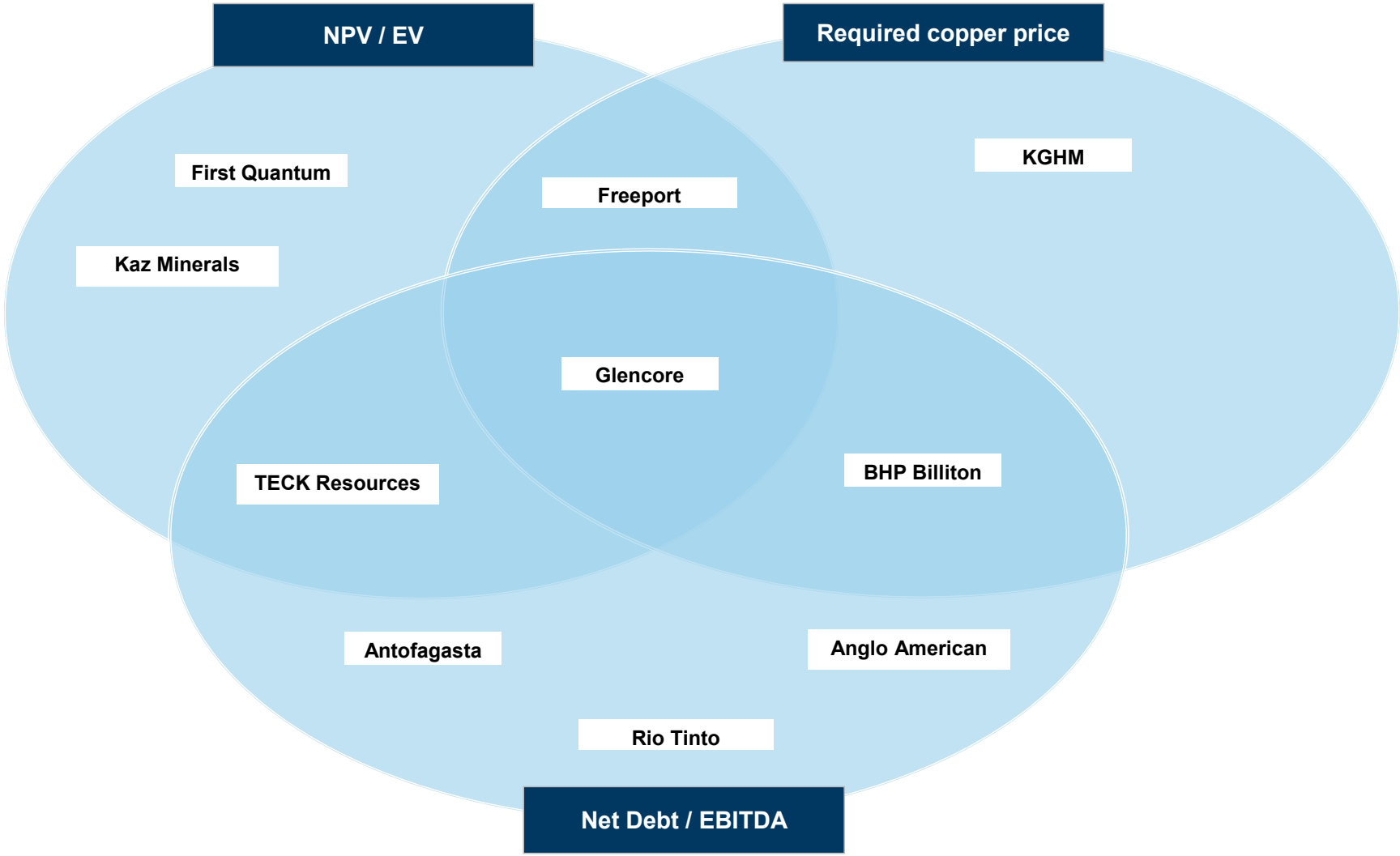
Source: Factset, Company data, Goldman Sachs Global Investment Research

Build or Buy remains the big decision: We have seen evidence of both

With the exception of Anglo American and Glencore, none of the big-cap mining companies in our coverage screen as having a portfolio of attractive copper assets (on our estimates). Given the attractiveness of copper for the miners (the big revenue pool that it represents) coupled with relatively strong balance sheets for most of the companies, we believe there is an important decision to be made: Build or Buy.

- **Build:** While the big miners – BHP, Rio, Glencore and Anglo American – have portfolios of growth options, these do not appear compelling, on our estimates. In our view, companies are likely to go ahead with brownfield expansions and projects where capex has partly been spent. Given that attractive greenfield options are increasingly scarce and expensive, we believe miners could look to acquire other attractive assets. BHP has recently opted to pursue expansion at Spence, and we believe that it is likely to go ahead with the Olympic Dam expansion too. Meanwhile, according to comments by RIO's CEO, the company is also looking to expand in copper.
- **Buy:** There are a number of projects owned by companies that do not have the resources to bring them to fruition. Given the historical precedents, we believe that miners with stronger balance sheets might look to acquire smaller companies; we have seen evidence of this with KAZ Minerals buying Baimskaya recently.

Exhibit 2: GLEN is best positioned, followed by Freeport, BHP and Teck

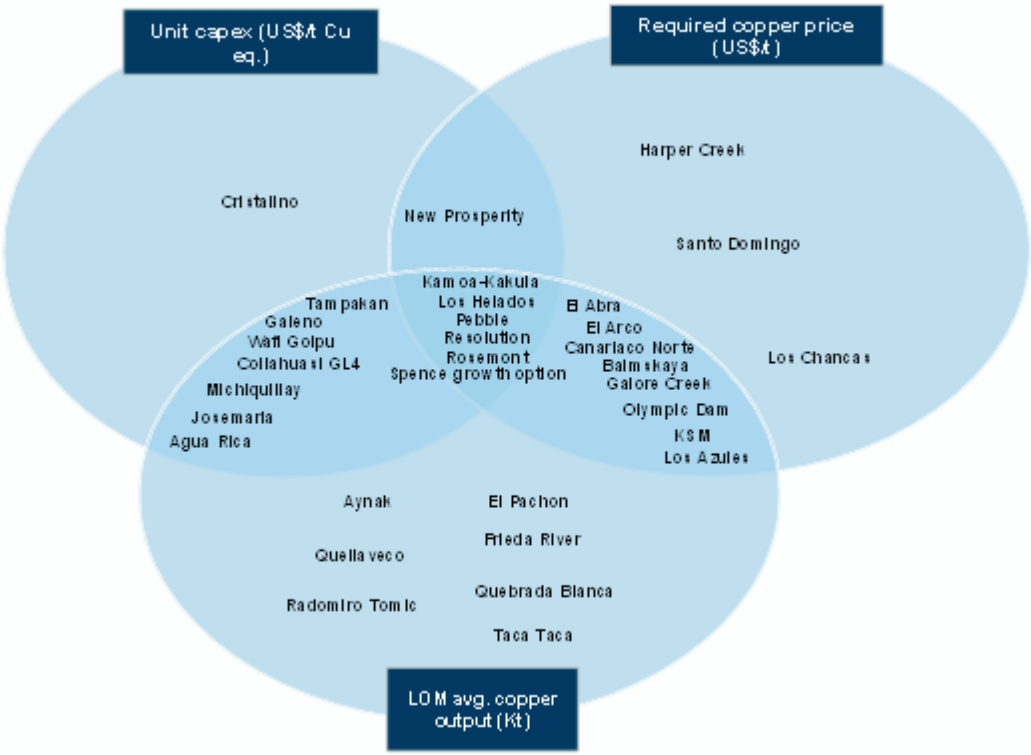


Source: Goldman Sachs Global Investment Research

Juniors continue to have the best undeveloped projects

To attempt to identify the most attractive projects, we look at three metrics: (1) capex intensity; (2) the required copper price to bring a project online; and (3) LOM average copper production. We look at projects for which the owners either do not appear to have the balance sheet strength to undertake such a big project and/or are solely exploration companies. *Note that one of the projects highlighted in our Top Copper Projects report - 2017, Baimskaya, was recently acquired by Kaz Minerals.*

Exhibit 3: Identifying the most attractive projects from our analysis



Source: Company data, Goldman Sachs Global Investment Research

Analysing what the market has overlooked over the past few years for copper

We discuss below what we believe the market has overlooked in the past few years that has led to significant downgrades to consensus price forecasts:

- **Supply:** In our view, the market has consistently overestimated the concentrate supply coming online. **Possible reason:** Project delivery being delayed vs. expectations.

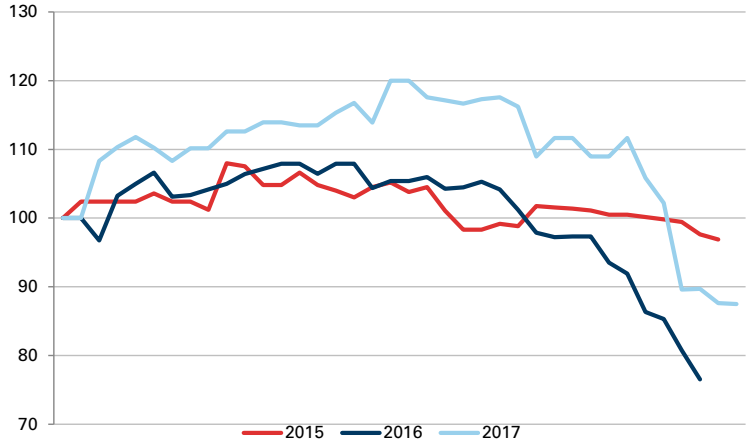
However, this has been offset by the following two factors:

- **Demand:** Demand has been one of the biggest downside surprises, with the market consistently downgrading forecasts. **Possible reason:** The slowdown in China in 2014. However, it is worth noting that demand forecasts more recently have been upgraded – mainly a function of stronger demand from China and RoW.
- **Disruptions:** Here, we believe the market has been overestimating the total number of disruptions. **Possible reason:** As copper prices fell, producers focused more closely on their operations, which resulted in fewer disruptions.

After shifting to a more bearish view on copper versus its historically bullish stance, the market appears to be turning more positive again, with consensus moving from a forecast surplus in 2018-20 to a deficit, implying price forecasts are likely to increase.

Exhibit 4: The average downgrade to consensus copper price forecasts for 2015-17 was 14% over a period of four years

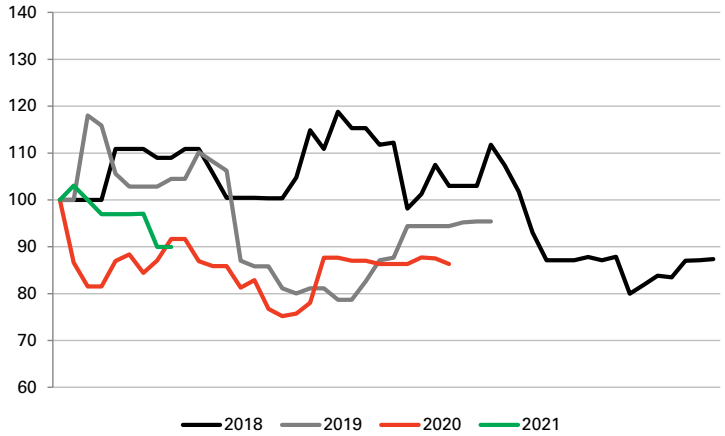
Commodity price forecasts for 2015/16/17 – rebased to 100 as of four years back



Source: Bloomberg

Exhibit 5: Consensus has downgraded its price expectations for copper for 2018-21 by an average 10% over the past few years

Commodity price forecasts for 2018/19/20 – rebased to 100 as of four years back



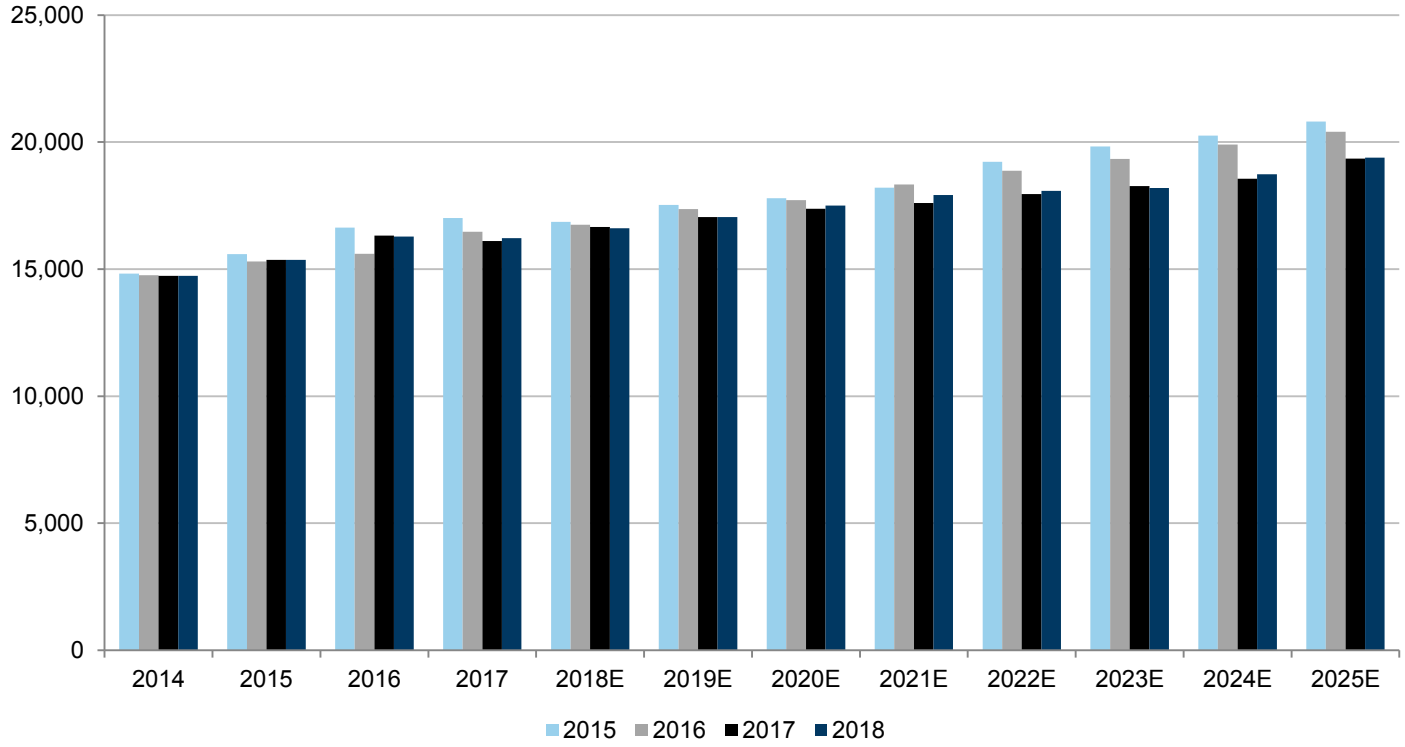
Source: Bloomberg

Supply: Market has been overly bullish on supply

As apparent from the exhibit below, the market has consistently been overly bullish on supply. It is difficult to determine the reasons for this, but they may include: (1) excessive optimism on growth projects, which rarely come online on time; and (2) a greater than expected grade decline.

How to read the chart: The bars represent Wood Mackenzie forecasts for copper concentrate production for the editions 2015, 2016, 2017 and 2018; for example, the four bars in the cluster 2019E represent what Wood Mackenzie was forecasting for 2019 in 2015, 2016, 2017 and the current forecast.

Exhibit 6: Market has been overly bullish when forecasting supply
Supply forecasts for 2014-2025 (Kt)



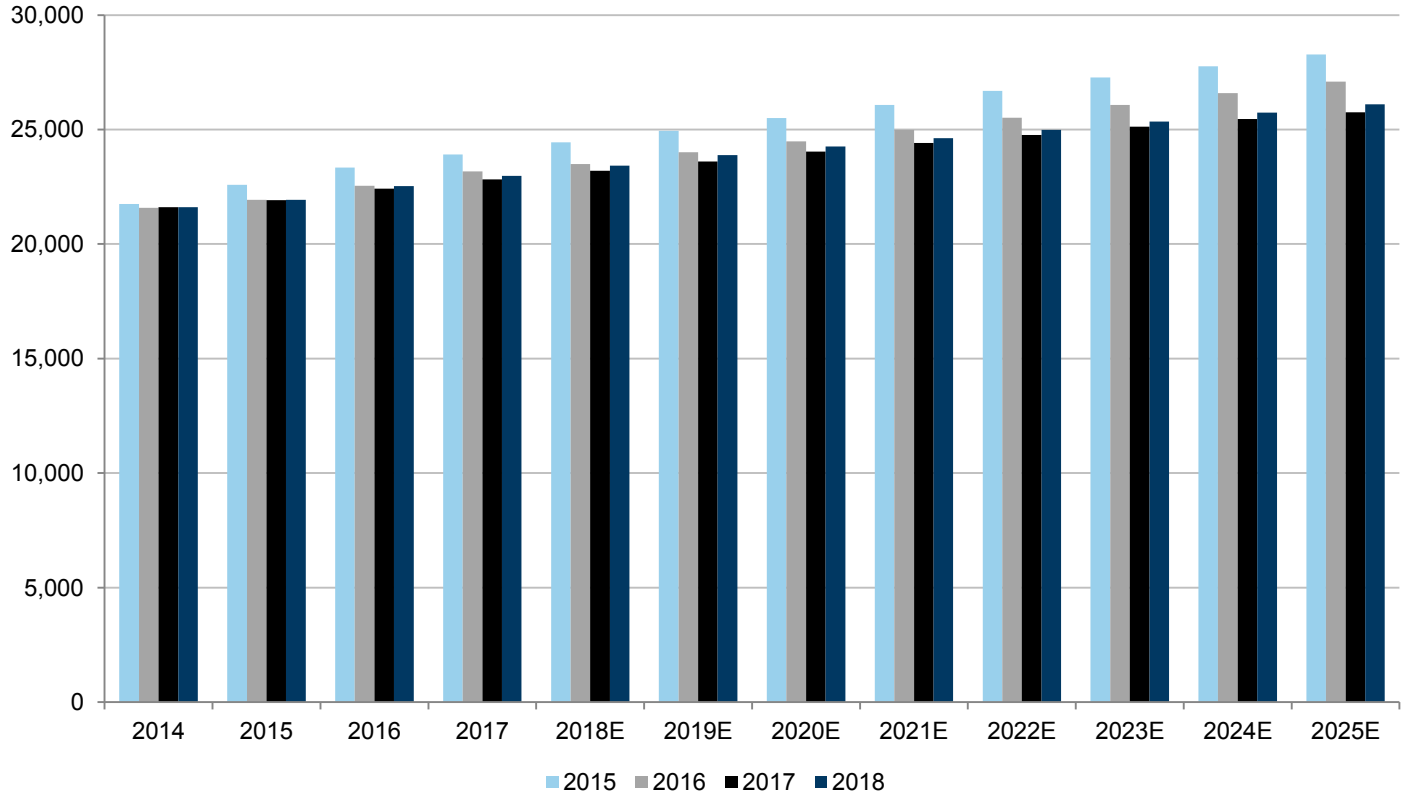
Source: Wood Mackenzie

Demand: Market has been overly bullish on demand

As shown in the exhibit below, the market has also been overly bullish on demand too. We believe the main reason for this has been the significant slowdown in Chinese consumption: the growth rate of Chinese copper consumption slowed from an average of 12.2% in 2008-13 to 6.2% in 2013-17.

How to read the chart: The bars represent Wood Mackenzie forecasts for copper refined consumption for the editions 2015, 2016, 2017 and 2018; for example, the four bars in the cluster 2019E represent what Wood Mackenzie was forecasting for 2019 in 2015, 2016, 2017 and the current forecast.

Exhibit 7: Market has been overly bullish when forecasting demand
Refined consumption forecasts for 2014-2025E (Kt)



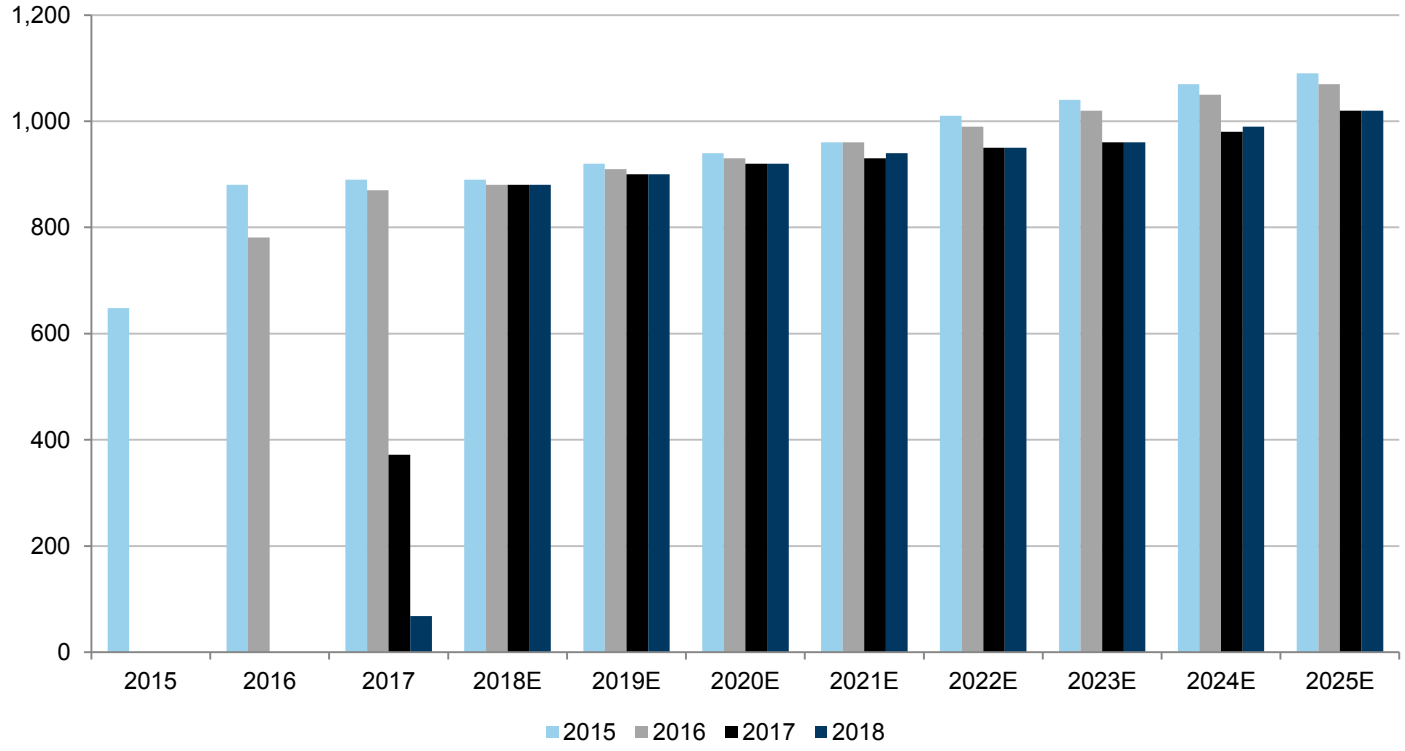
Source: Wood Mackenzie

Disruption allowance: Market has overestimated the amount of disruption

In our view, the market has probably been building in a higher level of disruption allowance than actually materialised. This has led to the new disruption allowance being continually reduced. A potential reason for the reduced level of disruption is that as copper prices fell, miners started focusing more closely on their operations and demands for pay rises by unions became less significant, which resulted in lower disruptions.

How to read the chart: The bars represent Wood Mackenzie forecasts for disruption allowance for the editions 2015, 2016, 2017 and 2018; for example, the four bars in the cluster 2019E represent what Wood Mackenzie was forecasting for 2019 in 2015, 2016, 2017 and the current forecast

Exhibit 8: Disruption allowance has steadily declined
Disruption allowance forecasts for 2015-2025E (Kt)



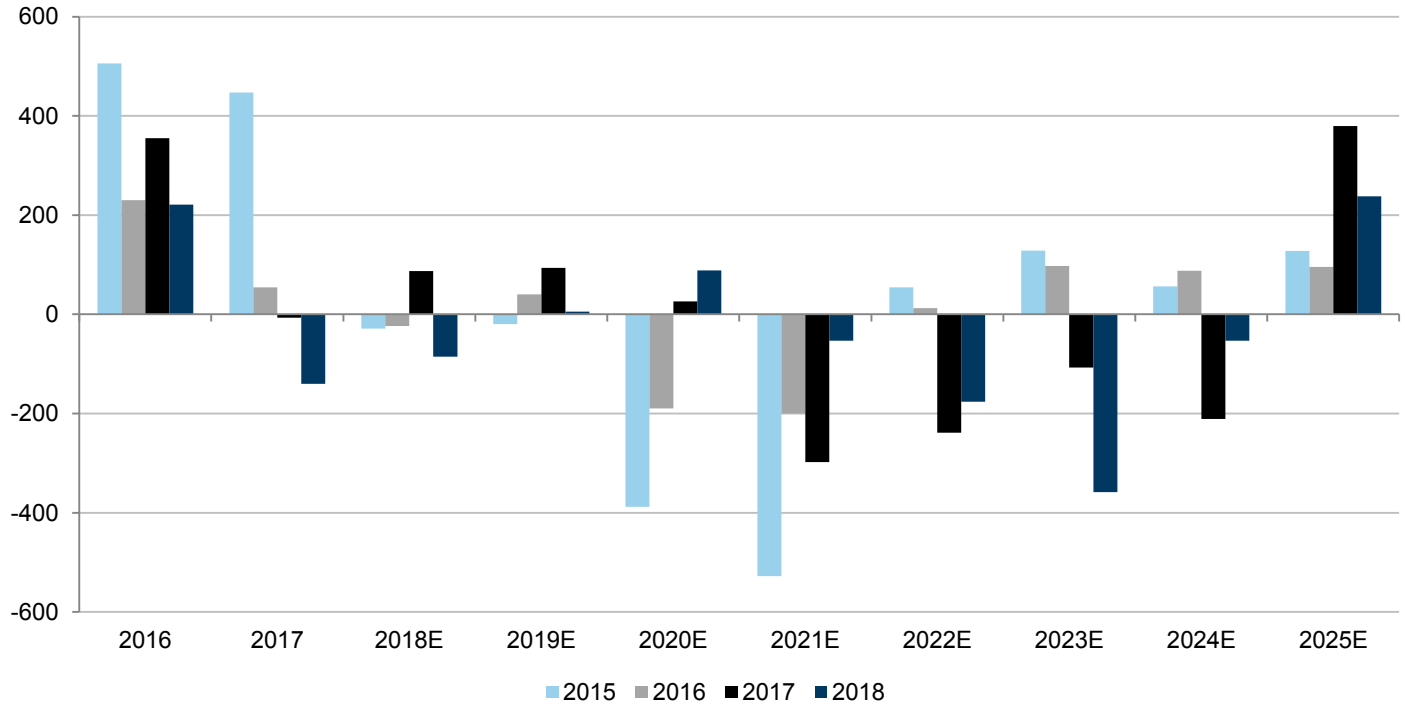
Source: Wood Mackenzie

Forecasts have narrowed and in some cases turned to surpluses

While supply forecasts have been bullish, the overly optimistic demand forecasts and disruption allowances have seen many deficit forecasts (e.g. 2018, 2019 and 2020) turn into surpluses (large and small), and in most cases large deficits turn into smaller ones (e.g. 2021). Most interesting, in our view, are the 2018/19 forecasts – in 2017, the forecast was for a surplus, and a fairly significant one. However, that has changed more recently as the market has moved into a deficit for 2018 and a much smaller surplus for 2019.

How to read the chart: The bars represent Wood Mackenzie forecasts for surpluses/deficits for the editions 2015, 2016 and 2017; for example, the four bars in the cluster 2018E represent what Wood Mackenzie was forecasting for 2018 in 2015, 2016, 2017 and the current forecast.

Exhibit 9: Surplus/deficit forecasts for copper, 2014-18 (Kt)



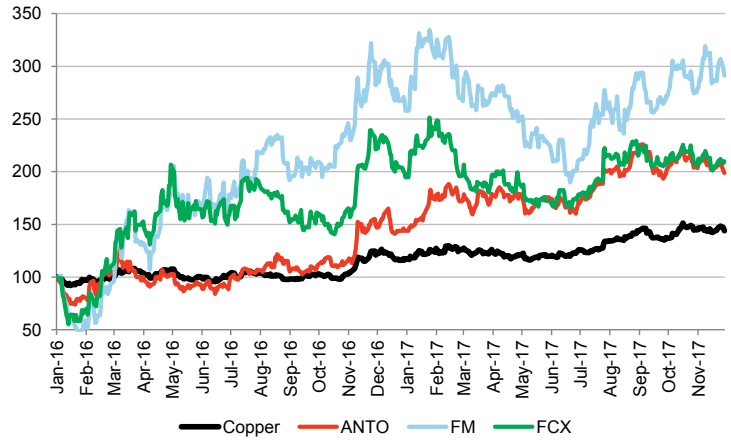
Source: Wood Mackenzie

Copper equities have traded poorly this year on reduced confidence in prices

2016/17 were strong years for copper and copper equities. Equities outperformed the underlying commodity (copper in this case) by multiples of 2-3x, mainly as investors grew more confident in the outlook for copper prices, underpinned by confidence in demand, and an increasingly consensus view that supply growth was disappointing and there were multiple risks to supply in the form of disruptions ahead.

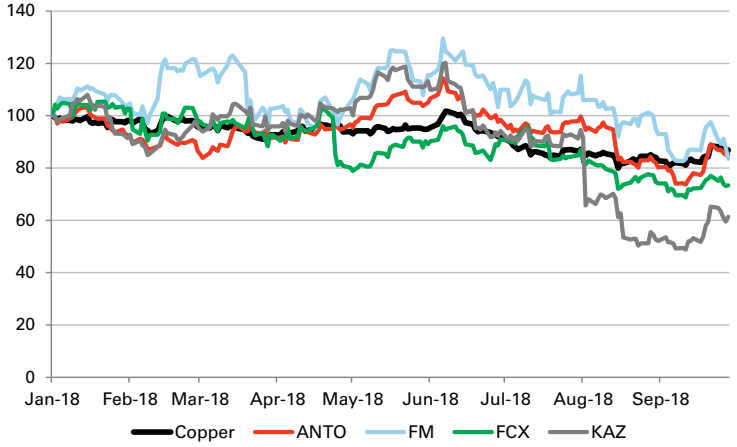
This year, however, has been very choppy for the equities. While the start of the year was strong, the equities have more than given up their gains as investors have become notably cautious on the future of copper, mainly owing to concerns over demand from EMs and China. As a result of these concerns, despite strong fundamentals and copper prices being relatively unchanged YTD, equities have traded poorly and most of them are down.

Exhibit 10: 2016/17 were very good years for copper/copper equities...



Source: Datastream

Exhibit 11: ...however, this year has been very choppy for the equities



Source: Datastream

Prefer equities with attractive projects, catalysts ahead

Our framework for selecting copper equities is simple – we prefer equities that have attractive projects (i.e. have a lower required copper price to bring the projects online, and are in stable jurisdictions) and have moved ahead with those projects. In addition, we also favour those that also have some catalysts in the near future.

Our key actionable ratings

- **Buy BHP**: (1) Strong returns; (2) Attractive commodity mix; (3) Strong copper portfolio.
- **Buy Anglo (on CL)**: (1) Quellaveco is a Tier 1 project; (2) Attractive commodity mix; and (3) Valuation undemanding.
- **Buy GLEN**: (1) Attractive commodity mix; (2) Strong FCF generation/potential for returns ramp-up; (3) Outcome of DoJ investigation a risk.
- **Buy Norlisk**: (1) FCF inflection; (2) Delevering ahead; (3) Consensus (Bloomberg) mispricing earnings, in our view.
- **Sell Antofagasta**: (1) Valuation high; (2) FCF/returns tier 4/3 vs. peers; (3) Growth options look uncompelling.
- **Buy First Quantum**: (1) Cobre to come online next year; (2) Strong FCF generation/delevering; and (3) Valuation undemanding.
- **Buy FCX**: (1) Strong copper exposure; (2) Grasberg resolution a positive; (3) Strong FCF generation.
- **Sell KGHM**: (1) Low cash generation; (2) Valuation looks demanding.
- **Buy MMG Ltd**: (1) High leverage to copper prices; (2) We see net gearing falling; (3) Strong FCF generation.
- **Buy Zijin Mining**: (1) Strong copper growth ahead; (2) Active in M&A; (3) Strong FCF generation.

Exhibit 12: Summary key financial metrics

Company	Share price Ccy	Last Close	Rating New	Rating Old	12m PT PT	12m PT Old	Return (%)	P/E 2018E	P/E 2019E	P/E 2020E	EV/EBITDA 2018E	EV/EBITDA 2019E	EV/EBITDA 2020E	Net debt/EBITDA 2018E	Net debt/EBITDA 2019E	Net debt/EBITDA 2020E	FCF Yield(%) 2018E	FCF Yield(%) 2019E	FCF Yield(%) 2020E	Dividend Yield(%) 2018E	Dividend Yield(%) 2019E	Dividend Yield(%) 2020E
Diversifieds																						
BHP - LSE	GBP	1,692.00	Buy	Buy	1,950	2,000	15%	15.76x	15.48x	17.63x	5.45x	5.64x	6.04x	0.40x	0.33x	0.24x	8.1%	7.0%	6.7%	5.0%	4.3%	3.9%
BHP - ASX	AUD	35.41	Buy	Buy	40.0	42.0	13%	18.15x	17.82x	20.30x	5.92x	6.06x	6.42x	0.40x	0.33x	0.24x	7.4%	6.5%	6.3%	4.4%	3.8%	3.4%
Rio -LSE	GBP	3,917.50	Neutral	Neutral	4,000	4,000	2%	9.77x	10.54x	11.84x	5.49x	5.56x	5.97x	0.02x	0.19x	0.32x	6.3%	6.4%	4.8%	6.2%	5.6%	5.1%
Rio Tinto - ASX	AUD	79.95	Neutral	Neutral	82.0	84.0	3%	10.97x	11.83x	13.29x	6.04x	6.09x	6.52x	0.02x	0.19x	0.32x	5.7%	5.8%	4.3%	5.5%	5.0%	4.5%
Glencore	GBP	333.55	Buy	Buy	400	375	20%	8.20x	8.45x	10.79x	4.13x	3.87x	4.06x	0.49x	0.31x	0.07x	20.9%	16.3%	16.0%	5.3%	4.2%	5.6%
Anglo American	GBP	1,755.40	Buy*	Buy*	2,200	2,000	25%	10.12x	10.22x	12.90x	4.33x	3.86x	4.48x	0.42x	0.19x	0.21x	8.7%	9.4%	3.8%	4.4%	4.6%	3.7%
Norilsk Nickel	USD	17.20	Buy	Buy	24	25	40%	7.03x	6.75x	7.07x	5.94x	5.32x	5.79x	1.32x	1.14x	1.46x	13.6%	8.0%	7.9%	13.1%	14.4%	13.9%
Teck Resources Ltd.	USD	24.33	Neutral	Neutral	30	28	23%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Teck Resources Ltd.	CAD	31.28	Neutral	Neutral	38	37	21%	7.03x	8.61x	10.26x	3.99x	4.42x	4.97x	0.53x	0.09x	-0.09x	11.0%	12.9%	5.8%	2.1%	0.6%	0.6%
Copper																						
Antofagasta	GBP	879.40	Sell	Neutral	725	800	-18%	29.43x	14.30x	12.33x	7.58x	5.61x	5.22x	0.30x	0.16x	0.11x	1.9%	2.5%	3.2%	1.3%	2.6%	3.0%
Boliden	SEK	253.60	Neutral	Neutral	250	250	-1%	9.39x	9.89x	10.59x	4.71x	4.97x	5.02x	0.07x	0.04x	-0.07x	8.5%	6.7%	7.9%	6.4%	6.1%	5.6%
First Quantum Minerals	CAD	14.99	Buy	Buy	18.0	24.0	20%	22.38x	11.69x	7.98x	9.24x	6.44x	4.79x	3.57x	2.41x	1.49x	-3.9%	4.1%	15.7%	0.1%	0.1%	0.2%
Lundin Mining Corp.	SEK	47.34	Neutral	Neutral	50.0	51.0	6%	15.41x	9.19x	7.54x	4.97x	3.94x	3.04x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.0%	1.8%	1.7%	1.7%
Lundin Mining Corp.	CAD	6.67	Neutral	Neutral	7.3	7.5	9%	15.27x	9.10x	7.47x	4.91x	3.90x	3.01x	-1.24x	-1.00x	-1.27x	-5.9%	2.0%	11.1%	1.8%	1.8%	1.8%
KAZ Minerals Plc	GBP	553.60	Neutral	Neutral	575	450	4%	7.67x	9.45x	9.84x	4.66x	5.27x	5.41x	1.90x	2.20x	2.28x	-5.9%	-2.1%	-1.3%	0.3%	0.2%	0.2%
Aurubis AG	EUR	60.60	Neutral	Neutral	60.0	61.0	-1%	12.12x	14.98x	13.02x	5.38x	5.63x	5.01x	-0.53x	-0.96x	-1.04x	14.0%	8.9%	6.0%	3.4%	3.3%	3.5%
KGHM Polska Miedz SA	PLN	90.40	Sell	Sell	89	88	-2%	9.35x	8.15x	11.10x	4.60x	4.35x	4.34x	1.15x	1.01x	0.88x	8.5%	4.3%	5.7%	1.2%	1.0%	0.9%
Freeport-McMoRan Inc.	USD	13.95	Buy	Buy	18.0	19.0	29%	8.79x	18.66x	14.81x	4.43x	7.20x	6.30x	0.93x	1.38x	0.86x	13.4%	4.3%	9.8%	1.4%	1.4%	1.4%
MMG Ltd	HKD	3.95	Buy	Buy	5.80	6.30	47%	14.75x	8.39x	7.44x	6.69x	5.41x	4.72x	3.67x	2.69x	2.06x	16.0%	18.4%	18.7%	0.0%	0.0%	0.0%
Jiangxi Copper	HKD	9.03	Neutral	Neutral	11.5	12.7	27%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Jiangxi Copper	CNY	14.47	Neutral	Neutral	17.10	18.80	18%	10.39x	10.10x	9.61x	5.36x	4.97x	4.50x	0.97x	0.91x	0.57x	-14.4%	2.9%	11.4%	4.0%	4.2%	4.4%
Zijin Mining	HKD	3.03	Buy	Buy	3.8	3.9	25%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%
Zijin Mining	CNY	3.57	Buy	Buy	4.80	4.90	34%	14.31x	14.05x	12.71x	6.02x	5.70x	6.26x	0.86x	0.58x	1.25x	8.9%	8.3%	9.2%	3.5%	3.6%	3.9%

** Denotes member of our Pan Europe Conviction Investment List*

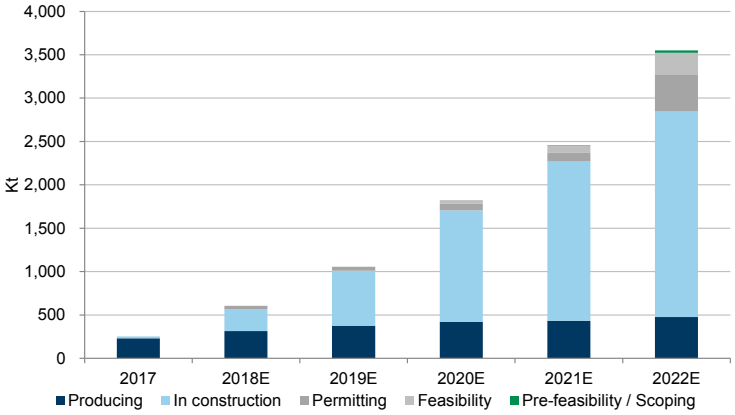
Source: Factset, Company data, Goldman Sachs Global Investment Research

Supply: Pace of supply additions has slowed dramatically; country risks have increased

One big change from the 2017 edition of our report has been the pace of supply additions that we expect to come online in the next few years. Last year, we had forecast c.2.4 mn tonnes of new supply to come online between 2017 and 2020. Based on our latest models, we believe that a total of c.1.6 mn tonnes of new supply is set to come online between 2018 and 2020. While this partly reflects our removal of some projects that have come online/reached full production, the biggest reason for the decline in production adds is that the companies have continued to either delay or not move ahead with the growth projects as we had expected last year.

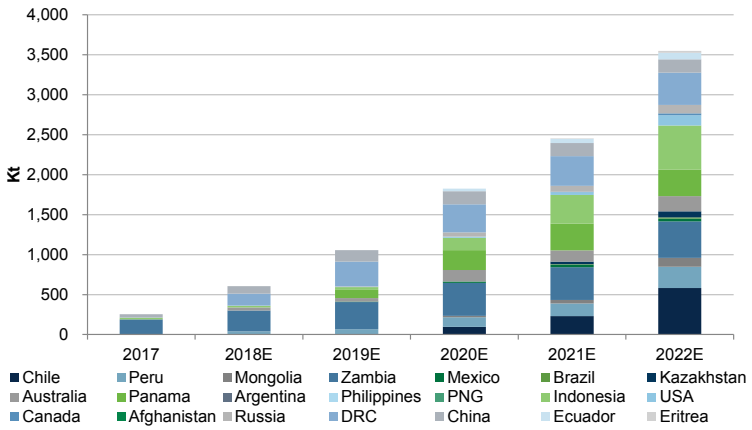
More than 60% of the production uplift according to our model is set to come from two countries – Zambia and DRC – where there has recently been a significant escalation in risk (a US$8 bn tax bill imposed on First Quantum in Zambia and material tension regarding new royalties in DRC). We do not expect the risk to subside in the near future.

Exhibit 13: On an unrisked basis, we expect a cumulative1.6 mn tonnes to be added to 2020
New copper production (Kt)



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 14: More production is coming from risky jurisdictions
New copper production by country (kt)

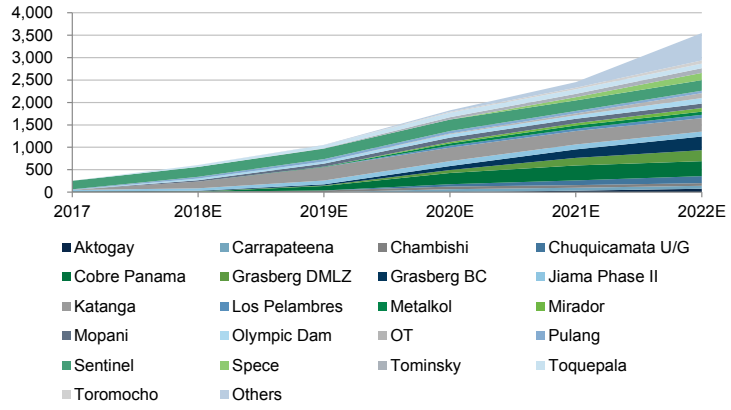


Source: Company data, Goldman Sachs Global Investment Research

Few mines/companies contributing the most to supply increase; raises risk of disruptions

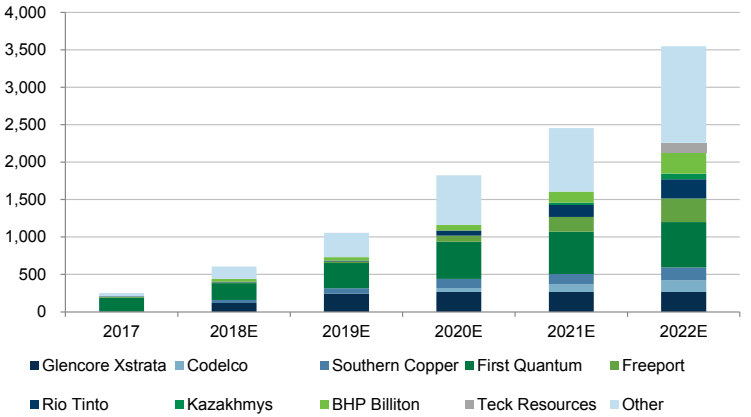
Another risk to a production uplift in the near-to-medium term is mine- and company-specific factors. Just three mines in our analysis (Sentinel, Cobre Panama and Katanga) contribute > 50% of the production increase we expect in the near term. Among these, we believe the majority of the risk relates to Cobre Panama and Katanga: Cobre Panama because it is a new mine that is scheduled to come online next year (new copper mines seldom reach their ramp-up targets) and Katanga given the risks associated with the jurisdiction (DRC). With regard to company-specific factors, the majority of the expected production increase comes from just 2-3 companies, with First Quantum and Glencore being the most important. While we do not foresee any company-specific factors affecting either of them, we highlight that risks do exist given the jurisdictions in which these companies operate.

Exhibit 15: c.50% of production increase to come from three mines in 2018/19E
Kt



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 16: c. 40% of the production increase to come from 2-3 companies over the next two years
Kt



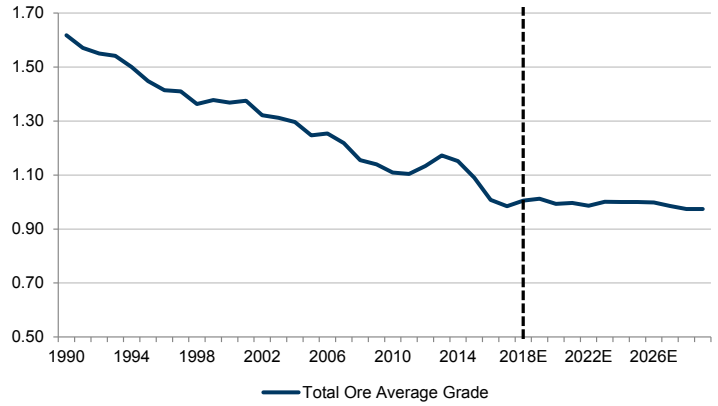
Source: Company data, Goldman Sachs Global Investment Research

Grade decline presents risks to forecasts; risk of disruption to rise as mines move underground

One change in our view since our last publication relates to grade decline. Last year, our view was that the grade decline we observed was likely a function of the grades that miners were choosing to mine in response to lower prices, rather than underlying mine degradation. However, given that the decline has persisted despite the improvement in prices, we believe it reflects the natural degradation of the resource, which has positive implications for copper prices. While Wood Mackenzie forecasts grade to remain constant, we see downside risk to these estimates.

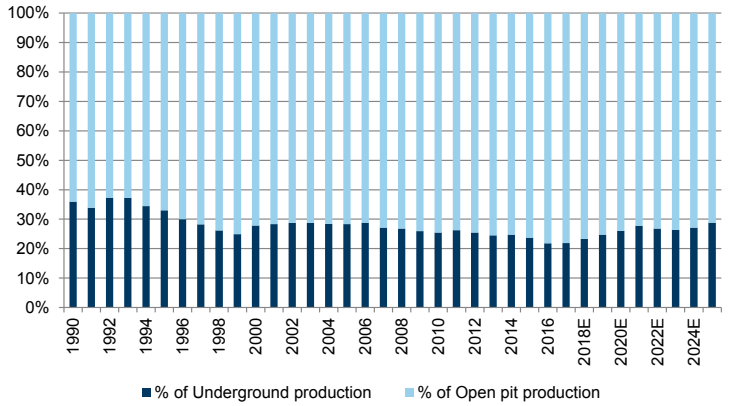
Another trend to keep in mind is the increasing number of mines moving underground. Wood Mackenzie forecasts the total proportion of underground operations to increase from c.22% as of 2017 to >30% by 2027. Underground mines by nature are riskier and are prone to disruptions, which could be a potential source of upside for copper prices in the longer term.

Exhibit 17: Grade has continued to decline over the last 3-4 years; this trend is likely to continue



Source: Wood Mackenzie

Exhibit 18: In addition, as the % of underground mines increases, the risk of disruptions is higher



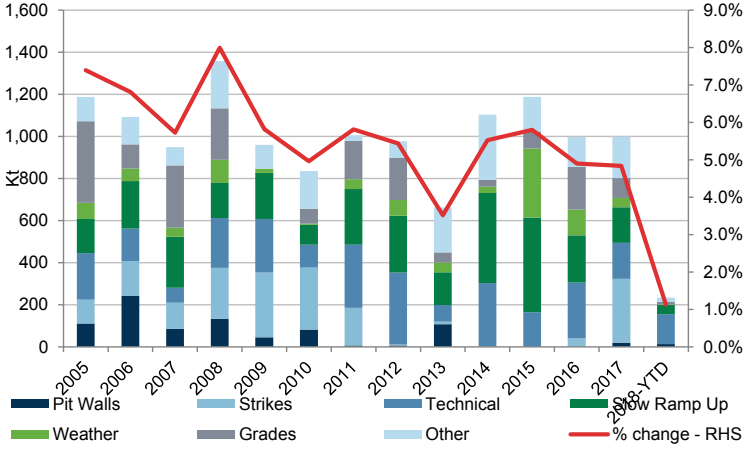
Source: Wood Mackenzie

Disruptions: YTD disruptions have been running low on successful wage talks, strong productivity

YTD disruptions have been running at a historically low rate, primarily a function of almost no wage-related disputes. We had believed that given the number of wage negotiations this year, there would likely be a meaningful number of disruptions, which have not materialised. The low level of labour-related disruptions is atypical for the current level of margins. To a large extent, the strikes have been avoided because the companies have been more accommodative to workers' demands than observed historically. We find that during past strikes, the resulting pay deals were normally much closer to companies' initial offers than unions' proposals (see Metals Express: Copper labour talks - what does history say?).

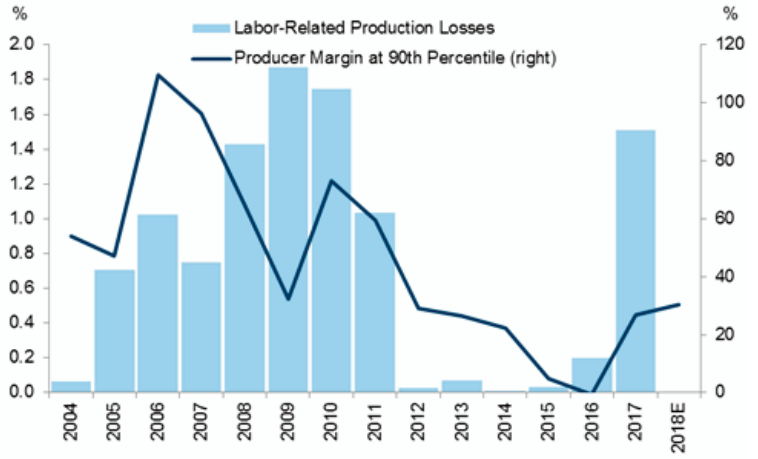
In our view, one reason why companies have been keen to avoid strikes this year is the elevated level of uncertainty regarding the future demand outlook and direction of copper prices. In particular, China's high copper demand per capita relative to its income leads to concerns that the country has brought forward a large amount of its future copper consumption, creating significant downside risks to forward demand growth. Such concerns also contribute to the still depressed level of mining company valuations, in our view. Lastly, the push for higher productivity has seen mines running more smoothly than we would have anticipated at the start of the year.

Exhibit 19: YTD copper disruptions have been at a historic low
Copper supply disruptions 2005-18 ytd



Source: Wood Mackenzie

Exhibit 20: Labour disruptions surprised to the downside in 2018



Source: Wood Mackenzie, Goldman Sachs Global Investment Research

Rising ESG issues having an impact on copper production

While YTD disruptions are running at an all-time low, we highlight that there have been a number of issues building. These reflect factors such as more stringent environment/climate-related policies by governments and local/federal authorities and protests by local communities leading to mining stoppages and/or the cancellation of mining concessions.

- **Las Bambas**: Since the mine reached full production in 2016, it has faced a number of problems. The most recent source of tension relates to allegations by populations living near the highways where the trucks carry copper ply that the trucks are encroaching on their land and having an adverse impact on the local environment. This issue has persisted and presents a material risk to the copper supply; Las Bambas produces c.300ktpa of copper each year.
- **Pebble**: Continued opposition by local communities in Alaska has led to the US government reversing its stance on the project. When the Trump government took office in 2016, the EPA had said that it was working towards approving the copper project in Alaska. First Quantum had also been interested in the project at one point. However, the project has been put on hold as of now. While we include the project in our analysis, we ascribe a low probability to it coming online.
- **Grasberg**: While the ownership issues at Grasberg are heading towards a resolution, with the Indonesian government set to own c.51% of the mine by early 2019, one remaining issue is the management of tailings that are disposed of into the sea via the local river system. The environmental ministry had said earlier this year that the company needs to reduce the amount of tailings from 90% to 50%.

Overall, we believe that the focus by governments on environmental standards, and opposition to mining activity from populations living in surrounding areas, are likely to increase. As an example, the government of Chile recently announced that it is seeking to put restrictions on new water extraction rights from lithium-rich Salar de Atacama salt flats. The region is home to lithium miners such as Albemarle and SQM. Regulators have banned the issuance of new permits to extract water from south of Salar's watershed – a key water supply to the Escondida and Zaldivar mines. The proposal by BHP to cut water use has been deemed insufficient by the government. While the impact is not quantifiable as of now, we believe that governments (across the world) are likely to focus increasingly on environmental protection, which will increase the costs and complexity involved in the extraction of copper.

Codelco, GLEN and Freeport: Three big determiners of copper supply

Codelco, Glencore and Freeport together account for c.25% of total copper production; this, as well as their significant pipeline of growth projects, makes them important for the copper market.

Codelco – multiple growth assets but capital a constraint

Codelco is the world's largest copper producer (c.10% of total copper produced in 2017). The company has multiple growth assets, Chuquicamata underground being the one that will deliver production near term; other assets are: Radomiro Tomic (Sulphides II) and Andina and El Teniente. These projects are still under study and are not expected to start production before 2023/24, as the company is currently prioritising spending on Chuquicamata underground given capital constraints and the significant debt load.

Despite declining copper grades, Codelco was able to raise year-on-year production in 2017, mainly due to strong performance from Chuquicamata and Andina. The company is now budgeting $21 bn through 2022 to maintain output levels after years of underinvestment. In June 2018, the Chilean government unveiled $1 bn of funding through February to support Codelco's growth projects and halt the decline in production levels. We view this as supportive of Codelco's plan to grow its copper production profile.

Chuquicamata: The mine is moving from an open pit mine to a modern underground operation with more mechanised processes in order to cut costs and raise production rates. This has caused concern among workers at the mine, who went on strike in July to protest against the underground plan. According to the latest news flow, the underground portion of the mine should start to produce copper from 3Q19; however, we take a more cautious view and assume first production in 2020.

Andina Phase II: The second phase of the project is to ramp up daily processing capacity by 150kt to 244kt. However, at the beginning of 2018, Codelco announced that it would alter the Andina mine plan as a result of glaciers. This will take approximately three years to carry out and is reliant on the improvement of the environmental impact study. We expect the project to be delayed, with construction set to start in 2019 and first production to take place in 2024.

El Teniente: The mine is the world's largest underground copper mine. In early 2018, it was facing medium-term copper production challenges owing to declining grades and the depletion of some of the current exploration areas. To address this, the company is working on the development of the NNM (Nuevo Nivel Mina), where we expect first production in 2023; revised capex of $5 bn (from $3 bn) was announced in July. The project should prolong production at El Teniente for an additional 50 years, allowing the division to maintain copper production of around 400ktpa.

Radomiro Tomic: The mine is currently undergoing phase 2 of development, which will include two dedicated 100kt/d concentrators. The project is in the feasibility stage, with Codelco already receiving EIA approvals. The next stage of the project is approval by the Codeclo board and Cochilo. Given the lack of news flow on the project and the prioritisation of the Chuquicamata mine, we assume the mine comes online in 2024.

Exhibit 21: Codelco has a number of growth projects but is focused on Chuquicamata for now
Codelco growth projects

Codelco				
Key Metrics	**Chuquicamata**	**Andina Phase II**	**El Teniente**	**Radomiro Tomic**
Project status	Construction	Feasibility	Construction	Pre-feasibility
Start Year	2020	2024	2023	2024
Capex ($ mn)	4,200	7,600	5,100	5,900
Average Production (ktpa)	329	343	407	343
Life of Mine	29	19	28+	27+
IRR (%)	13%	9%	13%	15%
NPV @ 8% (incl. sunk) (US$ mn)	4,203	319	3,497	3,654
NPV @ 8% (2017+) (US$ mn)	8745	319	409	4306
Reqd Copper Price ($/t)	7,482	8,796	7,460	6,553
C1 cash cost($/t)	3,181	3,161	3,627	3,239

Source: Company data, Goldman Sachs Global Investment Research

Freeport/Grasberg agreement after years of negotiations; production ramp-up still a concern

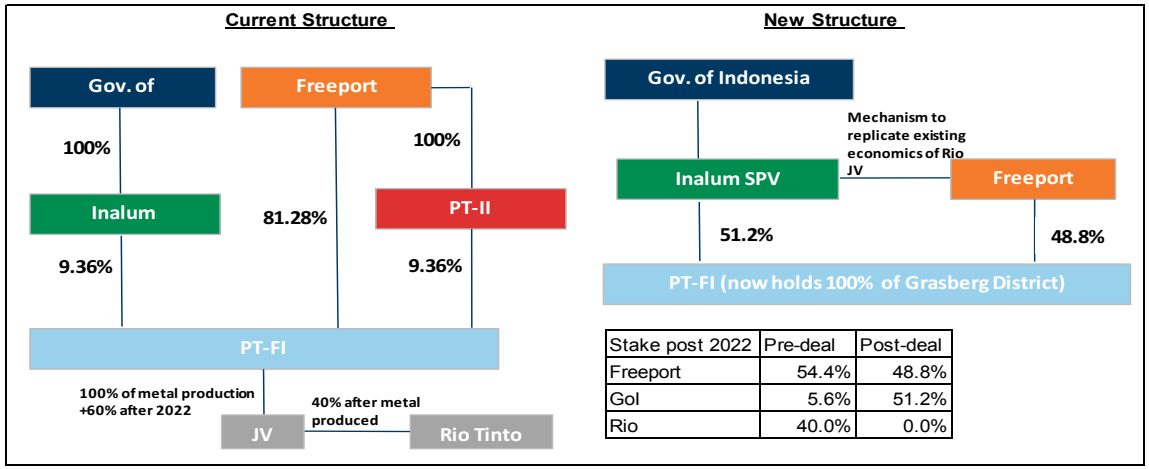
After several years of negotiations between Freeport and Indonesia, a binding agreement with PT Indonesia Asahan Aluminium was signed on September 27, 2018 regarding the divestment of a stake in Freeport's Grasberg mine. The overall deal size announced is the same as that highlighted in July's Heads of Agreement ($3.85 bn total proceeds, with $3.5 bn of proceeds for Rio's stake and $350 mn for Freeport's stake), but additional clarity was offered on the timing of the transfer of the stake, the path to resolving environmental claims and agreements on operating rights going forward.

Historically, the negotiations were centred on the ownership of the Indonesian Grasberg mine. The Indonesian government wanted Freeport to sell a part of the Grasberg stake to local investors to meet requirements for government ownership of at least 51% for the asset. This is part of a broader push by Jakarta to give Indonesians greater control of the country's natural resources. Production from the open pit mine is expected to end in 2018-19, with the mine transitioning to a fully underground operation by 2020.

Current structure

Under the current structure, Freeport owns a 90.64% stake in Grasberg through an 81.28% interest in PT-FI and an additional 9.36%. As part of this arrangement, Rio Tinto has also received a small, variable stream of the revenues depending on certain production thresholds, and after mining through a certain region of the Grasberg deposit was complete (planned for 2022-23), Rio Tinto's stream would increase to a full 40%, with the jointly owned PT-FI receiving the remainder. Effective ownership of Grasberg after this point would be Rio Tinto 40%, Freeport 54.4% (60% x 90.64%), and Government of Indonesia 5.6% (60% x 9.36%).

Exhibit 22: Grasberg: New structure vs. old structure



Stake post 2022	Pre-deal	Post-deal
Freeport	54.4%	48.8%
GoI	5.6%	51.2%
Rio	40.0%	0.0%

Source: Company data, Goldman Sachs Global Investment Research

New structure

Under the proposed new structure, Rio Tinto's JV interest would be converted to a share of PT-F that would transfer to Inalum (for $3.5 bn), with Freeport then divesting a 9.36% stake (for $350 mn) in PT-FI to Inalum. As shown above, effective ownership of Grasberg would then be split between Freeport, with a 48.8% stake in PT-FI ([90.64% - 9.36%] x 60%), and Inalum owning the balance of 51.2% – giving the government a stake of over 51%, which has been its long-term objective. Freeport would remain the operator of the mine despite Indonesia owning a majority of the equity and there will be no requirement for Freeport to divest any additional interest in the mine.

Under the terms of the new agreement, Freeport's cash flows would remain essentially the same as under the current structure, as the company would continue to receive the vast majority of cash flows through the period until which Rio Tinto's 40% interest would have kicked in. The only difference would be due to the immediate dilution of 9.36% ownership to Inalum for $350 mn, leaving FCX with an effective 81.28% of medium-term cash flows instead of 90.36%. Inalum will also fund the capital required for underground development that would have been contributed by Rio Tinto.

As part of this new structure, Freeport will construct a new $3 bn copper smelter in Indonesia within five years of the completion of the transaction. The capital is likely to come from project financing, with Freeport and Inalum contributing only limited equity if necessary.

Exhibit 23: Freeport has two projects at Grasberg that are being ramped up
Freeport growth projects

Freeport		
Key Metrics	**GrasbergDMLZ**	**Grasberg BC**
Project Status	Construction	Construction
Start Year	2015	2016
Capex ($ mn)	3,200	6,700
Average Production (ktpa)	125	246
Life of Mine	21	24
IRR (%)	13%	13%
NPV @ 8% (incl. sunk) (US$ mn)	2,998	5,817
NPV @ 8% (2017+) (US$ mn)	5,346	-169
Reqd Copper Price ($/t)	7,180	7,514
C1 cash cost($/t)	453	306

Source: Company data, Goldman Sachs Global Investment Research

Glencore's DRC concerns have eased, ramp-up progressing

On April 22, Katanga Mining Limited announced that its JV partner in the DRC, the state-owned Gecamines, had commenced legal proceedings in the DRC to dissolve its 75%-owned Kamoto Copper Company (KCC) following its alleged failure to address capital deficiency. The alternative was to give Katanga some time to request the appointment of an expert to assess and report on KCC's financial position.

Following this, on April 27, 2018, Ventora Development Sasu served freezing orders in the DRC against Mutanda and Kamoto Copper Company for approximately $695 mn and $2.28 bn, respectively. According to Ventora, Mutanda had breached an agreement in which it was required to make royalty payments to Ventora. In addition, Ventora said that KCC had breached an agreement between KCC, Gecamines and AHIL for which it was entitled to damages of $2.29 bn. On April 28, Ventora obtained from Kolwezi high court injunctions to pay against KCC and Mutanda in the amount of c.US$2.9 bn, which, if they had become permanent, would have allowed Ventora to permanently seize the assets; this would, in our view, have been detrimental to the investment view (AHIL/Ventora own royalties on Katanga/Mutanda).

On June 12, Glencore announced the settlement of the legal dispute with Gecamines and an agreement for the resolution of the capital deficiency at Katanga's 75%-owned DRC operating subsidiary KCC. This resulted in Glencore making a one-time payment of $150 mn to Gecamines and a $5.6 bn write-off of the $9 bn intercompany loan made to KCC. A couple of days later, Glencore announced that it had settled the dispute with Ventora and Africa Horizons regarding the non-payment of royalties. Mutanda and KCC will pay the royalties when they become due in non-US dollars, without involving US persons, in order to fulfil their obligations under the terms of the pre-existing contracts. We believe this has allayed investor concerns over Glencore's DRC assets being under threat of seizure.

Glencore: Katanga and Mopani ramp-up on track

Having shut down the Katanga and Mopani in 2H15 as copper prices fell, Glencore is well on the way to ramping up production at the two mines.

Katanga: The mine, located in the DRC, has now reached commercial production and is ramping up, with recent guidance pointing to production of 150kt for 2018 and 300kt in 2019. The mine recently faced legal and regulatory issues (explained above), but most have now been resolved. We still model the mine achieving its targeted production. The mine is of particular importance to Glencore given we expect it to produce 34.5ktpa of cobalt from 2019 onwards.

Mopani: Glencore has spent over $1 bn since 2014 for the development of new shafts that are expected to increase the mine life by c.25 years. The expansion is expected to add c.90ktpa of copper, with recent news flow suggesting first production in 2H18 and full ramp-up to name-plate capacity by 2020. Given that the majority of capex has already been spent, we believe the likelihood of reaching full capacity by 2020 is high.

Exhibit 24: Glencore has four growth projects, of which Katanga and Mopani are ramping up
Freeport growth projects

GLENCORE				
Key Metrics	**Katanga WOL**	**Mopani upgrade**	**El Pachon**	**Collahuasi**
Project Status	Construction	Construction	Pre-feasibility	Pre-feasibility
Start Year	2017	2018	2026	2025
Capex ($ mn)	1,159	1,025	2,026	4,350
Average Production (ktpa)	274	95	277	292
Life of Mine	17	26	25+	26+
IRR (%)	198%	19%	13%	15%
NPV @ 8% (incl. sunk) (US$ mn)	17,184	2,126	1,699	2,888
NPV @ 8% (2017+) (US$ mn)	17,567	3,161	1,699	2,888
Required Copper Price ($/t)	-1,243	5,489	10,029	6,651
C1 cash cost($/t)	-2,170	2,333	3,534	3,229

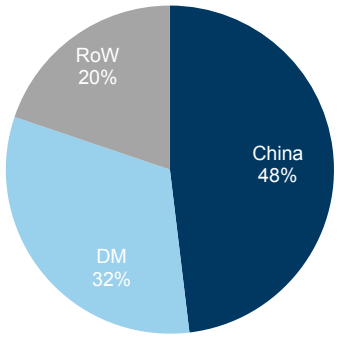
Source: Company data, Goldman Sachs Global Investment Research

Demand: Outlook has muddied, but overall remain positive

At the start of the year, we were positive on copper, led primarily by the fact that even as China was slowing, the rest of the world (DMs and EM ex. China) was growing at a very strong rate – the DM CAI (a proxy for growth) was at 3.6% as at January 2018 and EM CAI was at 7.1%. These numbers remained strong, while the further slowdown that the market appeared to be expecting in China did not materialise. China CAI strengthened from 7% as of December 2017 to 8% in February 2018.

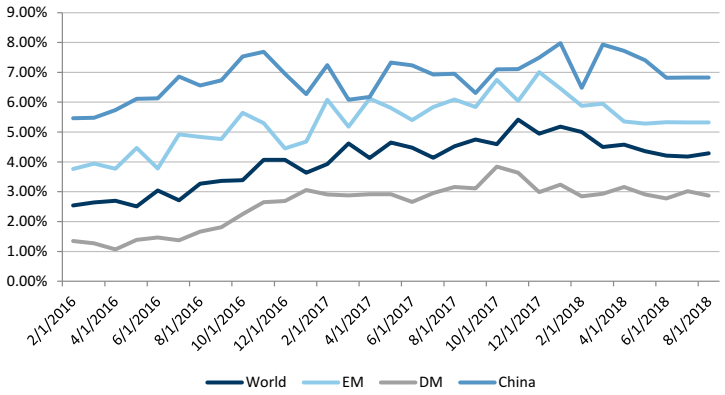
More recently, however, the view has changed. EM growth has been a source of investor concern given disappointing data coming out of South Africa and the recent slowdown in Turkey, among others. DM growth has also come down from very high levels – 3.6% (CAI) as of December 2017 – to a more normalised level of 3%. China remains a key uncertainty, with growth being very volatile.

Exhibit 25: China and DMs form c. 80% of the total copper demand
2017 copper demand by region



Source: Wood Mackenzie

Exhibit 26: Growth expectations, while still high, have reset to a more normalised level
Current Activity Indicators



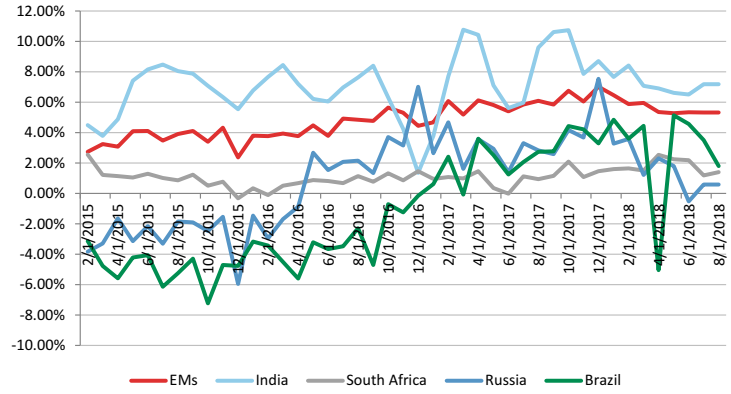
Source: Bloomberg

Growth, especially in EMs, has been negatively affected by recent developments

Both DMs and EMs (ex. China) are continuing to grow at a healthy pace despite the recent speedbumps. The majority of the recent concerns by investors have related to EMs, with DM growth remaining strong:

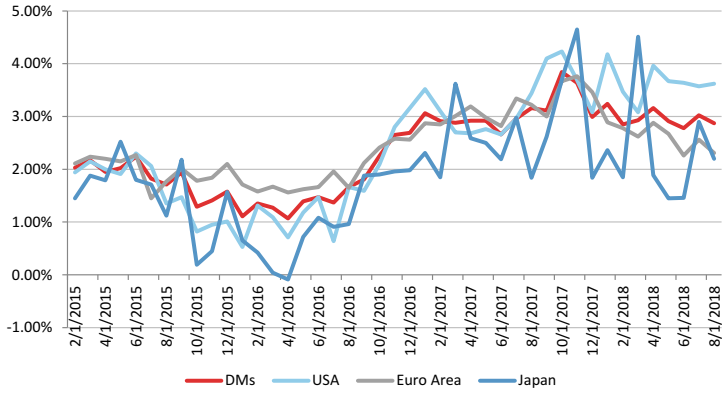
- **EMs**: Emerging markets ex. China have been under the spotlight recently, especially after the currency events in Turkey. This brought to the forefront growth concerns that had been present for the past few months, particularly in economies such as South Africa (which printed negative GDP growth in 2Q), Argentina, Russia and Brazil among others. Despite the recent developments, our economists expect roughly flat EM growth over the last three months (with the CAI at 5.3% in August).
- **DMs**: Despite the recent slowdown in the Euro area (where the CAI has come down from 3.75% to 2.55%), the overall CAI has remained robust at around 3%. Strong DM growth has been a function of strong US growth, among others. Our economists remain positive on DM growth, forecasting GDP growth of 2%-3% over next three years.

Exhibit 27: While some countries in EM have been choppy, growth has remained robust
EM CAI



Source: Bloomberg

Exhibit 28: DM growth has been more robust despite some economies registering choppy growth
DM CAI

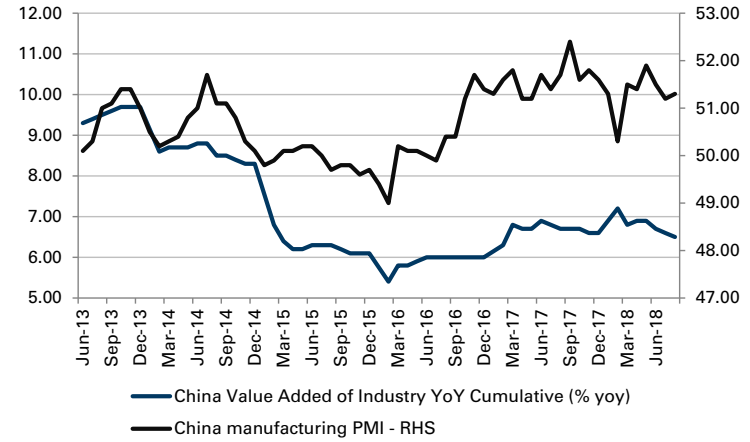


Source: Bloomberg

China: Recent data has been disappointing, but policy stance supportive

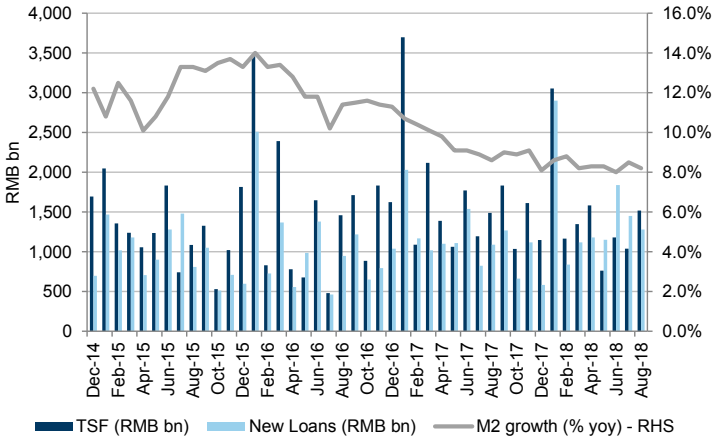
Recent China data has been disappointing, primarily the hard data that came out for the month of July, such as industrial production and FAI. This comes amid a focus by policymakers on targeting shadow lending activity to control financial risks. While our economists believe the campaign to curtail the shadow banking portion of credit has been successful (total social financing has been less than new loans for the last three months), some investors have been concerned that continued tightening will lead to China growth slowing given the disappointing data over the past couple of months. Against this backdrop, our economists believe there are other tools at the disposal of policymakers to ensure growth remains robust, as we discuss in the next section.

Exhibit 29: China data has been disappointing, both soft (PMI) and hard (IP)...



Source: Bloomberg

Exhibit 30: ...amid tightening credit (mainly reflecting a government focus on shadow banking)



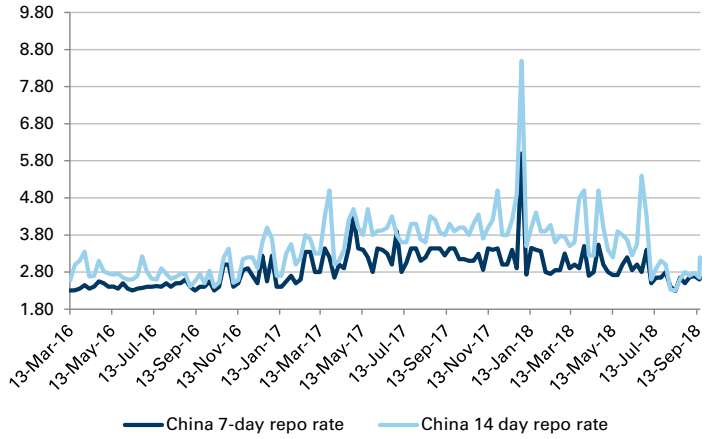
Source: Bloomberg

Recent policy comments have been supportive of growth

More recently, the rhetoric from China's policymakers has turned supportive of growth. This has come as more recent activity data has been disappointing amid the ongoing trade tensions. Policymakers have started loosening despite maintaining their focus on shadow banking. The loosening has been via other mechanisms – cutting money market rates and increasing the size of new loans (loans offered via official channels). In addition, for the first time in almost a year, policymakers have started to approve infrastructure projects, which is a clear positive for commodity prices.

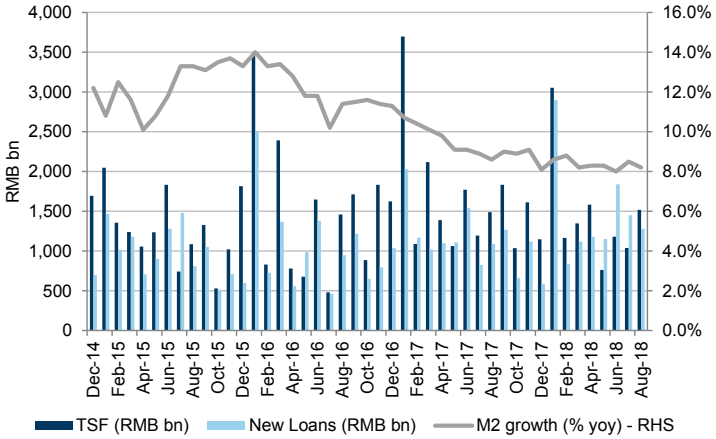
- The PBOC report released recently extended the dovish tone of policymakers. Our economists see increased flexibility by the PBOC to cut interest rates on key monetary facilities (e.g. OMOs) to guide funding costs lower as needed. The quarterly report highlighted that fiscal, regulatory and structural support is required to ensure effective monetary policy transmission.
- Money market rates have continued to drop, with the interest rates on short-term loans between Chinese banks having sunk to three-year lows in a bid to boost onshore demand. Our economists continue to expect policymakers to guide rates down to support growth.

Exhibit 31: China money market rates have dropped significantly



Source: Bloomberg

Exhibit 32: Most recent money data from China has been strong too



Source: Bloomberg

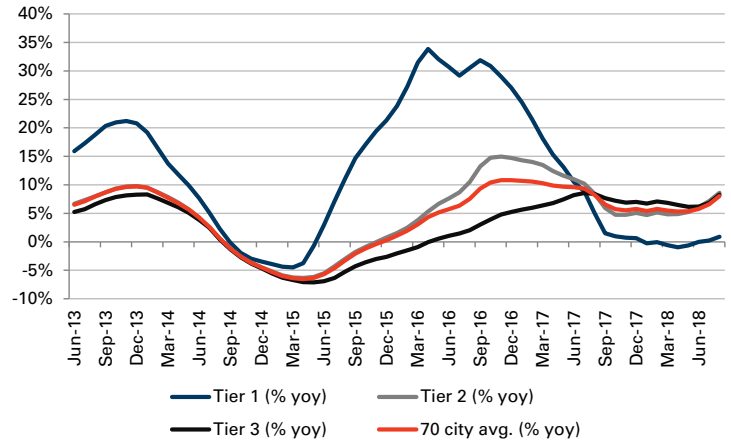
China property: While restrictions likely to remain in place, demand remains robust

The Chinese property market is likely to be biggest risk facing the Chinese economy and thus copper demand in the next 12 months, bar any significant escalation in trade tensions. Policymakers have been focused on restraining rising house prices by reining in speculative demand, and have considered imposing property taxes on homes in order to stabilise prices. Throughout 2017, the policies had the highest impact on property prices in Tier 1 cities, where prices fell throughout most of the year. However, the recent rebound in prices has been reflected in growing confidence from the country's developers as new starts have begun to rise again.

Property remains the biggest unknown in the Chinese demand equation. There has been conflicting news flow (Bloomberg) around what policymakers are looking to do. Some reports have suggested that China could seek to ban pre-sales (SHRPROP, the China property index, was down 3% on this news), while other reports have suggested that Shanghai could look to relax rules on mortgages, which would be a positive for demand. Overall, however, the data from China continues to look solid.

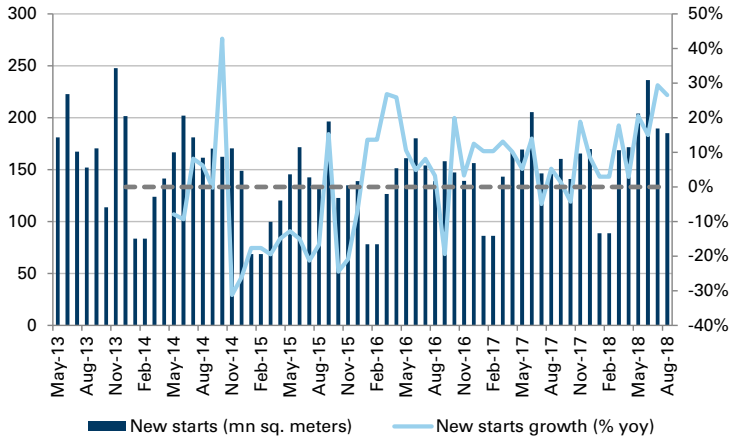
An important point to remember is that while property prices might decline, new starts are key, as they are the main determinant of commodity (including copper) demand.

Exhibit 33: Property prices have risen despite stringent restrictions applied by policymakers
China property prices (by tier)



Source: Bloomberg

Exhibit 34: New starts have begun to rise as higher profits have driven developers to increase development activity
China property new starts

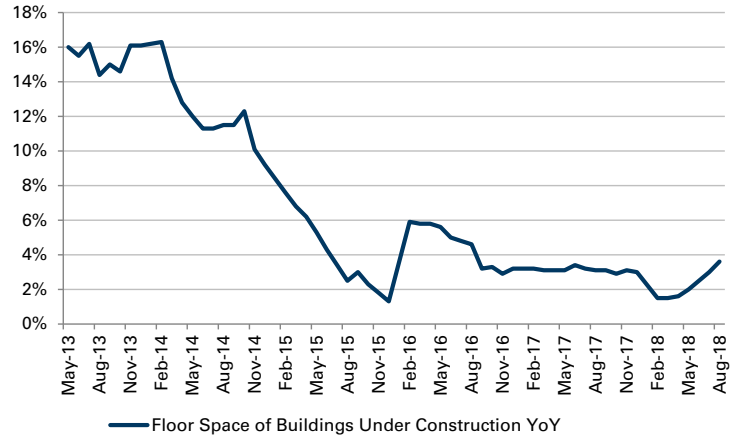


Source: Bloomberg

Future property pipeline looks robust; should be positive for demand

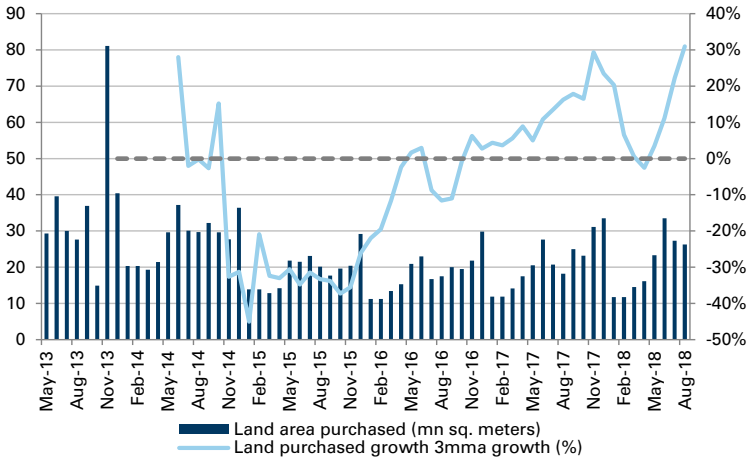
As discussed above, property datapoints – new starts and property prices – have been robust this year despite significant investor positioning to the contrary early in the year. While this is important, future demand is our focus in this section. Early data points indicate a strong pipeline of property development: floor space of buildings under construction and land sales have been strong YTD. This, in our view, is likely to be positive for future copper demand, as there is a lag of 18-24 months between construction starting and copper demand manifesting.

Exhibit 35: Growth of floorspace construction has rebounded this year, which is a positive for copper demand
Floor space of buildings under construction (% yoy)



Source: Bloomberg

Exhibit 36: Land purchased by property developers has been rising
China land purchased for construction activity



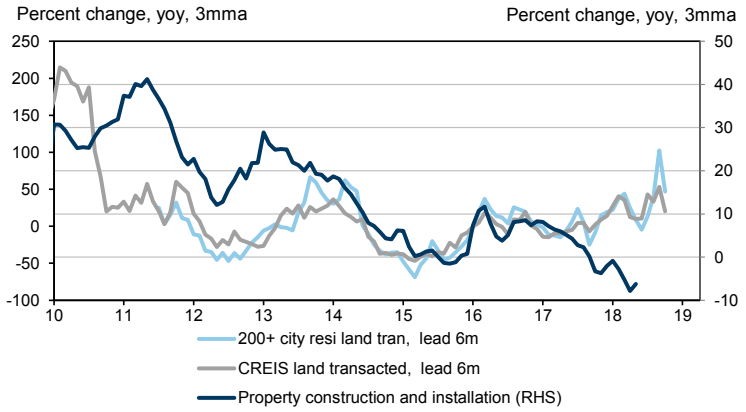
Source: Goldman Sachs Global Investment Research

See upside in fixed investment as policymakers look to shore up growth

In a recent note, our economists noted that the "policy put" from policymakers is likely to come from a pick-up in infrastructure spending.

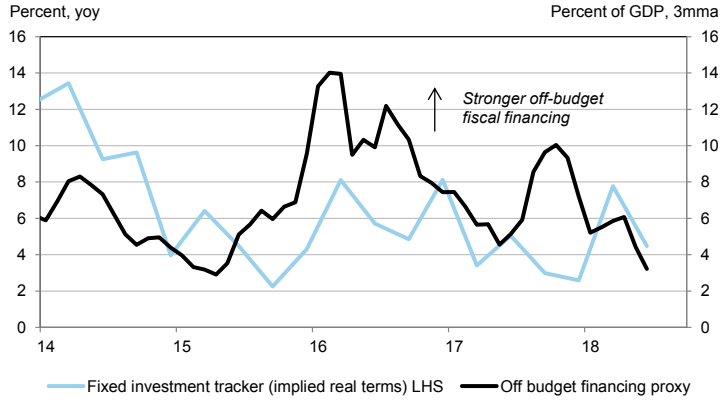
- Our economists see potential for property construction growth to normalise higher. Exhibit 37 illustrates the divergence in the trend of property construction vs. land transactions over the last half a year, but the recent faster home sales should help unclog the property pipeline and support a narrowing of this gap. Still more importantly, given the policy focus on local government spending as a primary lever to manage growth, they expect stronger infrastructure investment in the coming months to largely offset any residual weakness in headline activity.
- They also believe that a meaningful increase in their proxy for off-budget fiscal financing would send a favourable signal for near-term fixed investment. The proxy was still subdued for July, but in August the pace of special municipal bond issuance (a main sub-component of their proxy) encouragingly accelerated further, to more than RMB400 bn, and they believe that it should remain strong in the next two months.

Exhibit 37: Upside potential for property construction in the coming months



Source: CREIS, CEIC, Goldman Sachs Global Investment Research

Exhibit 38: A rise in off-budget fiscal financing would send a favourable signal for near-term fixed investment



Source: Goldman Sachs Global Investment Research

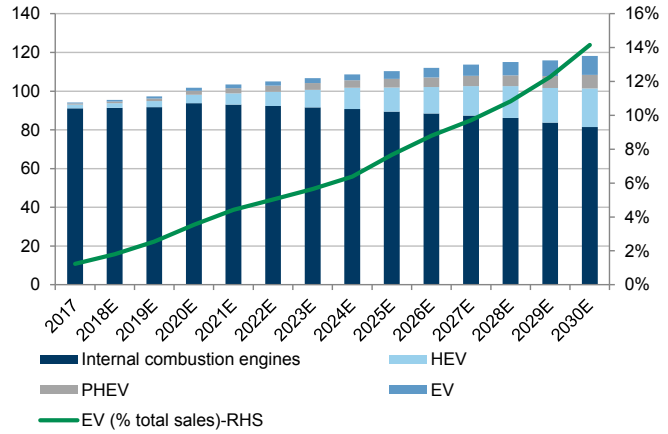
Electric vehicles driving demand for copper

The future of EVs is ultimately dependent on supportive policy and sufficient infrastructure development (e.g. charging). Following our original analysis of the impact for copper demand in 'Copper: Top Projects 2017', we extend our forecasts to 2030 and add a consideration for the charging infrastructure that will be required alongside the copper that the vehicles will demand. Analysis by our Autos team suggests EV penetration could reach 8% by 2025 (see 'Electric Vehicle Boom: ICE-ing the combustion engine') and gain momentum from there, resulting in a potential cumulative incremental copper demand of 21.8 mn tonnes by 2030 including charging units. Given that the growth of EVs could vary significantly, we consider bull/bear cases that imply cumulative copper demand of 18.8 mn/27.9 mn tonnes respectively over the next 13 years.

EV penetration at 8% by 2030 demands 4.4 mn tonnes of copper by 2030

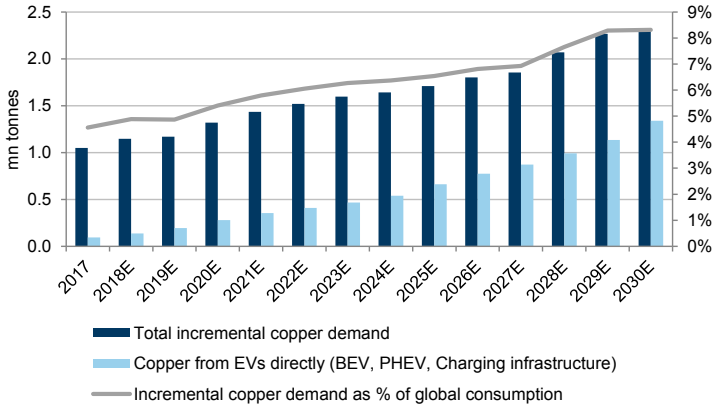
Copper's high electrical conductivity and efficiency make it an important metal for electrification. Not only is it found in the electric motor, but in the battery and cabling of electric vehicles; copper content scales up from 39kg in hybrids to 83kg in fully battery powered vehicles. At an EV penetration rate of 8% by 2030, we forecast copper demand to reach 7.5 mn tonnes cumulatively from PHEVs (plug-in electric vehicles) and BEVs (battery electric vehicles) combined.

Exhibit 39: EVs and PHEVs to reach 14% of the global fleet by 2030E, as ICEs are gradually phased out...
Vehicle sales (millions)



Source: Goldman Sachs Global Investment Research

Exhibit 40: We estimate copper demand from EVs to reach 8% by 2030, a cumulative 7.5 mn tonnes from 2018
Incremental copper demand of BEVs combined with charging infrastructure, total demand from vehicles and % of global copper consumption

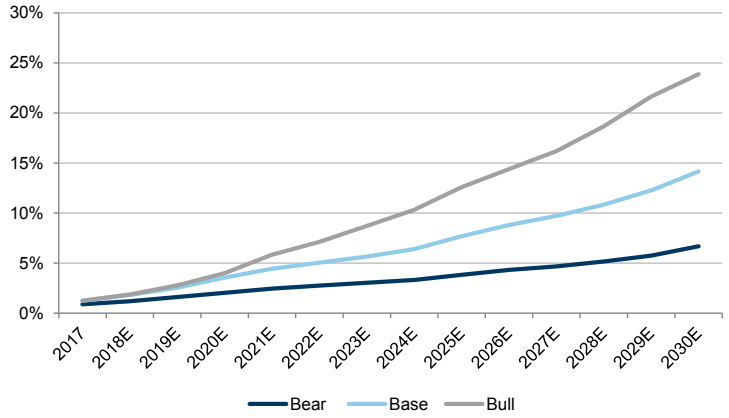


Source: Goldman Sachs Global Investment Research

The bull and bear case for copper based on EV penetration

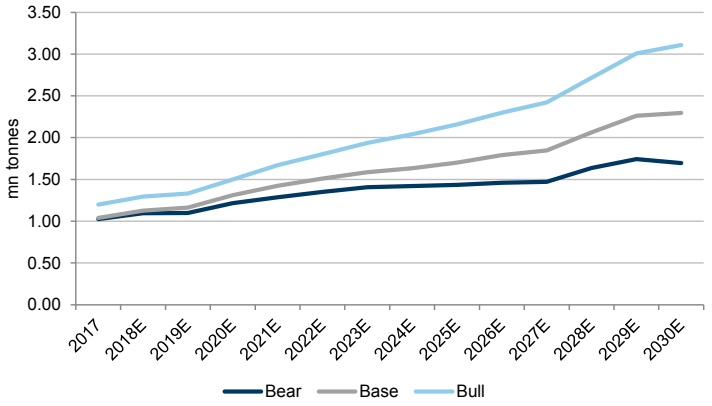
Government policy will be crucial to EV growth. Incentives, including subsidies, have potential to promote an increased market share. Similarly, the withdrawal of such benefits could result in a slowdown in EV adoption (e.g. as in Denmark). However, the cost of the battery is also influential, and as it continues to decrease, EV sales should increase significantly. Our Autos team forecast a rapid uptake in EVs once the payback period hits three years. For the bear case, we have adjusted the relative share of each vehicle type such that EVs with PHEVs represent only 4% of total vehicles in 2025 (vs. 8% in the base case and 14% in the bull case). This could be a more likely scenario if governments are slow to encourage their populations to buy an electric vehicle, or do not invest enough in the necessary infrastructure.

Exhibit 41: The rate at which EVs gain a share of the global fleet is dependent on policy, battery cost and infrastructure
Bear/base/bull case for EVs and PHEVs as % of total autos



Source: Goldman Sachs Global Investment Research

Exhibit 42: Depending on this penetration rate, incremental cumulative copper demand could range from 18.8 mn to 27.9 mn tonnes by 2030
Bear/base/bull case from incremental copper demand in mn tonnes

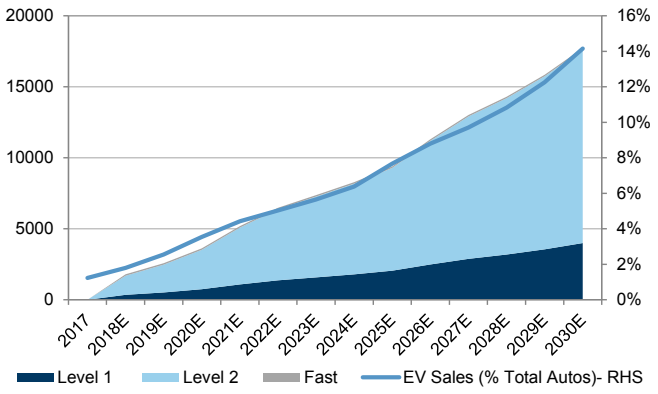


Source: Goldman Sachs Global Investment Research

Electric vehicles need to be charged...

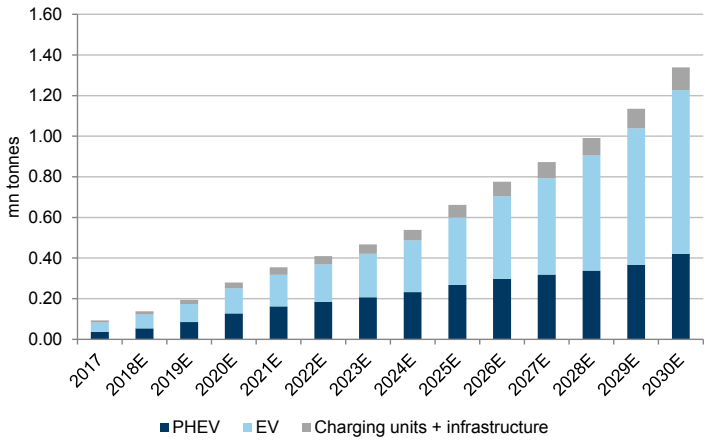
Currently, development in charging infrastructure is slow. This is a chicken and egg situation: drivers are reluctant to purchase electric vehicles until there is sufficient charging infrastructure, while governments are hesitating to provide such infrastructure until battery-powered cars become more dominant. In their report 'From Pump to Plug', our colleagues forecast the investment required for sufficient charging infrastructure by charging habits and charger types. EVs will likely primarily be charged by Level 1 and 2 chargers at home and at work, and may be wall-mounted or pedestal. Level 2 chargers are expected to dominate, with most cars being charged overnight as this would be sufficient to cover the majority of journeys (<200km). Level 1 chargers (1.3-1.9kW) are able to cover >75% of typical trips driven a day, but for the <6% of journeys over 200 km, fast chargers (50-150kW) along motorways will boost range. Resultant copper demand has been calculated on the assumption (based on data complied by Goldman Sachs) that Level 1 and 2 chargers contain 0.25kg of copper per kilowatt, while fast chargers have 0.04kg Cu/kW. Furthermore, we assume that Level 1, 2 and fast chargers have charging capacity of 1.9kw, 7kW and 75kW respectively. Various estimates by industry experts suggest that copper demand from required infrastructure is equivalent to 4-9x that of charging units, for which we input 4x. Hence, combined with the annual additions of charging units by type, the copper demand from charging infrastructure scales up from 0.02 mn to 0.1 mn tonnes over the next 13 years. Given that the demand from the charging units alone is small relative to the vehicles, our rough estimate for additional charging infrastructure of 4x vs. 9x is likely to have little impact.

Exhibit 43: Level 2 chargers to dominate the infrastructure, with <6% fast chargers required for backup...
Charging additions (millions of units) for each charger type alongside EV penetration rate...



Source: Goldman Sachs Global Investment Research

Exhibit 44: ...but the amount of copper in the chargers is a small fraction of that in the vehicles themselves
Copper demand from electric vehicles and charging units in millions of tonnes



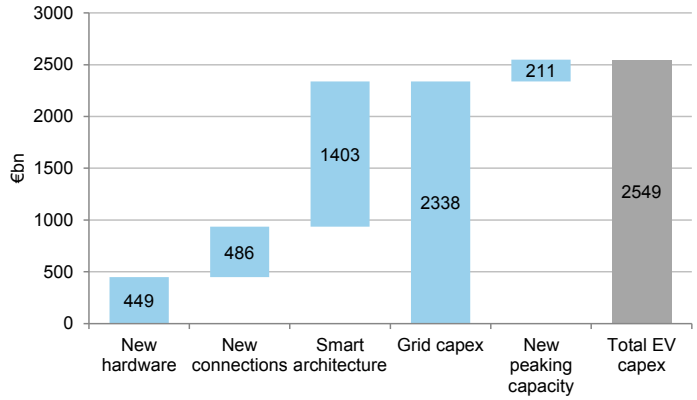
Source: Goldman Sachs Global Investment Research

...and chargers need to be connected to the grid

While the charging units alone demand a relatively small amount of copper, the cabling between units and connection to an electricity supply will require more. An EV global fleet penetration of 10% would require 220 mn chargers and c.$800 bn of grid investment for transformers, new lines and smart infrastructure. However, once EV penetration surpasses 25%, the grid itself will need to be upgraded to cope with increased electricity demand (note that one home-charging unit is considered to have the same demand as a whole house). Considering hypothetical full electrification, the capital expenditure requirement could amount to c.US$2.3 tn for charging infrastructure alone, in addition to c.US$2.6 tn for the power network. Furthermore, the large percentage of copper in potentially necessary new transformers and substations for a grid upgrade could inflate our estimate for total copper demand, assuming that there are more installed than replaced, but such data is difficult to obtain reliably.

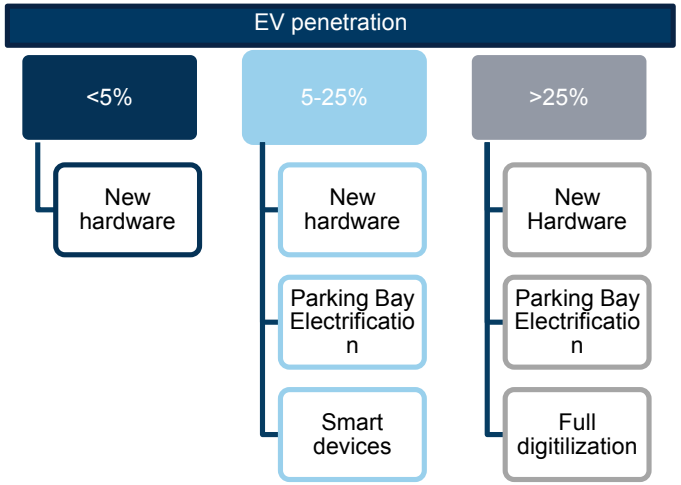
Limitations on fast EV adoption relate to the number of electric vehicles coming to market, how fast they come to market and how electricity supply will have to be upgraded to cope with increased demand.

Exhibit 45: To support full electrification by 2050, the grid would need to be upgraded completely, requiring significant investment...
Capital expenditure required for each component of EV infrastructure in € bn by 2050



Source: Goldman Sachs Global Investment Research

Exhibit 46: ...which will scale with the EV penetration rate
Infrastructure required as EV penetration increases



Source: Goldman Sachs Global Investment Research

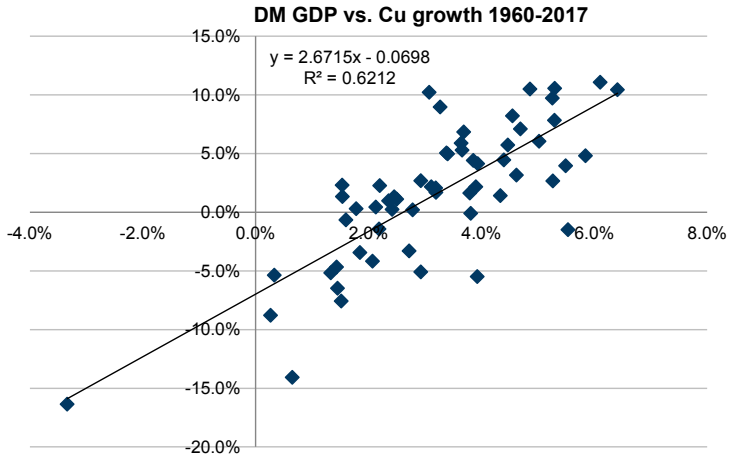
Strong DM growth to see consumption to increase, albeit at a low rate

Copper demand in developed markets (DMs) grew by an average c.2.8% pa over the 40 years to 2000. However, with the shift of production to the east, and stagnating economic growth over the past decade, DM copper consumption growth ran out of steam (2001-16 average copper consumption contracted at an average rate of 1.6%). While previously, we expected copper consumption in DMs to continue to decline, given the recent strength in growth, we now expect consumption to grow in the next few years.

Copper consumption intensity in DMs has peaked, however, and is on a path of slow decline. Our Commodities team forecasts copper consumption in OECD countries to grow this year and next before flattening out in 2020. One of the factors underpinning our positive thesis on copper is above-trend DM growth. Developed market copper consumption growth shows a relatively strong correlation to GDP growth over both periods; we observe a slightly stronger relationship more recently, with the R^2 increasing to 0.64 from 0.62 in 1960+.

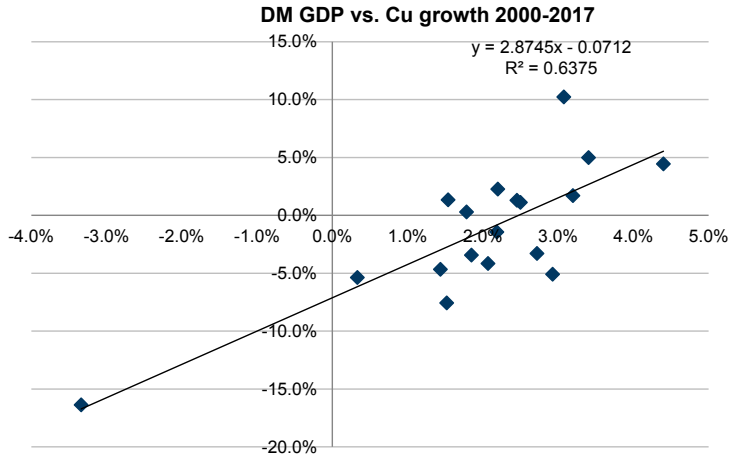
The exhibits below show the relationship between developed market copper consumption growth and GDP growth since 1960, and in 2000-17, respectively.

Exhibit 47: DM copper consumption correlates with GDP growth
Developed market copper consumption growth vs. GDP growth 1960-2017



Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Exhibit 48: Stronger correlation to GDP growth over the past ten years
Developed market copper consumption growth vs. GDP growth 2000-2017



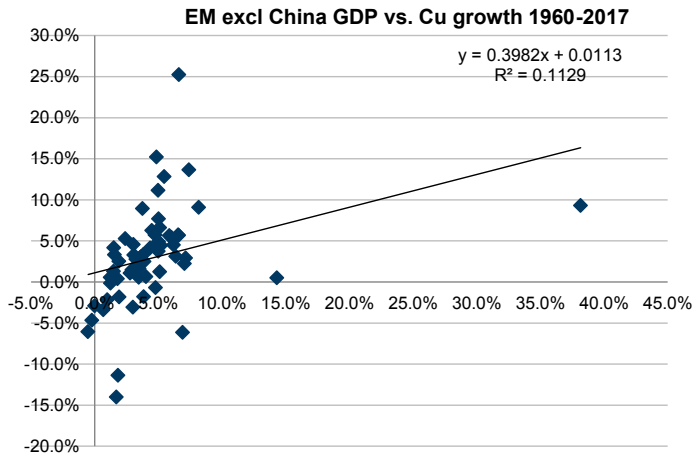
Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Fixed investment the key in EMs

Copper demand in emerging markets (EMs) grew by an average c.4.1% over the 40 years to 2000, accelerating to c.8% in 2000-17. However, most of the growth over the past decade has resulted from the emergence of China. Chinese copper consumption growth has averaged 12% pa over the past 17 years, with other emerging economies averaging growth of 4% pa. This bifurcation in copper consumption growth requires that we separately forecast copper demand for China and other emerging economies. First, we look to identify the main economic drivers of copper consumption growth. The exhibits below show the relationship between copper consumption growth and GDP growth since 1960 in China and other emerging economies.

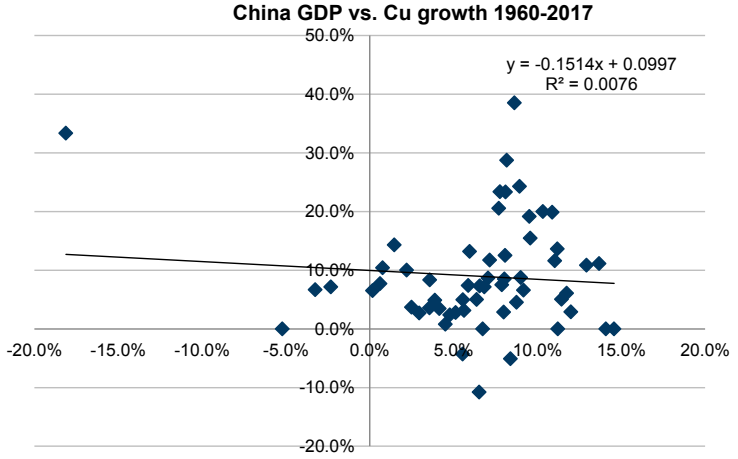
It is evident that over this period, there has been no clear relationship between copper consumption growth and GDP growth in China or other emerging economies. We believe the main reason for this has been the planned nature of development and central government backing in China and the former Soviet Union, which makes the level of fixed asset investment (FAI) a more relevant metric.

Exhibit 49: Little copper consumption and GDP growth correlation in EMs…
EMs ex. China copper consumption growth vs. GDP growth, 1960-2017



Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Exhibit 50: …and China
China copper consumption growth vs. GDP growth, 1960-2017

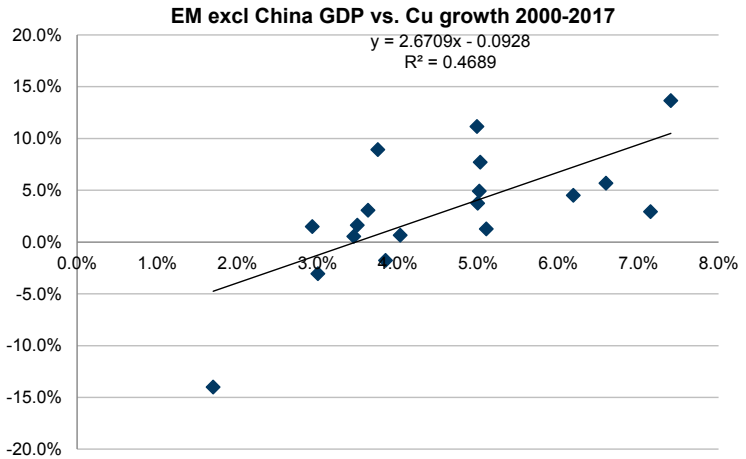


Source: The Conference Board, Wood Mackenzie, Goldman Sachs Global Investment Research

The Soviet Union comprised up to 70% of total copper consumption in emerging markets excluding China until the 1980s; however, the collapse of the Soviet Union significantly changed the dynamics of commodity consumption in the region. That being the case, we look at how the copper consumption growth to GDP growth relationship has changed in the post-Soviet era, excluding the period of stagnation and uncertainty of the 1990s.

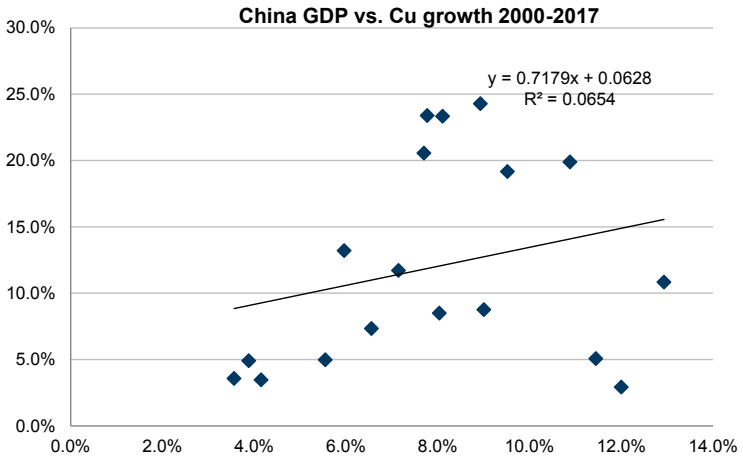
As expected, post-Soviet period copper consumption growth displays a stronger correlation to GDP growth, as the latter now relates more closely to market fundamentals than central government spending. Given the relatively strong correlation of non-China emerging markets copper consumption to GDP growth in the post-Soviet era, and for the sake of simplicity, we run copper demand sensitivities on the prevailing trend over that period. We assume (based on our economists' forecasts) an average GDP growth rate of c.5.5% in 2018-20. Based on the relationship over the past ten years, this would imply c.2.7% annual copper consumption growth, with every 0.1% move in our GDP assumption affecting our copper consumption growth forecast by c.0.4%.

Exhibit 51: Copper consumption to GDP correlation in post-Soviet era…
EM ex. China copper consumption growth vs. GDP growth, 2000-16



Source: The Conference Board, Wood Mackenzie, Goldman Sachs Global Investment Research

Exhibit 52: …but lack of correlation remains in China
China copper consumption growth vs. GDP growth, 2000-16



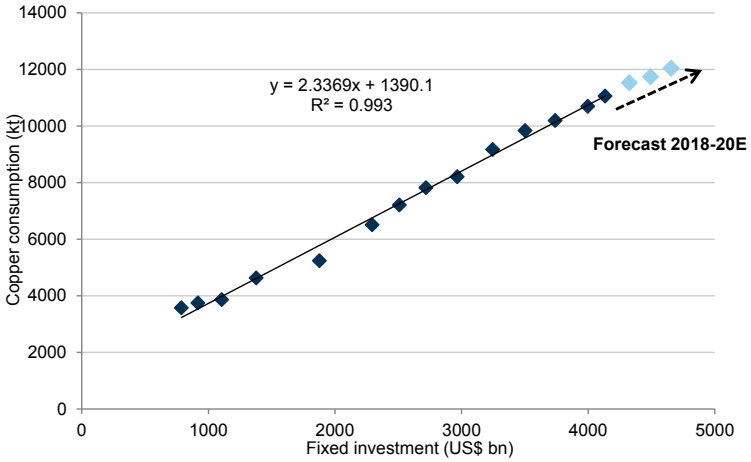
Source: The Conference Board, Wood Mackenzie, Goldman Sachs Global Investment Research

Copper consumption in China has been a function of FAI spend; focus shifting to value of growth from absolute

From 2004 onwards, China invested a significant proportion of its budget in fixed asset investment to bolster growth. This led to double-digit demand growth for almost all commodities (including copper). For the last 3-4 years, we have used this metric to forecast Chinese copper demand. However, we now believe that the trend is changing. The focus of the government has clearly shifted from an investment-driven growth model to a more consumption-driven model.

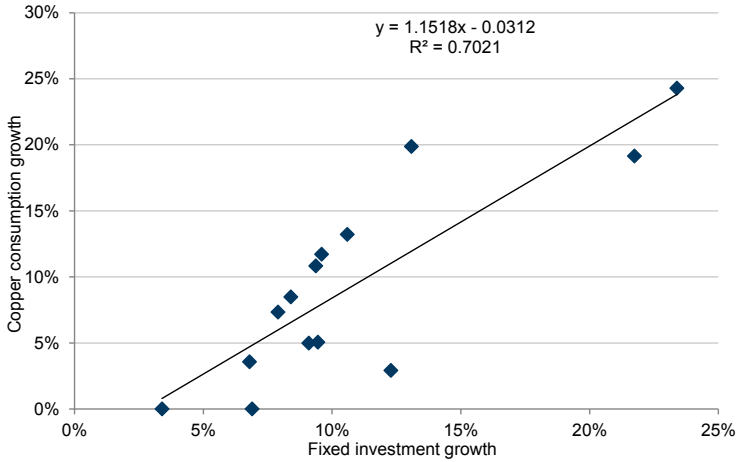
Of note, there is no evident change in the allocation of fixed investment to copper-intensive growth, with the slope little changed through the past ten-plus years. This is contrary to what we observe in steel, where there has been a clear flattening of the slope in the years following the global financial crisis compared with the previous five years since the emergence of China. Copper being an early- and medium-cycle commodity plays a part in this relationship, and our current copper demand growth forecast for China implies a continuation of the fixed investment to copper consumption growth relationship.

Exhibit 53: Strong correlation between Chinese fixed investment and commodity consumption on an absolute basis…
China's copper consumption vs. fixed investment



Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Exhibit 54: …and in terms of growth
China's copper consumption growth vs. fixed investment growth



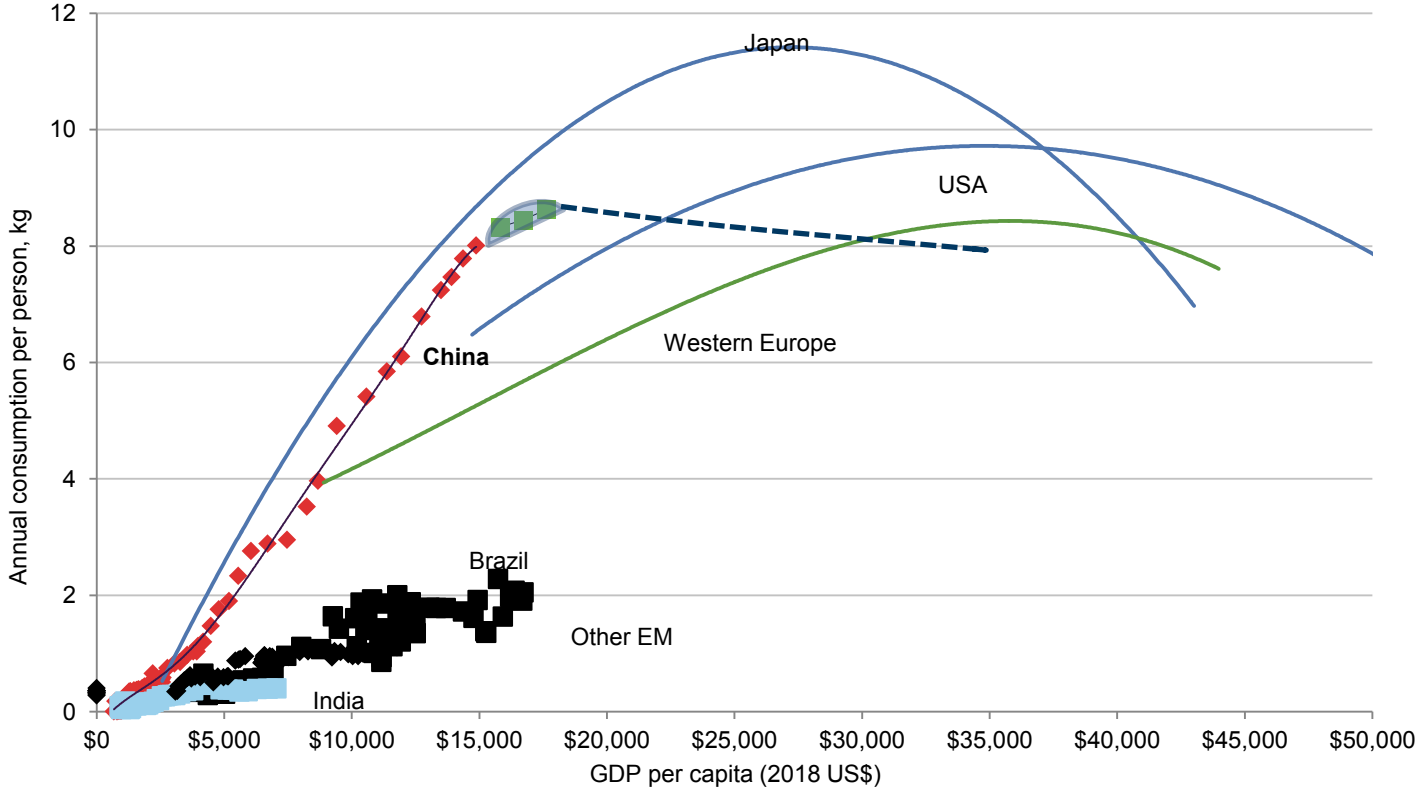
Source: The Conference Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Capex intensity softening in DMs but absolute demand still growing; expect China to remain strong

There are three trends to note in the chart below that we believe are important for copper demand in the near future:

1. **China**: China demand has been at the centre of discussion for the last few years, which is where we believe the market, including us, underestimated total demand. Over the last couple of iterations of our Top project analysis, we had forecast Chinese consumption to decrease, in line with our economists' forecasts of weaker Chinese growth. However, that has now changed as our economists are more confident in China's growth prospects, which makes our commodities team positive on Chinese copper growth – they forecast growth of c.2.9% over the next three years.
2. **DMs**: We expect copper intensity to continue to weakening in DMs. However, we believe that the absolute level of copper consumption is still growing, especially in economies exhibiting strong growth, such as the US. Therefore, despite the weakening in copper intensity, we continue to expect copper demand to grow – our commodities team forecasts growth of c. 0.5% over the next three years.
3. **EMs**: EMs have shown weaker trends more recently, especially with growth in South Africa continuing to disappoint (as of 2Q18, the country has entered a technical recession). The concerns more recently have been magnified by issues in Turkey, Argentina and Indonesia. India has been the only bright spot, with growth remaining strong. However, it is worth noting that even as EM growth has been tepid, EMs do not constitute a big portion of the copper demand – our commodities team forecasts growth of c.3.5% over the next three years.

Exhibit 55: China growth flattening; a long way to go for EM per capita copper consumption to make a sizable impact on S-D
Per capita consumption for copper vs. GDP per capita at main economies



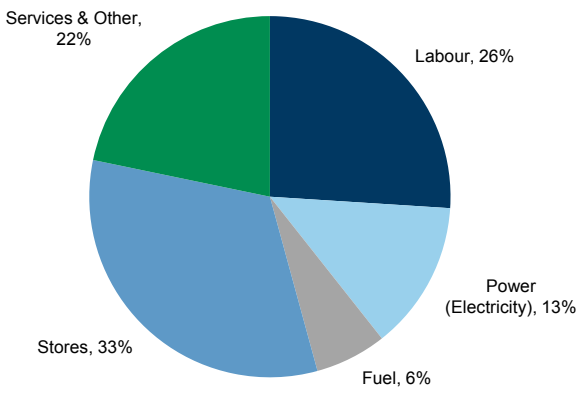
Source: The Conference Board Total Economy Board, Wood Mackenzie, CRU, Goldman Sachs Global Investment Research

Costs have bottomed out, inflation is back

The common theme until last year was that costs were on the decline owing to weaker FX, lower wages and lower consumables (oil/steel etc.), among other factors. Following some tentative signs of a return last year, inflation is now clearly back in the mining system. In their FY17/1H18 results, most of the copper companies in our global coverage reported cost inflation anywhere between 3% and 11%. In this section, we investigate the major reasons for the inflation, and outline our outlook for the next few years.

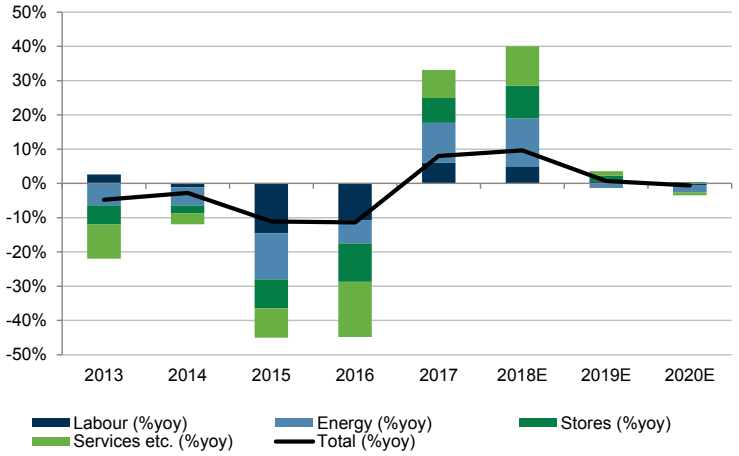
- **Labour costs**: Labour costs have escalated materially, with companies more often than not agreeing to the majority of increases proposed by mining unions amid a heightened threat of strike action compared with over the past 4-5 years.
- **Power (electricity and fuel),** which forms c.17% of the total cost base, is another area where base effects are likely to result in cost inflation. Oil prices have rallied materially, and our commodities team remain positive on the oil price over the next 12-18 months. This, coupled with high thermal coal/natural gas prices, has meant that the entire energy complex has been strong, implying high energy costs for mining companies.
- **Consumables,** especially steel, have also been strong, which has been another cause of inflation for the mining companies.

Exhibit 56: Labour, store and services form the bulk of the cost base
Average copper cost components – 2017



Source: Wood Mackenzie

Exhibit 57: Costs are set to rise materially
% changes yoy



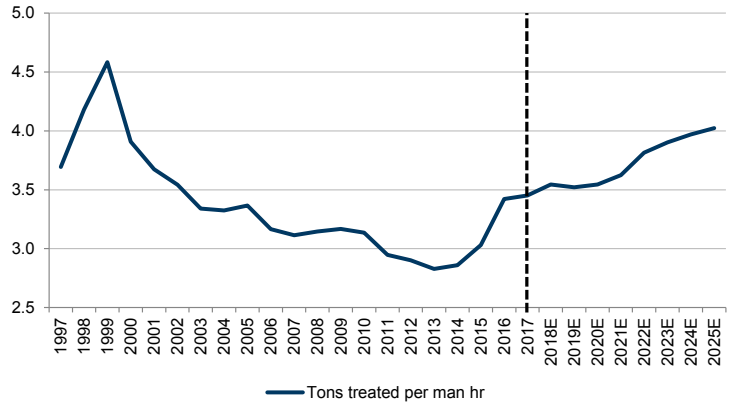
Source: Wood Mackenzie.

Productivity: Copper has lagged, room for improvement

Productivity is one area where copper companies have lagged, materially. While it has ticked up over the past couple of years, data from Wood Mackenzie shows that there is significant room for further improvement. If productivity does increase, the effect is likely to be deflationary, as it leads to more production and thus lower unit costs.

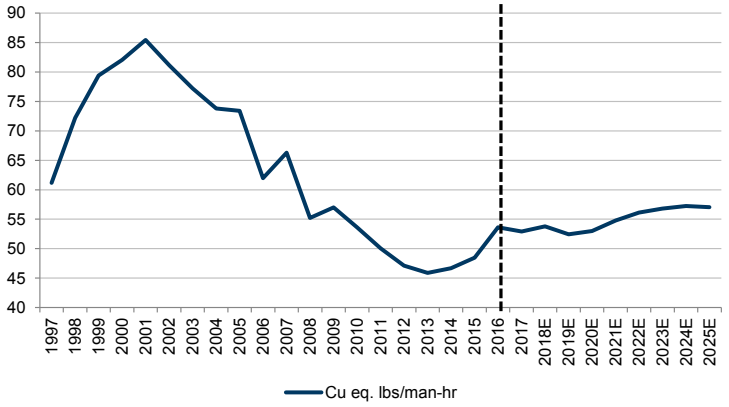
However, an interesting point to note is that the decline in productivity from 1998 to 2014 occurred in a period of continued copper price strength. The only time productivity did increase was when copper prices crashed (2014-16). This was likely a function of copper companies focusing more closely on their operations and cash flow, a focus that tends to increase when commodity prices are lower and decrease when they are higher.

Exhibit 58: There is significant scope for improvement in tonnes treated per man hour…
Tonnes treated per man hour



Source: Wood Mackenzie

Exhibit 59: …and copper equivalent production per man hour
Copper equivalent production per man hour



Source: Wood Mackenzie

Copper Top Projects: Key takeaways from our supply-side analysis

As part of our 2018 Copper Top Projects work, we have analysed 84 projects. We have made multiple changes with this iteration, which we detail later in this section. Key conclusions based on our work are:

- **Incentive price required to bring the 84 projects online** at a 17% IRR is US$7,067/t, up 33% from US$5,204/t last year. Note that over the life of mine, these projects potentially represent c.13 mn tonnes of copper supply. The reasons for the big increase in the required prices are:
  - Cost/capex/consumable inflation (e.g. oil).
  - Required IRR: We have increased the required IRR for the projects from 12% to 17%, a function of how we calculate the IRRs.
- **The incentive price required to bring the 33 risked projects** (projects that have been approved) is US$6,799/t, up c.34% yoy. Note that over their life of mines, these projects represent c.4.3 mn tonnes of copper supply.
- **Incentive price required to bring the 51 unapproved projects online** is c.US$7,307/t, up 36% yoy. This compares with the spot price of US$6,250/t. Over the life of mine, these mines represent c.8.8 mn tonnes of copper supply.
- **Environmental/social and political concerns** have resulted in a number of projects being either pushed out or suspended pending further review, which provides a further fillip to prices in the longer term, in our view.

Additions/deletions since Copper Top Projects 2017 analysis

We have removed the following projects because they have either fully ramped up, or the ramp-up is off the table: Bozshakol (Kaz Minerals), Bystrinksky (Norilsk Nickel), Encuentro Oxides (Antofagasta), Escondida ramp-up (BHP/Rio), and Kinsenda (Jinchuan Group International Resources).

New additions since our 2017 Copper Top Projects:

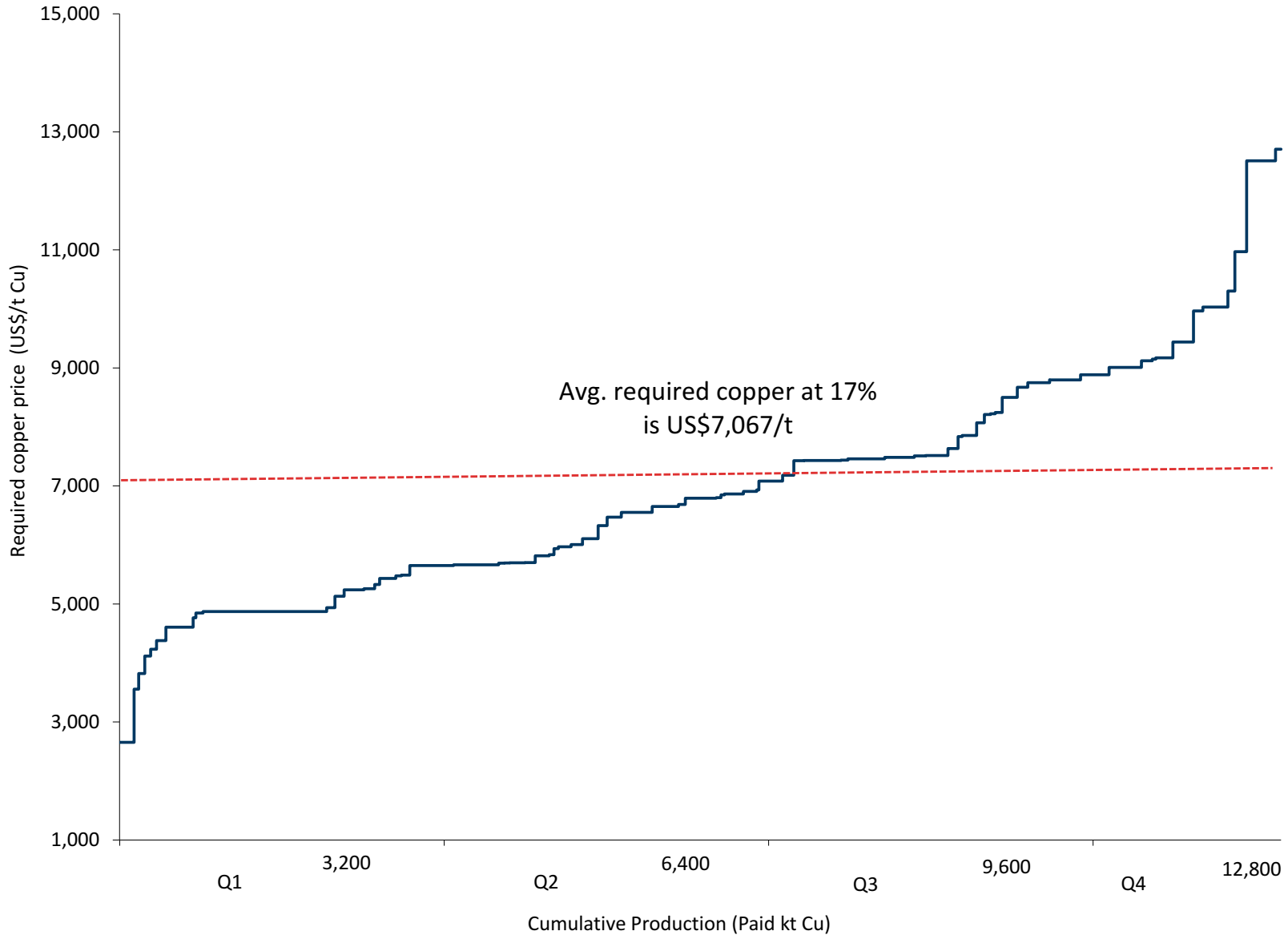
- Chambishi project in Zambia, owned by China Non-Ferrous metals and ZCCM
- El Abra project in Chile, owned by Freeport and Codelco
- El Arco project in Mexico, owned by Southern Copper
- Florence Copper in Phoenix, USA, owned by Taseko Copper
- Galore Creek in Canada, owned by TECK Resources and Newmont Mining Corporation
- Lone Star in Arizona, USA, owned by Freeport
- Los Azules in Argentina, owned by McEwen Mining
- Los Chancas in Peru, Chile, owned by Southern Copper
- Mantoverde in Chile, owned by Mantos Copper
- Michiquillay in Peru, Chile, owned by Southern Copper
- Salobo 3 in Brazil, owned by Vale
- San Nicolas in Mexico, owned by TECK Resources
- Vizcachitas in Chile, owned by Los Andes

As a result of higher assumed capex inflation across the board, and the additions/deletions of projects since our 2017 GS Top Copper Projects analysis, the average capital intensity of copper equivalent production has risen c.5% to US$14,869/t, from US$14,147/t. This is far above historical levels, and we believe that the increase in capex intensity in this iteration of GS Copper highlights: (1) the current inflationary environment; and (2) how companies have begun to raise capex budgets as concerns over EV-derived copper demand rises. Companies are trying to focus on internal projects, which are cheaper than acquiring copper mines given the high assumed copper price associated with acquisitions.

Based on the above changes, we calculate the average copper price required to generate a 17% IRR is US$7,067/t (USc320/lb, real 2018$) with a fourth-quartile requirement of > US$9,000/t (USc4.1/lb, real 2018$). The exhibit on the next page shows our copper incentive price curve for all GS Copper projects using their respective required IRRs. At the higher end of the cost curve, we see mainly highly capital-intensive greenfield projects, some of which require significant infrastructure beyond the scope of the mining operations, including roads or power stations. These are generally located in riskier jurisdictions requiring a higher acceptable IRR for boards to approve.

Our revised estimate of an average incentive copper price of c.US$7,067 for the GS Copper projects is c.33% higher than our previous estimate (published in our 2017 *GS Top Copper Projects* report of July 5, 2017).

Exhibit 60: The required copper price for the copper projects we analyse is > US$7000/t
Incentive price required for new copper projects (US$/t)



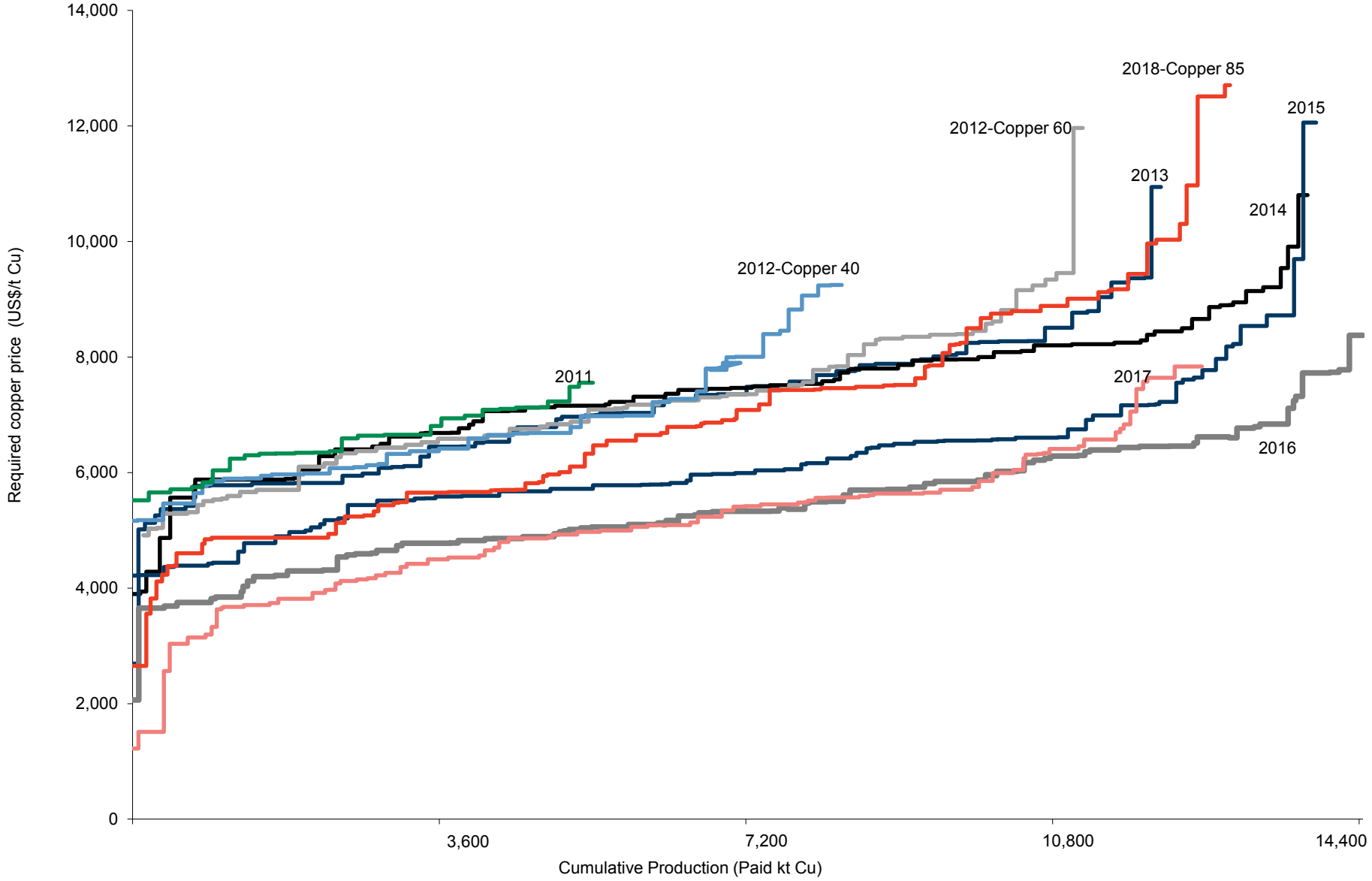
Source: Company data, Goldman Sachs Global Investment Research

Key Changes: Capex and costs rising

A core theme that has developed over the past eight iterations of this report has been deflation. This year, however, attention has turned to inflation as global growth has been stronger, fueling higher inflation and rising yields. This has led to a c.33% yoy incentive price rise in our *GS Top Copper projects 2018* report:

- **Input inflation:** Since the inflection of commodity prices post the China super-cycle, prices of almost all the inputs needed to build a mine (steel, oil etc.) fell significantly. This year, however, stronger global growth driven by the stronger US economy has seen the return of inflation. This can be seen through the prism of labour costs, as mining companies have had to agree to higher wage settlements than they might have expected this time last year.
- **Capex inflation:** Apart from input cost inflation, overall capex has also risen (capex intensity is up 2% yoy and likely faces further upward pressure), as a result of stronger global growth as well as the requirement to build out copper production profiles to meet demand from new sources. In addition, there has been a focus on bringing projects online in stages, which enables a company to use near-term cash flows to fund future developments. We have also seen projects in other commodities being delayed.
- **Cost inflation:** Based on the current increase in costs for miners, evident from the 2Q18 earnings results, we assume cost inflation of 3% in our model, a reversal of our assumption last year of cost deflation of 1% for the first four years and 3% inflation thereafter.
- **FX no longer the support:** The FX tailwind that reversed last year has continued to further solidify into a headwind for the mining companies. While more recently, there has been a material depreciation in producer country FX – mainly led by Turkey concerns – our economists remain constructive on producer country FX.

Exhibit 61: Copper price required for projects to come online has risen after falling for four consecutive years



Source: Company data, Goldman Sachs Global Investment Research

Risked projects look attractive on spot copper prices

Of the 84 projects we analyse, 33 are risked and 51 are unapproved. Risked projects are those that we believe have a high probability of proceeding to construction, as they have been approved by their boards or have seen substantial work already undertaken. Unapproved projects are those that are either yet to be approved, have recently run into environmental issues, or are being re-evaluated in the current copper price environment. For unapproved projects, we continue to see the risk of project deferrals and/ or cancellations, as companies engage in more extended feasibility studies to assess the overall returns of these projects.

The incentive price curves in the exhibit below include all the projects considered in the top projects analysis. However, the economics of risked projects remain relatively more attractive when compared with unapproved projects. The average incentive price required for risked projects is US$6,799/t compared with the average incentive price required for unapproved projects of US$7,307/t. The exhibit below shows the project economics for risked and unapproved projects, including any capex that the companies have spent to date.

Exhibit 62: Project economics for risked projects look more attractive than unapproved projects
Project economics of risked and unapproved projects including sunk costs

	LOM output	Unit capex (US$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US$ mn) GSe	IRR (GSe)	NPV @ 8% (2018+) (US$ mn) GSe	IRR (GSe) (2018+)	Cu price required @ risked-IRR
GS Copper Top Projects total	13159 ktpa	$14,614 /t	$163,267	14.9%	$189,408	19.2%	$7,067 /t
Risked projects	4308 ktpa	$13,071 /t	$84,343	16.2%	$109,483	32.5%	$6,799 /t
Unsanctioned projects	8851 ktpa	$15,409 /t	$78,924	13.7%	$79,925	13.8%	$7,307 /t

Source: Company data, Goldman Sachs Global Investment Research

Of the 33 risked projects in our analysis, there are 23 projects (accounting for a cumulative LOM average of c.3.4mtpa) where some capex has been spent by companies and the mines are either ramping up/beginning to ramp up; the remaining 10 projects (accounting for a cumulative LOM average of c.1.4mt pa) are those where growth capex is yet to be spent.

While we do not see much risk apart from minor production disruptions and slower ramp-up profiles for the projects currently ramping up, we highlight that both Grasberg expansion projects, Cobre Panama and Chuquicamata, are key to determining the amount of supply coming on board in the next few years. Our analysis of average incentive prices, excluding sunk costs for projects in which some capex has been invested, suggests these projects have very attractive NPVs at spot copper prices, and we thus continue to have high confidence that these projects will be delivered.

The exhibit below shows the projects on which some capex has been invested to date. The average incentive price, excluding sunk costs, required for these projects is US$7,271(USc3.30/lb, 2018$ real terms). This compares with US$5,305/t for the same analysis last year, highlighting the viability of these projects. The average IRR of the projects is 16.4%, including capex already spent, above our average of 14.9% for GS Top Projects analysis, and while the IRR slips to 14.5% ignoring sunk costs, there remains a likelihood of these projects developing.

Exhibit 63: Risked projects with some capex invested look attractive if we ignore sunk costs

Projects where capex has been spent

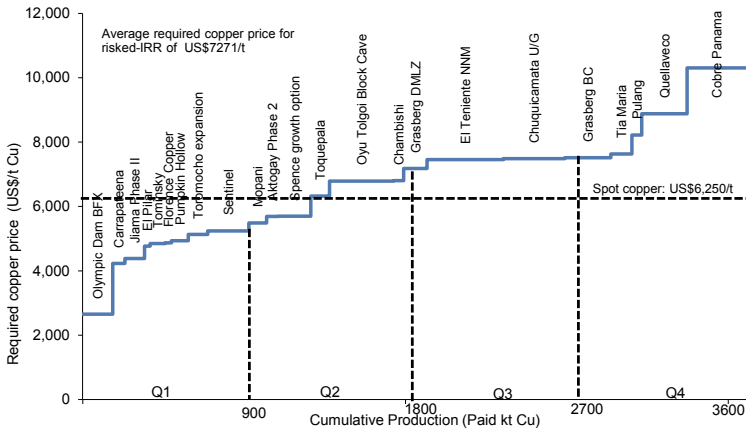
Project	Owner 1	Country	Status	Project type	Board approved	Start date	Announced Capex (US$ mn)	GS Capex (US$ mn)	Unit capex (US$ / t) Cu	Unit capex (US$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US$ mn)	NPV @ 8% (2018+) (US$ mn)	Payback (years)	IRR	IRR (2018+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost ($/t)	Total cash cost (c/lb)
Aktogay Phase 2	KAZ Minerals	Kazakhstan	Producing	Brownfield	Yes	2021	$1,200	$1,220	**$19,629 /t**	**$18,558 /t**	$1,148	$1,148	5.76	**16.1%**	**16.1%**	**$5,692 /t**	81 ktpa	62 ktpa	$3,649 /t	166 c/lb
Asmara	Sichuan R&BMIDC	Eritrea	Permitting	Greenfield	Yes	2021	$559	$609	**$26,386 /t**	**$12,337 /t**	$668	$668	6.92	**23.1%**	**23.1%**	**$6,932 /t**	28 ktpa	23 ktpa	$1,683 /t	76 c/lb
Aynak	China Metallurgical Gro	Afghanistan	Permitting	Greenfield	No	2024	$4,400	$4,900	**$15,313 /t**	**$15,313 /t**	-$543	-$543	9.66	**5.9%**	**5.9%**	**$12,509 /t**	320 ktpa	320 ktpa	$5,374 /t	244 c/lb
Baimskaya	Baimskaya Mining Comp	Russia	Feasibility	Greenfield	Yes	2024	$5,500	$5,600	**$31,206 /t**	**$23,156 /t**	$2,350	$2,381	6.35	**12.4%**	**12.5%**	**$5,433 /t**	316 ktpa	179 ktpa	$2,114 /t	96 c/lb
Carrapateena	OZ Minerals	Australia	Construction	Greenfield	Yes	2020	$687	$789	**$12,138 /t**	**$10,126 /t**	$1,224	$1,453	4.05	**21.3%**	**31.4%**	**$4,233 /t**	66 ktpa	65 ktpa	$3,628 /t	165 c/lb
Casino	Western Copper & Gold	Canada	Permitting	Greenfield	Yes	2023	$3,345	$3,545	**$41,357 /t**	**$25,365 /t**	-$432	-$399	11.78	**6.7%**	**6.8%**	**$8,069 /t**	181 ktpa	86 ktpa	$4,836 /t	219 c/lb
Chambishi	China Non-Ferrous Met	Zambia	Construction	Greenfield	Yes	2018	$700	$750	**$13,777 /t**	**$10,479 /t**	$228	$408	8.17	**13.4%**	**21.8%**	**$6,800 /t**	59 ktpa	54 ktpa	$4,630 /t	210 c/lb
Chuquicamata U/G	Codelco	Chile	Construction	Brownfield	Yes	2020	$4,000	$4,200	**$12,764 /t**	**$11,222 /t**	$4,203	$6,670	9.04	**13.2%**	**24.6%**	**$7,482 /t**	366 ktpa	329 ktpa	$4,266 /t	193 c/lb
Cobre Panama	First Quantum	Panama	Construction	Greenfield	Yes	2019	$6,300	$6,350	**$20,196 /t**	**$19,164 /t**	$3,505	$8,745	8.59	**10.5%**	**38.7%**	**$8,883 /t**	334 ktpa	314 ktpa	$4,021 /t	182 c/lb
El Pilar	Southern Copper	Mexico	Construction	Greenfield	Yes	2019	$159	$179	**$5,818 /t**	**$5,818 /t**	$409	$409	3.98	**31.6%**	**31.6%**	**$4,765 /t**	33 ktpa	31 ktpa	$4,300 /t	195 c/lb
El Teniente NNM	Codelco	Chile	Construction	Brownfield	Yes	2023	$5,000	$5,100	**$12,530 /t**	**$11,904 /t**	$3,497	$4,720	7.35	**12.6%**	**17.2%**	**$7,460 /t**	434 ktpa	407 ktpa	$4,567 /t	207 c/lb
Florence Copper	Taseko Mines Ltd.	USA	Construction	Greenfield	Yes	2018	$200	$220	**$6,576 /t**	**$6,576 /t**	$885	$905	6.62	**32.1%**	**38.1%**	**$4,870 /t**	39 ktpa	33 ktpa	$3,971 /t	180 c/lb
Grasberg BC	Freeport	Indonesia	Construction	Brownfield	Yes	2016	$6,400	$6,700	**$27,245 /t**	**$20,363 /t**	$5,817	$9,643	6.91	**13.0%**	**35.0%**	**$7,514 /t**	429 ktpa	246 ktpa	$2,346 /t	106 c/lb
Grasberg DMLZ	Freeport	Indonesia	Construction	Brownfield	Yes	2015	$3,100	$3,200	**$25,562 /t**	**$18,411 /t**	$2,998	$5,346	9.68	**13.3%**	**47.7%**	**$7,180 /t**	245 ktpa	125 ktpa	$2,379 /t	108 c/lb
Jiama Phase II	China Gold Internationa	China	Producing	Brownfield	Yes	2017	$716	$736	**$7,050 /t**	**$5,495 /t**	$3,945	$4,664	4.78	**28.9%**	--	**$4,380 /t**	110 ktpa	104 ktpa	$3,234 /t	147 c/lb
Katanga	Glencore	DRC	Construction	Brownfield	Yes	2017	$1,096	$1,159	**$4,237 /t**	**$1,866 /t**	$17,184	$17,567	2.05	**198.0%**	--	**-$1,243 /t**	300 ktpa	274 ktpa	$755 /t	34 c/lb
Lone Star	Freeport	USA	Construction	Greenfield	Yes	2020	$850	$900	**$10,992 /t**	**$10,992 /t**	$632	$683	7.87	**12.8%**	**13.5%**	**$4,870 /t**	89 ktpa	82 ktpa	$4,906 /t	223 c/lb
Mantoverde	Mantos Copper	Chile	Pre-feasibilit	Brownfield	yes	2022	$800	$850	**$11,586 /t**	**$10,863 /t**	$234	$234	7.75	**11.3%**	**11.3%**	**$4,870 /t**	79 ktpa	73 ktpa	$4,880 /t	221 c/lb
Metalkol	ENRC	DRC	Construction	Greenfield	Yes	2019	$833	$900	**$13,514 /t**	**$5,764 /t**	$4,884	$5,608	3.89	**30.1%**	**114.6%**	**$3,820 /t**	70 ktpa	67 ktpa	$701 /t	32 c/lb
Mirador	EcuaCorriente S.A	Ecuador	Construction	Greenfield	Yes	2020	$1,400	$1,500	**$19,026 /t**	**$17,139 /t**	$1,696	$2,067	6.80	**15.5%**	**20.1%**	**$10,303 /t**	81 ktpa	79 ktpa	$3,415 /t	155 c/lb
Mopani	Glencore	Zambia	Construction	Brownfield	Yes	2018	$950	$1,025	**$10,807 /t**	**$10,757 /t**	$2,126	$3,161	5.04	**19.3%**	--	**$5,489 /t**	99 ktpa	95 ktpa	$3,764 /t	171 c/lb
Olympic Dam BFX	BHP Billiton	Australia	Permitting	Brownfield	No	2018	$2,940	$3,040	**$18,842 /t**	**$17,499 /t**	$6,681	$6,681	6.97	**40%**	**39.6%**	**$2,653 /t**	177 ktpa	161 ktpa	$2,612 /t	118 c/lb
Oyu Tolgoi Block Cav	Rio Tinto	Mongolia	Construction	Brownfield	Yes	2020	$5,095	$5,395	**$15,749 /t**	**$13,374 /t**	$4,073	$5,130	7.74	**13.9%**	**17.0%**	**$6,791 /t**	491 ktpa	343 ktpa	$3,891 /t	177 c/lb
Pulang	Chinalco	China	Producing	Greenfield	Yes	2017	$943	$950	**$17,988 /t**	**$16,061 /t**	$174	$1,194	9.68	**9.2%**	--	**$8,221 /t**	55 ktpa	53 ktpa	$4,550 /t	206 c/lb
Pumpkin Hollow	Nevada Copper	USA	Construction	Greenfield	Yes	2020	$1,050	$1,100	**$12,197 /t**	**$10,884 /t**	$1,330	$1,596	7.28	**17.2%**	**25.0%**	**$4,938 /t**	125 ktpa	90 ktpa	$4,415 /t	200 c/lb
Quellaveco	Anglo American	Peru	Construction	Greenfield	Yes	2023	$5,200	$5,400	**$22,258 /t**	**$20,184 /t**	$1,775	$1,901	7.82	**10.8%**	**11.0%**	**$8,750 /t**	313 ktpa	243 ktpa	$4,527 /t	205 c/lb
Santo Domingo	Capstone Mining	Chile	Feasibility	Greenfield	Yes	2023	$1,750	$1,850	**$29,959 /t**	**$17,588 /t**	$1,610	$1,662	5.84	**17.2%**	**17.8%**	**$5,476 /t**	130 ktpa	62 ktpa	$1,251 /t	57 c/lb
Sentinel	First Quantum	Zambia	Producing	Greenfield	Yes	2015	$2,000	$2,000	**$9,086 /t**	**$9,086 /t**	$5,275	$6,929	5.39	**19.7%**	--	**$5,239 /t**	255 ktpa	220 ktpa	$4,126 /t	187 c/lb
Spence growth option	BHP Billiton	Chile	Construction	Brownfield	Yes	2021	$2,460	$2,510	**$14,492 /t**	**$12,933 /t**	$3,851	$3,851	5.32	**18.8%**	**18.8%**	**$5,697 /t**	197 ktpa	173 ktpa	$3,652 /t	166 c/lb
Tia Maria	Southern Copper	Peru	Permitting	Greenfield	Yes	2022	$1,400	$1,500	**$13,360 /t**	**$13,360 /t**	$1,179	$1,657	7.12	**12.6%**	**18.8%**	**$7,632 /t**	120 ktpa	112 ktpa	$4,041 /t	183 c/lb
Tominsky	Russian Copper Compan	Russia	Construction	Greenfield	Yes	2018	$1,183	$1,283	**$16,042 /t**	**$16,042 /t**	$2,058	$2,375	nm	**18.8%**	**27.9%**	**$4,846 /t**	105 ktpa	80 ktpa	$3,479 /t	158 c/lb
Toquepala	Southern Copper	Peru	Construction	Brownfield	Yes	2018	$1,300	$1,310	**$13,091 /t**	**$12,121 /t**	$2,343	$3,318	6.00	**16.2%**	**67.2%**	**$6,325 /t**	103 ktpa	100 ktpa	$3,829 /t	174 c/lb
Toromocho expansion	Chinalco	Peru	Construction	Brownfield	Yes	2020	$1,360	$1,400	**$13,512 /t**	**$11,601 /t**	$2,634	$2,738	5.94	**21.2%**	**23.5%**	**$5,130 /t**	123 ktpa	104 ktpa	$3,494 /t	158 c/lb
Total - Risked	-	-	-	-	-	-	$67,536	$70,230	**$16,301 /t**	**$13,071 /t**	$84,693	$109,833	7.99	**16.3%**	**32.7%**	**$6,799 /t**	5,455 ktpa	4,308 ktpa	$510 /t	23 c/lb

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 64 shows the 23 risked projects in our GS Top Projects copper analysis on which some capex has been spent. Exhibit 65 shows the same projects using the remaining capex figure. This suggests that close to half the projects being considered, including historical capex, would not have been NPV positive at spot prices and would therefore be unlikely to obtain approval. However, given the advanced stages these projects have now reached, with part of the capex having been spent, we estimate almost all projects are economically viable even if copper prices were to fall 14%.

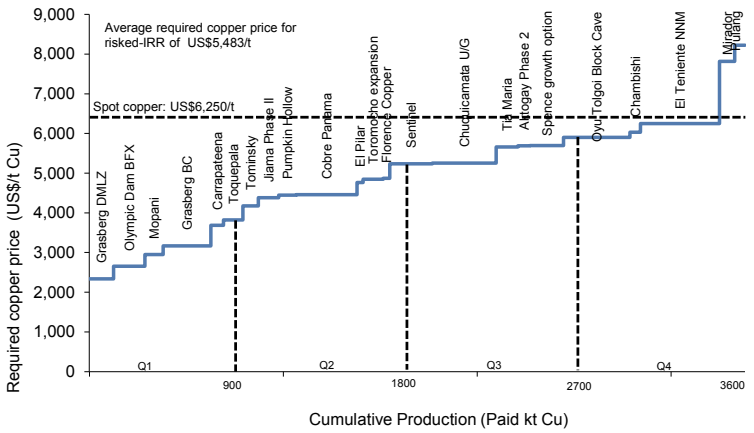
In general, the projects presented in Exhibit 65 vary in terms of capex share already spent, as well as the stability of jurisdictions in which they are based. Accordingly, the curve is for illustrative purposes only, to evaluate the incentive price relative to current spot and long-term assumptions, and not for relative project rankings.

Exhibit 64: At spot copper prices, c.50% of the projects would not have been approved
Incentive cost curve for projects where part of capex has been spent including sunk costs



Source: Company data, Goldman Sachs Global Investment Research

Exhibit 65: However, taking sunk costs into consideration, this falls to just three projects (13%)
Incentive cost curve for projects where part of capex has been spent excluding sunk costs



Source: Company data, Goldman Sachs Global Investment Research

Unapproved projects - unviable at current prices

Our analysis consists of 51 unapproved copper projects that are either yet to receive board approvals or have recently run into environmental issues/face a re-evaluation of economics in the current copper price environment. These projects together account for c.8.8 mtpa of LOM average copper production, with start dates of 2020 and beyond. We acknowledge that these projects have relatively weaker project economics than risked projects, with an average required incentive copper price of US$7,307/t (USc3.31/lb, 2018$ real terms). We believe these projects may continue to face challenges, causing delays to initial company plans. These challenges may be in the form of:

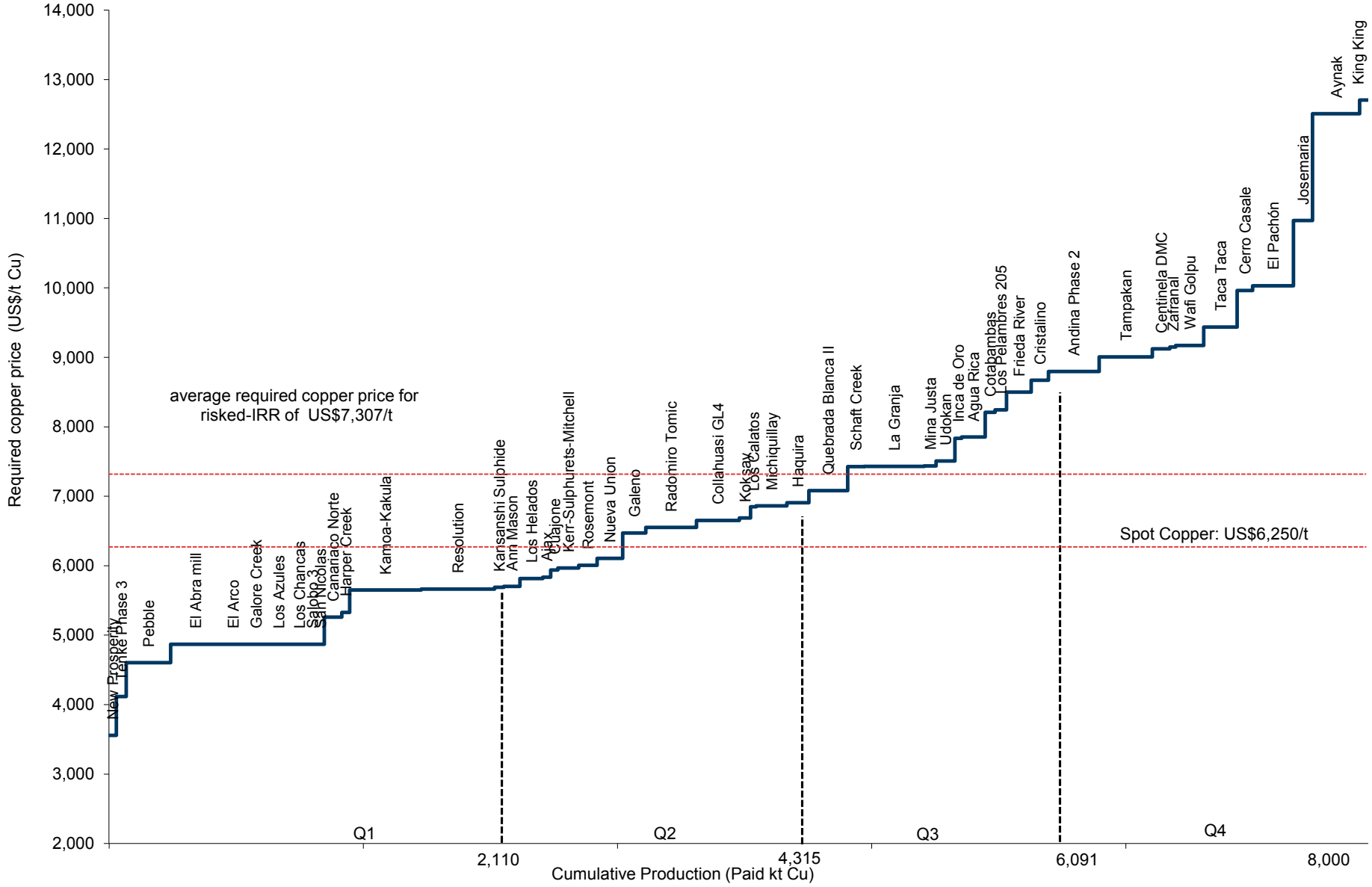
- **Environmental-social, permitting**: The permitting process for new mines or mine expansions is becoming increasingly challenging, both in developed and emerging economies. Issues faced by miners include water and power availability, community relocations and other environmental concerns raised by the localities. Aynak in Afghanistan and Tampakan in the Philippines are examples of projects that have faced issues.
- **Fiscal/sovereign**: This applies more to emerging economies, where a mining code may only be recently implemented and subject to change, or might not be in place at all. Associated issues revolve mainly around taxation, royalties and government ownership. The Oyu Tolgoi mine is a good example of this risk, where discussions with the Mongolian government regarding the Phase 2 development took longer to be resolved than initially estimated. Recent issues in DRC around royalties and the ongoing dispute between the Zambian Revenue Authority and First Quantum are good examples of the continued challenge of mining in EM countries.
- **Changing project economics/more prudent use of capital by miners**: While project economics are looking better than they were over the last couple of years, it is important to note that capex/cost estimates have also increased. Therefore, it might be a misconception that higher prices will result in more projects being given greenlight.

We highlight that our project assumptions are likely more conservative than those used by project owners, particularly in relation to company-guided capex estimates and ramp-up schedules. Following the many announced capex over-runs for recently commissioned projects, or projects currently under construction, we believe it is more prudent to factor in capex inflation within our analysis. As a result, our aggregate capex estimate for the 51 unapproved copper projects is c.US$161 bn, which compares with company-guided estimates totaling c.US$150 bn. We believe this to be a fair assessment of the potential upward capex pressure, reflecting the fact that most projects in this list are many years away from commissioning.

The exhibit on the next page shows the incentive price that we believe is required for the unapproved projects.

Exhibit 66: More than 3/4 of the projects are not viable at spot copper prices

Copper Top Projects – Incentive price curve for unapproved projects



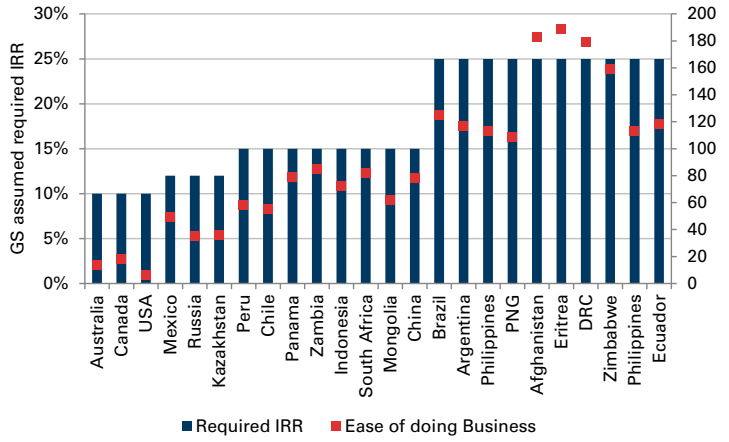
Source: Company data, Goldman Sachs Global Investment Research

Significant production coming from risky jurisdictions, potential +ve for copper

This year, we have changed how we calculate the IRRs in our project analysis. Previously, we used the Frazer scores for each geography, which give an indication of how easy it is to establish/operate a mine in a particular country. However, given the more theoretical nature of these scores, which does not capture the ongoing issues in many geographies (e.g. DRC), we move this year to the Ease of Business score, a metric released by the World Economic Forum. This is a combination of multiple factors that we think provides a better representation of the situation on the ground.

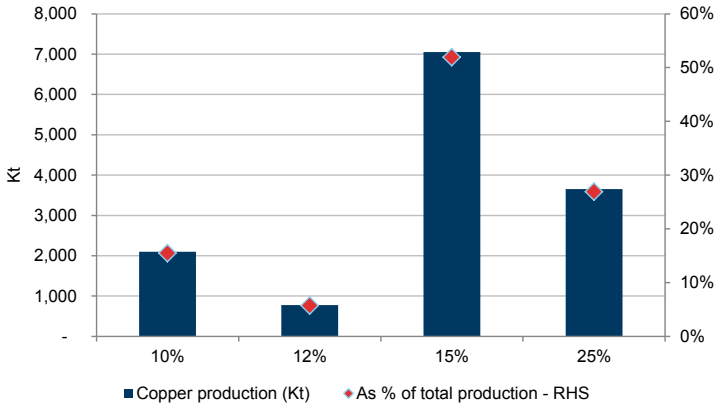
The exhibits below show the required IRR and the score for each country (Exhibit 67), and production weighted by IRR (Exhibit 68), which is a representation of how much production comes from each jurisdiction, risked by the ease of doing business). Worth noting is that c.28% of production growth comes from high-risk jurisdictions such as DRC, Argentina and Afghanistan. We believe a bigger haircut (given the historical disappointment) needs to be applied to production coming from these geographies vs. that from lower-risk jurisdictions.

Exhibit 67: We use the Ease of Doing Business metric to get to the required IRR for each country



Source: World Economic Forum, Goldman Sachs Global Investment Research

Exhibit 68: Significant production coming from risky jurisdictions
Copper production by risk



Source: Company data, Goldman Sachs Global Investment Research

Cobalt - EV demand to continue to see the metal in a deficit

Demand for cobalt will increase as electric vehicles sales rise, given it is a key component of the lithium ion batteries in these cars. In Copper: Top Projects' 2017, we forecast the impact of electric vehicles on cobalt demand by multiplying annual sales of each vehicle type by estimated cobalt content. For this analysis, we start with our Autos team's forecasts for automotive lithium ion batteries, and incorporate a more detailed consideration of the cobalt content in each type of Li-ion battery and how the mix will develop to 2020.

Different Li-ion batteries have similar chemistry, whereby Li-ions discharge from the anode, through an electrolyte, to the cathode. The anode is typically made of graphite, but the cathode contains varying proportions of cobalt, nickel and manganese. Given cobalt is the most expensive metal of the three, and that the cathode represents c.25% of the total cost, the cell cost is very sensitive to Co content. LCO batteries, with a pure cobalt cathode, are therefore too expensive to warrant use in electric vehicles, so the most important batteries are NCAs (mainly Tesla) and NMCs of varying cathode metal ratios. With an aim to lower battery costs, which will be a key facilitator of electric vehicle adoption, battery manufacturers are developing the cells to minimise cobalt content, which we account for in our analysis of demand.

Exhibit 69: Lithium ion batteries consist of five main types, each varying in cobalt content and performance

Criteria	Lithium Cobalt Oxide LCO	Lithium Manganese Oxide LMO	Lithium Iron Phosphate LFP	Nickel Manganese Cobalt NMC	Nickel Cobalt Aluminum NCA
Voltage	3.7V	3.8V	3.3V	3.8V	3.6V
Specific energy (Wh/kg)	150-240	100 - 150	90-120	150-220	200-300
Cycle time	>500	>300	>1000	>1000	>500
Safety	Low	Medium	High	Medium	Low
Cost	High	Low	Medium	Medium-High	Medium
Cathode cobalt content (1)	100%	0%	0%	20%	15%
Areas of application	Electronic devices	Consumer devices / EV	Energy storage / EV	Energy storage / EVs	EV
Used by / in	Portable electronics inc.iPhone	Nissan Leaf / Renault ZOE	Golf carts, electric scooters, home solar	Tesla Powerwall Chevy Volt	Tesla Model S, BMW i3
Pros	High energy density	High operating voltage	Good energy density	Good power / energy density	High energy / density
		High safety (thermal stability)	High Safety	Thermally stable	
Cons	Expensive	Shortened cycle life at higher temperature	Low operating voltage	Moderate cost	Higher cost
	Safety risk		Higher self-discharge	Moderate stability	Low safety
	Low charge / discharge rate	Lower energy density	Limited moisture tolerance	Higher weight / energy	

(1) Cathode typically represents 40% battery weight (2) Based on NMC 622, NMC 811 would lower Co to 10% cathode

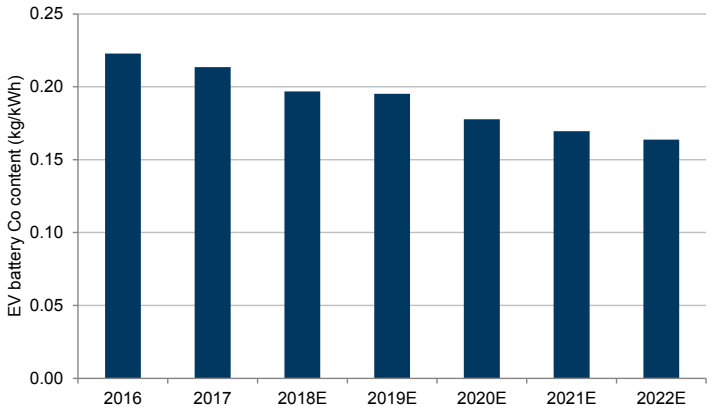
Source: Data compiled by Goldman Sachs Global Investment Research

Even as batteries reduce cobalt content, overall metal demand is set to rise

Our analysis is based on lithium ion battery forecasts for automotives generated by our Autos team. By varying the relative overall proportions of each battery type from 2017 to 2022 and factoring in a general shift from higher Co content batteries to lower (e.g. increasing the market share of NMC 811 batteries), our average EV battery Co content decreases from 0.22kg/kWh to 0.13g/kWh across the period.

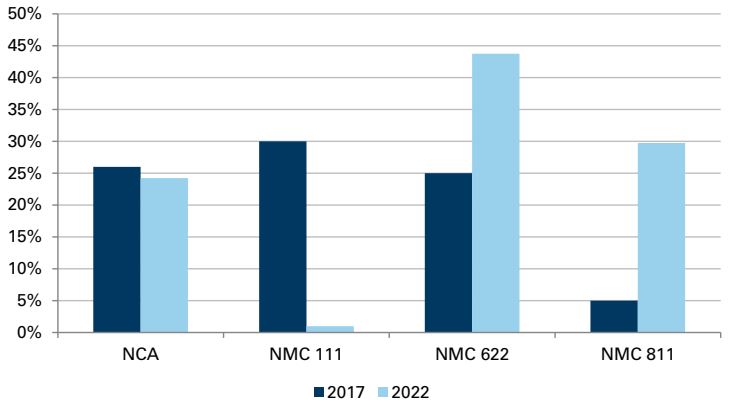
Assessing the potential future share of each battery type is difficult owing to potentially rapid advances in technology, so we have made rough estimates for how relative proportions of each will change in the future. Tesla has historically been differentiated by its use of NCA batteries. With regard to the NMC batteries used by most other manufacturers, there is a general shift from NMC 111 (equal ratios of Ni, Mn, Co) to NMC 622 in the near term and NMC 811 in the medium to long term. The 811 battery already exists, but its use has not yet spread significantly beyond China given some safety concerns. This is because of the thermal stability Co can provide to nickel, so successfully eliminating cobalt from lithium batteries is likely to be some years away. Our estimates attempt to capture these insights, but a clear risk to our thesis relates to how the technology changes and how fast Co content is reduced, if EVs are to be significant at all over the next four years.

Exhibit 70: Cobalt content in EV batteries to start decreasing with a drive to lower costs
Co content in EV batteries to decrease from 0.22kg/kWh to 0.16kg/kWh from 2016 to 2022



Source: Data compiled by Goldman Sachs Global Investment Research, McKinsey

Exhibit 71: We expect NMC 622 and 811 batteries to capture share from NMC 111s as battery makers reduce cobalt content
Estimates for share of each battery type used in electric vehicles for 2017 and 2022E



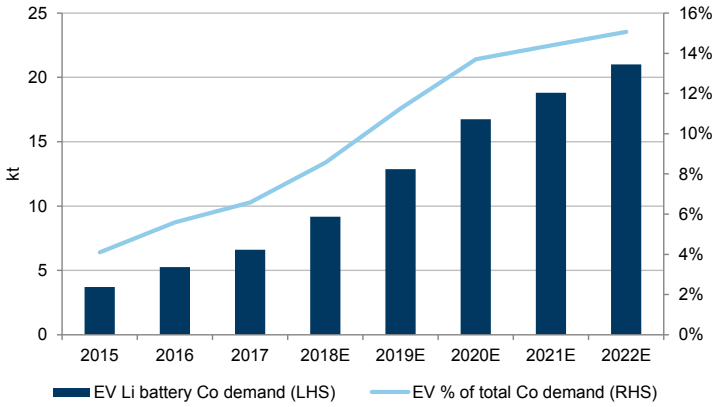
Source: Data compiled by Goldman Sachs Global Investment Research

Batteries are supercharging cobalt demand

Combining the cobalt content estimates with forecast EV lithium battery capacity (GWh), we forecast cobalt demand from batteries alone more than tripling from 2017 to 21kt in 2022. Given that this equates to a CAGR of c.33%, we apply an overall CAGR of 6.8% (reflecting EV share of demand) to the total cobalt demand for 2016 to calculate the overall demand expected. The result is c.100kt in 2017 (also indicated by the Cobalt Institute), increasing by almost 40% by 2022. This is lower than other forecasts we have seen, likely a result of more conservative EV forecasts and our incorporation of an expected reduction in Co content per kWh. In summary, regardless of an overall reduction in cobalt content per kWh, EV batteries are growing fast enough to outweigh this, resulting in increasing annual demand overall.

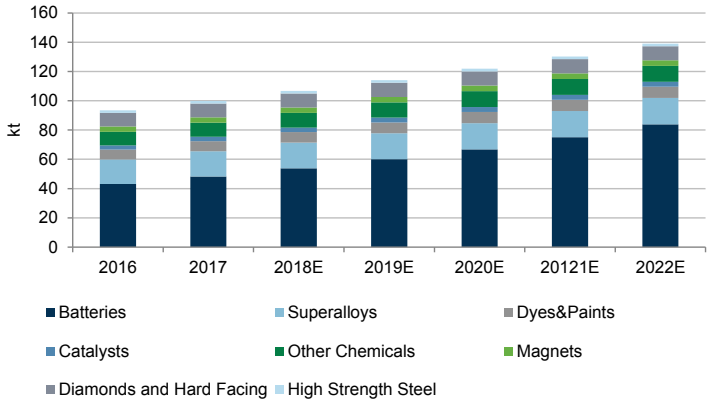
Our analysis is based on our assumption that batteries will be the key driver of future cobalt demand, given that they have historically accounted for 45% of the total. Hence, assuming that all other end-uses of the metal stay roughly constant, cobalt consumption from batteries increases by c.12% yoy such that by 2022E, batteries are responsible for 60% of demand. Again, we may be relatively conservative in our view, given that other estimates surpass 60% by 2020 and that we neglect any exceptional growth in other end-markets. For example, it could be that growth in cobalt demand from superalloys is higher than our forecasts, suggesting jet engines require more new metal as scrap supply is insufficient.

Exhibit 72: Lithium batteries from EVs will demand 21kt of cobalt in 2022, representing double the share of total demand last year
Cobalt demand in kilo-tonnes to reach 15% of total demand by 2022E



Source: Goldman Sachs Global Investment Research

Exhibit 73: Batteries for EVs and devices combined likely to be the key driver of cobalt demand growth over the next few years
Cobalt demand forecasts by end-market in kilo-tonnes



Devices include portable electronics, medical equipment, energy storage etc.

Source: Data compiled by Goldman Sachs Global Investment Research

Exhibit 74: Cobalt S-D Model

GLOBAL COBALT INDUSTRY ANALYSIS
SUPPLY AND DEMAND MODEL

Supply											
Cobalt mine production ('000 tonnes)	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018E**	**2019E**	**2020E**	**2021E**	**2022E**
Democratic Republic of the Congo											
Tenke Fungurume	11.8	11.7	12.8	16.0	16.1	16.4	16.2	16.2	16.2	16.2	16.2
Katanga	**2.1**	**2.3**	**2.8**	**2.9**	**-**	**-**	**11.0**	**28.0**	**30.0**	**30.0**	**30.0**
Mutanda/Comide	8.5	13.7	14.4	16.5	24.5	23.9	24.2	24.8	24.8	24.8	24.8
Mukondo Mountain	9.6	9.7	8.5	9.5	4.8	7.1	7.1	7.1	7.1	7.1	7.1
Big Hill (STL)	4.0	4.3	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Etoile Mine	1.3	1.2	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ruashi	3.0	3.0	3.9	4.3	3.3	3.8	3.8	3.8	3.8	3.8	3.8
Other DRC	11.7	12.1	17.7	14.1	9.4	16.7	16.7	16.7	16.7	16.7	16.7
Total DRC	**52.0**	**58.0**	**66.9**	**69.3**	**64.0**	**73.9**	**85.1**	**102.7**	**104.7**	**104.7**	**104.7**
Rest of the world											
Murrin Murrin	2.5	2.6	2.8	2.8	2.8	2.8	2.7	2.6	2.6	2.6	2.6
Mopani	0.3	-	-	-	-	-	-	-	-	-	-
Sudbury	0.6	0.9	0.8	0.8	0.9	0.8	0.9	0.9	0.9	0.9	0.9
Voisey's Bay	1.2	1.3	1.0	0.8	0.9	1.8	1.4	1.4	1.4	1.4	1.4
VNC	0.4	1.1	1.4	2.4	3.2	2.8	3.0	3.0	3.0	3.0	3.0
Thompson	0.1	0.3	0.5	0.4	0.7	0.1	0.4	0.4	0.4	0.4	0.4
Others	45.9	55.9	49.6	49.5	38.5	27.7	33.1	33.1	33.1	33.1	33.1
Global cobalt mine production ('000 tonnes)	**103.0**	**120.0**	**123.0**	**126.0**	**111.0**	**110.0**	**126.5**	**144.0**	**146.0**	**146.0**	**146.0**
yoy %	*-6%*	*17%*	*2%*	*2%*	*-12%*	*-1%*	*15%*	*14%*	*1%*	*0%*	*0%*
Refined cobalt production ('000 tonnes) @ 75% conversion	**77.3**	**90.0**	**92.3**	**94.5**	**83.3**	**82.5**	**94.9**	**108.0**	**109.5**	**109.5**	**109.5**
yoy %	*-6%*	*17%*	*2%*	*2%*	*-12%*	*-1%*	*15%*	*14%*	*1%*	*0%*	*0%*
Demand ('000 tonnes)											
Batteries	**30.6**	**32.9**	**39.1**	**41.1**	**43.1**	**48.2**	**53.8**	**60.0**	**66.7**	**75.1**	**84.0**
% Total	*41%*	*41%*	*45%*	*45%*	*46%*	*48%*	*50%*	*52%*	*55%*	*57%*	*60%*
Superalloys	13.1	14.6	15.8	16.3	16.8	17.3	17.5	17.7	18.0	18.0	18.0
% Total	*18%*	*18%*	*18%*	*18%*	*18%*	*17%*	*16%*	*15%*	*15%*	*14%*	*13%*
Dyes&Paints	6.2	6.4	6.6	6.6	6.8	7.0	7.2	7.5	7.7	7.7	7.7
% Total	*8%*	*8%*	*7%*	*7%*	*7%*	*7%*	*7%*	*7%*	*6%*	*6%*	*6%*
Catalysts	2.2	2.3	2.5	2.6	2.8	2.9	3.1	3.2	3.4	3.4	3.4
% Total	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*3%*	*2%*
Other Chemicals	8.0	8.4	8.9	9.0	9.3	9.7	10.1	10.4	10.8	10.8	10.8
% Total	*11%*	*11%*	*10%*	*10%*	*10%*	*10%*	*9%*	*9%*	*9%*	*8%*	*8%*
Magnets	3.6	3.4	3.5	3.5	3.6	3.7	3.7	3.8	3.8	3.8	3.8
% Total	*5%*	*4%*	*4%*	*4%*	*4%*	*4%*	*3%*	*3%*	*3%*	*3%*	*3%*
Diamonds and Hard Facing	9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.7	9.7
% Total	*12%*	*12%*	*10%*	*10%*	*10%*	*9%*	*9%*	*8%*	*8%*	*7%*	*7%*
High Strength Steel	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8
% Total	*2%*	*2%*	*2%*	*2%*	*2%*	*2%*	*2%*	*2%*	*1%*	*1%*	*1%*
Global apparent demand ('000 tonnes)	**74.9**	**79.4**	**87.7**	**90.6**	**94.0**	**100.4**	**107.2**	**114.5**	**122.3**	**130.6**	**139.5**
yoy %		*6%*	*10%*	*3%*	*4%*	*7%*	*7%*	*7%*	*7%*	*7%*	*7%*
Supply surplus/(deficit) ('000 tonnes)	**2**	**11**	**5**	**4**	**-11**	**-18**	**-12**	**-6**	**-13**	**-21**	**-30**

Source: USGS, Reuters, Wood Mackenzie, Company data, Goldman Sachs Global Investment Research

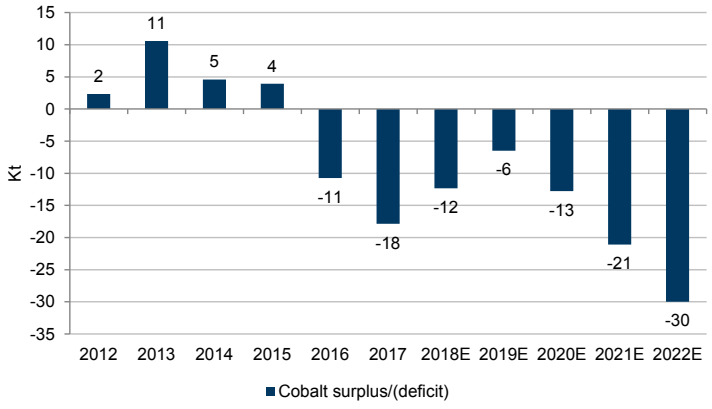
Cobalt bull-bear case: Battery safety concerns to likely impede aggressive substitution

Although other end markets represent a significant portion of cobalt demand, the biggest consumer remains batteries, which currently account for c.50% of cobalt demand. In line with our base case forecasts, we assume this grows to account for 60% of demand by 2022.

For our bull and bear analysis, we maintain our Autos team's base case for EV uptake, with the variable factor being the rate of substitution of cobalt in EV batteries. We have adjusted the relative share of each battery type in line with our views on changes in battery composition; in summary, we expect **increasing battery demand with decreasing amounts of cobalt.** In our bull case, we assume a slower substitution of cobalt in batteries (relative to our base case). However, for the bear case, we have adjusted for a relatively accelerated uptick in material substitution resulting in a lower cobalt content per battery and subsequently lower demand.

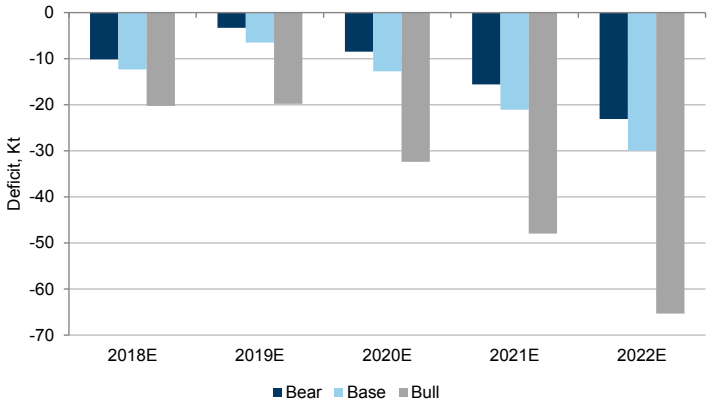
Exhibit 76 shows the wide range of outcomes depending on the rate of cobalt substitution as evidenced by our 2022E deficit, which lies between -23kt for our bear case and -65kt for our bull case. We maintain our base case as a more likely scenario, as battery compositions will likely stay constant to maintain vehicle safety standards.

Exhibit 75: Cobalt S-D balance to remain in deficit as demand (mainly from EV batteries) outpaces supply...



Source: USGS, Reuters, Wood Mackenzie, Company data, Goldman Sachs Global Investment Research

Exhibit 76: ...however, cobalt substitution in batteries will be the main determinant of how big or small this supply deficit is



Source: Wood Mackenzie, Goldman Sachs Global Investment Research

Company Profiles

BHP Billiton (BLT.L/BHP.AX): Returns to accelerate after onshore shale sale; remain Buy

We remain Buy rated on BHP (BLT.L / BHP.AX) with 12-month price targets of GBp1,950/A$40.

Very strong copper portfolio; Escondida strike averted

BHP has a strong copper portfolio and is the largest copper producer in our coverage. The company is in the process of increasing production at two of its mines: (1) Spence Hypogene; and (2) Olympic Dam. The Spence growth option was approved last year for total capex of US$2.5 bn + the US$1.43 bn to be spent over 20 years – BHP has outsourced the building of the desalination plant. The expansion at Olympic Dam has been more difficult, and BHP has continued to struggle to keep production steady with different issues affecting the overall production. While we take into account the growth optionality at the mine, where the company is planning to add c.160Kt (for capex of US$3 bn, on our estimates), we highlight that risks from this mine are likely skewed to the downside. BHP averted the Escondida strike in August by reaching a last-minute deal with workers. While the details of the offer are not public, we believe it was likely higher than that made before the government-mediated talks. While the lack of disruption had a negative short-term effect on copper prices, the inflationary impact of the deal is positive for copper prices longer term.

Lack of catalysts, but still see material value; valuation remains attractive

Our upgrade of BHP on April 15 was predicated on: (1) strong cash conversion in 2H18 vs. 1H18; (2) strong returns, with the FY18 results; and (3) attractive valuation, both absolute and vs. RIO. Another catalyst was the divestment of the onshore oil assets, for which we estimate a value of US$7-US$14 bn. BHP announced recently that it had reached a deal to sell the assets for US$10.8 bn (note that we take no view on the transaction). While most of the catalysts for BHP have materialised, we remain Buy-rated on the stock as we see material value; BHP continues to trade at a 7% discount to RIO vs. a historical premium of 2% on 12-month-forward consensus EV/EBITDA (I/B/E/S).

Valuation and key risks

We are Buy rated on BLT.L/BHP.AX and value it on 6.5x (50/50 FY19/FY20E) EBITDA to derive our 12-month price targets of 1,950p and A$40 (previously 2,000p/A$42). Our estimates change as we update for the new copper price deck and mtm for 3Q commodity prices and FX. Our EPS estimates rise despite the fall in EBITDA on account of lower tax.

Key risks include: (1) operational issues, especially at the iron ore operations given their importance to FCF generation; (2) a potential asset swap for the onshore assets – this would imply no cash in, which could disappoint investors, in our view; and (3) a significant slowdown in China, which would likely affect demand for key commodities in BHP's portfolio.

Rio Tinto (RIO.L / RIO.AX): M&A likely ahead as growth in copper sought; remain Neutral

We remain Neutral rated on Rio Tinto (RIO.L / RIO.AX) with 12-month price targets of GBp4,000/A$82.

Focus on copper but no immediate growth projects; M&A likely

Copper is a small part of RIO's earnings profile: as of 2018, we expect copper to contribute <15% to the company's EBITDA. While Rio has a couple of growth projects – the one in the near term being the Oyu Tolgoi underground expansion – the company does not have any other approved growth projects in the pipeline. The other projects, Resolution and La Granja, are too far away to affect investor investment decisions currently, in our view. Given that the company has been vocal about increasing its exposure in copper (note that its expected copper exposure has come down after the sale of its Grasberg stake), we believe the most likely way it would achieve this is through M&A.

Remains a call on iron-ore prices; other commodities too small to move the dial

Rio Tinto has remained a straight call on iron-ore prices as its exposure to the commodity has increased. RIO's focus has been on selling "non-core" assets, which have included high-cost aluminium assets, all of the coal assets and more recently the stake in the Grasberg mine. This has seen the contribution of iron ore to RIO's EBITDA increase to >60% as of 2018, the highest in our coverage. While we see downside to iron-ore prices in the near term, we believe that the company's focus on returns is likely to support the share price in the near term.

Valuation and key risks

We value RIO on an unchanged 6x 50/50 2018/19E EV/EBITDA. Our 12-month price targets are 4,000p/A$82 (previously 4,000p/A$84). Our estimates change as we update for the new copper price deck and mtm for 3Q commodity prices and FX.

Higher/lower iron ore prices, FX, and political and fiscal uncertainty are the key risks to our investment thesis. We are Neutral rated.

Anglo American (AAL.L): Growth ahead, valuation undemanding; Buy (on CL)

We remain Buy rated on Anglo American, with a 12-month price target of Gbp2,200. The stock is on our Conviction List.

Quellaveco - the first Greenfield project approved in a long time

With its 1H18 results, Anglo American approved the Quellaveco mine, which is the first greenfield mine approved since the commodity downturn started in 2014. Capex was c.US$5-US$5.3 bn and production is expected to be c.300Ktpa. This computes to a capex intensity of c.US$22,250/t vs. an average of US$17,750/t for the Quellaveco mine. The reason for this higher capex intensity is that our analysis also includes a significant number of brownfield expansions, where the capex intensity is obviously lower. The company expects the costs to be c.US$1.05/lb of copper production (real terms). This is an improvement over the guidance that was given previously. Capex is expected to be limited to 1H19 as the company utilises the cash in from Mitsubishi.

Copper to become an increasingly important part of Anglo's earnings driver; other commodity mix favourable too

As of FY17, copper contributed c.17% to Anglo's EBITDA. However, we forecast this number to increase steadily to c.35% by FY2020 on account of higher copper prices and production. The main production increase comes from the improvement in Los Bronces – we forecast production to increase from c.310Kt in 2017 to c.370Kt in 2019. We expect flat production from the remaining mines – note that Quellaveco does not come online until FY23, on our estimates.

More broadly, we remain positive on Anglo's commodity mix: (1) the iron-ore portfolio remains strong, especially given that the lump premium has continued to strengthen amid higher demand from Chinese steel mills; and (2) Met coal also remains strong as the Chinese mills continue to buy higher-quality coking coal; the bid to reduce pollution should be a positive for both the lump premium and coking coal.

Valuation and key risks

We maintain our Buy rating (on CL) on Anglo. We value the shares at 5x (previously 4.5x) 50/50 2018/19E EV/EBITDA, driving a 12-month price target of 2,200p (previously 2,000p). We increase our multiple to reflect the increased contribution of copper – one of our preferred commodities – in the company's earnings. Our estimates change as we update for the new copper price deck and mtm for 3Q commodity prices and FX.

Key risks to our view include lower commodity prices, stronger FX and political risk associated with changes in the South African mining charter.

Glencore (GLEN.L): Strong growth ahead; remain Buy despite uncertainties

We remain Buy rated on Glencore with a 12-month price target of GBp400.

High-quality copper portfolio; material growth ahead

Glencore has one of the strongest and the most diverse copper portfolios in our coverage. GLEN produced c.1.3 mn tonnes of copper in FY17 and is in the process of ramping up production from two of its mines in Africa – Katanga in DRC and Mopani in Zambia. On our estimate, the mines could add a further c.200Kt this year and upwards of 350Kt next year to GLEN's production profile, taking its total production to over 1.5 mn tonnes by FY2020. Note that as copper volumes ramp up, the cobalt production from GLEN's mines is also set to increase; we expect total cobalt production to increase to c.60Kt by FY20.

Growing volumes (both copper and cobalt), coupled with our positive view on the commodities, should make copper an increasingly important part of GLEN's earnings. We forecast the contribution to increase from c.30% this year to >45% by FY2020.

Investment thesis - DoJ investigation a risk, but we see risks as more than priced in

GLEN remains one of the best positioned stocks in our coverage given its strong balance sheet and attractive growth projects (both in copper, as discussed earlier, and zinc). This balance sheet strength combined with a lack of growth projects in the pipeline (the capex on the growth projects has either been spent or is in the last stages) means that Glencore can focus on investor returns – dividends + buy-backs – which we believe should remain supportive of the share price.

While there are some uncertainties around the investment case owing to the ongoing DoJ investigation, we highlight that the company's fundamentals remain strong and valuation attractive. With a material volume ramp-up ahead, we forecast earnings momentum remaining strong over the next few halves.

Valuation and key risks

We value Glencore on a SOTP, which values the industrial assets at 4x 2018E EV/EBITDA and the marketing division at 15x 2018E P/E, and mark to market the listed entities. We increase our multiple from 3.5x to 4x to reflect the FCF generation capacity of the business. Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Our 12-month price target increases from 375p to 400p.

Key risks to our price target and thesis are: (1) uncertainty relating to the ongoing DoJ investigation; (2) lower commodity prices; (3) political and fiscal risks; and (4) FX volatility.

Norilsk Nickel (NKELyq.L): Well-balanced basket of late cycle commodities; Buy

We remain Buy rated on Nornickel (CEEMEA Focus List), with a 12-month price target of US$24.0.

Copper - 30% of metals basket, key growth project is ramping up

Nornickel enjoys a well-balanced metals exposure, with c.1/3 of revenue coming broadly equally from nickel, copper and PGMs. Nornickel produces c.400kt of Cu pa and expects to increase output further as it has recently launched (hot commissioning started in November 2017) its key growth copper project Bystrinsky GOK, with 70-75kt of Cu and 250-260koz Au output at full ramp-up expected by 2021. Nornickel accounts for c.2% of global copper production, with all mining and processing assets located in Russia.

Investment thesis intact - undervalued play on late-cycle commodities

Norilsk Nickel is the world's largest producer of palladium and one of the largest producers of nickel, platinum, and copper. We believe the market still overlooks the extent to which the company's FCF generation is benefiting from a weakening ruble and a positive outlook on its key metals prices. We see scope for the inflection in FCF to drive a reduction in leverage and support shareholder distributions: we forecast ND/EBITDA to halve by end 2019 to 1.1x (2.1x in 2017), and believe the company will be able to deliver high and growing shareholder returns under different scenarios of dividend payout. We are c.10% ahead of Bloomberg 2019 EBITDA consensus mainly owing to our higher outlook for the nickel price deck. The shares trade at a 2019E dividend yield of 14% (vs. mid cycle of 7.5%) and 2019E EV/EBITDA of 5.3x (vs. mid cycle of 6.2x).

Valuation and key risks

We are Buy rated on Norilsk Nickel (on CEEMEA Focus List). Our 12m PT of US$24.0 (down from US$25.0 on our updated copper price deck) is based on a target multiple of 7.3x (a c.10% premium to Nornickel's past five-year average multiple) applied to 2018-19E EBITDA (methodology unchanged). Key downside risks to our view and price target include a stronger-than-expected ruble, weaker-than-expected commodity prices, cost and capex overruns, value-destructive acquisitions/divestments, and changes in shareholding structure leading to changes in cash allocation and development strategy.

Antofagasta (ANTO.L): High capex intensity growth to keep FCF suppressed; down to Sell

We downgrade Antofagasta to Sell from Neutral with a reduced 12-month price target of 725p.

Los Pelambres/Centinela expansion to suppress FCF generation

Antofagasta is in the process of evaluating the Los Pelambres and Centinela expansion plans. For Los Pelambres, the capex is likely to be US$1.8 bn (US$1.95 including our assumed capex escalations); we expect first production in 2020 and the mine reaching full capacity of c.100kt by FY2023. Note that this is likely to be implemented in two stages: a c.55Ktpa expansion that is likely to start next year, and the 35ktpa expansion due to start in 2021/22. At Centinela, the company is still evaluating whether to build a new concentrator (adding capacity of 90Ktpd) or to modify the existing one (which adds capacity of 60Ktpd). While a decision has not been taken, we believe it is likely to choose the 90Ktpd option given that the company has the balance sheet power.

It is worth noting that both these projects feature in the fourth quartile of the projects we have analysed. The capex intensity for the projects is > US$23,000/t, significantly higher than the average of US$17,450/t.

Grade tick-up likely to see production move up; we see risks to production guidance for FY18

In the near to medium term, lower grade has led to production disappointing in 1H18. The company has guided to a material pick-up in grade, particularly at the Centinela mine, which should see a significant ramp-up in 2H18. While we forecast a production uplift of c.20% HoH, we still expect the company to miss its FY18 guidance: Anto's FY18 guidance is 705-740Kt vs. our forecast of 700Kt. Any slippage here is likely to mean that the company misses on its FY18 guidance and would be a negative catalyst. Note that the production data from Chilean Copper Association showed a continued decline in production at both Los Pelambres and Centinela in July, which means that the uplift required in the remaining months is even higher.

Valuation and key risks

We value Anto on a 5.5x (previously 5x) 50/50 2018/19E EV/EBITDA to derive our 12-month price target of 725p (previously 800p), and downgrade the stock to Sell. We increase our target multiple to reflect mid-cycle earnings vs. peak earnings as was implied by our copper price assumptions previously. Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Our price target implies downside of 18% vs. average upside of 15% for our coverage. Our 2019 EBITDA estimate is c.10% below StarMine SmartEstimates consensus (Thomson Reuters).

Key risks to our view and price target include higher/lower copper prices than we expect, a weaker/stronger Chilean peso and stronger/weaker operational performance than we forecast. The key near-term risk relates to the guidance cut that we expect the company to announce with the 3Q results. If the company is able to ramp up production at Los-Pelambres/Centinela, this would be a material risk to our thesis.

What would make us more positive: To be more positive, we would need to see the company: (1) move down the cost curve; (2) improve production to reach the guidance; and (3) improve the economics of the brownfield project.

Exhibit 77: Antofagasta key financials

Antofagasta Plc

Ticker	ANTO.L				
Market Cap & EV	US$11,275mn	US$13,952mn			
Free Float	35%				
Year End	December				

Price as at close on 03 Oct 18	GBp 879	Analyst #1	Eugene King
12-month Price Target	GBp 725	Email	eugene.king@gs.com
Upside/ (Downside)	-18%	Analyst #2	Abhinandan Agarwal
Rating	Sell	Email	abhinandan.agarwal@gs.com

Production	2016	2017	2018E	2019E	2020E	2021E
Copper (kt)	709	704	702	775	774	814
Los Pelambres	355	344	345	357	358	385
Centinela concentrates	180	164	144	194	192	205
Zaldivar (Attr.)	52	52	52	56	56	56
Centinela cathodes	56	65	89	92	91	92
Michilla	0	0	0	0	0	0
Antucoya	66	80	71	76	77	76
Enceuntro Oxides	0	0	0	0	0	0
Molybdenum (kt)	7	11	12	12	12	13
Gold (koz)	271	212	182	194	192	205
Silver (koz)	3,799	3,388	2,888	3,099	3,095	3,324
Transport (kt)	6,496	6,085	6,419	6,244	6,244	6,244

Assumptions (year avg.)	2016	2017	2018E	2019E	2020E	2021E
Copper (US$/t)	4,870	6,170	6,555	6,875	7,000	7,100
Copper (USc/lb)	221	280	297	312	318	322
Copper TC/RC Charges (US$/t)	550	523	465	424	424	424
Molybdenum (US$/t)	14,024	15,518	22,858	20,000	20,000	20,000
Gold (US$/oz)	1,248	1,258	1,262	1,288	1,350	1,450
Silver (US$/oz)	1,714	1,706	1,219	1,717	1,929	2,231
CLP/US$	675	649	634	635	650	650
US$/GBP	1.36	1.29	1.34	1.30	1.30	1.30

Revenue by Division (%)	2016	2017	2018E	2019E	2020E	2021E
Los Pelambres	51%	51%	52%	47%	47%	48%
Centinela	37%	35%	34%	41%	40%	40%
Michilla	0%	0%	0%	0%	0%	0%
Antucoya	8%	11%	10%	10%	0%	0%
Enceuntro Oxides	0%	0%	0%	0%	9%	9%
Centinela DMC	0%	0%	0%	0%	0%	0%
Transport	4%	4%	4%	3%	0%	0%
Water	0%	0%	0%	0%	3%	3%

EBITDA by Division (%)	2016	2017	2018E	2019E	2020E	2021E
Los Pelambres	922	1428	1307	1495	1656	1792
Centinela	563	859	460	914	984	1019
Zaldivar	85	134	65	58	59	58
Michilla	0	0	0	0	0	0
Antucoya	65	207	159	226	227	225
Enceuntro Oxides	0	0	0	0	0	0
Centinela DMC	0	0	0	0	0	0
Transport	73	75	67	65	71	74
Corporate & Exploration	-101	-141	-152	-176	-176	-176

Production Costs (USc/lb)	2016	2017	2018E	2019E	2020E	2021E
Weighted avg gross costs (pre by-products)	156	164	182	177	182	188
Weighted avg net costs (post by-products)	123	124	143	141	146	149

Valuation (x)	2016	2017	2018E	2019E	2020E	2021E
Share price (GBp)	879	879	879	879	879	879
Market Cap (USD mn)	11,746	11,174	11,598	11,265	11,265	11,265
EV (USD mn)	9,464	13,455	13,952	14,156	14,411	15,372
EV/EBITDA - (attrib. EBITDA)	**5.9x**	**5.2x**	**7.3x**	**5.5x**	**5.1x**	**5.1x**
PE	**18.5x**	**14.9x**	**29.4x**	**14.3x**	**12.3x**	**11.0x**
Dividend yield (%)	**2%**	**4%**	**1%**	**3%**	**3%**	**3%**
FCF yield (%)	**0%**	**11%**	**2%**	**3%**	**4%**	**-2%**
EV/GCI	0.6x	0.8x	0.8x	0.7x	0.7x	0.7x
Price/book	1.4x	1.2x	1.2x	1.1x	1.0x	0.9x

Profit & Loss (USD mn)	2016	2017	2018E	2019E	2020E	2021E
Sales	**3,622**	**4,749**	**4,477**	**5,397**	**5,706**	**6,125**
Operating Costs	-2,100	-2,320	-2,635	-2,873	-2,944	-3,191
EBITDA	**1,522**	**2,430**	**1,841**	**2,523**	**2,762**	**2,934**
D&A	-578	-581	-682	-710	-707	-662
EBIT	**943**	**1,849**	**1,159**	**1,813**	**2,055**	**2,272**
Net finance costs	-59	-68	-63	-53	-47	-55
Others	30	51	-64	-66	-65	-66
Underlying pre-tax profit	**914**	**1,832**	**1,032**	**1,694**	**1,943**	**2,151**
Income tax	-314	-634	-344	-567	-650	-720
Tax rate (%)	34%	35%	33%	33%	33%	33%
Minorities	-221	-447	-304	-339	-378	-402
Underlying net profit	**363**	**750**	**383**	**788**	**915**	**1,030**
Underlying EPS (USD)	0.37	0.76	0.39	0.80	0.93	1.04
Extraordinaries	-222	1	0	0	0	0
Reported net profit	**141**	**751**	**383**	**788**	**915**	**1,030**
Reported EPS (USD)	0.14	0.76	0.39	0.80	0.93	1.04
Shares outstanding (mn)	986	986	986	986	986	986
DPS (USD)	0.18	0.51	0.15	0.30	0.35	0.39
Dividend payout ratio (%)	129%	67%	37%	38%	38%	38%

Cash Flow Analysis (USD mn)	2016	2017	2018E	2019E	2020E	2021E
Cash flow from operations	**1,013**	**2,190**	**1,218**	**1,658**	**1,973**	**2,014**
Capex	-1,009	-1,002	-963	-1,320	-1,520	-2,220
Free cash flow	**3**	**1,189**	**255**	**338**	**453**	**-206**
Others	-51	-574	-347	-203	-330	-353
Surplus/ (Deficit)	**-48**	**615**	**-92**	**135**	**123**	**-559**

Balance Sheet (USD mn)	2016	2017	2018E	2019E	2020E	2021E
Cash	2,049	2,252	1,646	1,646	1,646	1,646
Other Current Assets	1,387	1,378	1,223	1,512	1,558	1,709
Total current assets	**3,435**	**3,630**	**2,868**	**3,158**	**3,204**	**3,355**
Net fixed assets	8,738	9,064	9,335	9,944	10,758	12,315
Other long-term assets	1,551	1,515	1,491	1,491	1,491	1,491
Total assets	**13,724**	**14,210**	**13,695**	**14,593**	**15,452**	**17,162**
Short-term debt	837	754	562	562	562	562
Other Current Liabilities	717	809	640	752	775	850
Total current liabilities	**1,554**	**1,562**	**1,202**	**1,314**	**1,337**	**1,412**
Long-term debt	2,283	1,955	1,632	1,497	1,375	1,934
Other long-term liabilities	1,377	1,551	1,489	1,489	1,489	1,489
Total liabilities	**5,214**	**5,068**	**4,323**	**4,300**	**4,200**	**4,835**
Total common equity	6,815	7,318	7,243	7,826	8,407	9,080
Minority interest	1,694	1,823	2,128	2,467	2,845	3,247
Total liabilities & equity	**13,724**	**14,210**	**13,695**	**14,593**	**15,452**	**17,162**
Total Debt	3,120	2,709	2,194	2,060	1,937	2,496
Net Debt	1,072	456	548	414	291	850
Net debt/ EBITDA	0.7x	0.2x	0.3x	0.2x	0.1x	0.3x
Capital Employed	11,630	11,850	11,566	12,353	13,189	14,823

Ratios	2016	2017	2018E	2019E	2020E	2021E
CROCI (%)	8%	13%	7%	10%	10%	10%
Net debt / equity	13%	5%	6%	4%	3%	7%
ROIC (%)	5%	10%	7%	10%	11%	11%
ROA (%)	3%	5%	3%	5%	6%	6%
ROCE (%)	3%	6%	3%	6%	7%	7%
ROE (%)	4%	8%	4%	8%	8%	8%
Gearing (%)	14%	6%	7%	5%	3%	9%

Source: Company data, Goldman Sachs Global Investment Research

Boliden (BOL.ST): Remain Neutral on lack of catalysts

We remain Neutral rated on Boliden (BOL.ST) with a 12-month price target of Skr250.

A smelter more than a miner, with falling production profile

Boliden owns both mines and smelters with exposure to zinc and copper. On our estimates, activities related to the extraction and refining of copper account for c.40%-45% of Boliden's earnings. Overall, Boliden's smelting capacity in both zinc and copper exceeds its mine production, which leaves the company exposed to the concentrate market. In copper specifically, Boliden currently has a smelting capacity of c.380kt while we estimate its FY18 mine zinc in concentrate production to be around 112kt. In addition, Boliden faces a falling production profile owing to falling copper grades at its Aitik mine and the potential depletion of its Kylyahti mine by 2020E. Hence, investment in exploration/external growth is likely required to maintain a integrated business model in copper.

Remain Neutral on the stock given lack of catalysts

Our pricing deck, in the absence of any material growth drivers, implies a rolling over in Boliden's returns and cash generation from recent highs. Following the recent sell-off in the shares, Boliden trades c.10% below the sector average. However, our Neutral view on the stock reflects a lack of clear catalysts in the near term.

Valuation and key risks

We value Boliden using a 5.5x EV/EBITDA multiple applied to our 2018 estimate to derive a 12-month price target of Skr250 (unchanged). Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Our price target is unchanged on account of lower net debt.

Key risks are higher/lower commodity prices, a further deterioration in smelting terms/improvement above our expectations, and a strengthening/weakening Skr vs. the USD.

First Quantum (FM.TO): Cobre targets likely to be revised but doesn't change our investment thesis; remain Buy

We are Buy rated on First Quantum with a 12-month price target of C$18.

Cobre Panama coming online next year, albeit at a lower level

We continue to expect Cobre Panama to coming online in 2019. However, we believe that the current guidance of c.150Kt for 2019 is on the optimistic side, and forecast lower volumes of c.100kt for next year. This reflects reason the significant construction work still required to be done at the mine, as a result of which we believe that the production targets are likely to be reset. However, we do not believe that the resetting of the target would be a material negative for the shares as most investors we have spoken to believe the 2019 target is optimistic.

Sentinel still growing, capex decision on Kansanshi to be taken soon

From the existing portfolio, First Quantum still has some growth left, mostly from Sentinel, where the mine is yet to reach full production. The bottleneck there is the smelting capacity at Kansanshi, which the company is working around; First Quantum can either invest in a new smelter or use third-party smelters. In addition, we believe that First Quantum will need to take a decision on Kansanshi capex soon (the Kansanshi 2.5 plan was put on hold in 2015).

Zambia risks set to abate over the medium term; deleveraging to drive re-rating

In March 2018, the Zambian Revenue Authority imposed a c.US$8 bn fine on First Quantum for "underpayment of taxes". With its 1Q2018 results, First Quantum stated that it had been through 1/3rd of the documents by value and that it expected the final amount to be small. This was reiterated with the 2Q results. We believe a resolution of this issue, ending the associated uncertainty, would be positively received by the market. We also expect significant deleveraging for First Quantum, which should allow the shares to continue to re-rate; we forecast net debt to EBITDA to decrease from 5x in 2017 to c.1x by 2020E. This reflects production ramps-up at Cobre Panama and capex winding down.

Valuation and key risks

We value First Quantum Minerals on a 50/50 blend of 5.5x 2018/19E EV/EBITDA, giving a 12m price target of C$18 (previously C$24). Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Key risks to our view are projects underperforming, Cobre Panama being delayed, weaker copper prices and balance sheet stress.

Lundin Mining (LUMIN.ST/LUN.TO): Candelaria ramp-up proceeding according to plan; focus likely to remain on inorganic growth

We are Neutral rated on Lundin Mining (LUMIN.ST/LUN.TO) with 12-month price targets of Skr50/C$7.3.

Strong B/S likely to be deployed towards M&A rather than enhanced returns

While Lundin has one of the strongest balance sheets in our coverage, we believe this is unlikely to translate into higher investor returns. In our view, the company's focus remains inorganic growth, and we would expect it to look for alternative acquisitions. While the company has a successful record of making acquisitions, we note that asset valuations, especially copper, are high at present. This creates the risk of dilution in the event of M&A.

While we expect operational improvement at Candelaria, we believe the investor focus is likely be on corporate level activity. As a result, we take a more conservative view and remain Neutral rated on the stock.

Lack of immediate catalysts post withdrawal from Nevsun acquisition

Lundin Mining bid for Nevsun Resources on May 7. However, in September, Nevsun announced that it has entered into a friendly all-cash offer to be acquired by Zijin Mining for US$1.41 bn. This is an all-cash deal and represents a 26% premium to Lundin Mining's offer. Lundin subsequently announced that it would not increase its offer for the company.

We had regarded the announced Nevsun acquisition as an important catalyst for the company. Nevsun intends to build the Timok project, which Lundin had expressed an interest in acquiring for the last couple of years, and which would have provided a growth opportunity for Lundin. However, following the termination of Lundin's approach for Nevsun, we see no immediate alternative catalysts.

Valuation and key risks

We value Lundin Mining (LUN.TO/LUMIN.ST) on a 50/50 blend of 5x (unchanged) 2018/19E EV/EBITDA, giving 12m price targets of C$7.3/Skr50 (previously C$7.5/Skr51). Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX.

Key risks to our view are higher/lower copper and zinc prices, market assessment of potential M&A and operational performance.

KAZ Minerals: Growth ahead but balance sheet stretched; remain Neutral

We remain Neutral rated on KAZ Minerals with a 12-month price target of GBp575.

Growth delivered, more ahead...

KAZ Minerals has been the best performing stock in our coverage over the past three years as it has delivered on growth, bringing Bozshakol and Aktogay to production on time and reaching c.300Ktpa of copper production. While this has been a strong performance, investors we have spoken to had hoped that after the company approved the US$1.2 bn Aktogay expansion and moved to sell a stake in its Koksay mine to China Nonferrous Metal Industry's Foreign Engineering and Construction Company Ltd, it was likely to move to a stage where it would delever and start to ramp up investor returns. However, the company more recently announced that it was acquiring the Baimskaya mine for US$900 mn. This positions the company well for growth: Aktogay Phase II should start to deliver tonnes in 2022 and Baimskaya in 2025/26.

...but balance sheet concerns material after Baimskaya acquisition

We believe the key reason why the stock has underperformed this year is concern that the balance sheet could become stretched as the company starts to spend capex on Baimskaya in the next couple of years, together with the last remaining capex on the Aktogay expansion. In addition, the market appeared to have expectations of a period of delevering that would have led to a ramp-up in returns – a catalyst that has been pushed out by at least 7-8 years (on our price forecasts).

We believe that a key development to monitor over the next couple of years will be how the company decides to fund the Baimskaya project. We see three potential options: (1) going alone and using the balance sheet to fund the project; (2) project financing, using local banks/funding sources to fund the project; this normally locks the cash flows from the project for a period of time; or (3) bringing on a partner (as Anglo did with Quellevaco); we believe this is the most likely scenario as not only does it monetise the project but it also reduces the company's risk exposure.

Valuation and Key risks

We value KAZ Minerals on 5x 50/50 2018/19E EV/EBITDA to derive our 12-month price target of 575p (previously 4x 50/50 2018/19E EV/EBITDA to get to 450p). The reason for the increase in our multiple is the new work we have done on Baimskaya, which raises our confidence in the economic viability of the project. Our estimates change as we update for the new copper deck and mtm for 3Q commodity prices and FX. Key risks to our view include higher/lower copper prices, higher/lower production volumes vs. our assumptions and FX. Another potential risk is the material capex coming ahead at Aktogay, and potentially at Baimskaya, which could present risk to the balance sheet.

Freeport (FCX): Highest copper exposure among the US mining stocks, Maintain Buy

We remain Buy rated on Freeport with a new 12-month price target of $18.

Large, diversified copper miner set to emerge

FCX provides the most concentrated copper exposure across our North American coverage group, with copper expected to contribute 75% of full year revenues by our estimates and gold and molybdenum making up the remainder. FCX is currently developing the Lone Star project in Arizona, which leverages existing mine infrastructure from the Safford operation and is expected to produce 200 mn lbs/year for 20 years, starting toward the end of 2020. FCX also sees future potential for a large sulfide resource at El Abra and numerous other brownfield developments in the US and maintains a 39.6% ownership stake (54% after completion of the feasibility study) in the Lower Zone of the Timok copper-gold project in Serbia with Nevsun.

Final execution of the Grasberg divestment agreement and progress on the mine's transition underground will be the key drivers over 2019

The longstanding negotiations among FCX, Rio Tinto, and the Indonesian government regarding long-term operations and ownership of the Grasberg mine took another step toward full resolution with the September 27, 2018 signing of the Divestment Agreement. The agreement, which will see FCX cede majority ownership of the mine to Inalum, a state-owned company, while maintaining control of operations, investment, and governance, also allows Freeport to maintain essentially the same cash flows as expected pre-divestment. Remaining hurdles through year-end 2018 include anti-trust approvals, finalizing of the mining permit, and documentation and resolution of environmental issues, with the transaction expected to close during 1Q19. Once complete, we look for FCX to focus on the operating challenges at Grasberg, which faces a highly complex transition from an open-pit mine to a fully underground operation – adding some downside risks to production in the near term, in our view.

Valuation and key risks

Our 12-month price target moves to $18 from $19 on lower EBITDA projections over the next two years, somewhat offset by a higher valuation multiple and a higher NAV. Our price target is derived from an average of two valuation methods: (1) a 6.0x EV multiple on an average of our estimated EBITDA over two four quarter periods: forward quarters 5-8 (3Q19-2Q20) and forward quarters 9-12 (3Q20-2Q21), and (2) an NAV model with an overall discount rate of 8.7%.

Key Risks: (1) FCX and the Indonesian government could still fail to come to a resolution on environmental matters, leading to production cuts or shutdowns at the Grasberg mine; and (2) continued operational issues at the DMLZ or elsewhere could reduce Freeport's ability to meet production guidance and/or push increases in expected cash cost.

Teck Resources (TECK): Met Coal remains the key driver of earnings, cash flow - maintain Neutral

We remain Neutral rated on TECK/TECK_B.TO and increase our 12-month price targets to US$30/C$38 from US$28/C$37 on new copper and other commodity price assumptions.

TECK operates across base metals, bulks, and energy production

TECK maintains varied mining operations across the Americas, out of which we expect its copper assets to provide 22% of revenues/EBITDA in 2018. Exports of high-quality met coal out of the Pacific Northwest are TECK's most important operations today, contributing nearly 56% of EBITDA (ex corporate expense) in 2018E, while zinc and energy, on our estimates, contribute 20% and 2%, respectively. The company's copper assets today comprise Highland Valley (Canada, 100%), Andacollo (Chile, 90%), Quebrada Blanca (QB1, Chile, 76.5%), and its interest in Antamina (Peru, 22.5%). In total, on a consolidated basis for the three majority-owned mines plus attributable production from Antamina, we expect TECK to report 288kt of copper production for 2018.

Quadra Blanca "QB2" could double copper production by 2024

Since 2015, TECK's main project has been Fort Hills, a large-scale (C$23 billion), long-lived Canadian scale oil sands operation with Suncor as majority owner and operator. Now, the company's attention is rotating toward copper, where TECK has 90% ownership of the C$4.7 billion Quebrada Blanca 2 (QB2) copper project that could produce up to 300ktpa of copper at a "2nd quartile" cost position and a 25 year mine life – leveraging, as TECK's management has highlighted, only 25% of the current reserve and resource base. With regulatory approval of the EIA complete as of August 8, 2018, the company plans to sell down 20%-25% of its ownership to a development partner, chosen over 4Q18, and pursue Board approval soon afterward. First production is projected for mid-2021.

Valuation and key risks

Over the near term, our new reduced GIR copper forecast and changes in FX offset the benefits of marginally higher coking coal prices and lead to reductions in our earnings estimates for TECK. However, higher projected medium-term copper prices lift our NAV. While our forward quarter 5-8 EBITDA estimate decline, a slightly higher multiple and a higher NAV drive our 12-month price targets up to $30/C$38 from $28/$C37.

Key risks: (1) Commodity prices; (2) cost inflation; and (3) better-than-expected results of trials for alternative water treatment at Elkview, which could lower future expectations of coal operating costs and required sustaining capital.

Aurubis (NAFG.DE): Remain Neutral on continued bearish outlook for TC/RCs

We remain Neutral rated on Aurubis with a 12-month price target of €60.

Continue to see downside risks to TC/RCs in 2019

We continue to believe that treatment and refining charges are likely to face downward pressure in 2019, mainly as a result of the concentrate deficit we forecast the market to be in. Our forecasts imply a c.10% drop in both TCs and RCs, which implies the company's earnings profile remaining challenged despite the €60 mn cost-cutting programme.

Things that could surprise us

Factors that could surprise us to the upside here are: (1) refining charges: refining charges have remained strong mainly as a result of China imposing bans on certain type of copper imports. While our view remains that this was likely a one-off, China is looking to impose a ban on additional scrap imports; (2) the company has stated that it is looking to sell RFP (flat rolled products), its downstream business (the contribution to earnings from the business is c.€10 mn this year, on our estimates). If a sale of this business resulted in material cash inflows that were returned to shareholders, this would also be a positive catalyst; (3) M&A: The CEO has talked about acquiring more smelting business and growing earnings inorganically. If the company were to make a synergistic acquisition, this would be a positive catalyst for the stock.

Valuation and key risks

Our revised 12m price target of €60 (from €61) values the stock on a 5.5x EV/EBITDA multiple on 50/50 FY18/19E earnings. In our valuation, we assume: (1) benchmark TC/RCs settling at US$75/t and USc7.5/lb vs. this year's level of US$82.5/t and USc8.25/lb; and (2) scrap RCs coming off recent highs (-10% in FY19E vs. FY18E), albeit remaining elevated vs. history given the changes in China's import policy. Our estimates change on account of updated copper prices, and mtm of 3Q commodity prices and FX.

Key risks to our view include: lower/higher-than-expected tailwinds from a recovery in copper scrap availability post recent ferrous price moves; higher/lower sulfuric acid prices; and the efficiency program delivering above/below expectations.

KGHM (KGH.WA): Persistently weak FCF generation not priced in; Sell

We remain Sell rated on KGHM with a 12-month price target of PLN89.

KGH copper business

Copper contributes c.70% of KGHM's 2017E top line (the rest is mainly silver). Major copper assets for KGH are located in the south-western part of Poland. KGH also has production facilities in North America (Canada, United States) and a JV with Sumitomo Sierra Gorda (open-pit mine in Chile).

Investment thesis

Our Sell view is based on low cash generation stemming from production reconfiguration amid continued high capex (2018-20E average capex/sales of 15%). This leads to negative FCF for the company even amid a supportive macro environment (for example, in 1H18 when Cu prices were at three-year highs, KGH reported an FCF loss amounting to 9% of its sales (vs. broadly breakeven FCF in the previous five years)). Yet, even after a significant de-rating (down 22% YTD in US$ terms), we believe the current valuation fails to reflect these challenges, with KGH trading at a premium to its own history (2019E EV/EBITDA of 5.5x vs. the five-year historical average of 3.2x). This is unjustified, in our view, given the continued suppressed FCF that we expect over the next three years. At spot macro assumptions (FX, metals), KGH trades at 6.9x EV/EBITDA and a 2% FCF yield for 2019E.

Valuation and key risks

We are Sell rated on KGHM. Our 12-month SOTP-based price target is PLN89 (up slightly from PLN88 on weaker FX). The increase in our estimates reflects our incorporation of our latest copper price assumptions. Our price target rises less significantly owing to an increase in net debt. Key risks to our view are higher-than-expected Cu/Ag prices, a weaker-than-expected PLN/USD, better-than-expected cost management, the disposal/closure of non-performing international assets and easing taxation in Poland.

MMG (1208.HK): Benefit from rising copper price, maintain Buy

We remain Buy rated on MMG with a 12-month price target of HK$5.8

Lower guidance for Las Bambas copper production for 2018E

MMG has lowered its Las Bambas copper output guidance to 375kt-395kt from the previous 410kt-430kt for 2018 as: (1) instability events have affected mining rates and access to high-grade ore in Las Bambas; and (2) mill throughput rates have increased but have yet to reach the plan. MMG expects these issues to affect production in 2018 but not in the medium term. Hence, we revise down Las Bambas production by 7% to 382kt in 2018E and 3% to 400kt in 2019E to reflect our own view that geological issues for the mine are likely to continue for a while. We also revise up C1 cost to US$1.1/lb from US$1.0/lb for 2018E owing to lower production volume.

Benefit from rising copper prices

We believe MMG remains a key beneficiary under rising copper prices owing to its high leverage and high exposure to copper (80% of EBITDA in 2019E from copper). Despite lower copper price assumptions for 2018-20 and reduced production volumes from Las Bambas, we expect MMG to generate US$0.99-1.21 bn of free cash flow with a free cash flow yield at 24%-29% for 2018-20E. With strong cash flow and a disciplined investment strategy, we expect net gearing to fall to 193% by 2020E from 682% in 2017A.

Valuation and key risks

Our 12-month target price of HK$5.8 (from HK$6.30) is based on historical P/B vs. ROE correlation, or 2019E P/B of 3.0x and ROE of 28%. We cut our earnings estimates by 30% for 2018, 33% for 2019 and 25% for 2020 to reflect lower copper price assumptions and output from Las Bambas in 2018-19. For each US$0.5/lb change in the copper price, we estimate earnings would move by 58% for 2019.

Key risks to our price target and thesis are: (1) commodity prices including copper, zinc and lead; and (2) operational risks including a sudden decline in ore grade.

Zijin (2899.HK): Emerging copper play; maintain Buy

We remain Buy rated on Zijin-H/A with 12-month price targets of HK$3.8 for H-share and Rmb4.8 for A-share.

Continued volume growth, benefit from rising copper/gold prices

We expect Zijin copper output to grow by 17%-25% in 2018-19, driven by ramp-up of the Kolwezi project and expansion of the Duobaoshan project, and copper output to almost double by 2022E from 2017A when the Kamoa project fully ramps up. By 2022, we estimate copper will contribute 57% of total gross profit (from 31% in 2017A) and gold will contribute 27%. Apart from growth from new project ramp-up and existing project expansion, Zijin is also looking for other acquisition opportunities. The company recently announced that it would acquire a 63% interest in RTB Bor Group in Serbia through public bidding and an increase of capital. The company has also proposed a cash takeover of Nevsun at a consideration of CAD$6/share. Both transactions are still in the bidding process and we calculate Zijin would pay Rmb18 bn in total for acquisitions if it secures the two deals on the current proposed terms. We estimate that if completed, these two deals could bring at least 268kt of copper output to Zijin, versus Zijin's 2017 copper output of 208kt. However, as most projects in the deals are greenfield or need upgrades, the timing of operation and earnings contribution is uncertain.

Gold price assumptions change

Our commodities team recently revised down their gold price forecast to US$1,262/oz in 2018 and US$1,288/oz in 2019 from a prior US$1,340/oz in 2018 and US$1,450/oz in 2019 as they believe EM concerns have created a sizeable fall in financial and physical holdings. However, they still expect gradually higher gold prices driven by renewed EM demand.

Valuation and key risks

Our 12-month target prices of HK$3.8 (from HK$3.9) for H-share and Rmb4.8 (from Rmb4.9) for A-share are based on historical P/B vs. ROE correlation, or 2019E P/B of 1.9x/2.8x for H/A-share and ROE of 12%. We cut our earnings estimates by 9% for 2018, 20% for 2019 and 17% for 2020 to reflect lower copper and gold price assumptions.

Key risks to our price target and thesis are: (1) gold and copper prices: FY19E earnings change 11% for every US$100/oz change in the gold price or 5% for every US$0.01/lb change in the copper price; and (2) project execution, which is key to sustaining the company's growth profile.

Jiangxi Copper (0358.HK): Fairly valued with no volume growth

We remain Neutral rated on Jiangxi Copper H/A with a 12-month price target of HK$11.5 for H-share and Rmb17.1 for A-share.

Fairly valued with no volume growth

In line with our commodities team's copper price forecast, we expect the SHFE copper price to average US$2.96/lb in 2018 and US$3.06/lb in 2019. Under this copper price assumption, we expect Jiangxi Copper's recurring profit to reach Rmb2.6 bn in 2018 and Rmb2.7 bn in 2019. We believe current valuation, at a 2019E EV/EBITDA of 5x, looks fair considering no volume growth for the company.

China copper demand to maintain low-single-digit growth

We expect Chinese copper demand growth to remain soft at 1%-3% per year for 2018-19. Our recent channel checks with fabricators suggested demand for copper was mostly flat MoM in September 2018, with a continued deceleration of order growth in air conditioners offset by a slight improvement in grid orders – remaining soft overall, in line with seasonal patterns. For each US$0.5/lb change in the copper price, we estimate earnings would move by 23% for 2019E. The company's balance sheet remains healthy, with net gearing at 8%-14% for 2018-20E.

Valuation and key risks

Our 12-month target price is based on historical P/B vs. ROE correlation, or 2019E P/B of 0.7x/1.2x for H/A-share and ROE of 5.4%. Our price targets are HK$11.5 (from HK$12.7) for H-share and Rmb17.1 (from Rmb18.8) for A-share. We cut our earnings estimate by 12% for 2018, 19% for 2019 and 17% for 2020 to reflect lower copper price assumptions.

Key risks to our price target and thesis are: (1) Jiangxi Copper's earnings are highly leveraged to commodity prices (copper and gold), which depend on industry supply additions and global economic growth;)2) changes in government trade policy could have an impact on earnings; and (3) CNY fluctuations would have an impact on earnings.

Copper supply-demand balance

Exhibit 78: Copper Supply model

('000 tonnes)	2010	2011	2012	2013	2014	2015	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Mine Production																
Base Conc Production	12813	12692	13150	14416	14765	15410	16344	16397	17172	17841	18573	19121	19442	18910	18796	18233
New Conc Production									0	10	171	266	481	750	966	1246
Adjustment									0	0	0	0	0	300	500	1000
Disruption Allowance									-500	-803	-937	-969	-996	-998	-1013	-1024
Total Concs/Precips Production	12813	12692	13150	14416	14765	15410	16344	16397	16672	17048	17806	18418	18926	18962	19249	19455
% change		*-0.9%*	*3.6%*	*9.6%*	*2.4%*	*4.4%*	*6.1%*	*0.3%*	*1.7%*	*2.3%*	*4.5%*	*3.4%*	*2.8%*	*0.2%*	*1.5%*	*1.1%*
Smelter Production																
less direct use concs	-18	-21	-18	-20	-21	-14	-11	-15	-20	-22	-20	-18	-16	-16	-16	-16
Concs available for smelting	12795	12671	13132	14396	14744	15396	16333	16382	16652	17026	17786	18400	18910	18946	19233	19439
Conc stock change	251	-203	170	668	-147	105	215	-117	-50	-100	250	150	150	0	-100	-300
Concs needed by smelters	12544	12874	12962	13728	14891	15291	16118	16499	16702	17126	17536	18250	18760	18946	19333	19739
Smelter losses	-478	-459	-495	-487	-556	-553	-509	-524	-551	-565	-579	-602	-619	-625	-638	-651
Add: Scrap/Resmelted blister	2646	2966	3130	2986	2811	2675	2893	3094	3090	3168	3244	3376	3471	3600	3673	3751
Total Smelter Production	14712	15381	15597	16227	17146	17413	18502	19069	19241	19729	20202	21024	21612	21920	22368	22839
Electro- and Fire-Refined Production																
less resmelted and direct use of blister	-689	-672	-781	-726	-796	-872	-985	-1083	-1068	-1049	-1009	-1084	-1134	-1134	-1134	-1134
Blister stock change	-68	-23	-66	-33	-2	42	136	158	-80	30	30	60	80	10	20	50
Blister required for refineries	14091	14732	14882	15534	16352	16499	17381	17828	18253	18650	19163	19880	20398	20776	21214	21655
Add Scrap	1622	1650	1764	1634	1693	1715	1537	1577	1597	1632	1677	1739	1785	1870	1909	1949
Electro-refined Cu Production	15713	16382	16646	17168	18045	18214	18918	19405	19850	20282	20840	21619	22183	22646	23123	23604
Electrowon Cathode Production																
Base SxEw Production	3236	3345	3510	3652	3712	3785	3825	3689	3692	3848	3826	3563	3398	3203	2999	2647
New SxEw Production									8	22	65	86	123	153	173	185
Adjustment									0	0	0	0	0	0	0	100
Disruption Allowance									-100	-174	-195	-182	-176	-168	-159	-147
Total SxEw Production	3236	3345	3510	3652	3712	3785	3825	3689	3600	3696	3697	3467	3344	3188	3013	2784
% change		*3.4%*	*4.9%*	*4.0%*	*1.7%*	*1.9%*	*1.1%*	*-3.6%*	*-2.4%*	*2.7%*	*0.0%*	*-6.2%*	*-3.5%*	*-4.7%*	*-5.5%*	*-7.6%*
Total Refined Cu Production	18950	19727	20156	20820	21757	21998	22743	23094	23449	23977	24537	25086	25527	25834	26136	26388
% change		*4.1%*	*2.2%*	*3.3%*	*4.5%*	*1.1%*	*3.4%*	*1.5%*	*1.5%*	*2.3%*	*2.3%*	*2.2%*	*1.8%*	*1.2%*	*1.2%*	*1.0%*

Source: Goldman Sachs Global Investment Research, Wood Mackenzie

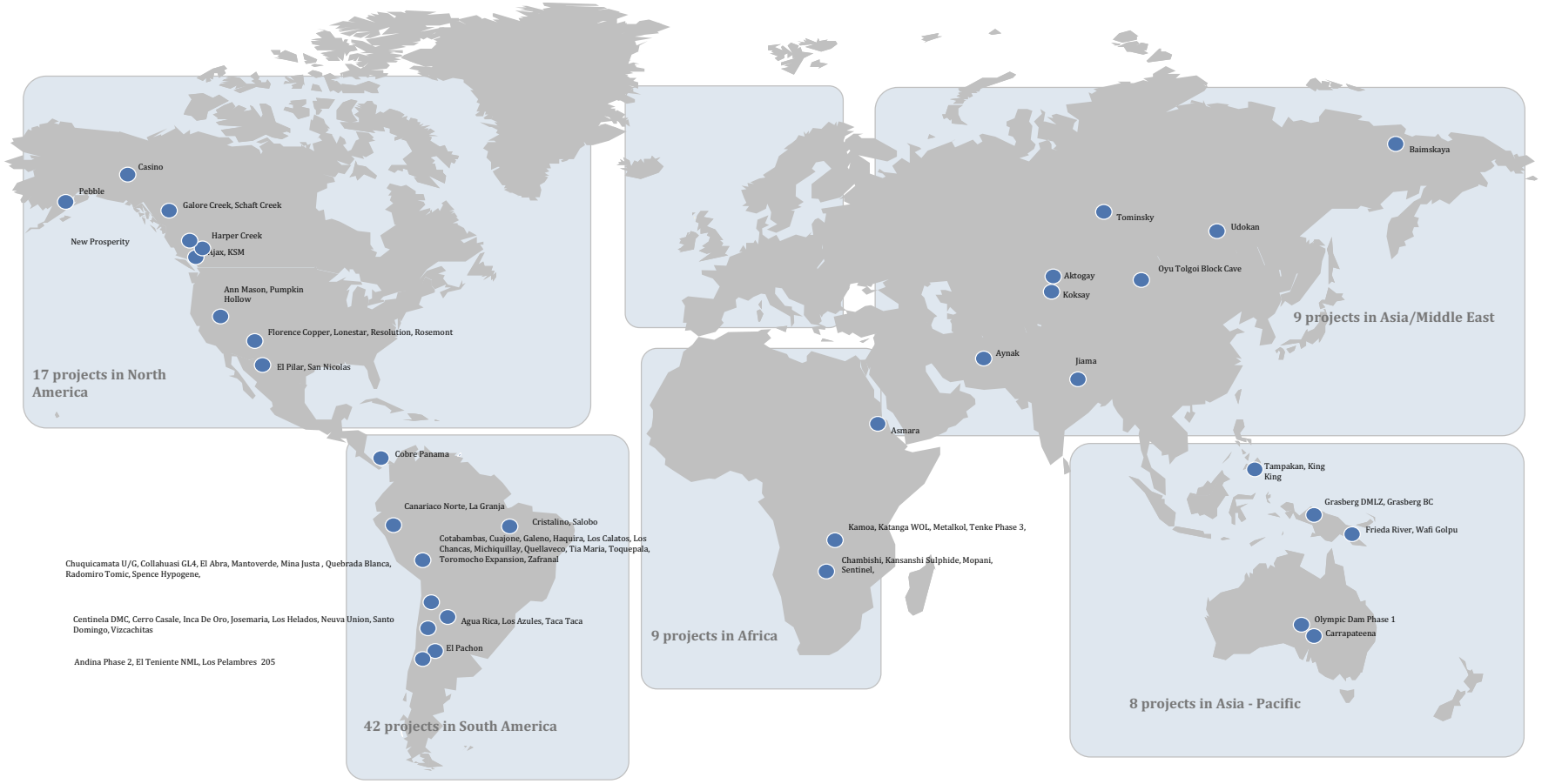
Exhibit 79: Copper Demand model

('000 tonnes)	2011	2012	2013	2014	2015	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Consumption - DM															
US	1757	1762	1795	1815	1847	1853	1811	1721	1724	1708	1695	1689	1690	1696	1710
% change y/y	*-0.5%*	*0.3%*	*1.9%*	*1.1%*	*1.8%*	*0.3%*	*-2.3%*	*-5.0%*	*0.2%*	*-0.9%*	*-0.8%*	*-0.4%*	*0.1%*	*0.4%*	*0.8%*
Europe	4083	3735	3773	3835	3670	3701	3754	3822	3867	3918	3974	4030	4088	4147	4207
% change y/y	*1.5%*	*-8.5%*	*1.0%*	*1.6%*	*-4.3%*	*0.8%*	*1.4%*	*1.8%*	*1.2%*	*1.3%*	*1.4%*	*1.4%*	*1.4%*	*1.4%*	*1.4%*
Japan	1003	985	990	1050	1008	985	1025	1046	1078	1077	1074	1071	1067	1062	1058
% change y/y	*-5.4%*	*-1.8%*	*0.5%*	*6.1%*	*-4.0%*	*-2.3%*	*4.1%*	*2.0%*	*3.1%*	*-0.1%*	*-0.3%*	*-0.3%*	*-0.4%*	*-0.5%*	*-0.4%*
Other DM	1774	1626	1637	1600	1588	1625	1648	1608	1575	1547	1531	1523	1521	1526	1537
% change y/y	*-10.2%*	*-8.3%*	*0.7%*	*-2.3%*	*-0.7%*	*2.3%*	*1.4%*	*-2.4%*	*-2.1%*	*-1.8%*	*-1.0%*	*-0.5%*	*-0.1%*	*0.3%*	*0.7%*
Sub-Total DM	**8617**	**8108**	**8195**	**8300**	**8113**	**8164**	**8238**	**8197**	**8244**	**8250**	**8274**	**8313**	**8366**	**8431**	**8512**
% change y/y	*-2.3%*	*-5.9%*	*1.1%*	*1.3%*	*-2.3%*	*0.6%*	*0.9%*	*-0.5%*	*0.6%*	*0.1%*	*0.3%*	*0.5%*	*0.6%*	*0.8%*	*1.0%*
Consumption - EM															
China	7815	8204	9165	9836	10185	10678	11054	11526	11739	12033	12267	12472	12628	12773	12903
% change y/y	*8.5%*	*5.0%*	*11.7%*	*7.3%*	*3.5%*	*4.8%*	*3.5%*	*4.3%*	*1.9%*	*2.5%*	*1.9%*	*1.7%*	*1.3%*	*1.1%*	*1.0%*
Other EM	3175	3262	3326	3485	3628	3727	3748	3853	3995	4147	4363	4637	4974	5375	5846
% change y/y	*-0.1%*	*2.7%*	*2.0%*	*4.8%*	*4.1%*	*2.7%*	*0.6%*	*2.8%*	*3.7%*	*3.8%*	*5.2%*	*6.3%*	*7.3%*	*8.1%*	*8.8%*
Sub-Total EM	**10990**	**11466**	**12491**	**13321**	**13813**	**14405**	**14802**	**15379**	**15734**	**16180**	**16630**	**17109**	**17602**	**18148**	**18749**
% change y/y	*5.9%*	*4.3%*	*8.9%*	*6.6%*	*3.7%*	*4.3%*	*2.8%*	*3.9%*	*2.3%*	*2.8%*	*2.8%*	*2.9%*	*2.9%*	*3.1%*	*3.3%*
Total Global Consumption	**19607**	**19574**	**20686**	**21621**	**21926**	**22569**	**23040**	**23576**	**23978**	**24430**	**24904**	**25422**	**25968**	**26579**	**27261**
% change y/y	*2.1%*	*-0.2%*	*5.7%*	*4.5%*	*1.4%*	*2.9%*	*2.1%*	*2.3%*	*1.7%*	*1.9%*	*1.9%*	*2.1%*	*2.1%*	*2.3%*	*2.6%*
Total Global Production															
Mine Production	16037	16660	18068	18477	19194	20169	20086	20272	20743	21504	21885	22271	22150	22262	22240
% change y/y	*-0.1%*	*3.9%*	*8.5%*	*2.3%*	*3.9%*	*5.1%*	*-0.4%*	*0.9%*	*2.3%*	*3.7%*	*1.8%*	*1.8%*	*-0.5%*	*0.5%*	*-0.1%*
Refined Copper	19727	20156	20820	21757	21998	22743	23094	23449	23977	24537	25086	25527	25834	26136	26388
% change y/y	*4.1%*	*2.2%*	*3.3%*	*4.5%*	*1.1%*	*3.4%*	*1.5%*	*1.5%*	*2.3%*	*2.3%*	*2.2%*	*1.8%*	*1.2%*	*1.2%*	*1.0%*
Global Supply/Demand Balance	120	582	134	136	72	174	54	-126	-1	107	182	105	-134	-442	-873
Inventory															
Exchange (Comex, LME, SHFE)	545	589	507	307	482	539	543								
Other	2867	3405	3621	3957	3855	3972	4022								
Total	3412	3994	4128	4264	4337	4511	4565	4438	4437	4545	4727	4831	4697	4255	3382
Stock days of consumption	64	74	73	72	72	73	72	69	68	68	69	69	66	58	45
Cash Prices (annual average)															
Current Dollars ($/t)	8810	7949	7322	6862	5494	4862	6166	6550	6885	7023	7163	7306	7729	8446	9764
Current Dollars (c/lb)	400	361	332	311	249	221	280	297	312	319	325	331	351	383	443
Real 2018 Dollars ($/t)	9812	8674	7874	7261	5807	5075	6292	6550	6750	6750	6750	6750	7000	7500	8500
Real 2018 Dollars (c/lb)	445	393	357	329	263	230	285	297	306	306	306	306	318	340	386

Source: Goldman Sachs Global Investment Research, Wood Mackenzie

Copper top projects location

Exhibit 80: Map of projects analysed as part of the Copper Top Projects



Source: Company data

Copper Top Projects: Summaries

Exhibit 81: Copper Top Projects: Summary

Project	Owner 1	Country	Status	Project type	Board approved	Start date	Announced Capex (US$ mn)	GS Capex (US$ mn)	Unit capex (US$ / t) Cu	Unit capex (US$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US$ mn)	NPV @ 8% (2017+) (US$ mn)	Payback (years)	IRR	IRR (2017+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost ($/t)	Total cash cost (c/lb)	EBITDA margin
Agua Rica	Yamana Gold	Argentina	Feasibility	Greenfield	No	2023	$2,200	$2,200	**$13,750 /t**	**$10,043 /t**	$2,139	$2,139	5.32	**19.4%**	**19.4%**	**$7,854 /t**	200 ktpa	160 ktpa	$4,198 /t	190 c/lb	44%
Ajax	KGHM	Canada	Permitting	Greenfield	No	2021	$900	$1,000	**$18,868 /t**	**$12,953 /t**	$336	$370	8.36	**14.0%**	**15.3%**	**$6,249 /t**	69 ktpa	53 ktpa	$4,327 /t	196 c/lb	37%
Aktogay Phase 2	KAZ Minerals	Kazakhstan	Producing	Brownfield	Yes	2021	$1,200	$1,220	**$19,629 /t**	**$18,558 /t**	$1,148	$1,148	5.76	**16.1%**	**16.1%**	**$5,692 /t**	81 ktpa	62 ktpa	$3,649 /t	166 c/lb	59%
Andina Phase 2	Codelco	Chile	Feasibility	Brownfield	No	2024	$6,800	$7,600	**$22,157 /t**	**$20,644 /t**	$319	$319	9.44	**8.6%**	**8.6%**	**$8,796 /t**	350 ktpa	343 ktpa	$4,498 /t	204 c/lb	46%
Ann Mason	Mason Resources Corp	USA	Scoping	Greenfield	No	2023	$1,351	$1,451	**$13,191 /t**	**$12,284 /t**	$821	$821	6.74	**15.1%**	**15.1%**	**$5,702 /t**	121 ktpa	110 ktpa	$4,629 /t	210 c/lb	42%
Asmara	Sichuan R&BMIDC	Eritrea	Permitting	Greenfield	Yes	2021	$559	$609	**$26,386 /t**	**$12,337 /t**	$668	$668	6.92	**23.1%**	**23.1%**	**$6,932 /t**	28 ktpa	23 ktpa	$1,683 /t	76 c/lb	49%
Aynak	China Metallurgical Group Corp.	Afghanistan	Permitting	Greenfield	No	2024	$4,400	$4,900	**$15,313 /t**	**$15,313 /t**	-$543	-$543	9.66	**5.9%**	**5.9%**	**$12,509 /t**	320 ktpa	320 ktpa	$5,374 /t	244 c/lb	36%
Baimskaya	Baimskaya Mining Company LLC	Russia	Feasibility	Greenfield	Yes	2024	$5,500	$5,600	**$31,206 /t**	**$23,156 /t**	$2,350	$2,381	6.35	**12.4%**	**12.5%**	**$5,433 /t**	316 ktpa	179 ktpa	$2,114 /t	96 c/lb	58%
Canariaco Norte	Candente Copper Corp	Peru	Feasibility	Greenfield	No	2023	$1,565	$1,700	**$14,286 /t**	**$13,153 /t**	$1,939	$1,939	4.32	**21.1%**	**21.1%**	**$5,259 /t**	166 ktpa	119 ktpa	$3,760 /t	171 c/lb	59%
Carrapateena	OZ Minerals	Australia	Construction	Greenfield	Yes	2020	$687	$789	**$12,138 /t**	**$10,126 /t**	$1,224	$1,453	4.05	**21.3%**	**31.4%**	**$4,233 /t**	66 ktpa	65 ktpa	$3,628 /t	165 c/lb	53%
Casino	Western Copper & Gold Corp.	Canada	Permitting	Greenfield	Yes	2023	$3,345	$3,545	**$41,357 /t**	**$25,365 /t**	-$432	-$399	11.78	**6.7%**	**6.8%**	**$8,069 /t**	181 ktpa	86 ktpa	$4,836 /t	219 c/lb	33%
Centinela DMC	Antofagasta	Chile	Feasibility	Brownfield	No	2022	$2,700	$2,970	**$24,829 /t**	**$18,425 /t**	$726	$726	9.11	10.1%	10.1%	**$9,122 /t**	130 ktpa	120 ktpa	$4,065 /t	184 c/lb	43%
Cerro Casale	Barrick Gold	Chile	Permitting	Greenfield	No	2025	$6,000	$6,000	**$57,313 /t**	**$25,032 /t**	$989	$989	8.66	**10.1%**	**10.1%**	**$9,964 /t**	110 ktpa	105 ktpa	$4,438 /t	201 c/lb	66%
Chambishi	China Non-Ferrous Metals	Zambia	Construction	Greenfield	Yes	2018	$700	$750	**$13,777 /t**	**$10,479 /t**	$228	$408	8.17	**13.4%**	**21.8%**	**$6,800 /t**	59 ktpa	54 ktpa	$4,630 /t	210 c/lb	37%
Chuquicamata U/G	Codelco	Chile	Construction	Brownfield	Yes	2020	$4,000	$4,200	**$12,764 /t**	**$11,222 /t**	$4,203	$6,670	9.04	**13.2%**	**24.6%**	**$7,482 /t**	366 ktpa	329 ktpa	$4,266 /t	193 c/lb	42%
Cobre Panama	First Quantum	Panama	Construction	Greenfield	Yes	2019	$6,300	$6,350	**$20,196 /t**	**$19,164 /t**	$3,505	$8,745	8.59	**10.5%**	**38.7%**	**$8,883 /t**	334 ktpa	314 ktpa	$4,021 /t	182 c/lb	51%
Collahuasi GL4	Glencore	Chile	Pre-feasibility	Brownfield	No	2025	$4,000	$4,350	**$14,921 /t**	**$14,041 /t**	$2,888	$2,888	6.53	**15.2%**	**15.2%**	**$6,651 /t**	300 ktpa	292 ktpa	$4,742 /t	215 c/lb	45%
Cotabambas	Panoro Minerals Ltd.	Peru	Pre-feasibility	Greenfield	No	2023	$1,533	$1,633	**$24,123 /t**	**$17,347 /t**	$218	$218	9.41	**9.7%**	**9.7%**	**$8,210 /t**	72 ktpa	68 ktpa	$4,144 /t	188 c/lb	39%
Cristalino	Vale	Brazil	Pre-feasibility	Greenfield	No	2025	$1,500	$1,550	**$13,129 /t**	**$12,183 /t**	$1,686	$1,686	4.91	**17.8%**	**17.8%**	**$8,672 /t**	121 ktpa	118 ktpa	$4,285 /t	194 c/lb	51%
Cuajone	Southern Copper	Peru	Feasibility	Brownfield	No	2024	$500	$500	**$10,200 /t**	**$9,809 /t**	$1,049	$1,049	3.73	**24.9%**	**24.9%**	**$7,920 /t**	50 ktpa	49 ktpa	$4,919 /t	223 c/lb	53%
El Abra mill	Freeport	Chile	Pre-feasibility	Brownfield	No	2027	$5,074	$5,274	**$15,502 /t**	**$15,502 /t**	-$2,230	-$2,230	6.00	**-8.9%**	**-8.9%**	**$4,870 /t**	347 ktpa	340 ktpa	$7,515 /t	341 c/lb	36%
El Arco	Southern Copper	Mexico	Scoping	Greenfield	No	2026	$3,000	$3,200	**$18,955 /t**	**$16,936 /t**	$890	$890	8.05	**11.1%**	**11.1%**	**$4,870 /t**	190 ktpa	169 ktpa	$8,333 /t	378 c/lb	43%
El Pachón	Glencore	Argentina	Pre-feasibility	Greenfield	No	2026	$4,100	$4,500	**$16,243 /t**	**$15,878 /t**	$1,699	$1,699	6.70	**13.0%**	**13.0%**	**$10,029 /t**	402 ktpa	277 ktpa	$4,703 /t	213 c/lb	41%
El Pilar	Southern Copper	Mexico	Construction	Greenfield	Yes	2019	$159	$179	**$5,818 /t**	**$5,818 /t**	$409	$409	3.98	**31.6%**	**31.6%**	**$4,765 /t**	33 ktpa	31 ktpa	$4,300 /t	195 c/lb	49%
El Teniente NNM	Codelco	Chile	Construction	Brownfield	Yes	2023	$5,000	$5,100	**$12,530 /t**	**$11,904 /t**	$3,497	$4,720	7.35	**12.6%**	**17.2%**	**$7,460 /t**	434 ktpa	407 ktpa	$4,567 /t	207 c/lb	39%
Florence Copper	Taseko Mines Ltd.	USA	Construction	Greenfield	Yes	2018	$200	$220	**$6,576 /t**	**$6,576 /t**	$885	$905	6.62	**32.1%**	**38.1%**	**$4,870 /t**	39 ktpa	33 ktpa	$3,971 /t	180 c/lb	56%
Frieda River	Guangdong Rising H.K. (Holdings) Ltd.	PNG	Permitting	Greenfield	No	2027	$3,600	$3,800	**$22,782 /t**	**$17,861 /t**	$2,361	$2,361	5.01	**18.8%**	**18.8%**	**$8,499 /t**	290 ktpa	167 ktpa	$3,070 /t	139 c/lb	60%
Galeno	China Minmetals	Peru	Feasibility	Greenfield	No	2026	$2,500	$2,700	**$17,161 /t**	**$14,288 /t**	$1,252	$1,252	6.24	**15.4%**	**15.4%**	**$6,471 /t**	164 ktpa	157 ktpa	$3,876 /t	176 c/lb	50%
Galore Creek	Teck Resources	Canada	Pre-feasibility	Greenfield	No	2029	$5,160	$5,460	**$38,551 /t**	**$29,614 /t**	-$169	-$169	8.94	**7.5%**	**7.5%**	**$4,870 /t**	158 ktpa	142 ktpa	$4,299 /t	195 c/lb	0%
Grasberg BC	Freeport	Indonesia	Construction	Brownfield	Yes	2016	$6,400	$6,700	**$27,245 /t**	**$20,363 /t**	$5,817	$9,643	6.91	**13.0%**	**35.0%**	**$7,514 /t**	429 ktpa	246 ktpa	$2,346 /t	106 c/lb	68%
Grasberg DML/Z	Freeport	Indonesia	Construction	Brownfield	Yes	2015	$3,100	$3,200	**$25,562 /t**	**$18,411 /t**	$2,998	$5,346	9.68	**13.3%**	**47.7%**	**$7,180 /t**	245 ktpa	125 ktpa	$2,379 /t	108 c/lb	66%
Haquira	First Quantum	Peru	Scoping	Greenfield	No	2025	$2,058	$2,500	**$16,882 /t**	**$15,275 /t**	$1,211	$1,211	6.92	**13.9%**	**13.9%**	**$6,906 /t**	230 ktpa	148 ktpa	$4,741 /t	215 c/lb	46%
Harper Creek	Yellowhead Mining Inc.	Canada	Permitting	Greenfield	No	2025	$799	$960	**$17,878 /t**	**$16,767 /t**	$613	$613	6.27	**15.6%**	**15.6%**	**$5,329 /t**	71 ktpa	54 ktpa	$4,786 /t	217 c/lb	48%
Inca de Oro	Guangdong Rising H.K. (Holdings) Ltd.	Chile	Feasibility	Greenfield	No	2026	$800	$1,000	**$21,914 /t**	**$17,903 /t**	$220	$220	7.65	**10.9%**	**10.9%**	**$7,835 /t**	59 ktpa	46 ktpa	$4,260 /t	193 c/lb	41%
Jiama Phase II	China Gold International	China	Producing	Brownfield	Yes	2017	$716	$736	**$7,050 /t**	**$5,495 /t**	$3,945	$4,664	4.78	**28.9%**	--	**$4,380 /t**	110 ktpa	104 ktpa	$3,234 /t	147 c/lb	44%
Josemaria	NGEx Resources	Argentina	Pre-feasibility	Greenfield	No	2025	$2,000	$2,000	**$15,385 /t**	**$11,359 /t**	$318	$318	5.43	**11.3%**	**11.3%**	**$10,971 /t**	164 ktpa	130 ktpa	$4,763 /t	216 c/lb	48%
Kamoa-Kakula	Ivanhoe Mines	DRC	Pre-feasibility	Greenfield	No	2024	$2,400	$2,500	**$5,152 /t**	**$5,152 /t**	$10,370	$10,370	6.27	**28.8%**	**28.8%**	**$5,650 /t**	623 ktpa	485 ktpa	$3,989 /t	181 c/lb	62%
Kansanshi Sulphide	First Quantum	Zambia	Permitting	Brownfield	No	2021	$565	$585	**$9,429 /t**	**$8,836 /t**	$553	$553	4.88	**20.8%**	**20.8%**	**$5,689 /t**	65 ktpa	62 ktpa	$4,294 /t	195 c/lb	49%
Katanga	Glencore	DRC	Construction	Brownfield	Yes	2017	$1,096	$1,159	**$4,237 /t**	**$1,866 /t**	$17,184	$17,567	2.05	**198.0%**	--	**-$1,243 /t**	300 ktpa	274 ktpa	-$755 /t	34 c/lb	59%
Kerr-Sulphurets-Mitchell	Seabridge Gold	Canada	Pre-feasibility	Greenfield	No	2025	$5,500	$5,800	**$41,312 /t**	**$18,852 /t**	$496	$511	6.90	**9.1%**	**9.1%**	**$5,967 /t**	175 ktpa	140 ktpa	$2,497 /t	113 c/lb	57%
King King	St. Augustine Copper&Gold	Philippines	Permitting	Greenfield	No	2025	$2,042	$2,300	**$37,597 /t**	**$22,900 /t**	$683	$683	7.30	**12.0%**	**12.0%**	**$12,706 /t**	94 ktpa	61 ktpa	$3,728 /t	169 c/lb	51%
Koksay	KAZ Minerals	Kazakhstan	Pre-feasibility	Greenfield	No	2025	$1,500	$1,700	**$22,431 /t**	**$20,411 /t**	$413	$413	10.60	**11.6%**	**11.6%**	**$6,686 /t**	80 ktpa	76 ktpa	$5,193 /t	236 c/lb	44%
La Granja	Rio Tinto	Peru	Pre-feasibility	Greenfield	No	2028	$7,500	$7,500	**$18,195 /t**	**$18,195 /t**	$1,612	$1,612	10.10	**11.9%**	**11.9%**	**$7,431 /t**	501 ktpa	412 ktpa	$4,846 /t	220 c/lb	41%
Lone Star	Freeport	USA	Construction	Greenfield	Yes	2020	$850	$900	**$10,992 /t**	**$10,992 /t**	$632	$683	7.87	**12.8%**	**13.5%**	**$4,870 /t**	89 ktpa	82 ktpa	$4,906 /t	223 c/lb	34%
Los Azules	McEwen Mining	Argentina	Pre-feasibility	Greenfield	No	2025	$2,641	$2,691	**$16,054 /t**	**$14,795 /t**	$2,104	$2,104	5.29	**18.6%**	**18.6%**	**$4,870 /t**	230 ktpa	168 ktpa	$4,278 /t	194 c/lb	47%
Los Calatos	CD Capital	Peru	Scoping	Greenfield	No	2023	$655	$705	**$18,598 /t**	**$16,345 /t**	$462	$462	7.16	**14.8%**	**14.8%**	**$6,848 /t**	38 ktpa	38 ktpa	$4,095 /t	186 c/lb	50%
Los Chancas	Southern Copper	Peru	Scoping	Greenfield	No	2024	$2,800	$2,900	**$25,679 /t**	**$20,729 /t**	$543	$543	10.31	**10.0%**	**10.0%**	**$4,870 /t**	126 ktpa	113 ktpa	$4,839 /t	219 c/lb	47%
Los Helados	NGEx Resources	Chile	Pre-feasibility	Greenfield	No	2031	$1,225	$1,325	**$8,520 /t**	**$7,025 /t**	$1,727	$1,727	4.38	**16.3%**	**16.3%**	**$5,817 /t**	200 ktpa	156 ktpa	$4,911 /t	223 c/lb	48%
Los Pelambres 205	Antofagasta	Chile	Feasibility	Brownfield	No	2020	$1,800	$1,950	**$25,023 /t**	**$23,847 /t**	$27	$118	10.28	8.3%	9.1%	$8,246 /t	99 ktpa	78 ktpa	$4,281 /t	194 c/lb	48%
Mantoverde	Mantos Copper	Chile	Pre-feasibility	Brownfield	yes	2022	$800	$850	**$11,586 /t**	**$10,863 /t**	$234	$234	7.75	**11.3%**	**11.3%**	**$4,870 /t**	79 ktpa	73 ktpa	$4,880 /t	221 c/lb	33%
Metalkol	ENRC	DRC	Construction	Greenfield	Yes	2019	$833	$900	**$13,514 /t**	**$5,764 /t**	$4,884	$5,608	3.89	**30.1%**	**114.6%**	**$3,820 /t**	70 ktpa	67 ktpa	-$701 /t	-32 c/lb	76%
Michiquillay	Southern Copper	Peru	Scoping	Greenfield	No	2023	$2,500	$2,700	**$12,893 /t**	**$11,314 /t**	$569	$631	6.28	**16.0%**	**16.0%**	**$6,863 /t**	223 ktpa	209 ktpa	-$1,516 /t	-69 c/lb	0%
Mina Justa	Minsur	Peru	Feasibility	Greenfield	No	2021	$1,400	$1,500	**$19,130 /t**	**$19,130 /t**	$336	$336	6.64	**11.5%**	**11.5%**	**$7,438 /t**	110 ktpa	78 ktpa	$3,923 /t	178 c/lb	60%
Mirador	EcuaCorriente S.A	Ecuador	Construction	Greenfield	Yes	2020	$1,400	$1,500	**$19,026 /t**	**$17,139 /t**	$1,696	$2,067	6.80	**15.5%**	**20.1%**	**$10,303 /t**	81 ktpa	79 ktpa	$3,415 /t	155 c/lb	59%
Mopani	Glencore	Zambia	Construction	Brownfield	Yes	2018	$950	$1,025	**$10,807 /t**	**$10,757 /t**	$2,126	$3,161	5.04	**19.3%**	--	**$5,489 /t**	99 ktpa	95 ktpa	$3,764 /t	171 c/lb	47%
New Prosperity	Taseko Mines Limited	Canada	Pre-feasibility	Greenfield	No	2025	$814	$1,200	**$23,509 /t**	**$13,274 /t**	$995	$999	5.75	**18.5%**	**18.6%**	**$3,557 /t**	53 ktpa	51 ktpa	$3,244 /t	147 c/lb	45%
Nueva Union	Gold Corp.	Chile	Feasibility	Greenfield	No	2022	$3,500	$3,800	**$21,881 /t**	**$16,593 /t**	$3,458	$3,767	6.23	**15.9%**	**17.7%**	**$6,105 /t**	240 ktpa	174 ktpa	$3,599 /t	163 c/lb	50%
Olympic Dam BFX	BHP Billiton	Australia	Permitting	Brownfield	No	2018	$2,940	$3,040	**$18,842 /t**	**$17,499 /t**	$6,681	$6,681	6.97	**39.62%**	**39.6%**	**$2,653 /t**	177 ktpa	161 ktpa	$2,612 /t	118 c/lb	72%
Oyu Tolgoi Block Cave	Rio Tinto	Mongolia	Construction	Brownfield	Yes	2020	$5,095	$5,395	**$15,749 /t**	**$13,374 /t**	$4,073	$5,130	7.74	**13.9%**	**17.0%**	**$6,791 /t**	491 ktpa	343 ktpa	$3,891 /t	177 c/lb	52%
Pebble	Northern Dynasty	USA	Pre-feasibility	Greenfield	No	2027	$4,690	$5,800	**$19,265 /t**	**$13,089 /t**	$4,306	$4,306	9.74	**13.1%**	**13.1%**	**$4,604 /t**	350 ktpa	301 ktpa	$2,984 /t	135 c/lb	56%
Pulang	Chinalco	China	Producing	Greenfield	Yes	2017	$943	$950	**$17,988 /t**	**$16,061 /t**	$174	$1,194	9.68	**9.2%**	--	**$8,221 /t**	55 ktpa	53 ktpa	$4,550 /t	206 c/lb	37%
Pumpkin Hollow	Nevada Copper	USA	Construction	Greenfield	Yes	2020	$1,050	$1,100	**$12,197 /t**	**$10,884 /t**	$1,330	$1,596	7.28	**17.2%**	**25.0%**	**$4,938 /t**	125 ktpa	90 ktpa	$4,415 /t	200 c/lb	45%
Quebrada Blanca II	Teck Resources	Chile	Permitting	Brownfield	No	2022	$4,714	$4,900	**$18,543 /t**	**$17,314 /t**	$3,387	$3,540	7.34	**13.9%**	**14.4%**	**$7,083 /t**	320 ktpa	264 ktpa	$4,349 /t	197 c/lb	52%
Quellaveco	Anglo American	Peru	Construction	Greenfield	Yes	2023	$5,200	$5,400	**$22,258 /t**	**$20,184 /t**	$1,775	$1,901	7.82	**10.8%**	**11.0%**	**$8,750 /t**	313 ktpa	243 ktpa	$4,527 /t	205 c/lb	56%
Radomiro Tomic	Codelco	Chile	Feasibility	Brownfield	No	2024	$5,400	$5,900	**$17,201 /t**	**$16,714 /t**	$3,654	$3,654	8.14	**15.4%**	**15.4%**	**$6,553 /t**	394 ktpa	343 ktpa	$4,323 /t	196 c/lb	46%
Resolution	Rio Tinto	USA	Scoping	Greenfield	No	2027	$6,000	$6,500	**$13,040 /t**	**$12,279 /t**	$4,197	$4,309	5.35	**14.6%**	**15.0%**	**$5,500 /t**	600 ktpa	498 ktpa	$4,509 /t	205 c/lb	45%
Rosemont	Hudbay Minerals	USA	Permitting	Greenfield	No	2022	$1,921	$2,021	**$16,136 /t**	**$14,058 /t**	$685	$685	6.41	**13.4%**	**13.4%**	**$6,005 /t**	141 ktpa	125 ktpa	$4,080 /t	185 c/lb	49%
Salobo 3	Vale	Brazil	Pre-feasibility	Brownfield	No	2022	$1,000	$1,100	**$18,343 /t**	**$12,272 /t**	$1,817	$1,817	5.14	**19.5%**	**19.5%**	**$4,870 /t**	65 ktpa	60 ktpa	$2,079 /t	94 c/lb	61%
San Nicolas	Teck Resources	Mexico	Pre-feasibility	Greenfield	No	2025	$650	$750	**$14,621 /t**	**$8,641 /t**	$1,140	$1,140	3.79	**24.4%**	**24.4%**	**$4,870 /t**	54 ktpa	51 ktpa	$2,685 /t	122 c/lb	61%
Santo Domingo	Capstone Mining	Chile	Feasibility	Greenfield	Yes	2023	$1,750	$1,850	**$29,959 /t**	**$17,588 /t**	$1,610	$1,662	5.84	**17.2%**	**17.8%**	**$5,476 /t**	130 ktpa	62 ktpa	$1,251 /t	57 c/lb	81%
Schaft Creek	Teck Resources	Canada	Feasibility	Greenfield	No	2024	$3,257	$3,700	**$34,071 /t**	**$23,834 /t**	$7	$8	10.43	**8.0%**	**8.0%**	**$7,428 /t**	125 ktpa	109 ktpa	$5,252 /t	238 c/lb	44%
Sentinel	First Quantum	Zambia	Producing	Greenfield	Yes	2015	$2,000	$2,000	**$9,086 /t**	**$9,086 /t**	$5,275	$6,929	5.39	**19.7%**	--	**$5,239 /t**	255 ktpa	220 ktpa	$4,126 /t	187 c/lb	59%
Spence growth option	BHP Billiton	Chile	Construction	Brownfield	Yes	2021	$2,460	$2,510	**$14,492 /t**	**$12,933 /t**	$3,851	$3,851	5.32	**18.8%**	**18.8%**	**$5,697 /t**	197 ktpa	173 ktpa	$3,652 /t	166 c/lb	64%
Taca Taca	First Quantum	Argentina	Scoping	Greenfield	No	2025	$3,431	$3,900	**$17,192 /t**	**$15,056 /t**	$2,456	$2,456	6.84	**15.8%**	**15.8%**	**$9,437 /t**	244 ktpa	227 ktpa	$3,957 /t	179 c/lb	52%
Tampakan	Indophil Resources	Philippines	Feasibility	Greenfield	No	2025	$5,900	$6,100	**$16,920 /t**	**$14,004 /t**	$3,406	$3,406	5.81	**16.2%**	**16.2%**	**$9,007 /t**	451 ktpa	361 ktpa	$4,498 /t	204 c/lb	52%
Tenke Phase 3	China Molybdenum	DRC	Feasibility	Brownfield	No	2022	$500	$600	**$9,045 /t**	**$5,214 /t**	$1,443	$1,443	2.51	**42.8%**	**42.8%**	**$4,117 /t**	69 ktpa	66 ktpa	$2,829 /t	128 c/lb	61%
Tia Maria	Southern Copper	Peru	Permitting	Greenfield	Yes	2022	$1,400	$1,500	**$13,360 /t**	**$13,360 /t**	$1,179	$1,657	7.12	**12.6%**	**18.8%**	**$7,632 /t**	120 ktpa	112 ktpa	$4,041 /t	183 c/lb	56%
Tominsky	Russian Copper Company	Russia	Construction	Greenfield	Yes	2018	$1,183	$1,283	**$16,042 /t**	**$16,042 /t**	$2,058	$2,375	nm	**18.8%**	**27.9%**	**$4,846 /t**	105 ktpa	80 ktpa	$3,479 /t	158 c/lb	57%
Toquepala	Southern Copper	Peru	Construction	Brownfield	Yes	2018	$1,300	$1,310	**$13,091 /t**	**$12,121 /t**	$2,343	$3,318	6.00	**16.2%**	**67.2%**	**$6,325 /t**	103 ktpa	100 ktpa	$3,829 /t	174 c/lb	56%
Toromocho expansion	Chinalco	Peru	Construction	Brownfield	Yes	2020	$1,360	$1,400	**$13,512 /t**	**$11,601 /t**	$2,634	$2,738	5.94	**21.2%**	**23.5%**	**$5,130 /t**	123 ktpa	104 ktpa	$3,494 /t	158 c/lb	60%
Udokan	Baikal Mining Company	Russia	Construction	Greenfield	No	2023	$2,450	$2,695	**$21,117 /t**	**$20,029 /t**	$1,141	$1,422	8.13	**11.4%**	**12.8%**	**$6,799 /t**	130 ktpa	128 ktpa	$4,153 /t	188 c/lb	54%
Vizcachitas	Los Andes	Chile	Pre-feasibility	Greenfield	No	2025	$2,900	$3,000	**$21,387 /t**	**$19,384 /t**	-$182	-$182	11.23	**7.1%**	**7.1%**	**$4,870 /t**	173 ktpa	140 ktpa	$8,777 /t	398 c/lb	34%
Wafi Golpu	Harmony Gold	PNG	Feasibility	Greenfield	No	2025	$2,800	$3,000	**$15,744 /t**	**$12,732 /t**	$3,388	$3,388	5.98	**18.2%**	**18.2%**	**$9,171 /t**	207 ktpa	191 ktpa	$1,894 /t	86 c/lb	56%
Zafranal	Teck Resources	Peru	Pre-feasibility	Greenfield	No	2024	$1,157	$1,270	**$32,523 /t**	**$29,983 /t**	-$93	-$93	8.72	**6.9%**	**6.9%**	**$9,148 /t**	89 ktpa	39 ktpa	$4,962 /t	225 c/lb	38%
Total	-	-	-	-	-	-	$216,628	$230,910	**$17,548 /t**	**$14,614 /t**	$163,975	$190,116	14.72	**15.0%**	**19.3%**	**$7,067 /t**	15987 ktpa	13159 ktpa	$44 /t	2 c/lb	52%

Source: Company data, Wood Mackenzie, Goldman Sachs Global Investment Research

Exhibit 82: Top Projects: Copper production details to 2030E

Kt

	2016	2017	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
Agua Rica	0	0	0	0	0	0	0	76	152	200	200	200	200	200	200
Ajax	0	0	0	0	0	6	24	60	69	63	60	60	56	56	58
Aktogay Phase 2	0	0	0	0	0	33	76	81	81	81	81	60	60	60	60
Andina Phase 2	0	0	0	0	0	0	0	0	140	233	350	350	350	350	350
Ann Mason	0	0	0	0	0	0	0	60	101	121	121	121	121	121	121
Asmara	0	0	0	0	0	8	25	28	28	28	28	28	28	28	28
Aynak	0	0	0	0	0	0	0	0	39	79	158	319	319	319	319
Baimskaya	0	0	0	0	0	0	0	0	0	0	0	34	99	180	219	286
Canariaco Norte	0	0	0	0	0	0	0	79	166	166	121	121	121	121	121
Carrapateena	0	0	0	0	66	66	66	64	64	64	64	64	64	64	64
Casino	0	0	0	0	0	0	0	5	10	42	80	84	76	77	77
Centinela DMC	0	0	0	0	0	0	0	14	72	130	130	130	130	130	130
Cerro Casale	0	0	0	0	0	0	0	0	0	28	76	110	110	110	110
Chambishi	0	0	11	37	59	59	59	59	59	59	59	59	59	59	59
Chuquicamata U/G	0	0	0	0	52	104	157	209	261	313	366	366	366	366	366
Cobre Panama	0	0	0	100	250	334	334	334	334	334	334	334	334	320	320
Collahuasi GL4	0	0	0	0	0	0	0	0	0	123	259	300	300	300	300
Cotabambas	0	0	0	0	0	0	0	18	36	72	72	72	72	72	72
Cristalino	0	0	0	0	0	0	0	0	0	55	121	121	121	121	121
Cuajone	0	0	0	0	0	0	0	0	17	50	50	50	50	50	50
El Abra mill	0	0	0	0	0	0	0	0	0	0	0	36	72	145	217
El Arco	0	0	0	0	0	0	0	0	0	0	7	26	66	131	190
El Pachón	0	0	0	0	0	0	0	0	0	0	201	402	402	402	263
El Pilar	0	0	0	5	19	33	33	33	33	33	33	33	33	33	33
El Teniente NNM	0	0	0	0	0	0	0	32	190	317	434	434	434	434	434
Florence Copper	0	0	2	2	4	12	18	24	39	39	39	39	39	39	39
Frieda River	0	0	0	0	0	0	0	0	0	0	0	0	96	175	290
Galeno	0	0	0	0	0	0	0	0	0	0	82	115	164	164	164
Galore Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	10	48
Grasberg DMLZ	12	9	8	13	66	169	245	187	187	187	187	187	161	161	161
Grasberg BC	8	11	12	23	89	189	305	384	429	310	310	310	310	310	310
Haquira	0	0	0	0	0	0	0	0	0	46	138	230	149	149	149
Harper Creek	0	0	0	0	0	0	0	0	0	20	61	71	71	59	59
Inca de Oro	0	0	0	0	0	0	0	0	0	0	30	59	59	59	44
Jiama Phase II	0	29	55	86	110	110	110	110	110	110	110	110	110	110	110
Josemaria	0	0	0	0	0	0	0	0	0	13	64	129	164	150	146
Kamoa-Kakula	0	0	0	0	0	0	0	0	24	48	233	377	369	360	406
Kansanshi Sulphide	0	0	0	0	0	16	65	65	65	65	65	65	65	65	65
Katanga	0	3	150	300	300	300	300	300	300	300	300	300	300	300	300
Kerr-Sulphurets-Mit	0	0	0	0	0	0	0	0	0	9	18	45	89	134	175
King King	0	0	0	0	0	0	0	0	0	37	94	94	75	75	71
Koksay	0	0	0	0	0	0	0	0	0	11	34	80	80	80	80
La Granja	0	0	0	0	0	0	0	0	0	0	0	0	27	73	82
Lone Star	0	0	0	0	3	15	37	89	89	89	89	89	89	89	89
Los Azules	0	0	0	0	0	0	0	0	0	206	220	169	174	230	229
Los Calatos	0	0	0	0	0	0	0	23	38	38	38	38	38	38	38
Los Chancas	0	0	0	0	0	0	0	0	10	29	48	78	126	126	126
Los Helados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Los Pelambres 205	0	0	0	0	45	54	75	99	99	99	99	76	76	76	76
Mantoverde	0	0	0	0	0	0	10	49	79	79	79	79	79	79	79
Michiquillay	0	0	0	0	0	0	0	56	112	223	223	223	223	223	223
Metalkol	0	0	0	10	50	70	70	70	70	70	70	70	70	70	70
Mina Justa	0	0	0	0	0	22	59	79	110	110	110	110	110	110	110
Mirador	0	0	0	0	31	51	81	81	81	81	81	81	81	81	81
Mopani	0	0	31	67	99	99	99	99	99	99	99	99	99	99	99
Nueva Union	0	0	0	0	0	0	87	175	196	227	227	227	240	240	240
New Prosperity	0	0	0	0	0	0	0	0	0	32	53	53	53	53	53
Olympic Dam BFX	0	0	38	45	76	76	123	177	177	177	177	177	177	177	177
Oyu Tolgoi Block Ca	0	0	0	0	16	44	109	164	218	300	327	409	491	491	491
Pebble	0	0	0	0	0	0	0	0	0	0	0	17	87	140	175
Pulang	0	11	39	55	55	55	55	55	55	55	55	55	55	55	55
Pumpkin Hollow	0	0	0	0	7	9	18	45	90	125	125	125	125	125	125
Quebrada Blanca II	0	0	0	0	0	0	91	183	229	274	320	274	274	274	274
Quellaveco	0	0	0	0	0	0	0	23	69	115	184	313	313	313	313
Radomiro Tomic	0	0	0	0	0	0	0	0	0	99	148	197	296	345	394	394
Resolution	0	0	0	0	0	0	0	0	0	0	0	0	218	436	600	600
Rosemont	0	0	0	0	0	0	56	141	141	132	132	132	132	132	132
Salobo 3	0	0	0	0	0	4	16	47	51	51	51	51	56	61	65
San Nicolas	0	0	0	0	0	0	0	0	0	18	36	54	54	54	54
Santo Domingo	0	0	0	0	0	0	0	74	130	87	55	55	55	55	55
Schaft Creek	0	0	0	0	0	0	0	0	5	24	48	77	96	120	125
Sentinel	139	190	220	235	255	236	236	236	236	236	236	236	236	236	236
Spence growth optic	0	0	0	0	0	72	161	188	197	197	197	197	197	197	197
Taca Taca	0	0	0	0	0	0	0	0	0	61	153	244	237	237	237
Tampakan	0	0	0	0	0	0	0	0	0	104	261	417	451	375	375
Tia Maria	0	0	0	0	0	0	36	60	96	120	120	120	120	120	120
Tenke Phase 3	0	0	0	0	0	0	34	69	69	69	69	69	69	69	69
Tominsky	0	0	0	7	53	74	105	105	105	105	105	105	105	105	105
Toquepala	0	0	40	68	102	102	102	103	103	103	103	103	103	103	103
Toromocho expansic	0	0	0	0	18	35	70	110	123	110	110	110	110	110	110
Udokan	0	0	0	0	0	0	0	39	78	130	130	130	130	130	130
Vizcachitas	0	0	0	0	0	0	0	0	0	5	20	39	69	99	128
Wafi Golpu	0	0	0	0	0	0	0	0	0	48	97	101	154	207	207
Zafranal	0	0	0	0	0	0	0	0	7	30	59	89	89	89	63

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 83: Top Projects: Copper risked projects summary

Project	Owner 1	Country	Status	Project type	Board approved	Start date	Announced Capex (US$ mn)	GS Capex (US$ mn)	Unit capex (US$ / t) Cu	Unit capex (US$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US$ mn)	NPV @ 8% (2018+) (US$ mn)	Payback (years)	IRR	IRR (2018+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost ($/t)	Total cash cost (c/lb)
Aktogay Phase 2	KAZ Minerals	Kazakhstan	Producing	Brownfield	Yes	2021	$1,200	$1,220	**$19,629 /t**	**$18,558 /t**	$1,148	$1,148	5.76	**16.1%**	**16.1%**	**$5,692 /t**	81 ktpa	62 ktpa	$3,649 /t	166 c/lb
Asmara	Sichuan R&BMIDC	Eritrea	Permitting	Greenfield	Yes	2021	$559	$609	**$26,386 /t**	**$12,337 /t**	$668	$668	6.92	**23.1%**	**23.1%**	**$6,932 /t**	28 ktpa	23 ktpa	$1,683 /t	76 c/lb
Aynak	China Metallurgical Gro	Afghanistan	Permitting	Greenfield	No	2024	$4,400	$4,900	**$15,313 /t**	**$15,313 /t**	-$543	-$543	9.66	**5.9%**	**5.9%**	**$12,509 /t**	320 ktpa	320 ktpa	$5,374 /t	244 c/lb
Baimskaya	Baimskaya Mining Comp	Russia	Feasibility	Greenfield	Yes	2024	$5,500	$5,600	**$31,206 /t**	**$23,156 /t**	$2,350	$2,381	6.35	**12.4%**	**12.5%**	**$5,433 /t**	316 ktpa	179 ktpa	$2,114 /t	96 c/lb
Carrapateena	OZ Minerals	Australia	Construction	Greenfield	Yes	2020	$687	$789	**$12,138 /t**	**$10,126 /t**	$1,224	$1,453	4.05	**21.3%**	**31.4%**	**$4,233 /t**	66 ktpa	65 ktpa	$3,628 /t	165 c/lb
Casino	Western Copper & Gold	Canada	Permitting	Greenfield	Yes	2023	$3,345	$3,545	**$41,357 /t**	**$25,365 /t**	-$432	-$399	11.78	**6.7%**	**6.8%**	**$8,069 /t**	181 ktpa	86 ktpa	$4,836 /t	219 c/lb
Chambishi	China Non-Ferrous Met	Zambia	Construction	Greenfield	Yes	2018	$700	$750	**$13,777 /t**	**$10,479 /t**	$228	$408	8.17	**13.4%**	**21.8%**	**$6,800 /t**	59 ktpa	54 ktpa	$4,630 /t	210 c/lb
Chuquicamata U/G	Codelco	Chile	Construction	Brownfield	Yes	2020	$4,000	$4,200	**$12,764 /t**	**$11,222 /t**	$4,203	$6,670	9.04	**13.2%**	**24.6%**	**$7,482 /t**	366 ktpa	329 ktpa	$4,266 /t	193 c/lb
Cobre Panama	First Quantum	Panama	Construction	Greenfield	Yes	2019	$6,300	$6,350	**$20,196 /t**	**$19,164 /t**	$3,505	$8,745	8.59	**10.5%**	**38.7%**	**$8,883 /t**	334 ktpa	314 ktpa	$4,021 /t	182 c/lb
El Pilar	Southern Copper	Mexico	Construction	Greenfield	Yes	2019	$159	$179	**$5,818 /t**	**$5,818 /t**	$409	$409	3.98	**31.6%**	**31.6%**	**$4,765 /t**	33 ktpa	31 ktpa	$4,300 /t	195 c/lb
El Teniente NNM	Codelco	Chile	Construction	Brownfield	Yes	2023	$5,000	$5,100	**$12,530 /t**	**$11,904 /t**	$3,497	$4,720	7.35	**12.6%**	**17.2%**	**$7,460 /t**	434 ktpa	407 ktpa	$4,567 /t	207 c/lb
Florence Copper	Taseko Mines Ltd.	USA	Construction	Greenfield	Yes	2018	$200	$220	**$6,576 /t**	**$6,576 /t**	$885	$905	6.62	**32.1%**	**38.1%**	**$4,870 /t**	39 ktpa	33 ktpa	$3,971 /t	180 c/lb
Grasberg BC	Freeport	Indonesia	Construction	Brownfield	Yes	2016	$6,400	$6,700	**$27,245 /t**	**$20,363 /t**	$5,817	$9,643	6.91	**13.0%**	**35.0%**	**$7,514 /t**	429 ktpa	246 ktpa	$2,346 /t	106 c/lb
Grasberg DMLZ	Freeport	Indonesia	Construction	Brownfield	Yes	2015	$3,100	$3,200	**$25,562 /t**	**$18,411 /t**	$2,998	$5,346	9.68	**13.3%**	**47.7%**	**$7,180 /t**	245 ktpa	125 ktpa	$2,379 /t	108 c/lb
Jiama Phase II	China Gold Internationa	China	Producing	Brownfield	Yes	2017	$716	$736	**$7,050 /t**	**$5,495 /t**	$3,945	$4,664	4.78	**28.9%**	--	**$4,380 /t**	110 ktpa	104 ktpa	$3,234 /t	147 c/lb
Katanga	Glencore	DRC	Construction	Brownfield	Yes	2017	$1,096	$1,159	**$4,237 /t**	**$1,866 /t**	$17,184	$17,567	2.05	**198.0%**	--	**-$1,243 /t**	300 ktpa	274 ktpa	$755 /t	34 c/lb
Lone Star	Freeport	USA	Construction	Greenfield	Yes	2020	$850	$900	**$10,992 /t**	**$10,992 /t**	$632	$683	7.87	**12.8%**	**13.5%**	**$4,870 /t**	89 ktpa	82 ktpa	$4,906 /t	223 c/lb
Mantoverde	Mantos Copper	Chile	Pre-feasibilit	Brownfield	yes	2022	$800	$850	**$11,586 /t**	**$10,863 /t**	$234	$234	7.75	**11.3%**	**11.3%**	**$4,870 /t**	79 ktpa	73 ktpa	$4,880 /t	221 c/lb
Metalkol	ENRC	DRC	Construction	Greenfield	Yes	2019	$833	$900	**$13,514 /t**	**$5,764 /t**	$4,884	$5,608	3.89	**30.1%**	**114.6%**	**$3,820 /t**	70 ktpa	67 ktpa	$701 /t	32 c/lb
Mirador	EcuaCorriente S.A	Ecuador	Construction	Greenfield	Yes	2020	$1,400	$1,500	**$19,026 /t**	**$17,139 /t**	$1,696	$2,067	6.80	**15.5%**	**20.1%**	**$10,303 /t**	81 ktpa	79 ktpa	$3,415 /t	155 c/lb
Mopani	Glencore	Zambia	Construction	Brownfield	Yes	2018	$950	$1,025	**$10,807 /t**	**$10,757 /t**	$2,126	$3,161	5.04	**19.3%**	--	**$5,489 /t**	99 ktpa	95 ktpa	$3,764 /t	171 c/lb
Olympic Dam BFX	BHP Billiton	Australia	Permitting	Brownfield	No	2018	$2,940	$3,040	**$18,842 /t**	**$17,499 /t**	$6,681	$6,681	6.97	**40%**	**39.6%**	**$2,653 /t**	177 ktpa	161 ktpa	$2,612 /t	118 c/lb
Oyu Tolgoi Block Cav	Rio Tinto	Mongolia	Construction	Brownfield	Yes	2020	$5,095	$5,395	**$15,749 /t**	**$13,374 /t**	$4,073	$5,130	7.74	**13.9%**	**17.0%**	**$6,791 /t**	491 ktpa	343 ktpa	$3,891 /t	177 c/lb
Pulang	Chinalco	China	Producing	Greenfield	Yes	2017	$943	$950	**$17,988 /t**	**$16,061 /t**	$174	$1,194	9.68	**9.2%**	--	**$8,221 /t**	55 ktpa	53 ktpa	$4,550 /t	206 c/lb
Pumpkin Hollow	Nevada Copper	USA	Construction	Greenfield	Yes	2020	$1,050	$1,100	**$12,197 /t**	**$10,884 /t**	$1,330	$1,596	7.28	**17.2%**	**25.0%**	**$4,938 /t**	125 ktpa	90 ktpa	$4,415 /t	200 c/lb
Quellaveco	Anglo American	Peru	Construction	Greenfield	Yes	2023	$5,200	$5,400	**$22,258 /t**	**$20,184 /t**	$1,775	$1,901	7.82	**10.8%**	**11.0%**	**$8,750 /t**	313 ktpa	243 ktpa	$4,527 /t	205 c/lb
Santo Domingo	Capstone Mining	Chile	Feasibility	Greenfield	Yes	2023	$1,750	$1,850	**$29,959 /t**	**$17,588 /t**	$1,610	$1,662	5.84	**17.2%**	**17.8%**	**$5,476 /t**	130 ktpa	62 ktpa	$1,251 /t	57 c/lb
Sentinel	First Quantum	Zambia	Producing	Greenfield	Yes	2015	$2,000	$2,000	**$9,086 /t**	**$9,086 /t**	$5,275	$6,929	5.39	**19.7%**	--	**$5,239 /t**	255 ktpa	220 ktpa	$4,126 /t	187 c/lb
Spence growth option	BHP Billiton	Chile	Construction	Brownfield	Yes	2021	$2,460	$2,510	**$14,492 /t**	**$12,933 /t**	$3,851	$3,851	5.32	**18.8%**	**18.8%**	**$5,697 /t**	197 ktpa	173 ktpa	$3,652 /t	166 c/lb
Tia Maria	Southern Copper	Peru	Permitting	Greenfield	Yes	2022	$1,400	$1,500	**$13,360 /t**	**$13,360 /t**	$1,179	$1,657	7.12	**12.6%**	**18.8%**	**$7,632 /t**	120 ktpa	112 ktpa	$4,041 /t	183 c/lb
Tominsky	Russian Copper Compan	Russia	Construction	Greenfield	Yes	2018	$1,183	$1,283	**$16,042 /t**	**$16,042 /t**	$2,058	$2,375	nm	**18.8%**	**27.9%**	**$4,846 /t**	105 ktpa	80 ktpa	$3,479 /t	158 c/lb
Toquepala	Southern Copper	Peru	Construction	Brownfield	Yes	2018	$1,300	$1,310	**$13,091 /t**	**$12,121 /t**	$2,343	$3,318	6.00	**16.2%**	**67.2%**	**$6,325 /t**	103 ktpa	100 ktpa	$3,829 /t	174 c/lb
Toromocho expansion	Chinalco	Peru	Construction	Brownfield	Yes	2020	$1,360	$1,400	**$13,512 /t**	**$11,601 /t**	$2,634	$2,738	5.94	**21.2%**	**23.5%**	**$5,130 /t**	123 ktpa	104 ktpa	$3,494 /t	158 c/lb
Total - Risked	-	-	-	-	-	-	$67,536	$70,230	**$16,301 /t**	**$13,071 /t**	$84,693	$109,833	7.99	**16.3%**	**32.7%**	**$6,799 /t**	5,455 ktpa	4,308 ktpa	$510 /t	23 c/lb

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 84: Top Projects: Copper unapproved projects production details to 2030E

Project	Owner 1	Country	Status	Project type	Board approved	Start date	Announced Capex (US$ mn)	GS Capex (US$ mn)	Unit capex (US$ / t) Cu	Unit capex (US$ / t) Cu equ.	NPV @ 8% (incl. sunk) (US$ mn)	NPV @ 8% (2018+) (US$ mn)	Payback (years)	IRR	IRR (2018+)	Cu price required @ risked-IRR	Peak Cu output	LOM avg Cu output	Total cash cost ($/t)	Total cash cost (c/lb)	EBITDA margin
Ajax	KGHM	Canada	Permitting	Greenfield	No	2021	$900	$1,000	$18,868 /t	$12,953 /t	$336	$370	8.36	14.0%	15.3%	$6,249 /t	69 ktpa	53 ktpa	$4,327 /t	196 c/lb	35%
Agua Rica	Yamana Gold	Argentina	Feasibility	Greenfield	No	2023	$2,200	$2,200	$13,750 /t	$10,043 /t	$2,139	$2,139	5.32	19.4%	19.4%	$7,854 /t	200 ktpa	160 ktpa	$4,198 /t	190 c/lb	44%
Andina Phase 2	Codelco	Chile	Feasibility	Brownfield	No	2024	$6,800	$7,600	$22,157 /t	$20,644 /t	$319	$319	9.44	8.6%	8.6%	$8,796 /t	350 ktpa	343 ktpa	$4,498 /t	204 c/lb	46%
Ann Mason	Mason Resources Corp	USA	Scoping	Greenfield	No	2023	$1,351	$1,451	$13,191 /t	$12,284 /t	$821	$821	6.74	15.1%	15.1%	$5,702 /t	121 ktpa	110 ktpa	$4,629 /t	210 c/lb	42%
Aynak	China Metallurgical Group Corp.	Afghanistan	Permitting	Greenfield	No	2024	$4,400	$4,900	$15,313 /t	$15,313 /t	-$543	-$543	9.66	5.9%	5.9%	$12,509 /t	320 ktpa	320 ktpa	$5,374 /t	244 c/lb	36%
Canariaco Norte	Candente Copper Corp	Peru	Feasibility	Greenfield	No	2023	$1,565	$1,700	$14,286 /t	$13,153 /t	$1,939	$1,939	4.32	21.1%	21.1%	$5,259 /t	166 ktpa	119 ktpa	$3,760 /t	171 c/lb	58%
Centinela DMC	Antofagasta	Chile	Feasibility	Brownfield	No	2022	$2,700	$2,970	$24,829 /t	$18,425 /t	$726	$726	9.11	10.1%	10.1%	$9,122 /t	130 ktpa	120 ktpa	$4,065 /t	184 c/lb	43%
Cerro Casale	Barrick Gold	Chile	Permitting	Greenfield	No	2025	$6,000	$6,000	$57,313 /t	$25,032 /t	$989	$989	8.66	10.1%	10.1%	$9,964 /t	110 ktpa	105 ktpa	$4,438 /t	201 c/lb	66%
Collahuasi GL4	Glencore	Chile	Pre-feasibility	Brownfield	No	2025	$4,000	$4,350	$14,921 /t	$14,041 /t	$2,888	$2,888	6.53	15.2%	15.2%	$6,651 /t	300 ktpa	292 ktpa	$4,742 /t	215 c/lb	45%
Cotabambas	Panoro Minerals Ltd.	Peru	Pre-feasibility	Greenfield	No	2023	$1,533	$1,633	$24,123 /t	$17,347 /t	$218	$218	9.41	9.7%	9.7%	$8,210 /t	72 ktpa	68 ktpa	$4,144 /t	188 c/lb	39%
Cristalino	Vale	Brazil	Pre-feasibility	Greenfield	No	2025	$1,500	$1,550	$13,129 /t	$12,183 /t	$1,686	$1,686	4.91	17.8%	17.8%	$8,672 /t	121 ktpa	118 ktpa	$4,285 /t	194 c/lb	51%
Cuajone	Southern Copper	Peru	Feasibility	Brownfield	No	2024	$500	$500	$10,200 /t	$9,809 /t	$1,049	$1,049	3.73	24.9%	24.9%	$7,920 /t	50 ktpa	49 ktpa	$4,919 /t	223 c/lb	53%
El Abra mill	Freeport	Chile	Pre-feasibility	Brownfield	No	2027	$5,074	$5,274	$15,502 /t	$15,502 /t	-$2,230	-$2,230	6.00	-8.9%	-8.9%	$4,870 /t	347 ktpa	340 ktpa	$7,515 /t	341 c/lb	0%
El Arco	Southern Copper	Mexico	Scoping	Greenfield	No	2026	$3,000	$3,200	$18,955 /t	$16,936 /t	$890	$890	8.05	11.1%	11.1%	$4,870 /t	190 ktpa	169 ktpa	$8,333 /t	378 c/lb	0%
El Pachón	Glencore	Argentina	Pre-feasibility	Greenfield	No	2026	$4,100	$4,500	$16,243 /t	$15,878 /t	$1,699	$1,699	6.70	13.0%	13.0%	$10,029 /t	402 ktpa	277 ktpa	$4,703 /t	213 c/lb	0%
Frieda River	Guangdong Rising H.K. (Holdings)	PNG	Permitting	Greenfield	No	2027	$3,600	$3,800	$22,782 /t	$17,861 /t	$2,361	$2,361	5.01	18.8%	18.8%	$8,499 /t	290 ktpa	167 ktpa	$3,070 /t	139 c/lb	0%
Galore Creek	Teck Resources	Canada	Pre-feasibility	Greenfield	No	2029	$5,160	$5,460	$38,551 /t	$29,614 /t	-$169	-$169	8.94	7.5%	7.5%	$4,870 /t	158 ktpa	142 ktpa	$4,299 /t	195 c/lb	0%
Galeno	China Minmetals	Peru	Feasibility	Greenfield	No	2026	$2,500	$2,700	$17,161 /t	$14,288 /t	$1,252	$1,252	6.24	15.4%	15.4%	$6,471 /t	164 ktpa	157 ktpa	$3,876 /t	176 c/lb	0%
Haquira	First Quantum	Peru	Scoping	Greenfield	No	2025	$2,058	$2,500	$16,882 /t	$15,275 /t	$1,211	$1,211	6.92	13.9%	13.9%	$6,906 /t	230 ktpa	148 ktpa	$4,741 /t	215 c/lb	46%
Harper Creek	Yellowhead Mining Inc.	Canada	Permitting	Greenfield	No	2025	$799	$960	$17,878 /t	$16,767 /t	$613	$613	6.27	15.6%	15.6%	$5,329 /t	71 ktpa	54 ktpa	$4,786 /t	217 c/lb	48%
Inca de Oro	Guangdong Rising H.K. (Holdings)	Chile	Feasibility	Greenfield	No	2026	$800	$1,000	$21,914 /t	$17,903 /t	$220	$220	7.65	10.9%	10.9%	$7,835 /t	59 ktpa	46 ktpa	$4,260 /t	193 c/lb	0%
Josemaria	NGEx Resources	Argentina	Pre-feasibility	Greenfield	No	2025	$2,000	$2,000	$15,385 /t	$11,359 /t	$318	$318	5.43	11.3%	11.3%	$10,971 /t	164 ktpa	130 ktpa	$4,763 /t	216 c/lb	46%
Kamoa-Kakula	Ivanhoe Mines	DRC	Pre-feasibility	Greenfield	No	2024	$2,400	$2,500	$5,152 /t	$5,152 /t	$10,370	$10,370	6.27	28.8%	28.8%	$5,650 /t	623 ktpa	485 ktpa	$3,989 /t	181 c/lb	62%
Kansanshi Sulphide	First Quantum	Zambia	Permitting	Brownfield	No	2021	$565	$585	$9,429 /t	$8,836 /t	$553	$553	4.88	20.8%	20.8%	$5,689 /t	65 ktpa	62 ktpa	$4,294 /t	195 c/lb	49%
Kerr-Sulphurets-Mitch	Seabridge Gold	Canada	Pre-feasibility	Greenfield	No	2025	$5,500	$5,800	$41,312 /t	$18,852 /t	$496	$511	6.90	9.1%	9.1%	$5,967 /t	175 ktpa	140 ktpa	$2,497 /t	113 c/lb	57%
King King	St. Augustine Copper&Gold	Philippines	Permitting	Greenfield	No	2025	$2,042	$2,300	$37,597 /t	$22,900 /t	$683	$683	7.30	12.0%	12.0%	$12,706 /t	94 ktpa	61 ktpa	$3,728 /t	169 c/lb	51%
Koksay	KAZ Minerals	Kazakhstan	Pre-feasibility	Greenfield	No	2025	$1,500	$1,700	$22,431 /t	$20,411 /t	$413	$413	10.60	11.6%	11.6%	$6,686 /t	80 ktpa	76 ktpa	$5,193 /t	236 c/lb	44%
La Granja	Rio Tinto	Peru	Pre-feasibility	Greenfield	No	2028	$7,500	$7,500	$18,195 /t	$18,195 /t	$1,612	$1,612	10.10	11.9%	11.9%	$7,431 /t	501 ktpa	412 ktpa	$4,846 /t	220 c/lb	0%
Los Azules	McEwen Mining	Argentina	Pre-feasibility	Greenfield	No	2025	$2,641	$2,691	$16,054 /t	$14,795 /t	$2,104	$2,104	5.29	18.6%	18.6%	$4,870 /t	230 ktpa	168 ktpa	$4,278 /t	194 c/lb	46%
Los Calatos	CD Capital	Peru	Scoping	Greenfield	No	2023	$655	$705	$18,598 /t	$16,345 /t	$462	$462	7.16	14.8%	14.8%	$6,848 /t	38 ktpa	38 ktpa	$4,095 /t	186 c/lb	50%
Los Chancas	Southern Copper	Peru	Scoping	Greenfield	No	2024	$2,800	$2,900	$25,679 /t	$20,729 /t	$543	$543	10.31	10.0%	10.0%	$4,870 /t	126 ktpa	113 ktpa	$4,839 /t	219 c/lb	47%
Los Helados	NGEx Resources	Chile	Pre-feasibility	Greenfield	No	2031	$1,225	$1,325	$8,520 /t	$7,025 /t	$1,727	$1,727	4.38	16.3%	16.3%	$5,817 /t	200 ktpa	156 ktpa	$4,911 /t	223 c/lb	0%
Los Pelambres 205	Antofagasta	Chile	Feasibility	Brownfield	No	2020	$1,800	$1,950	$25,023 /t	$23,847 /t	$27	$118	10.28	8.3%	9.1%	$8,246 /t	99 ktpa	78 ktpa	$4,281 /t	194 c/lb	47%
Michiquillay	Southern Copper	Peru	Scoping	Greenfield	No	2023	$2,500	$2,700	$12,893 /t	$11,314 /t	$569	$631	6.28	16.0%	16.0%	$6,863 /t	223 ktpa	209 ktpa	$1,516 /t	69 c/lb	43%
Mina Justa	Minsur	Peru	Feasibility	Greenfield	No	2021	$1,400	$1,500	$19,130 /t	$19,130 /t	$336	$336	6.64	11.5%	11.5%	$7,438 /t	110 ktpa	78 ktpa	$3,923 /t	178 c/lb	60%
Nueva Union	Gold Corp.	Chile	Feasibility	Greenfield	No	2022	$3,500	$3,800	$21,881 /t	$16,593 /t	$3,458	$3,767	6.23	15.9%	17.7%	$6,105 /t	240 ktpa	174 ktpa	$3,599 /t	163 c/lb	51%
New Prosperity	Taseko Mines Limited	Canada	Pre-feasibility	Greenfield	No	2025	$814	$1,200	$23,509 /t	$13,274 /t	$995	$999	5.75	18.5%	18.6%	$3,557 /t	53 ktpa	51 ktpa	$3,244 /t	147 c/lb	45%
Pebble	Northern Dynasty	USA	Pre-feasibility	Greenfield	No	2027	$4,690	$5,800	$19,265 /t	$13,089 /t	$4,306	$4,306	9.74	13.1%	13.1%	$4,604 /t	350 ktpa	301 ktpa	$2,984 /t	135 c/lb	0%
Quebrada Blanca II	Teck Resources	Chile	Permitting	Brownfield	No	2022	$4,714	$4,900	$18,543 /t	$17,314 /t	$3,387	$3,540	7.34	13.9%	14.4%	$7,083 /t	320 ktpa	264 ktpa	$4,349 /t	197 c/lb	51%
Radomiro Tomic	Codelco	Chile	Feasibility	Brownfield	No	2024	$5,400	$5,900	$17,201 /t	$16,714 /t	$3,654	$3,654	8.14	15.4%	15.4%	$6,553 /t	394 ktpa	343 ktpa	$4,323 /t	196 c/lb	46%
Resolution	Rio Tinto	USA	Scoping	Greenfield	No	2027	$6,000	$6,500	$13,040 /t	$12,279 /t	$4,197	$4,309	5.35	14.6%	15.0%	$5,500 /t	600 ktpa	498 ktpa	$4,509 /t	205 c/lb	45%
Rosemont	Hudbay Minerals	USA	Permitting	Greenfield	No	2022	$1,921	$2,021	$16,136 /t	$14,058 /t	$685	$685	6.41	13.4%	13.4%	$6,005 /t	141 ktpa	125 ktpa	$4,080 /t	185 c/lb	49%
Salobo 3	Vale	Brazil	Pre-feasibility	Brownfield	No	2022	$1,000	$1,100	$18,343 /t	$12,272 /t	$1,817	$1,817	5.14	19.5%	19.5%	$4,870 /t	65 ktpa	60 ktpa	$2,079 /t	94 c/lb	63%
San Nicolas	Teck Resources	Mexico	Pre-feasibility	Greenfield	No	2025	$650	$750	$14,621 /t	$8,641 /t	$1,140	$1,140	3.79	24.4%	24.4%	$4,870 /t	54 ktpa	51 ktpa	$2,685 /t	122 c/lb	61%
Schaft Creek	Teck Resources	Canada	Feasibility	Greenfield	No	2024	$3,257	$3,700	$34,071 /t	$23,834 /t	$7	$8	10.43	8.0%	8.0%	$7,428 /t	125 ktpa	109 ktpa	$5,252 /t	238 c/lb	44%
Taca Taca	First Quantum	Argentina	Scoping	Greenfield	No	2025	$3,431	$3,900	$17,192 /t	$15,056 /t	$2,456	$2,456	6.84	15.8%	15.8%	$9,437 /t	244 ktpa	227 ktpa	$3,957 /t	179 c/lb	59%
Tampakan	Indophil Resources	Philippines	Feasibility	Greenfield	No	2025	$5,900	$6,100	$16,920 /t	$14,004 /t	$3,406	$3,406	5.81	16.2%	16.2%	$9,007 /t	451 ktpa	361 ktpa	$4,498 /t	204 c/lb	52%
Tenke Phase 3	China Molybdenum	DRC	Feasibility	Brownfield	No	2022	$500	$600	$9,045 /t	$5,214 /t	$1,443	$1,443	2.51	42.8%	42.8%	$4,117 /t	69 ktpa	66 ktpa	$2,829 /t	128 c/lb	61%
Udokan	Baikal Mining Company	Russia	Construction	Greenfield	No	2023	$2,450	$2,695	$21,117 /t	$20,029 /t	$1,141	$1,422	8.13	11.4%	12.8%	$6,799 /t	130 ktpa	128 ktpa	$4,153 /t	188 c/lb	54%
Wafi Golpu	Harmony Gold	PNG	Feasibility	Greenfield	No	2025	$2,800	$3,000	$15,744 /t	$12,732 /t	$3,388	$3,388	5.98	18.2%	18.2%	$9,171 /t	207 ktpa	191 ktpa	$1,894 /t	86 c/lb	56%
Zafranal	Teck Resources	Peru	Pre-feasibility	Greenfield	No	2024	$1,157	$1,270	$32,523 /t	$29,983 /t	-$93	-$93	8.72	6.9%	6.9%	$9,148 /t	89 ktpa	39 ktpa	$4,962 /t	225 c/lb	38%
Total - Unapproved	-	-	-	-	-	-	$149,092	$160,680	$18,155 /t	$15,409 /t	$79,282	$80,283	6.04	13.8%	13.9%	$7,307 /t	10,532 ktpa	8,851 ktpa	$97 /t	4 c/lb	50%

Source: Company data, Goldman Sachs Global Investment Research

Modeling each project – how we do it?

Below is a summary of how we model each project:

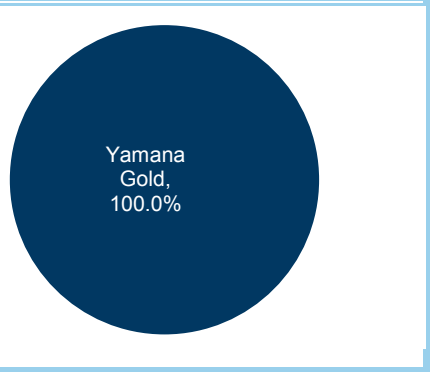
- We model the production profile of each project using the most recent information available. Where applicable, we include specific company guidance on production profiles and otherwise model output according to average LOM production information. Unless otherwise indicated by company guidance, we use reserve/resource details to determine the total mine life of each project.
- Based on disclosed grades, we include all by-product production to compute the Cu equivalent price requirements.
- Revenues of each project are determined using our GS commodities pricing assumptions for 2017-2020E, and we add 3% of price inflation for each year thereafter.
- Computing costs, we assume cost deflation of 1% over the next four years and inflation of c.3% thereafter. Unless otherwise specified by companies, we use a 50% split between costs in local currency and USD. Where applicable, we apply our GS forecasts for currencies over 2017-2020E – alternatively rates are set at spot.
- We add estimates for project D&A as well as royalties & taxes depending on the overall life of mine and jurisdiction of each project.
- We follow company guidance on initial capex assumptions and escalate growth capex estimates based on our assumptions. In term of sustaining capex, we model this as a percentage of revenue across all projects (we adjust this percentage where company guidance is available and the overall level of sustaining capex is significantly different from our assumption).
- To discount the cash flows computed, we apply a discount rate of across all projects; note that NPV 2017+ numbers exclude any cash flows incurred before 2017.
- Finally, to compute the required copper price for each project we set a required IRR based on the jurisdiction of each project.

Top Projects: Copper summaries

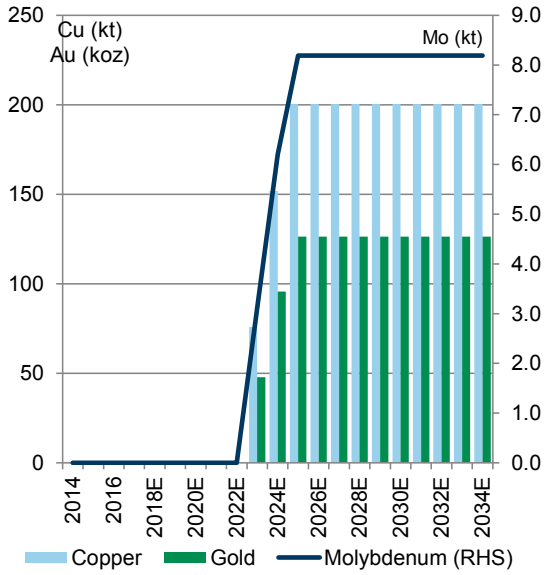
Exhibit 85: Agua Rica

Agua Rica	Argentina	160 ktpa	US$2,200 mn	19% IRR

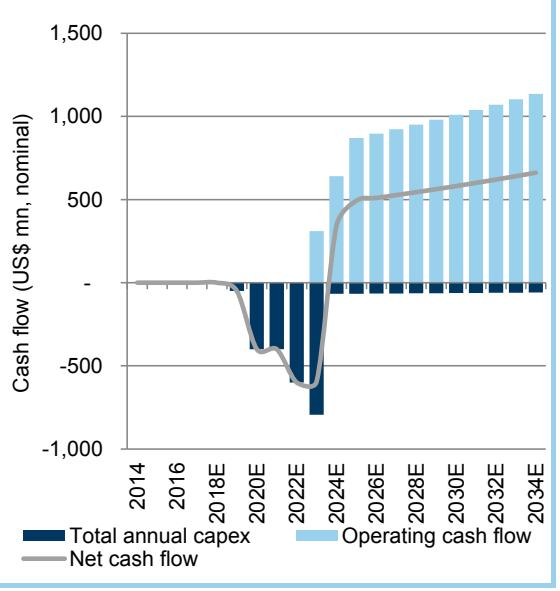
The Agua Rica project is located approximately 35 km from the Alumbrera mine in Argentina. The project is owned by Yamana Gold and is currently in the feasibility stage. The company is currently in the process of evaluating 2 options: a) a large-scale open pit scenario which contemplates integration with the neighbouring Alumbera mines (Yamana owns a 12.5% stake in the company). Under this scenario, the projected mine life could be 22 years with annual production levels of 200Kt of copper, 109Koz of gold, 1.6Moz of silver and 6Kt of Molybdenum; 2) The smaller stand alone scenario includes an open pit mine and underground mine and a combined open pit and underground mine. The underground scenario employs the application of sub-level caving. The projected mine life is 28 years with the annual production being 67Kt of copper, 43Koz of gold, 2Kt of Molybdenum and 363koz of silver. The feasibility study completed in 2016 for the open pit scenario and as such this scenario is technically advanced and development ready. Technical studies continue to advance the lower throughput standalone scenarios towards completion of a preliminary economic assessment later this year (2018) and a pre-feasibility study in 2019. Yamana continues to evaluate the alternative options and we currently model scenario 1 as our base case with slight capex escalations and commissioning in 2023.



Production profile



Cash flow chart



Economics summary

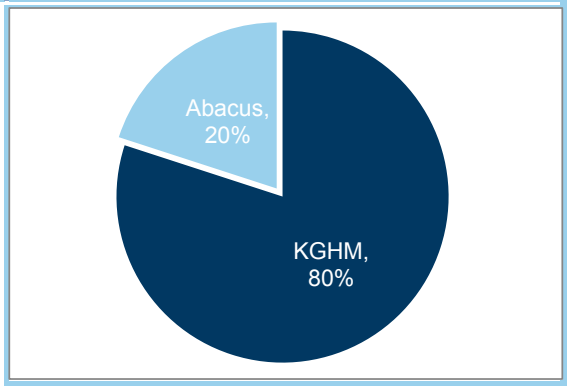
Internal rate of return	19%
NPV (including sunk costs)	US$2,139
NPV (2018+)	US$2,139
Cu required @ 25%	US$7,854 /t
Capex	US$2,200 mn
Capex / t Cu production	US$13,750
Capex / t Cu equ. production	US$10,043
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	909 mt
Copper grade	0.49% Cu
Contained copper	4,454 kt
Commissioning	2023
Peak copper production	200 ktpa
Average LOM production	160 ktpa
Life of mine	22
Gross unit cost	US$4,405 /t
Net unit cost (C1)	US$2,667 /t

Source: Company data, Goldman Sachs Global Investment Research

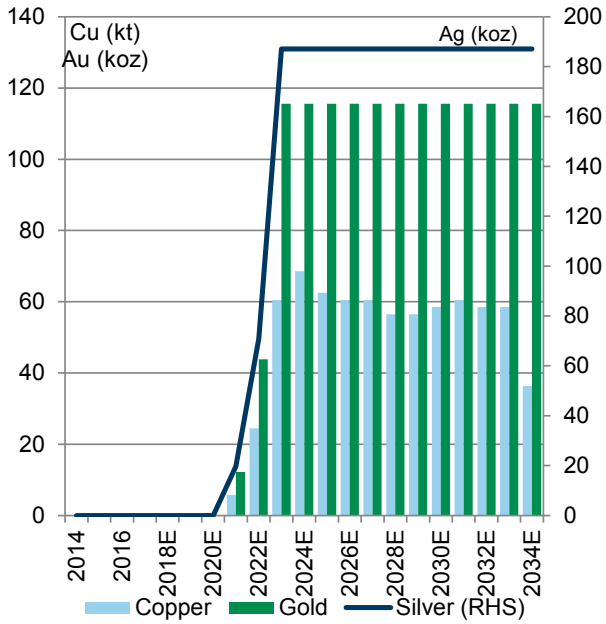
Exhibit 86: Ajax

Ajax	Canada	53 ktpa	US$1,000 mn	14% IRR

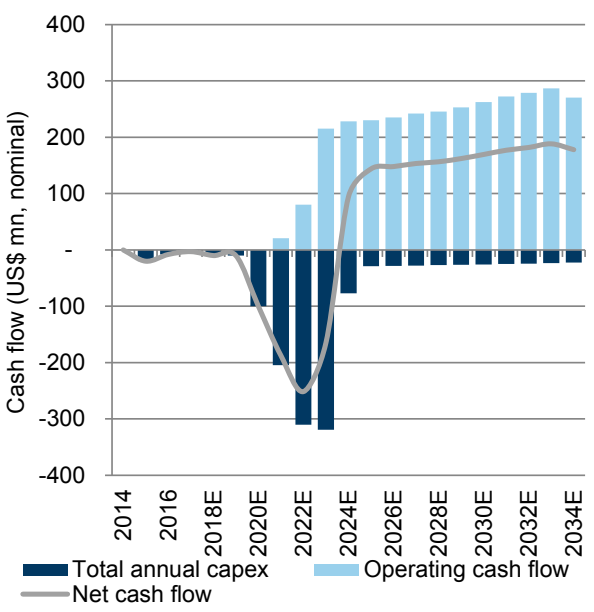
The Ajax project is an open-pit copper-gold mine located in British Columbia, Canada. It is a JV between KGHM (80% stake) and Abacus Mining (20% stake). The mine is expected to have a LOM of 18 years with average production of 53 ktpa of copper in concentrate and 125 koz of gold with total guided capex of US$1.3 bn (we adjust for inflation). The project is currently in the permitting phase. In December 2017, the Ministers of Environment and of Energy, Mines and Petroleum Resources of BC decided against the granting of an environmental assessment certificate for the Ajax project. In their opinion the project would have significant adverse effects and forwarded the project to the Canadian Ministry of Fisheries, Oceans and the Ministry of Natural Resources. In June 2018 the Canadian government rejected the proposed Ajax mine following the earlier decision by British Columbia to withhold the environmental certificate. The respective ministries will review the matter, while the federal government (comprised of various federal ministries) will make the final decision as to whether the project's adverse effects are sufficiently justified to allow the project to go ahead despite the negative impact. We expect construction of the mine to start in 2020 with first production no earlier than 2024.



Production profile



Cash flow chart



Economics summary

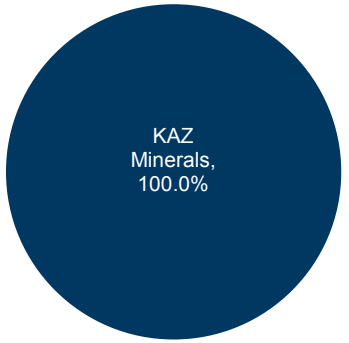
Internal rate of return	14%
NPV (including sunk costs)	US$336
NPV (2018+)	US$370
Cu required @ 10%	US$6,249 /t
Capex	US$1,000 mn
Capex / t Cu production	US$18,868
Capex / t Cu equ. production	US$12,953
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	426 mt
Copper grade	0.29% Cu
Contained copper	1,235 kt
Commissioning	2021
Peak copper production	69 ktpa
Average LOM production	53 ktpa
Life of mine	18
Gross unit cost	US$5,495 /t
Net unit cost (C1)	US$3,206 /t

Source: Company data, Goldman Sachs Global Investment Research

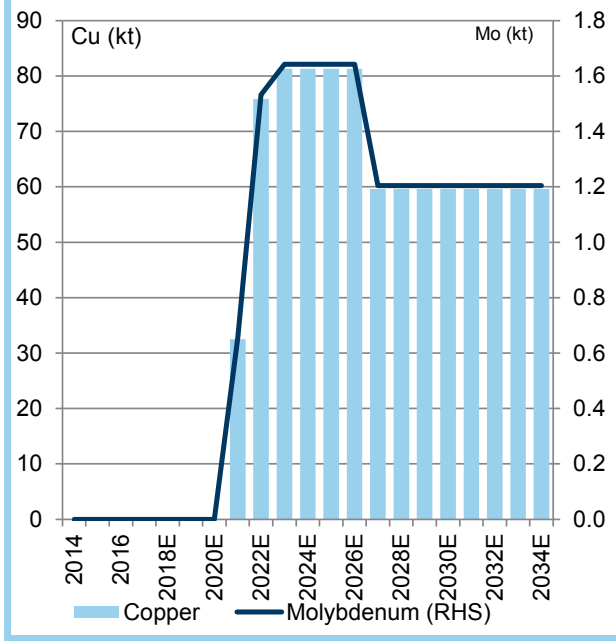
Exhibit 87: Aktogay Phase 2

Aktogay Phase 2	Kazakhstan	62 ktpa	US$1,220 mn	16% IRR

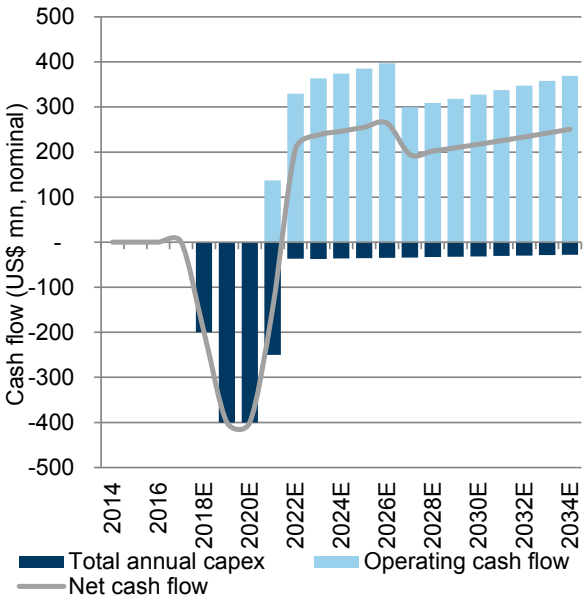
The Aktogay mine is located in eastern Kazakhstan and is solely owned by KAZ Minerals. With the mine having reached approximately the steady state production of c.100kt, the company announced in Dec. 2017 to go ahead with the US$1.2bn expansion of the project. Key details: a) Second concentrator will double the current sulphide ore processing capacity from 25 to 50mtpa; b) Of the US$1.2bn capex, US$200mn will be spent in 2018 with the remaining being spent in 2019/20; c) The new concentrator starts to ramp up in 2H21; d) Copper production from sulphide ore at Aktogay will increase by 80Kt to c. 170Ktpa from 2022-27 - supported by higher grades. However, the increase will fall to 60Kt post 2027 as grades come down; e) The net cash cost guidance to 2027 following the expansion is unchanged at 100-120 USc/lb; f) Due to the expansion, the mine life has been reduced from 50 years to 28 years; g) Sustaining capex is expected to increase from US$30-40mn to US$50-US$60mn from 2022 onwards.



Production profile



Cash flow chart



Economics summary

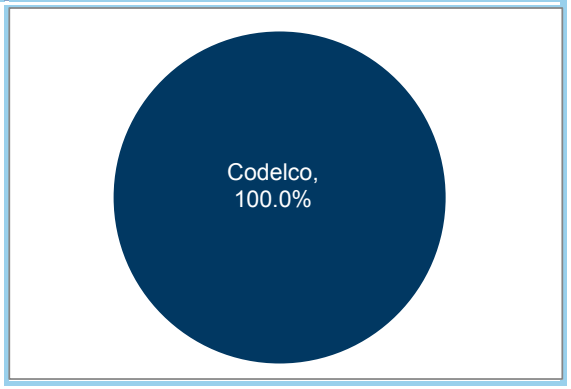
Internal rate of return	16%
NPV (including sunk costs)	US$1,148
NPV (2018+)	US$1,148
Cu required @ 12%	US$5,692 /t
Capex	US$1,220 mn
Capex / t Cu production	US$19,629
Capex / t Cu equ. production	US$18,558
Project type	Brownfield
Project status	Producing
Ore reserves / resources	1,469 mt
Copper grade	0.60% Cu
Contained copper	8,813 kt
Commissioning	2021
Peak copper production	81 ktpa
Average LOM production	62 ktpa
Life of mine	28
Gross unit cost	US$2,725 /t
Net unit cost (C1)	US$2,344 /t

Source: Company data, Goldman Sachs Global Investment Research

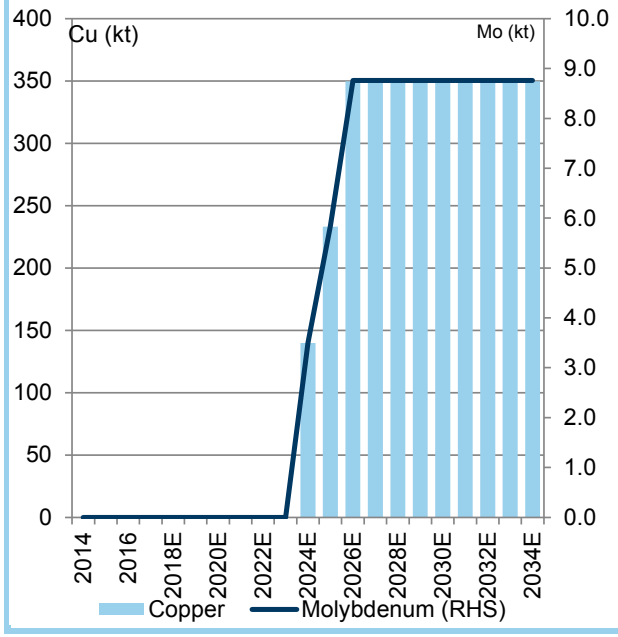
Exhibit 88: Andina Phase 2

Andina Phase 2	Chile	343 ktpa	US$7,600 mn	9% IRR

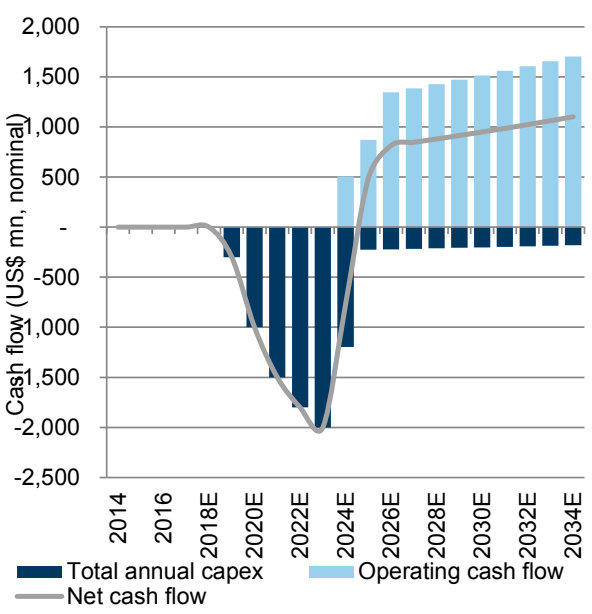
The Andina mine is owned by Codelco and located at Saladillo, 50 km northeast of Santiago in Chile. After the completion of phase one of the project, which took processing capacity from 72 ktpd to an average 94 ktpd, resulting in an increase of 70 ktpa of copper, the company is planning to embark on phase two of the project. The second phase was set to ramp up daily processing capacity by 150 kt to a total of 244 kt. The mine is expected to have an extended LOM given the 47 Mt copper resource base of the deposit. In September 2015, Codelco decided to suspend the project in its current form, seeking to create an alternative project that required less investment, optimises water usage and reduces its environmental impact. The company announced earlier this year that it was planning to alter its Andina mine as a result of glaciers. The project will take approx. 3 years to carry out and remains reliant upon the improvement of an environmental impact study. Whilst there has been limited newsflow on the expansion programme, given the US$250mn investment, we believe that the project is likely to be delayed. We expect the construction of the project to start in 2019 with first production in 2024.



Production profile



Cash flow chart



Economics summary

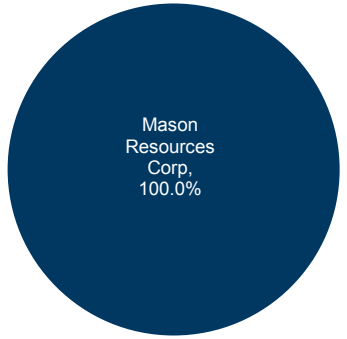
Internal rate of return	9%
NPV (including sunk costs)	US$319
NPV (2018+)	US$319
Cu required @ 15%	US$8,796 /t
Capex	US$7,600 mn
Capex / t Cu production	US$22,157
Capex / t Cu equ. production	US$20,644
Project type	Brownfield
Project status	Feasibility
Ore reserves / resources	965 mt
Copper grade	0.75% Cu
Contained copper	7,238 kt
Commissioning	2024
Peak copper production	350 ktpa
Average LOM production	343 ktpa
Life of mine	19
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$3,161 /t

Source: Company data, Goldman Sachs Global Investment Research

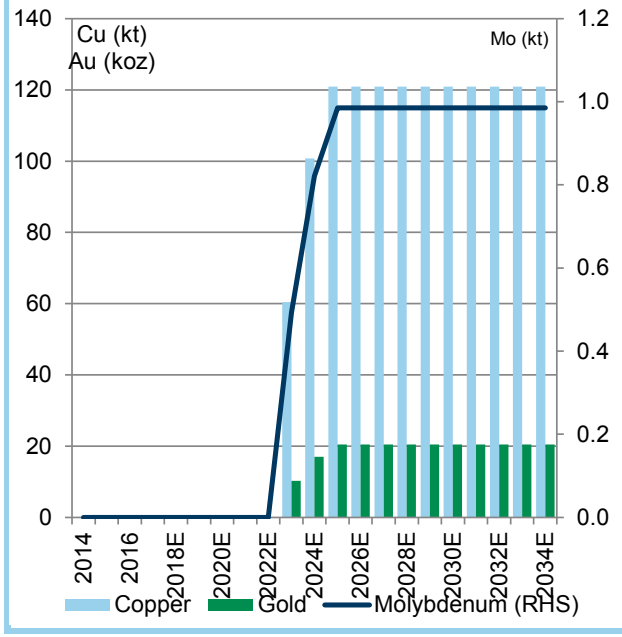
Exhibit 89: Ann Mason

Ann Mason	USA	110 ktpa	US$1,451 mn	15% IRR

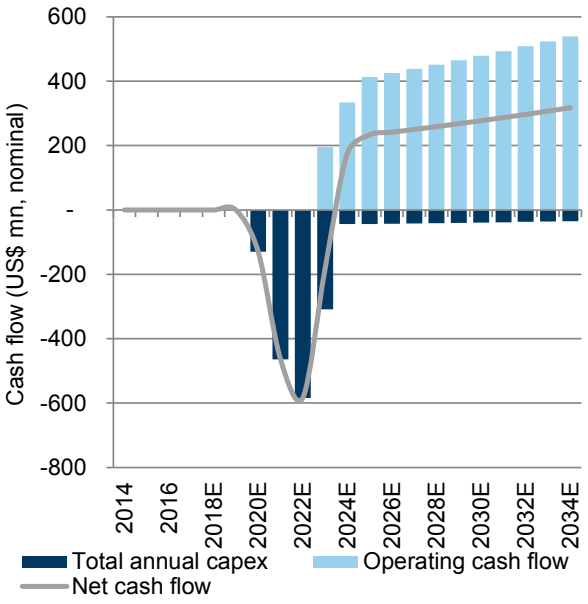
Ann Mason, located in the state of Nevada in the US, is a copper-molybdenum project with two known mineral deposits. Mason Resouces Corp. is the sole owner of the project. An updated Preliminary Economic Assessment report was submitted in May 2017, which envisions an open pit and conventional sulphide flotation milling operation with throughput of 120 ktpd and a 21-year LOM. The average annual production from the mine is expected to be c.110 ktpa of copper, c.1 ktpa of molybdenum, 20 kozpa of gold and 480 kozpa of silver. As per the latest resource statement, the mine has total resources of 1,400 mt with an average copper grade of 0.32%. Entree Gold which used to own the project recently spun-out its two US operations - Ann Mason and Lordsburg - to focus on its other investments. The company is curently evaluating options for its Ann Mason project which may include optimising certain aspects of the 2017 PEA, commencing a pre-feasibility study. Capex spend guidance for 2018 is <US$1mn. Given the various permitting processes and various stages that the project still has to go through, we do not expect production from the mine before 2023 and add inflation expectations to the guided capex while awaiting further details from the company.



Production profile



Cash flow chart



Economics summary

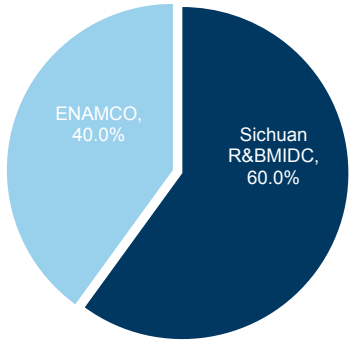
Internal rate of return	15%
NPV (including sunk costs)	US$821
NPV (2018+)	US$821
Cu required @ 10%	US$5,702 /t
Capex	US$1,451 mn
Capex / t Cu production	US$13,191
Capex / t Cu equ. production	US$12,284
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	1,400 mt
Copper grade	0.32% Cu
Contained copper	4,480 kt
Commissioning	2023
Peak copper production	121 ktpa
Average LOM production	110 ktpa
Life of mine	21
Gross unit cost	US$3,860 /t
Net unit cost (C1)	US$3,418 /t

Source: Company data, Goldman Sachs Global Investment Research

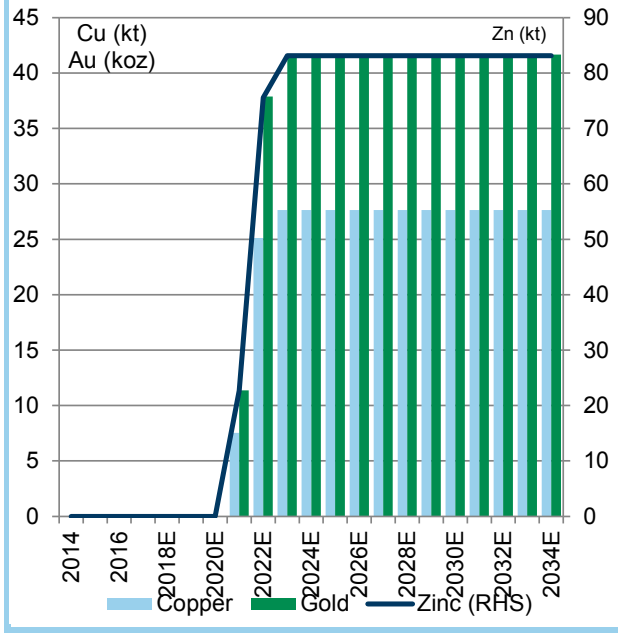
Exhibit 90: Asmara

Asmara	Eritrea	23 ktpa	US$609 mn	23% IRR

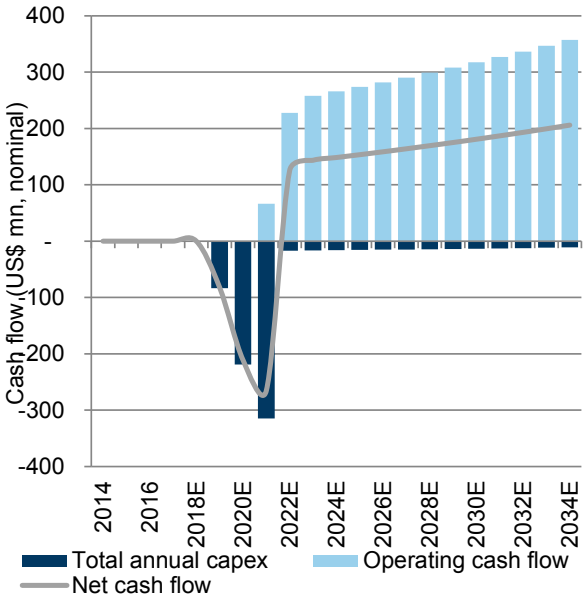
Asmara is a copper-gold-zinc mine located in Eritrea. Sichuan Road and Bridge Mining Investment Development Corp. acquired a 60% stake in the project from Sunridge Gold Corp in April 2016. The Eritrean government, through Eritrean National Mining Corporation (ENAMCO), holds the remaining 40% stake. The feasibility study of the project was submitted in in May 2013 and the Social and Environmental Impact Assessment Report in April 2014. The Asmara project operators obtained the mining license in October 2015. The project has a three-phase outline and on achieving full production is expected to produce 29 kt of copper, 42 koz of gold, 83 kt of zinc and 1 moz of silver annually. The life of the mine is 17 years. The total guided capex as per the feasibility study for all the phases of the project is US$560 mn (life of mine capex for Phases 1, 2 and 3 (gold, copper and zinc) are estimated at US$76.3mn, $428.2mn and $54.4mn); we add slight inflation expectations to this number. Given the change in ownership of the project and very limited newsflow, we expect a slower start to the project with first capex in 2019 and first production in 2021 - we will not be surprised should the project be further delayed.



Production profile



Cash flow chart



Economics summary

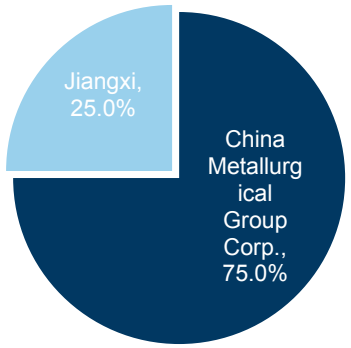
Internal rate of return	23%
NPV (including sunk costs)	US$668
NPV (2018+)	US$668
Cu required @ 25%	US$6,932 /t
Capex	US$609 mn
Capex / t Cu production	US$26,386
Capex / t Cu equ. production	US$12,337
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	57 mt
Copper grade	0.81% Cu
Contained copper	458 kt
Commissioning	2021
Peak copper production	28 ktpa
Average LOM production	23 ktpa
Life of mine	17
Gross unit cost	US$8,402 /t
Net unit cost (C1)	-US$1,854 /t

Source: Company data, Goldman Sachs Global Investment Research

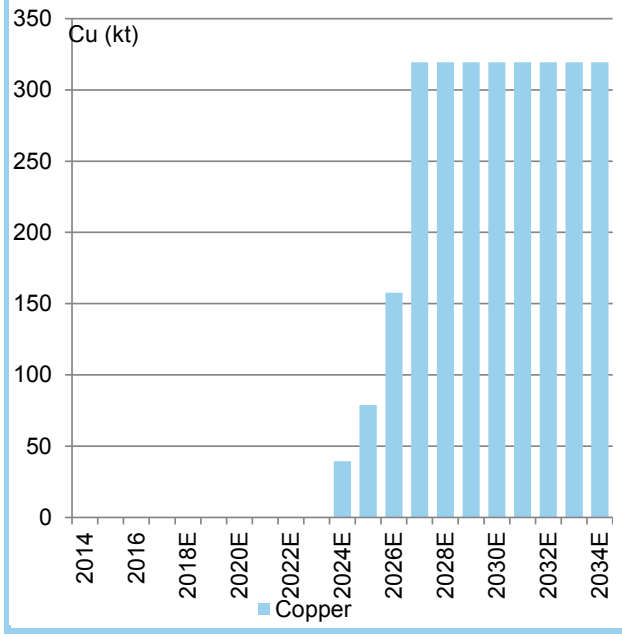
Exhibit 91: Aynak

Aynak	Afghanistan	320 ktpa	US$4,900 mn	6% IRR

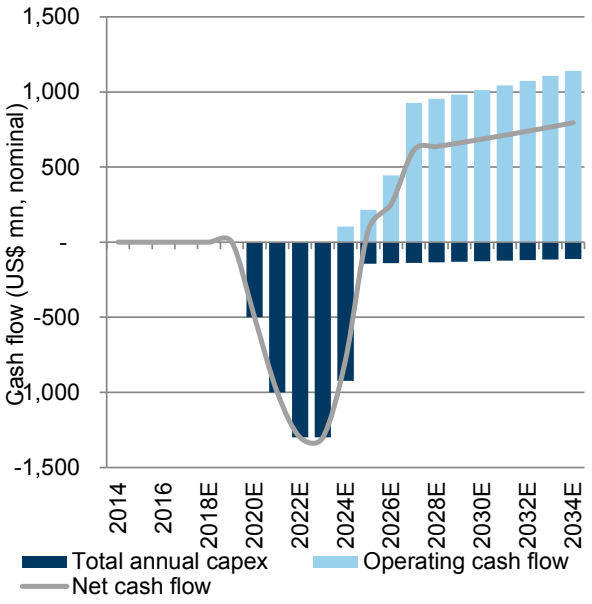
The Aynak mine is located in the north of Logar Province c.35 km southeast of Kabul, in the middle east of Afghanistan. The mine was first discovered in the early 1970s. The ownership of the mine is shared between China Metallurgical Group Corp (75%) and Jiangxi (25%, but Jiangxi will receive 50% of the production). The group officially signed an agreement on May 25, 2008 with the Afghan government to develop the deposit. Phase I of the project is expected to deliver an operation that will produce an average 320 ktpa of copper. The project has received approval, and pre-construction was initially set to commence in 2013 with pre-stripping in 2014 before commercial production starting in 2016. This timeline has not been adhered, as security concerns have delayed work on the project since 2007. The newsflow around the project has continued to indicate that multiple issues remain. More recently, the Ministry of Mines and Petroleum said that they had wrapped up their assessment of a list of demands by Chinese contractor for the mine and that the report would be sent to the high economic council. According to the reports, the Chinese consortium has requested to renegotiate the contracts. There is also an apparent lack of phosphate resources, which is required for further processing of copper ore, and according to news media the Afghan govt. is to provide.



Production profile



Cash flow chart



Economics summary

Internal rate of return	6%
NPV (including sunk costs)	-US$543
NPV (2018+)	-US$543
Cu required @ 25%	US$12,509 /t
Capex	US$4,900 mn
Capex / t Cu production	US$15,313
Capex / t Cu equ. production	US$15,313
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	350 mt
Copper grade	1.20% Cu
Contained copper	4,200 kt
Commissioning	2024
Peak copper production	320 ktpa
Average LOM production	320 ktpa
Life of mine	14
Gross unit cost	US$3,974 /t
Net unit cost (C1)	US$3,974 /t

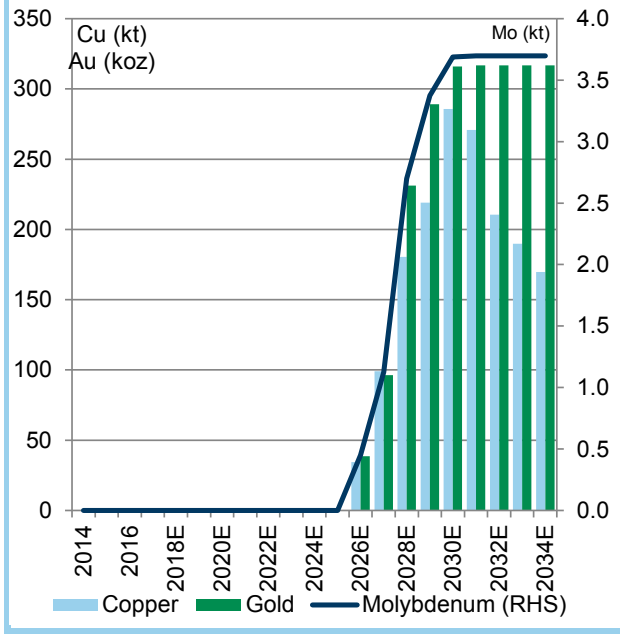
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 92: Baimskaya

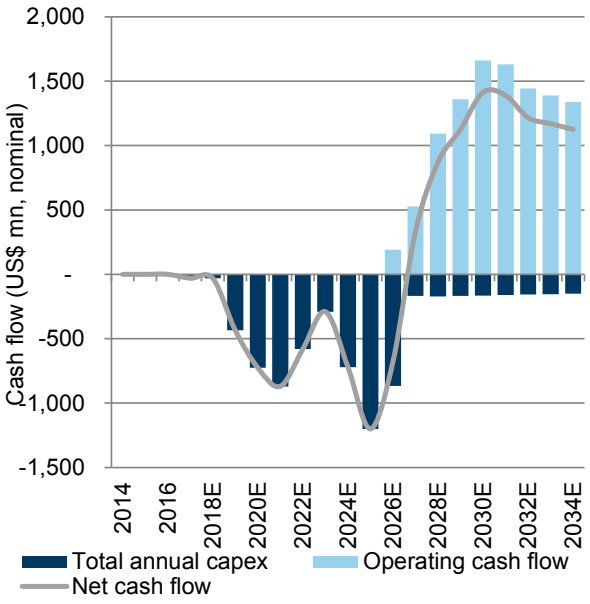
Baimskaya	Russia	179 ktpa	US$5,600 mn	12% IRR

Baimskaya is one of the largest undeveloped copper-porphyry deposits globally with resource potential over 23mt of copper and 64moz of gold. Baimskaya is currently 100% owned by Baimskaya Mining Company LLC, part of Millhouse Capital. In 2017, the project's Pre-Feasibility Study was completed by FLUOR (Canada). Preparation of the Feasibility Study is underway. Project development implies construction of on-site concentrator with annual processing capacity of 30+30 mln t of ore (in 2 phases). Total investment is estimated by company at US$4.2 bn (excl. infrastructure, which is state-funded). State permission for project development has been received, including participation of foreign financial and industrial partners. KAZ Minerals recently announced that it was looking to buy this project for US$900mn (cash + equity) and that it would look to develop it. The company has said that it would look to do its own feasibility study (FS) and would look at options to develop this project post the FS.

Production profile



Cash flow chart



Economics summary

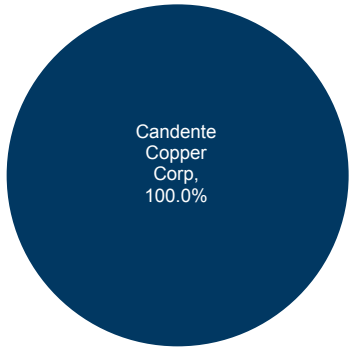
Internal rate of return	12%
NPV (including sunk costs)	US$2,350
NPV (2018+)	US$2,381
Cu required @ 12%	US$5,433 /t
Capex	US$5,600 mn
Capex / t Cu production	US$31,206
Capex / t Cu equ. production	US$23,156
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	2,024 mt
Copper grade	0.43% Cu
Contained copper	8,703 kt
Commissioning	2024
Peak copper production	316 ktpa
Average LOM production	179 ktpa
Life of mine	25+
Gross unit cost	US$3,202 /t
Net unit cost (C1)	US$3,202 /t

Source: Company data, Goldman Sachs Global Investment Research

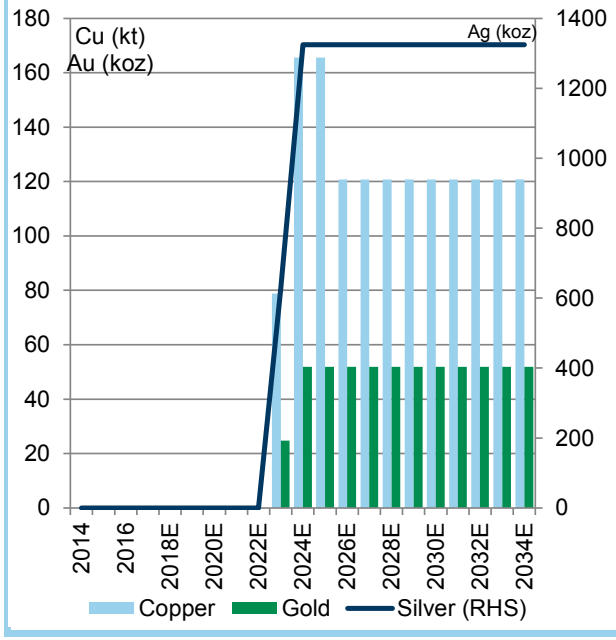
Exhibit 93: Canariaco Norte

Canariaco Norte	Peru	119 ktpa	US$1,700 mn	21% IRR

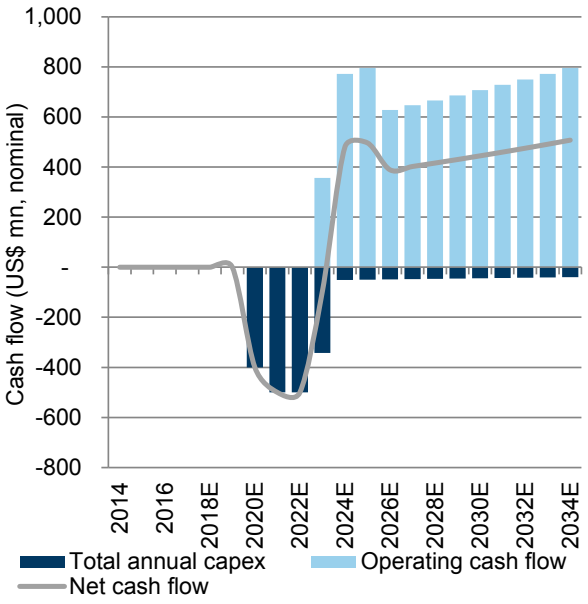
The Canariaco Norte porphyry copper deposit was discovered in northern Peru in the 1970s and was acquired by Candente Copper Corp (the present owner) in 2001. Reports have suggested that the feasibility study has shown the deposit could support the operation of a 100-110 ktpd throughput rate (up from 95 kt in the PFS owing to the recommendation of a larger SAG mill), producing 127 kt of copper pa and for a period spanning more than 20 years. The company's estimated capital outlay for the project was US$1.6 bn in the pre-feasibility study in 2011 (up from US$1.44 bn previously). A number of permits are required to support project development and operation. At this stage of the Project, environmental liabilities are limited to those expected for an exploration-stage project, and include reclamation of drill pads and access roads. There have been some interesting developments recently: a) The NSR (net smelter royalty) over the project was recently acquired by Anglo Pacific Group from Entree Resources; b) Several infrastructure programmes have recently been initiated by the Peruvian govt. in the district of Canaris which could potentially see the project being fast tracked. We still think it likely takes long for the company to get financing in place for the project.



Production profile



Cash flow chart



Economics summary

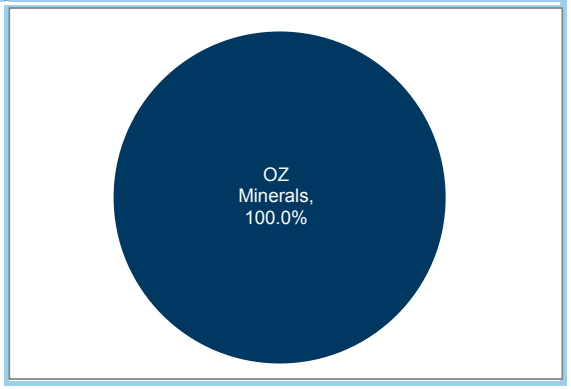
Internal rate of return	21%
NPV (including sunk costs)	US$1,939
NPV (2018+)	US$1,939
Cu required @ 15%	US$5,259 /t
Capex	US$1,700 mn
Capex / t Cu production	US$14,286
Capex / t Cu equ. production	US$13,153
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	752 mt
Copper grade	0.52% Cu
Contained copper	3,912 kt
Commissioning	2023
Peak copper production	166 ktpa
Average LOM production	119 ktpa
Life of mine	22
Gross unit cost	US$2,838 /t
Net unit cost (C1)	US$2,294 /t

Source: Company data, Goldman Sachs Global Investment Research

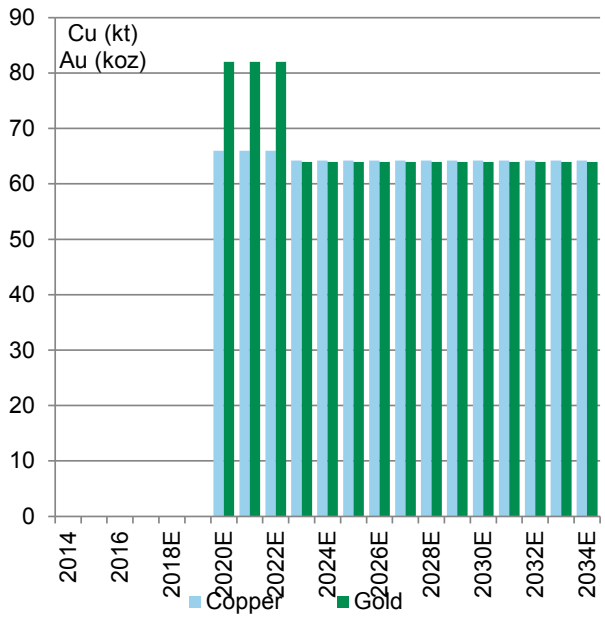
Exhibit 94: Carrapateena

Carrapateena	Australia	65 ktpa	US$789 mn	21% IRR

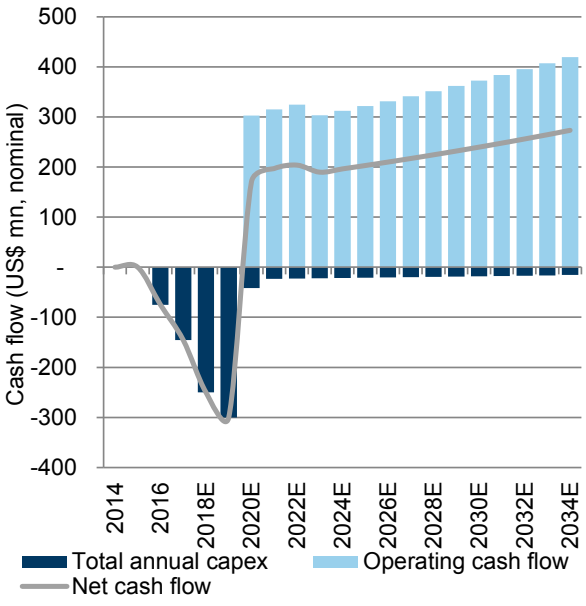
Carrapateena is a copper-gold deposit located in South Australia, 130 km north of Port Augusta. OZ Minerals acquired the Carrapateena copper-gold project from Teck Australia Pty in 2011 for US$250mn. The pre-feasibility study was released in November 2016 and the feasibility study was released in Aug. 2017. According to the FS the capex for the mine is A$916mn (c.US$750mn). The mine will have a life of 20 years with an estimated annual copper production of 65Kt and gold production of 67Koz. According to the company, the mine starts production in 4Q19 (we slightly delay it and expect first production in 2020). The company retains an expansion optionality in the throughput and resource extensions given the highly prospective region. According to Oz Minerals, it has sufficient cash balance and cash flows to finance the project. During 2019 OZ Minerals plans to conduct a scoping study.



Production profile



Cash flow chart



Economics summary

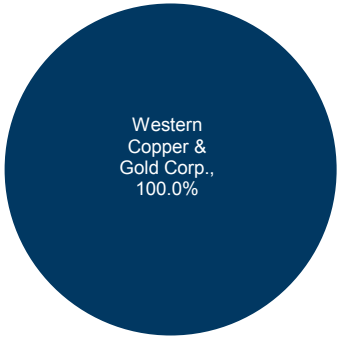
Internal rate of return	21%
NPV (including sunk costs)	US$1,224
NPV (2018+)	US$1,453
Cu required @ 10%	US$4,233 /t
Capex	US$789 mn
Capex / t Cu production	US$12,138
Capex / t Cu equ. production	US$10,126
Project type	Greenfield
Project status	Construction
Ore reserves / resources	79 mt
Copper grade	1.80% Cu
Contained copper	1,422 kt
Commissioning	2020
Peak copper production	66 ktpa
Average LOM production	65 ktpa
Life of mine	20
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$2,126 /t

Source: Company data, Goldman Sachs Global Investment Research

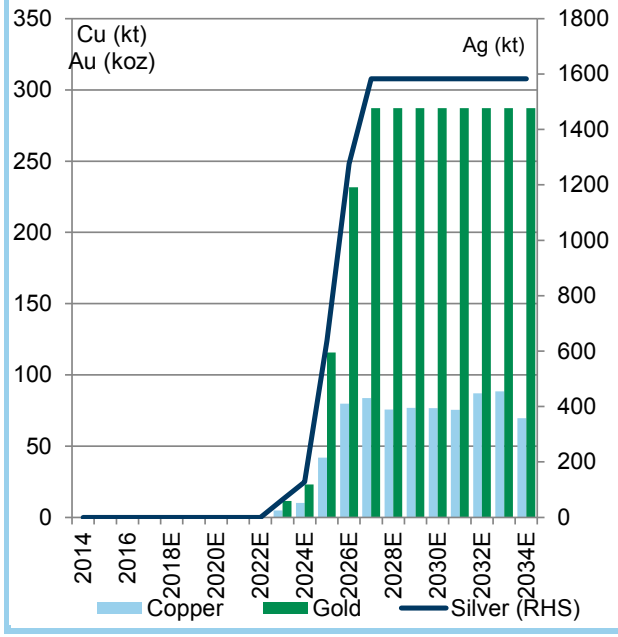
Exhibit 95: Casino

Casino	Canada	86 ktpa	US$3,545 mn	7% IRR

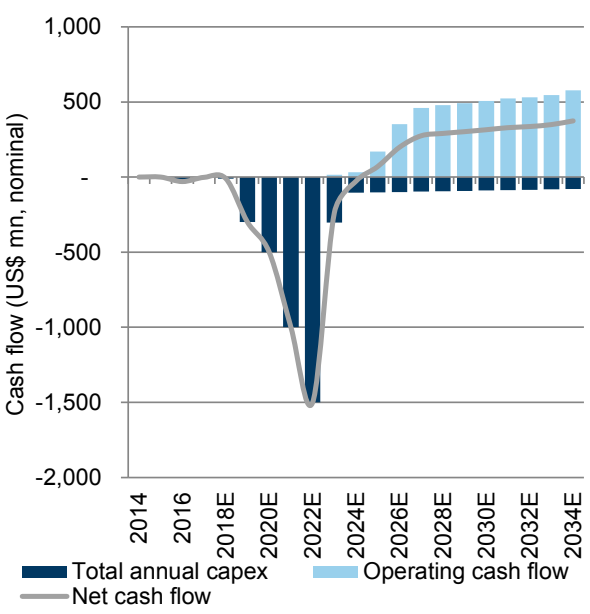
The Casino project, 100% owned by Western Copper and Gold Corporation, is a copper-gold project located in Western Central Yukon, Canada. The Casino porphyry copper-gold-molybdenum deposit will be developed as a conventional truck-shovel, open pit mine, initially processing the gold bearing oxide cap as a heap leach operation. Peak copper production is expected to be c.128 ktpa and gold production c.400 koz. The company finished the bankable feasibility study in January 2013 and submitted the EIA in January 2014, followed by two supplemental information reports in 2015. The project has been stuck in the permitting stage with no newsflow yet on the project financing being secured. The company however did update the market recently, commenting that the review undertaken of the 2013 economic metrics indicated that they were still relevant at the current commodity price / fx. In an encouraging development, the Yukon Territorial govt. and Federal govt. said that they will fund the initial 82 km of the existing access road to standards required by Casino project and 30% of the funding for the additional 126 km of the access road. However, given the considerable environmental hurdles, the company has decided to delay the submission of the Environmental and Socio-Economic Statement to the end of 2018. As such we have delayed the start of the project to 2023 from 2021 previously.



Production profile



Cash flow chart



Economics summary

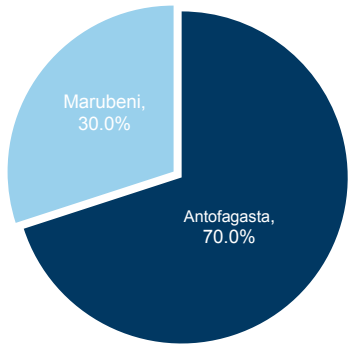
Internal rate of return	7%
NPV (including sunk costs)	-US$432
NPV (2018+)	-US$399
Cu required @ 10%	US$8,069 /t
Capex	US$3,545 mn
Capex / t Cu production	US$41,357
Capex / t Cu equ. production	US$25,365
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	965 mt
Copper grade	0.20% Cu
Contained copper	1,930 kt
Commissioning	2023
Peak copper production	181 ktpa
Average LOM production	86 ktpa
Life of mine	28+
Gross unit cost	US$6,699 /t
Net unit cost (C1)	US$2,905 /t

Source: Company data, Goldman Sachs Global Investment Research

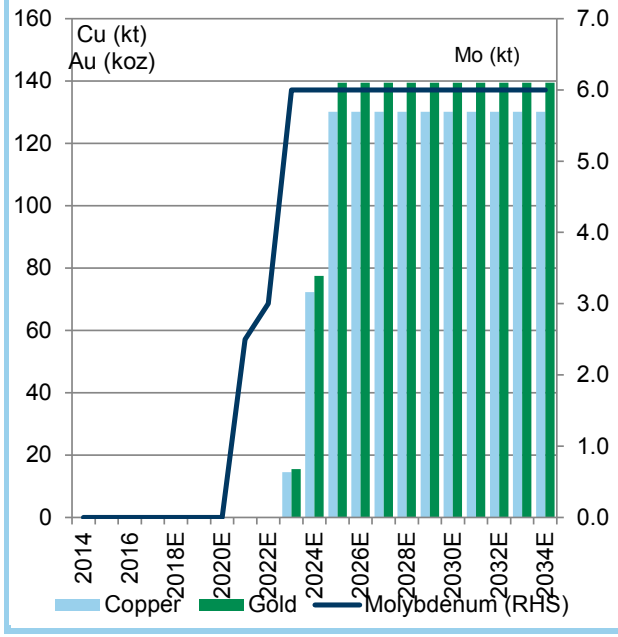
Exhibit 96: Centinela DMC

Centinela DMC	Chile	120 ktpa	US$2,970 mn	10% IRR

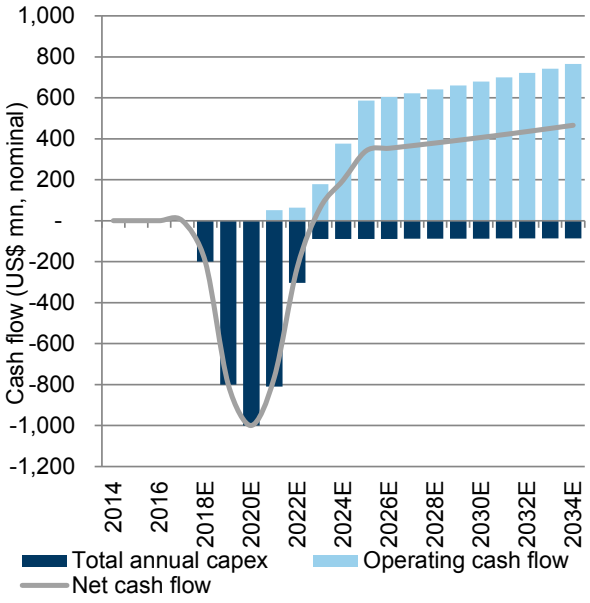
The Centinela DMC project consists of a single concentrator to be fed by the Esperanza Sur and Encuentro Sulphides deposits. Antofagasta continues to explore options for the development of deposits in the Centinela Mining District and decided that the most effective option would be if both deposits fed into a single concentrator. The company constructed a US$125 mn, 2.4Kt Molybedum plant, in 1H18 with first sales made in July 2018. The pre-feasibility study for the copper expansion project was completed at the end of 2015 and the EIA for the project has been received. The latest plan encompasses a 90 ktpd concentrator plant with annual copper output of c.140 ktpa, gold output of c.150 kozpa and Molybdenum output of 6 ktpa. However, the company is in the process of conducting a review of whether it can expand the existing concentrator (for which the PFS is underway). This will be a brownfield project with lower capex and lower construction risk, and as such lower risk associated with the project. However, there aren't enough details available for us to model this. The FS to build a second concentrator is expected to be completed by 2018 end and given either project would take 18-24 months for board approval, increased production would likely be from 2023. We model the first alternative- the expansion of existing conc is 2nd alternative.



Production profile



Cash flow chart



Economics summary

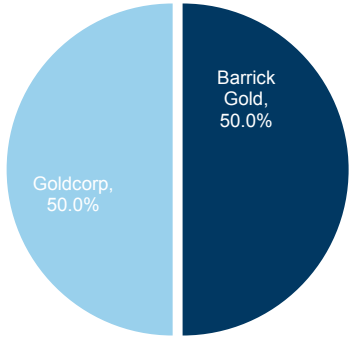
Internal rate of return	10%
NPV (including sunk costs)	US$726
NPV (2018+)	US$726
Cu required @ 15%	US$9,122 /t
Capex	US$2,970 mn
Capex / t Cu production	US$24,829
Capex / t Cu equ. production	US$18,425
Project type	Brownfield
Project status	Feasibility
Ore reserves / resources	2,065 mt
Copper grade	0.44% Cu
Contained copper	9,086 kt
Commissioning	2022
Peak copper production	130 ktpa
Average LOM production	120 ktpa
Life of mine	28+
Gross unit cost	US$4,769 /t
Net unit cost (C1)	US$2,535 /t

Source: Company data, Goldman Sachs Global Investment Research

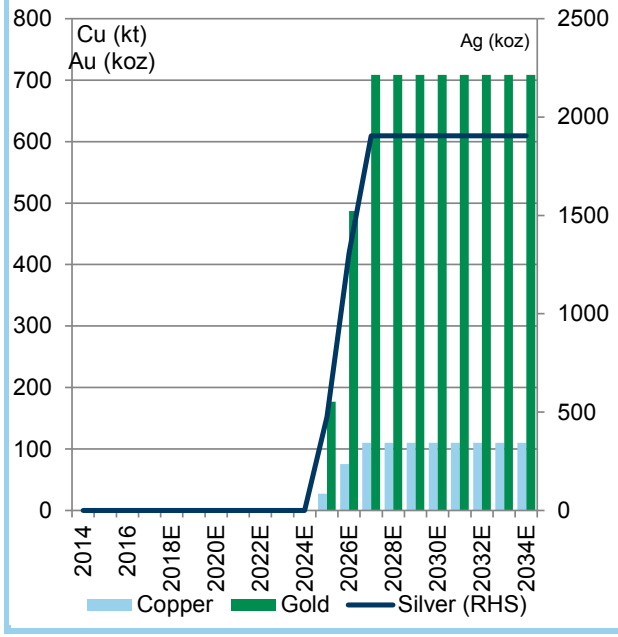
Exhibit 97: Cerro Casale

Cerro Casale	Chile	105 ktpa	US$6,000 mn	10% IRR

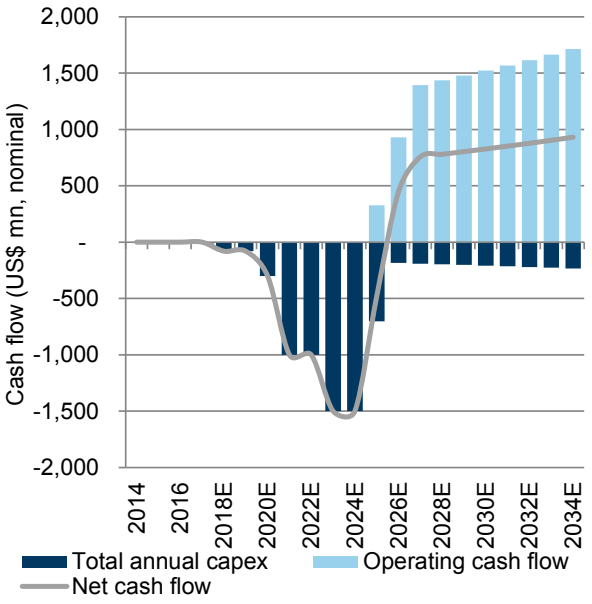
The Cerro Casale deposit is located in the Maricunga district of Region III in Chile. Ownership of the deposit is shared between Barrick Gold (50%) and Goldcorp (50%) after Barrick sold a 25% stake to Goldcorp and Kinross sold its 25% stake to Goldcorp in 2017. As part of the Goldcorp acquisition of the 50% stake in Cerro Casale, the company is required to spend a minimum of US$80mn in each successive 2-year period until the deferred payment obligation of US$260mn is satisfied. If Goldcorp does not spend the minimum in any two-year period, Goldcorp will instead be required to make a payment to Barrick equal to 50% of the shortfall, with a corresponding reduction in the deferred payment obligation. The 2 companies have formed a dedicated project team that will undertake 24 months of concept studies on the combined project. The target for this year is update geological review and model for the mine. A pre-feasibility study is also likely to be commenced this year. Given that the feasibility study commences this year, we believe it is fair to assume that the construction of the project doesn't start before 2020/21 with first production in 2025. Note that this is a delay of 3 years vs. our previous estimate.



Production profile



Cash flow chart



Economics summary

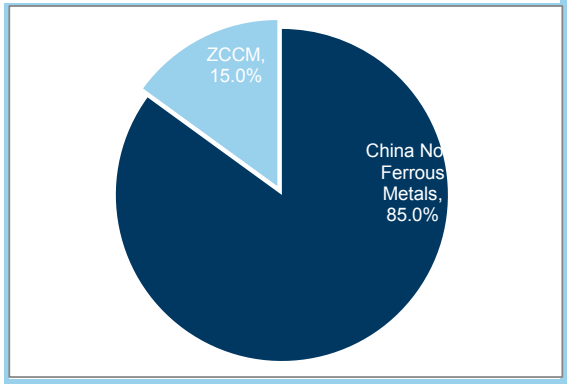
Internal rate of return	10%
NPV (including sunk costs)	US$989
NPV (2018+)	US$989
Cu required @ 15%	US$9,964 /t
Capex	US$6,000 mn
Capex / t Cu production	US$57,313
Capex / t Cu equ. production	US$25,032
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	1,198 mt
Copper grade	0.60% Cu
Contained copper	7,186 kt
Commissioning	2025
Peak copper production	110 ktpa
Average LOM production	105 ktpa
Life of mine	22
Gross unit cost	US$4,996 /t
Net unit cost (C1)	-US$3,513 /t

Source: Company data, Goldman Sachs Global Investment Research

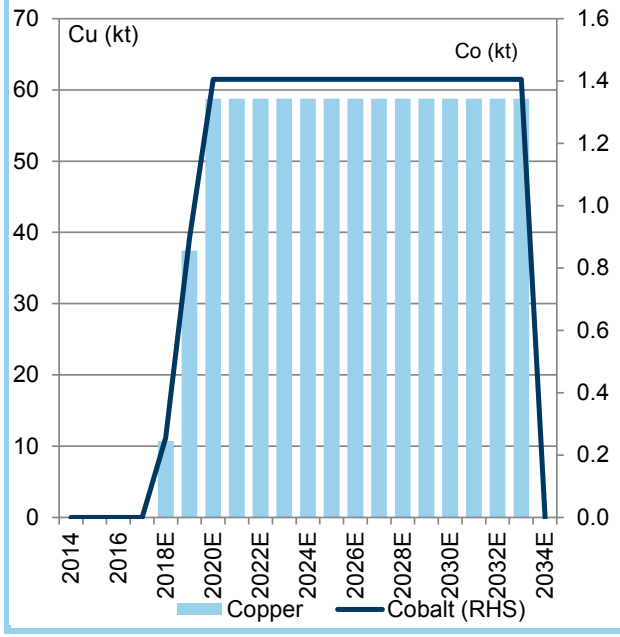
Exhibit 98: Chambishi

Chambishi	Zambia	54 ktpa	US$750 mn	13% IRR

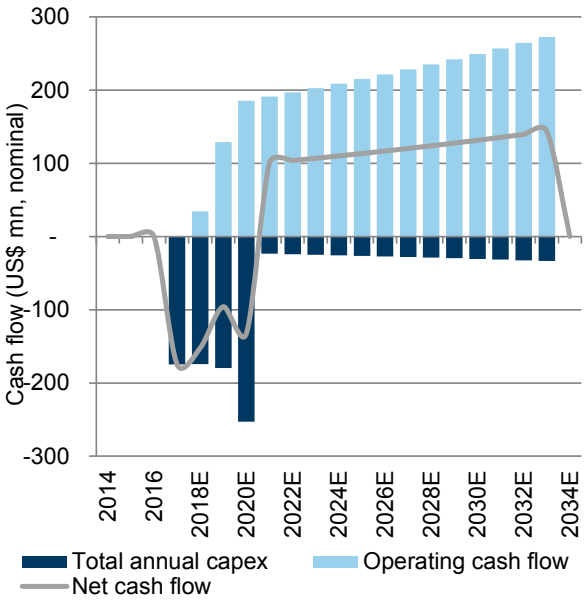
Chambishi is a copper mine in Zambia owned by China Non-Ferrous Metals (which owns 85% of the mine) and ZCCM (which owns 15%). The Chambishi copper deposits are classic Zambian-type Lower Roan hosted Copperbelt deposits. Chambishi and Mwambashi are located on the western limb of the Kafue Anticline, the dominant structural feature of the eastern Zambian Copperbelt, with the deposits themselves located on the margins of a palaeo-basin known as the Chambishi Basin. The core business of Chambishi is in refining copper and cobalt, the majority of which is sourced from DRC. As of mid-2016, CNMC reported that the construction of the Chambishi SouthEast mine - which adds c.60Kt to the mines' production profile at a capex of c.US$700mn (we add US$50mn to that number) will be completed by c.3Q18.



Production profile



Cash flow chart



Economics summary

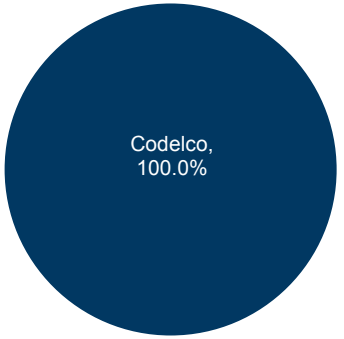
Internal rate of return	13%
NPV (including sunk costs)	US$228
NPV (2018+)	US$408
Cu required @ 15%	US$6,800 /t
Capex	US$750 mn
Capex / t Cu production	US$13,777
Capex / t Cu equ. production	US$10,479
Project type	Greenfield
Project status	Construction
Ore reserves / resources	59 mt
Copper grade	1.83% Cu
Contained copper	1,082 kt
Commissioning	2018
Peak copper production	59 ktpa
Average LOM production	54 ktpa
Life of mine	16
Gross unit cost	US$4,963 /t
Net unit cost (C1)	US$3,224 /t

Source: Company data, Goldman Sachs Global Investment Research

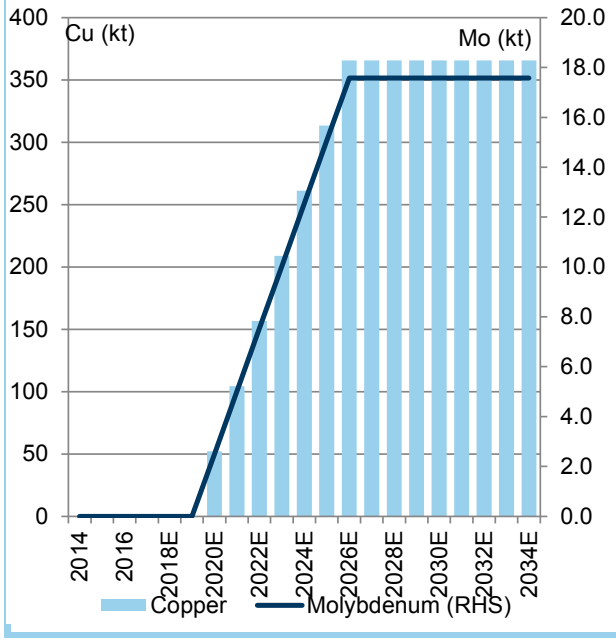
Exhibit 99: Chuquicamata U/G

Chuquicamata U/G	Chile	329 ktpa	US$4,200 mn	13% IRR

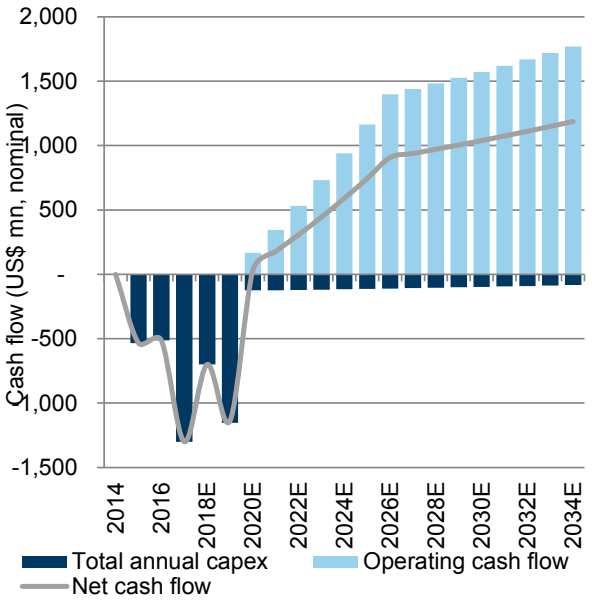
The Chuquicamata mine is located in Chile and is wholly owned by Codelco. The development of the underground mine is designed to exploit part of the remaining mineral resources once the current Chuquicamata open pit mine is exhausted, around 2020. The underground operation is expected to produce an average annual output of 366 kt of copper over a 29-year life of mine; this compares with open pit output of 340 kt in 2014. The feasibility study for the project was completed in 4Q12, three years after it commenced. Final board approval was given in mid-2014 and the project progress stood at 50% at the end of 1Q17. The company modified the underground expansion plan in May 2017 in order to enhance efficiencies in the operations by planning to mine three underground levels instead of four as envisaged earlier. However, the modification is not expected to have an impact on the production profile of the mine. Codelco filed an EIA (environmental impact assessment) report to carry out major upgrades at the mine. According to the latest newsflow, the underground portion of the mine should start to produce copper from 3Q19. However, given our experience with similar moves, we believe that there is some risk, and as such we take a more cautious view and assume first production in 2020.



Production profile



Cash flow chart



Economics summary

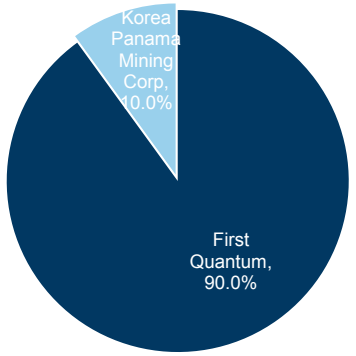
Internal rate of return	13%
NPV (including sunk costs)	US$4,203
NPV (2018+)	US$6,670
Cu required @ 15%	US$7,482 /t
Capex	US$4,200 mn
Capex / t Cu production	US$12,764
Capex / t Cu equ. production	US$11,222
Project type	Brownfield
Project status	Construction
Ore reserves / resources	1,333 mt
Copper grade	0.73% Cu
Contained copper	9,731 kt
Commissioning	2020
Peak copper production	366 ktpa
Average LOM production	329 ktpa
Life of mine	29
Gross unit cost	US$4,087 /t
Net unit cost (C1)	US$3,181 /t

Source: Company data, Goldman Sachs Global Investment Research

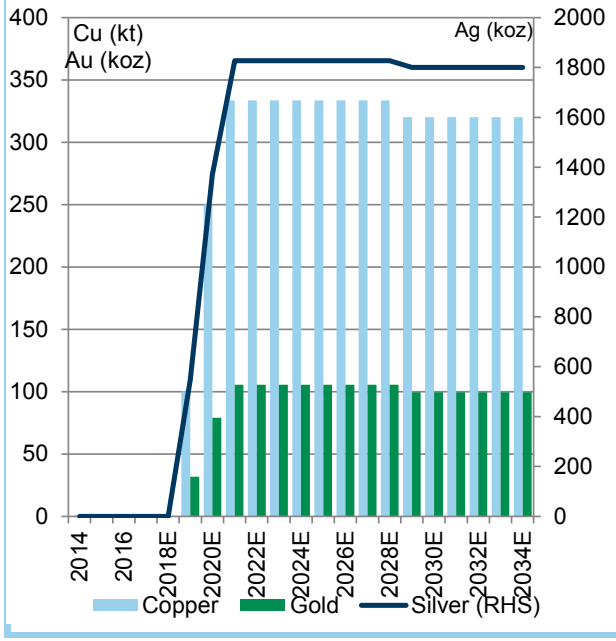
Exhibit 100: Cobre Panama

Cobre Panama	Panama	314 ktpa	US$6,350 mn	11% IRR

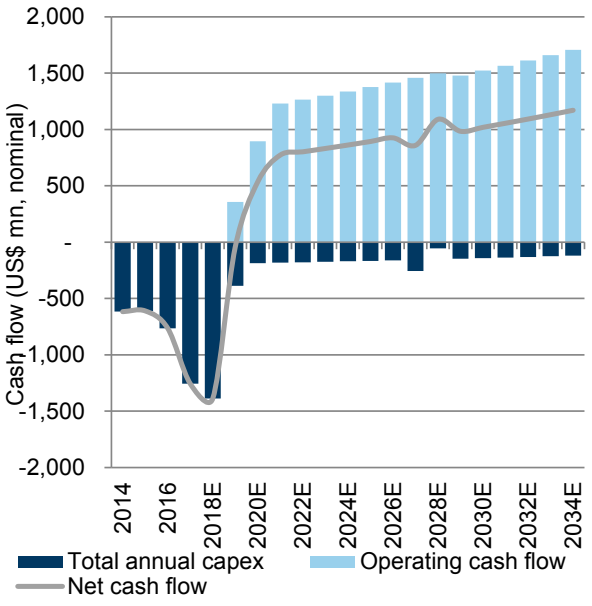
Cobre Panama is a large open pit copper development located 120km west of Panama City. The mine is 90% owned by First Quantum following the acquisition of Inmet Mining in 1H13, with the remaining 10% owned by Korea Panama Mining Corporation (KPMC) for which the company in its FY17 results gave new guidance for the mine. It expects the mine to reach commercial production in 2019 with production of 150Kt and reaching full capacity of 320Kt by 2020. The company also took up the capex estimate for the mine from US$5.5bn to US$6.3bn (we add c. US$50mn to the capex, in line with our inflation expectations). However, some events more recently have led us to think the 2019 guidance may not be achievable, notably there was a 6-week strike by workers at the mine which has delayed the construction. All the electrical wiring still needs to be completed, as a result of which we see a small downside to the production estimates for next year - we forecast copper production of 100Kt for 2019. First Quantum has sufficient funds to get the mine to commercial production, in our view.



Production profile



Cash flow chart



Economics summary

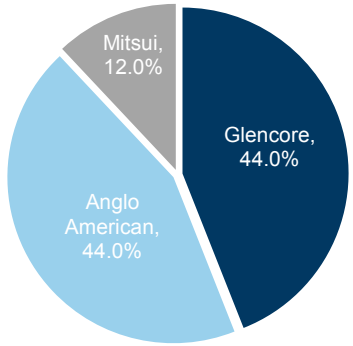
Internal rate of return	11%
NPV (including sunk costs)	US$3,505
NPV (2018+)	US$8,745
Cu required @ 15%	US$8,883 /t
Capex	US$6,350 mn
Capex / t Cu production	US$20,196
Capex / t Cu equ. production	US$19,164
Project type	Greenfield
Project status	Construction
Ore reserves / resources	3,182 mt
Copper grade	0.38% Cu
Contained copper	12,092 kt
Commissioning	2019
Peak copper production	334 ktpa
Average LOM production	314 ktpa
Life of mine	32+
Gross unit cost	US$3,179 /t
Net unit cost (C1)	US$2,843 /t

Source: Company data, Goldman Sachs Global Investment Research

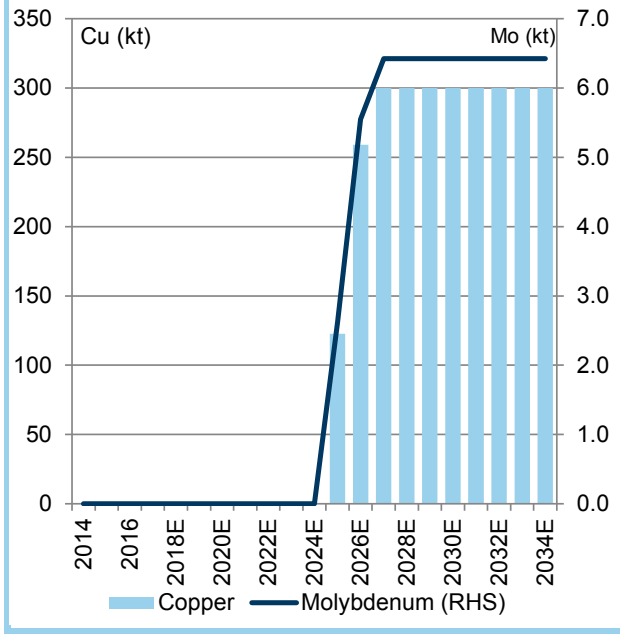
Exhibit 101: Collahuasi GL4

Collahuasi GL4	Chile	292 ktpa	US$4,350 mn	15% IRR

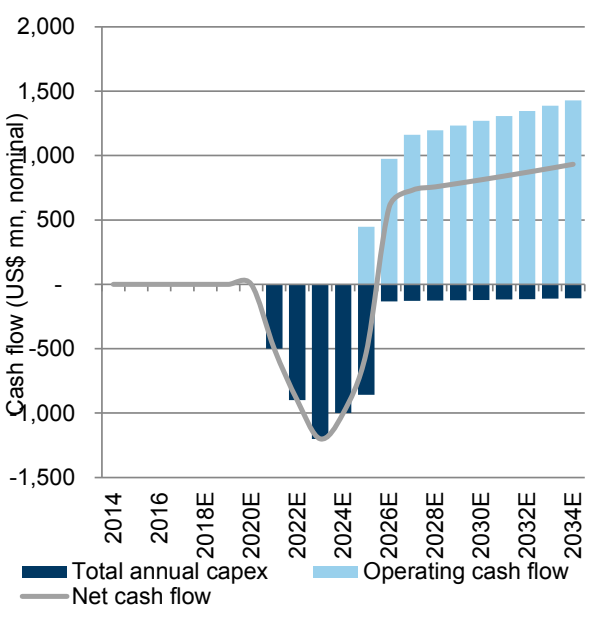
The Collahuasi mine is located on the Andean plateau in northern Chile. The ownership of the mine is shared between Glencore (44%) and Anglo American (44%) with the remaining stake held by Mitsui. The group of owners have undertaken a prefeasibility study into phase three of the expansion project which involves the construction of one, or possibly two, grinding lines. The introduction of these grinds would increase the concentrator plant capacity from 160 ktpd to either 270 ktpd or 380 ktpd, taking total copper production at the mine to 1 mtpa. The project is currently in the pre-feasibility stage. However, it had been deprioritised as Anglo and Glencore needed to resolve operating challenges at the underlying Collahuasi mine in 2012/13 and both major partners addressed high debt levels as prices fell below expected levels. There have been no updates provided on the project since. Estimated total capex for the project is US$4-6 bn depending on whether the owners decide on one or two 110 ktpd lines. Water issues will need to be resolved before any expansion can be done as any expansion would require pumping of desalinated sea water. The environmental study which was scheduled for 2017 was delayed last year and is to be submitted in 2018. Anglo has said that it plans to first invest in Quellaveco project and that Collahuasi expansion is at least 6 years away (our base case remains 2025).



Production profile



Cash flow chart



Economics summary

Internal rate of return	15%
NPV (including sunk costs)	US$2,888
NPV (2018+)	US$2,888
Cu required @ 15%	US$6,651 /t
Capex	US$4,350 mn
Capex / t Cu production	US$14,921
Capex / t Cu equ. production	US$14,041
Project type	Brownfield
Project status	Pre-feasibility
Ore reserves / resources	3,220 mt
Copper grade	0.93% Cu
Contained copper	29,946 kt
Commissioning	2025
Peak copper production	300 ktpa
Average LOM production	292 ktpa
Life of mine	26+
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$3,229 /t

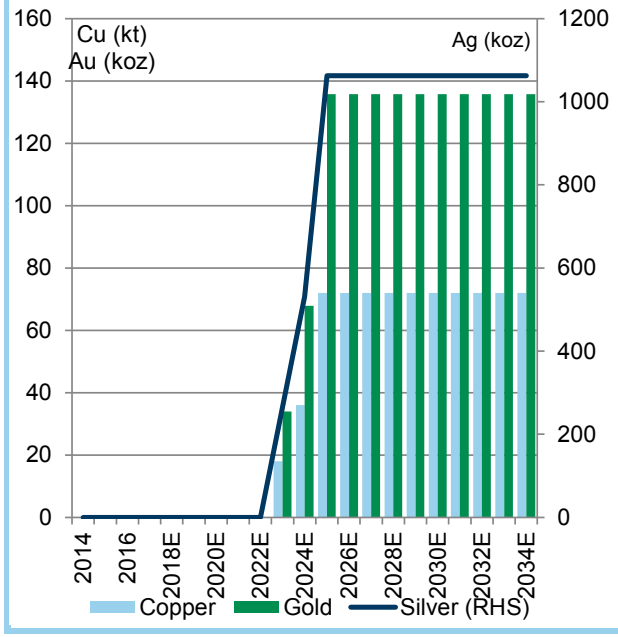
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 102: Cotabambas

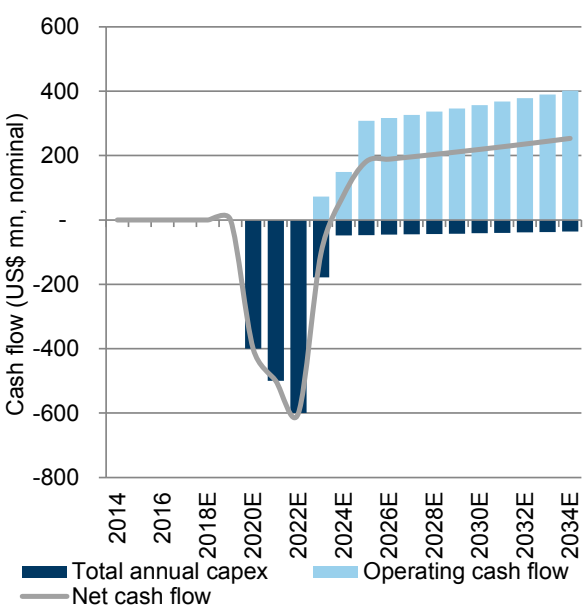
Cotabambas	Peru	68 ktpa	US$1,633 mn	10% IRR

Cotabambas is a greenfield open pit copper-gold-silver project located in Cotabambas Province of Peru. Panoro Minerals Ltd. is the sole owner of the project. The Preliminary Economic Assessment (PEA) for the project was published in April 2015. An updated PEA was published in September 2015, which envisages a concentrator plant with a throughput of 80 ktpd over a mine life of 20 years. The pre-feasibility study for the project is currently being conducted with guided development capex of US$1.5 bn (our estimate includes some inflation). In March 2016, the company entered into an early deposit precious metal streaming agreement with Silver Wheaton for an upfront payment of US$140 mn for 25% of payble gold production and 100% of silver production, for which the company is entitled to receive US$14.0 million spread over up to 9 years as an early deposit, with payments to be used to fund expenses related to the Cotabambas Project. Panoro has completed 6.6 kms of exploration and step-out drilling targeting areas of oxide, sulfide and skarn mineralization. The company this year plans to extend to program to up to 10 kms.

Production profile



Cash flow chart



Economics summary

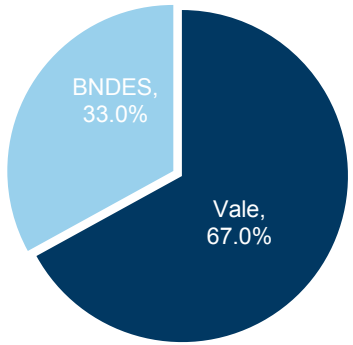
Internal rate of return	10%
NPV (including sunk costs)	US$218
NPV (2018+)	US$218
Cu required @ 15%	US$8,210 /t
Capex	US$1,633 mn
Capex / t Cu production	US$24,123
Capex / t Cu equ. production	US$17,347
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	117 mt
Copper grade	0.42% Cu
Contained copper	492 kt
Commissioning	2023
Peak copper production	72 ktpa
Average LOM production	68 ktpa
Life of mine	21
Gross unit cost	US$5,450 /t
Net unit cost (C1)	US$2,720 /t

Source: Company data, Goldman Sachs Global Investment Research

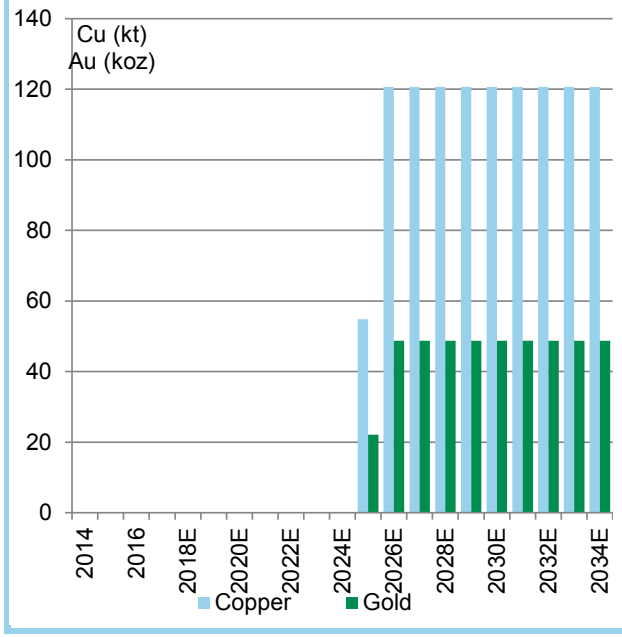
Exhibit 103: Cristalino

Cristalino	Brazil	118 ktpa	US$1,550 mn	18% IRR

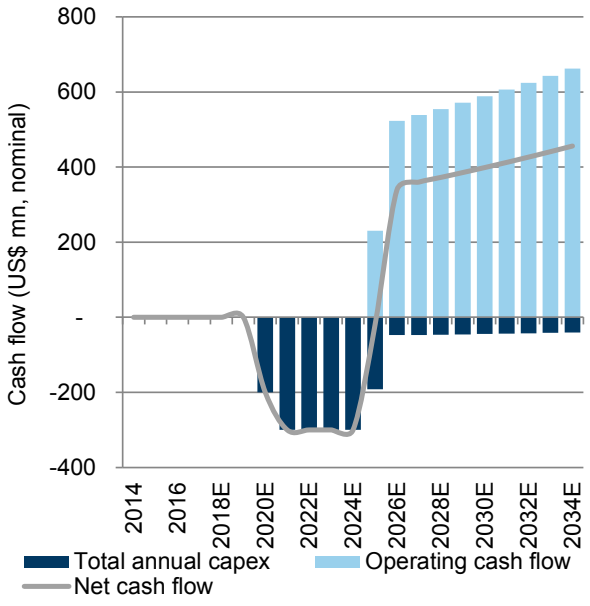
Cristalino, located in the Carajás copper region, Pará, Brazil, is a copper mine owned by Vale (67%) and BNDES (33%). A pre-feasibility study of the project was carried out in 2008/09 with a planned throughput of 16 mtpa. There have been no recent updates on the project from its owners as the focus has been on iron ore projects. We currently estimate the project commences in 2025, and assume a capex of US$1,800mn (assumption taken from WoodMac). There have been no updates from Vale on this project, as such we see the probability of this project coming online as very low.



Production profile



Cash flow chart



Economics summary

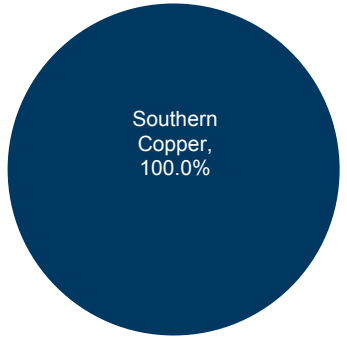
Internal rate of return	18%
NPV (including sunk costs)	US$1,686
NPV (2018+)	US$1,686
Cu required @ 25%	US$8,672 /t
Capex	US$1,550 mn
Capex / t Cu production	US$13,129
Capex / t Cu equ. production	US$12,183
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	379 mt
Copper grade	0.66% Cu
Contained copper	2,501 kt
Commissioning	2025
Peak copper production	121 ktpa
Average LOM production	118 ktpa
Life of mine	25
Gross unit cost	US$3,293 /t
Net unit cost (C1)	US$2,779 /t

Source: Company data, Goldman Sachs Global Investment Research

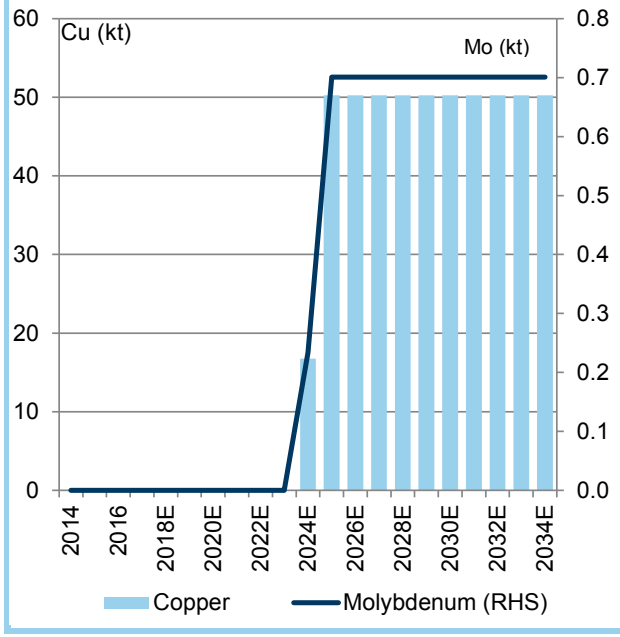
Exhibit 104: Cuajone

Cuajone	Peru	49 ktpa	US$500 mn	19% IRR

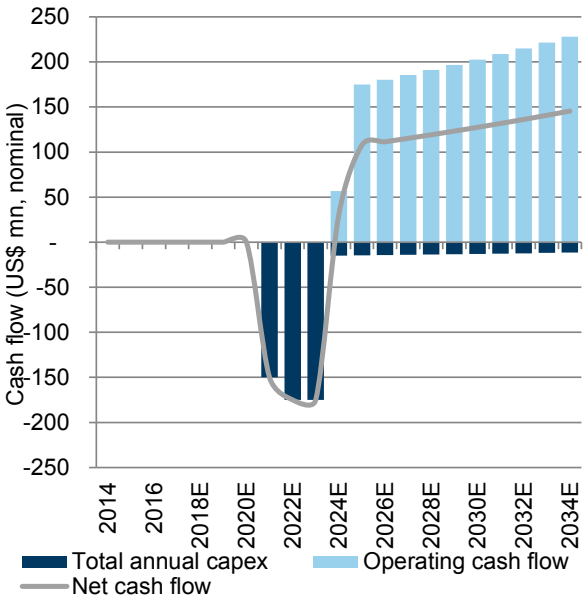
The Cuajone mine is located in southern Peru, 840 km from Lima and is wholly owned by Southern Copper. The operation currently produces c.160 ktpa of copper and is undergoing productivity upgrades to raise production by a further 22 ktpa. The company is also planning a concentrator upgrade at a later date, raising production capacity by a further 50 ktpa, with planned start-up from 2018. The project is still in the early stages and is not yet board approved. The preliminary capex estimate from the company is US$500 mn. There has been little newsflow on the project ever since it was postponed as the company prioritised Toquepala concentrator expansion over Cuajone expansion. The project doesn't feature in the company's latest list of potential projects for the near term, and as such we don't expect it to be greenlit in the near future. We expect the capex spend to start post 2020 with first production sometime in 2024.



Production profile



Cash flow chart



Economics summary

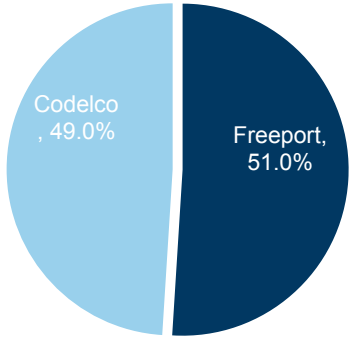
Internal rate of return	19%
NPV (including sunk costs)	US$600
NPV (2018+)	US$600
Cu required @ 15%	US$5,939 /t
Capex	US$500 mn
Capex / t Cu production	US$10,200
Capex / t Cu equ. production	US$9,809
Project type	Brownfield
Project status	Feasibility
Ore reserves / resources	1,782 mt
Copper grade	0.52% Cu
Contained copper	9,177 kt
Commissioning	2024
Peak copper production	50 ktpa
Average LOM production	49 ktpa
Life of mine	27+
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$3,370 /t

Source: Company data, Goldman Sachs Global Investment Research

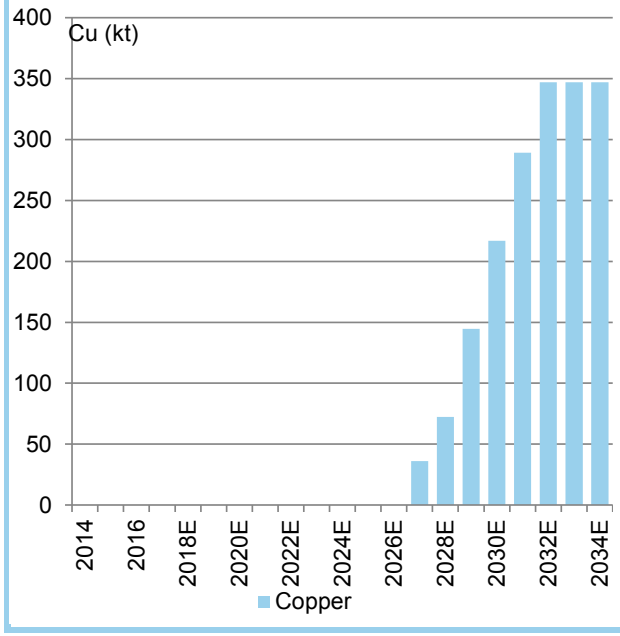
Exhibit 105: El Abra

El Abra mill	Chile	340 ktpa	US$5,274 mn	-9% IRR

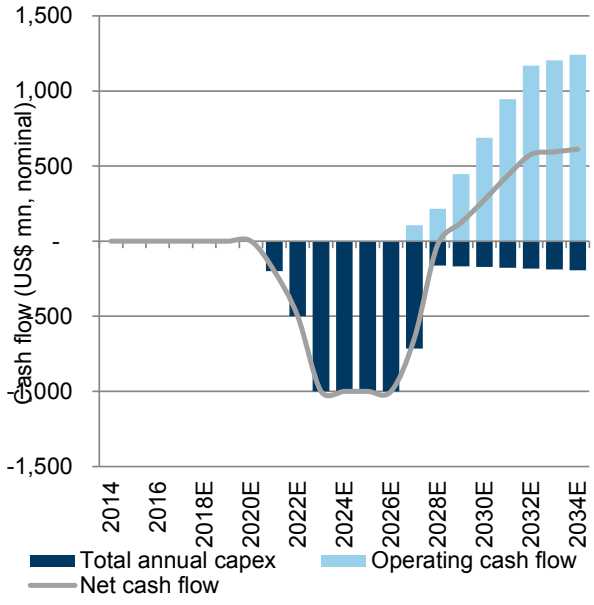
El Abra is a producing copper project locaed in Chile jointly owned by Freeport (51%) and Codelco (49%). The mine as of now is a SxEw project but there is a significant sulfide resource which the company estimates at 2bn tonnes at > 0.45% copper grade. Freeport is currently in the process of advancing technical studies for the project to build a 240kt/d concentrator - similar to the one it built at Cerro Verde. The estimated production according to the company could be c. 340Kt. There have been little details on the capex / costs etc. of the mine. Our assumption of the capex is based on the Cerro Verde capex (given that this project is similar to that one). We estimate the capex to be c. US$5.3bn for the project. According to the company it needs at least 3-4 years for feasibility and permitting with another 3-4 years needed for construction. Given Freeport has other projects it is pursuing right now, we believe that this is unlikely to be at the top of its priority list. As such we expect construction of this project to start in 2021 with first production in 2027 and the mine reaching full capacity by 2030.



Production profile



Cash flow chart



Economics summary

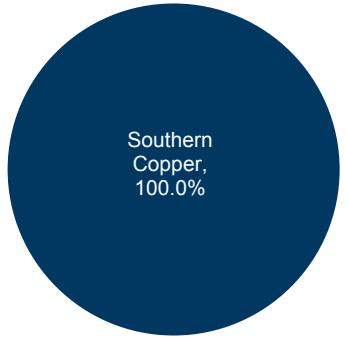
Internal rate of return	-9%
NPV (including sunk costs)	-US$2,230
NPV (2018+)	-US$2,230
Cu required @ 15%	US$4,870 /t
Capex	US$5,274 mn
Capex / t Cu production	US$15,502
Capex / t Cu equ. production	US$15,502
Project type	Brownfield
Project status	Pre-feasibility
Ore reserves / resources	394 mt
Copper grade	0.44% Cu
Contained copper	1,734 kt
Commissioning	2027
Peak copper production	347 ktpa
Average LOM production	340 ktpa
Life of mine	8
Gross unit cost	US$3,854 /t
Net unit cost (C1)	US$3,854 /t

Source: Company data, Goldman Sachs Global Investment Research

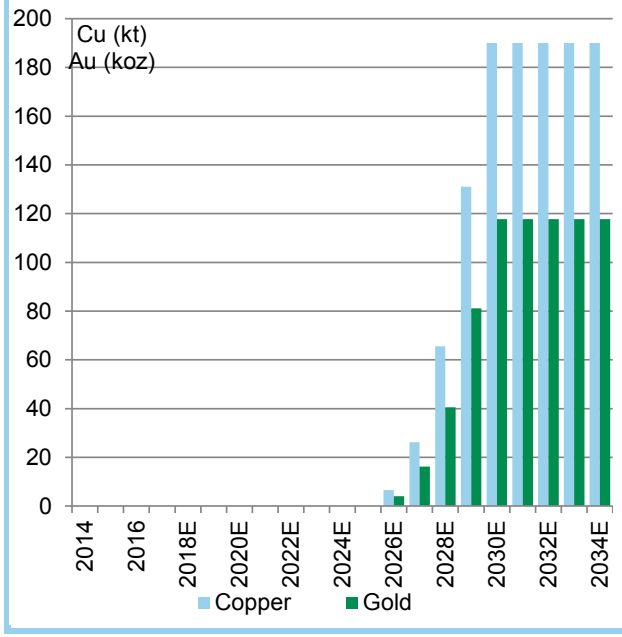
Exhibit 106: El Arco

El Arco	Mexico	169 ktpa	US$3,200 mn	11% IRR

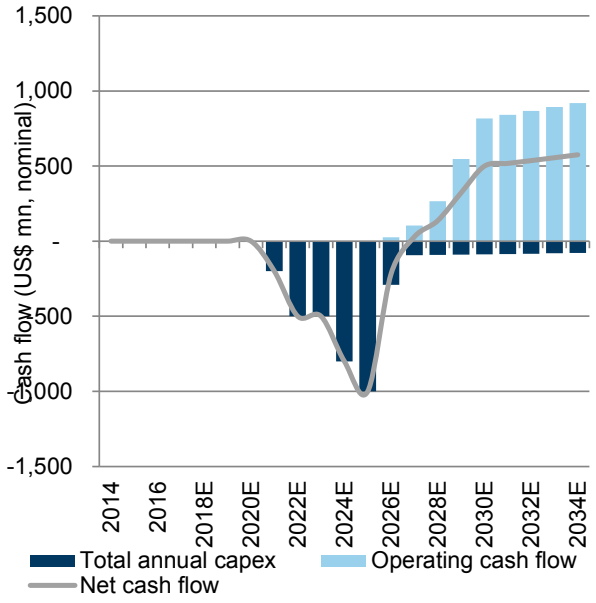
El Arco is a copper deposit located in the central part of the Baja California peninsula with ore reserves over 2.7bn tonnes. Copper grade is c. 0.4% and gold grade is 0.11g/t. The project includes an open-pit mine combining concentrator and SX-EW operations with an estimated production of 190Kt of copper and 105Koz of gold. The company since 2015 has been conducting exploration activities and the plan remains to continue to conduct those this year. In addition, Southern Copper will begin an engineering study to define optimization alternatives for the project and update the feasibility study, besides further analysis in the electrical energy supply. There are no capex estimates for the mine, as such based on our analysis, we assume capex of US$3.2bn (this includes an escalation of US$200mn). We assume first capex spend in 2021 with the mine beginning commercial production by 2026 and reaching full capacity by 2030.



Production profile



Cash flow chart



Economics summary

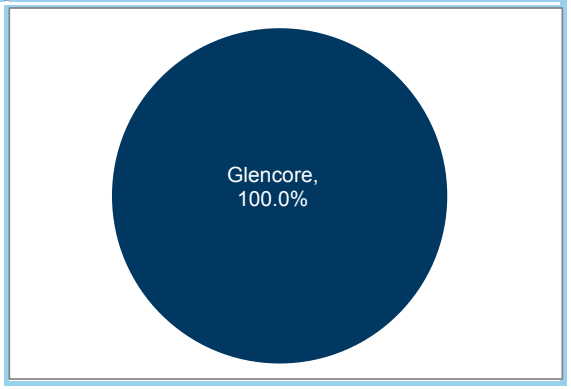
Internal rate of return	11%
NPV (including sunk costs)	US$890
NPV (2018+)	US$890
Cu required @ 12%	US$4,870 /t
Capex	US$3,200 mn
Capex / t Cu production	US$18,955
Capex / t Cu equ. production	US$16,936
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	2,700 mt
Copper grade	0.40% Cu
Contained copper	10,773 kt
Commissioning	2026
Peak copper production	190 ktpa
Average LOM production	169 ktpa
Life of mine	25+
Gross unit cost	US$3,970 /t
Net unit cost (C1)	US$3,182 /t

Source: Company data, Goldman Sachs Global Investment Research

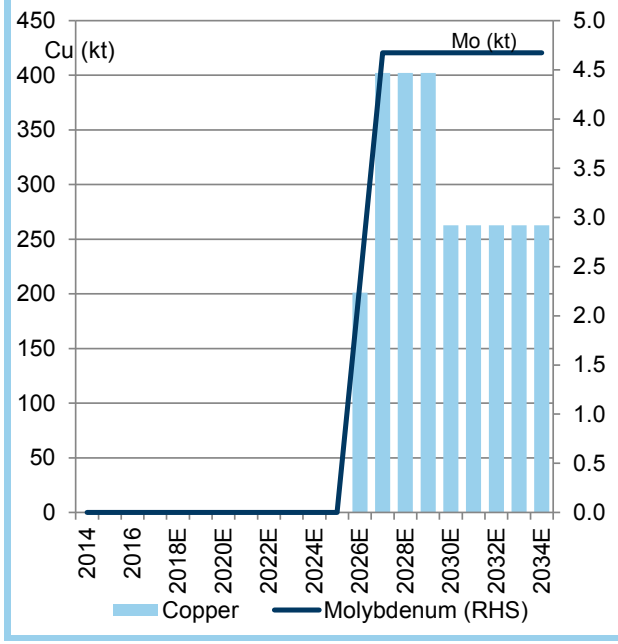
Exhibit 107: El Pachon

El Pachón	Argentina	277 ktpa	US$4,500 mn	13% IRR

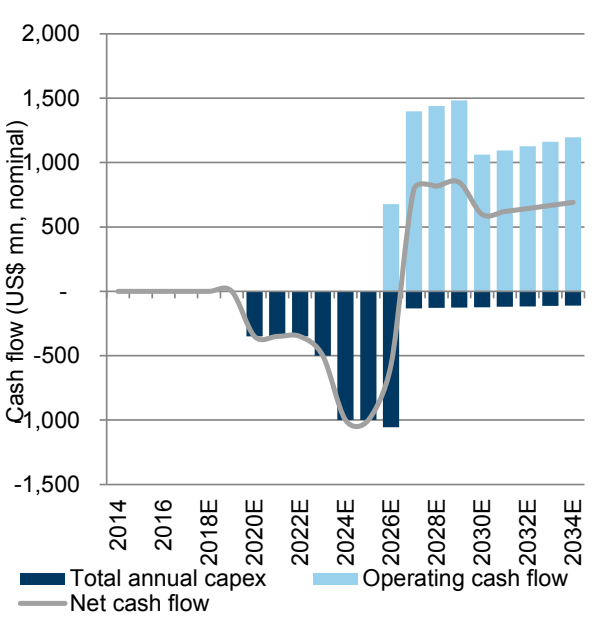
Glencore acquired the El Pachón asset as part of its Falconbridge acquisition in 2006. The mine is situated in west Argentina. The next steps would include completing the environmental and social impact assessment and progressing the feasibility study. Once complete, the project team would need to present the EIA to the relevant authorities in Argentina and Chile (given the copper will be shipped from Chile as the project falls under the Mining Integration Treaty signed in 1997 by Argentina and Chile). The environmental requirements for the project have been made more stringent with the passing of legislation that requires miners to perform an inventory of glacial ice before constructing. Glencore's last guided capex estimate was US$4.1 bn for the development of the mine. The company has guided to total production of 400 ktpa of copper for the first five years of operations, along with silver and molybdenum by-products. There has been no update from the company regarding this project of late, although there has been recent comments from Argentina's San Juan government for Glencore to decide whether to develop the project. As a result, we see elevated risk of delays to previous plans and a potential change in ownership. We delay the project start by 2 years (from 2024-2026) and see low probability that the project comes online.



Production profile



Cash flow chart



Economics summary

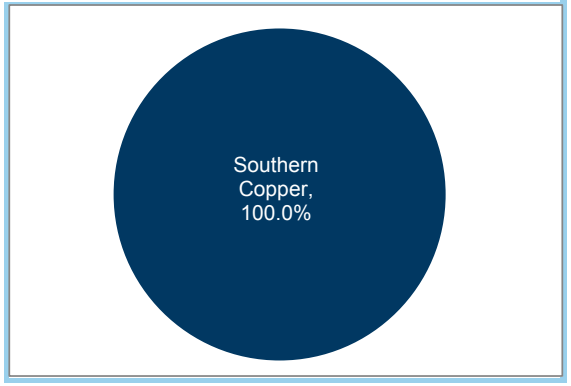
Internal rate of return	13%
NPV (including sunk costs)	US$1,699
NPV (2018+)	US$1,699
Cu required @ 25%	US$10,029 /t
Capex	US$4,500 mn
Capex / t Cu production	US$16,243
Capex / t Cu equ. production	US$15,878
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	1,590 mt
Copper grade	0.55% Cu
Contained copper	8,745 kt
Commissioning	2026
Peak copper production	402 ktpa
Average LOM production	277 ktpa
Life of mine	25+
Gross unit cost	US$3,860 /t
Net unit cost (C1)	US$3,534 /t

Source: Company data, Goldman Sachs Global Investment Research

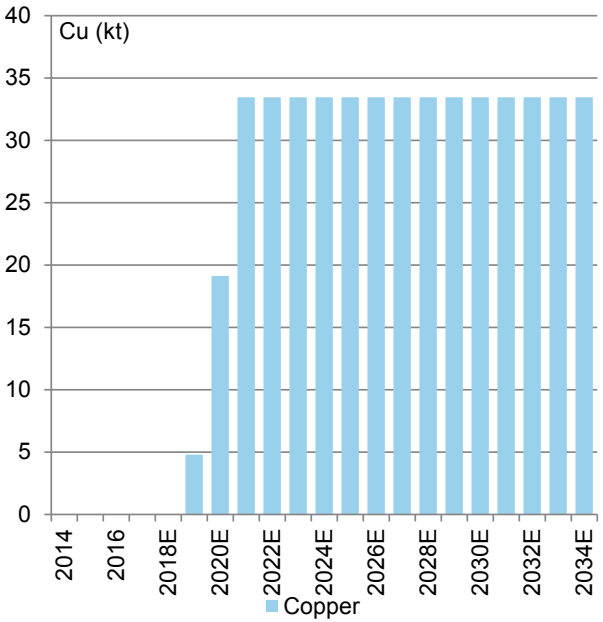
Exhibit 108: El Pilar

El Pilar	Mexico	31 ktpa	US$179 mn	32% IRR

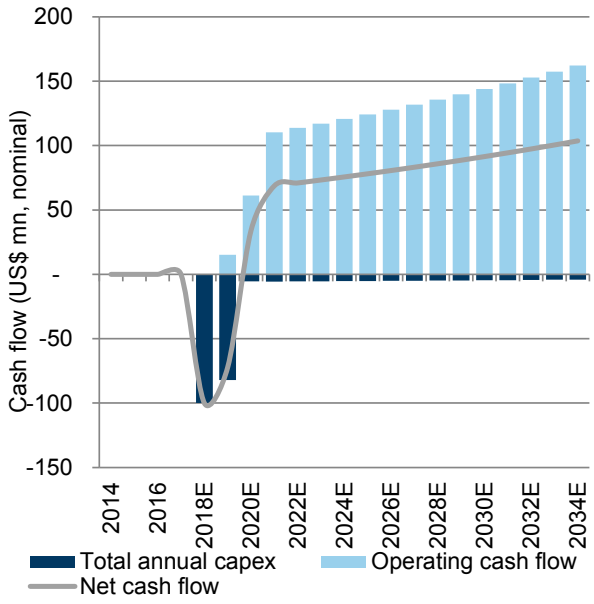
El Pilar, located in the state of Sonora, Mexico, is a greenfield open pit copper project. Southern Copper, the sole owner of the project, acquired the mine from Mercator Minerals Ltd. in July 2015 for a total consideration of US$100 mn cash. El Pilar is located about 45 km from Southern Copper's existing Buenavista mine. A feasibility study for the mine was published in 2011 and updated in 2012. The project envisages a conventional open-pit mine and a SX-EW plant producing 35 ktpa of copper cathodes over an initial 14-year mine life. As per the latest resource statement, the mine contains 325 Mt of ore, with copper content of 0.29%. The company was initially guiding for first production in 2018 with total capex of US$300 mn, however faced delays. According to the latest announcement by the company, it is looking to spend c. US$159 mn at the project to bring it into production next year (our estimate adjusts for inflation). The ore will be transported by truck from the pit to the primary crushers of the La Caridad concentrator. This will increase the over-all mineral ore grade (from 0.34% at La Caridad to 0.78% expected from Pilares). The company is currently preparing the mine plan and expects production to start in 2019.



Production profile



Cash flow chart



Economics summary

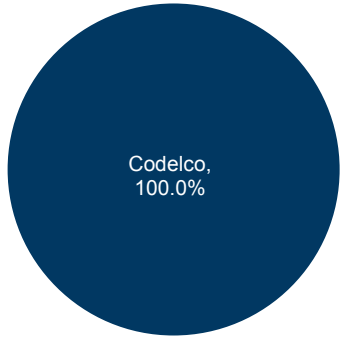
Internal rate of return	32%
NPV (including sunk costs)	US$409
NPV (2018+)	US$409
Cu required @ 12%	US$4,765 /t
Capex	US$179 mn
Capex / t Cu production	US$5,818
Capex / t Cu equ. production	US$5,818
Project type	Greenfield
Project status	Construction
Ore reserves / resources	295 mt
Copper grade	0.29% Cu
Contained copper	859 kt
Commissioning	2019
Peak copper production	33 ktpa
Average LOM production	31 ktpa
Life of mine	16
Gross unit cost	US$3,179 /t
Net unit cost (C1)	US$3,179 /t

Source: Company data, Goldman Sachs Global Investment Research

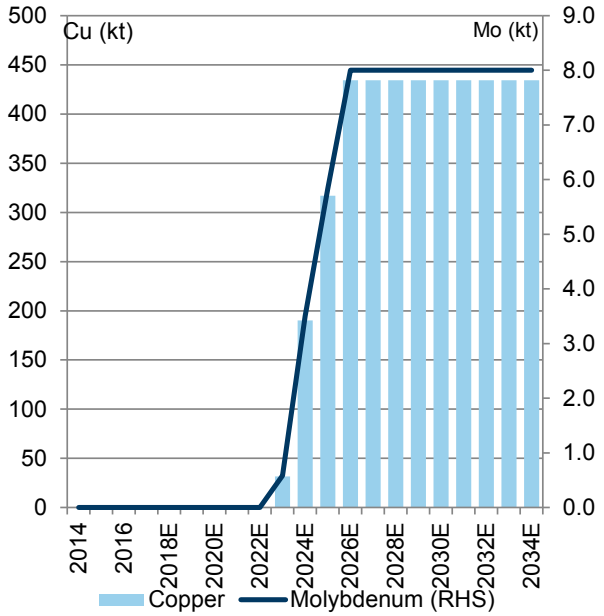
Exhibit 109: El Teniente NNM

El Teniente NNM	Chile	407 ktpa	US$5,100 mn	13% IRR

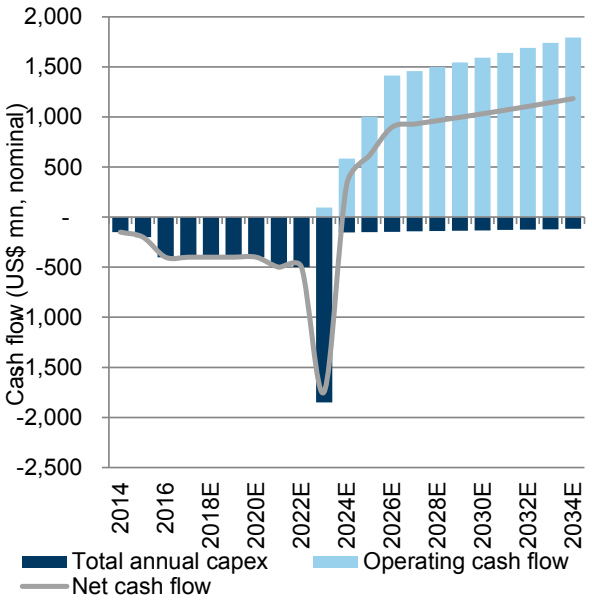
The El Teniente mine is located in Chile, about 150 km south of Santiago, and is the world's largest underground copper mine. The operation is wholly owned by Codelco. By the beginning of 2018 the El Teniente Division was facing short and medium term significant copper production challenges - copper production in 2017 was down from 475Kt (in 2016) to 464Kt. This is due to both copper grades going down and the depletion of some of the current exploitation areas. To address this, the company is working on both the development of the NNM (Nuevo Nivel Mina) that to Dec 2017 had an advance of 44.6% and the ramp up is expected for 2023 and the development of other mines/projects. To offset the lower head grades, the Colon concentrator could be marginally expanded to 143.5kt/d ore. The NNM project is not an expansion programme, rather it is a medium term structural project intended to prolong production at El Teniente for an additional 50 years, allowing the Division to maintain copper production of around 400kt/a. We believe that risks are skewed to the downside on the mine transitioning smoothly on the guided timeline. In July Codleco approved a US$2bn investment and revised capex for the project to US$5bn from US$3bn prior. First ore extraction is expected for 2023 including 35t/d of copper, rising to 140t/d as the mine becomes fully operational.



Production profile



Cash flow chart



Economics summary

Internal rate of return	13%
NPV (including sunk costs)	US$3,497
NPV (2018+)	US$4,720
Cu required @ 15%	US$7,460 /t
Capex	US$5,100 mn
Capex / t Cu production	US$12,530
Capex / t Cu equ. production	US$11,904
Project type	Brownfield
Project status	Construction
Ore reserves / resources	1,583 mt
Copper grade	0.68% Cu
Contained copper	10,764 kt
Commissioning	2023
Peak copper production	434 ktpa
Average LOM production	407 ktpa
Life of mine	28+
Gross unit cost	US$3,974 /t
Net unit cost (C1)	US$3,627 /t

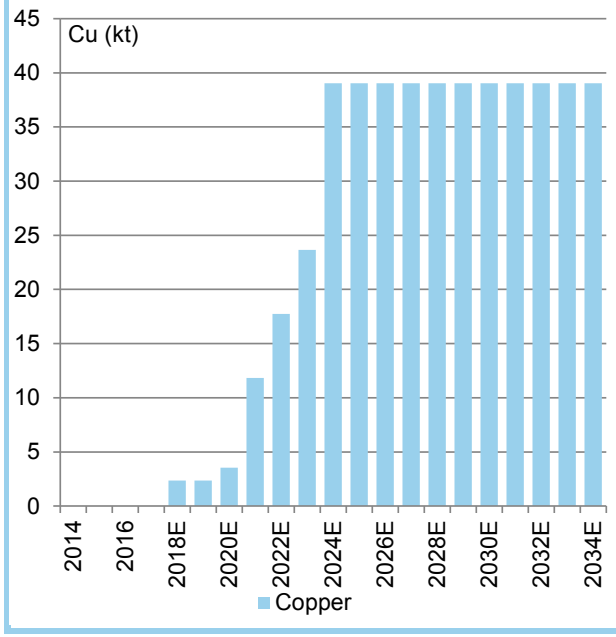
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 110: Florence Copper

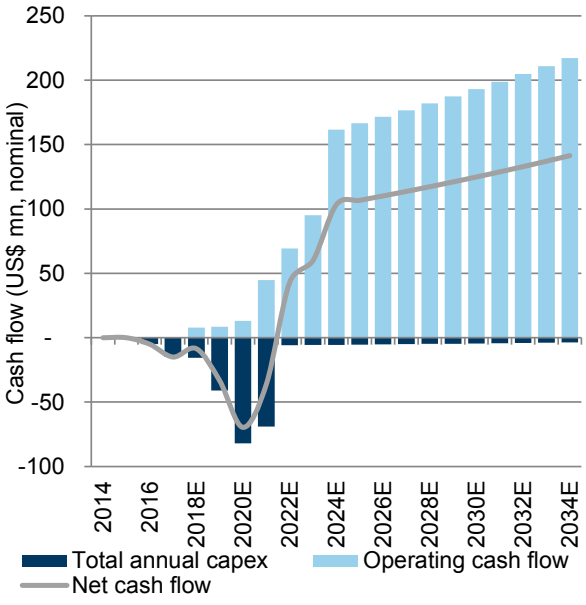
Florence Copper	USA	33 ktpa	US$220 mn	32% IRR

Florence Copper is a small copper project fully owned by Taseko Mines located in Phoenix USA. In September 2017, the company announced that it was moving forward with the construction of the Production Test Facility ("PTF") for the Florence Copper Project. The SX/EW plant and the associated wellfield, comprised of 24 production, monitoring, observation and point of compliance wells, will be built for approximately US$25 mn. The project is on-time and on budget with expenditures in the first quarter being approximately CAD$14.3mn or US$10.8 mn. The capex is guided to be c. US$210mn (we add US$20mn - inflation expectations). At full production the mine will produce c. 40ktpa of copper over a minelife of c. 20 years. The project has met every requirement by both the state and federal governments. The company forecasts that the project should start commercial production by 2Q18 and reach full production by FY20.

Production profile



Cash flow chart



Economics summary

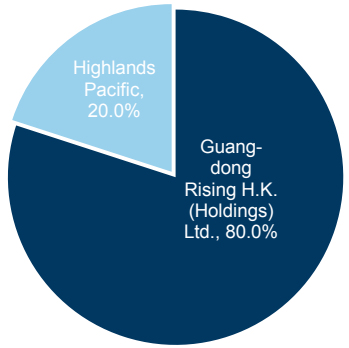
Internal rate of return	32%
NPV (including sunk costs)	US$885
NPV (2018+)	US$905
Cu required @ 10%	US$4,870 /t
Capex	US$220 mn
Capex / t Cu production	US$6,576
Capex / t Cu equ. production	US$6,576
Project type	Greenfield
Project status	Construction
Ore reserves / resources	345 mt
Copper grade	0.36% Cu
Contained copper	1,242 kt
Commissioning	2018
Peak copper production	39 ktpa
Average LOM production	33 ktpa
Life of mine	21
Gross unit cost	US$2,729 /t
Net unit cost (C1)	US$2,729 /t

Source: Company data, Goldman Sachs Global Investment Research

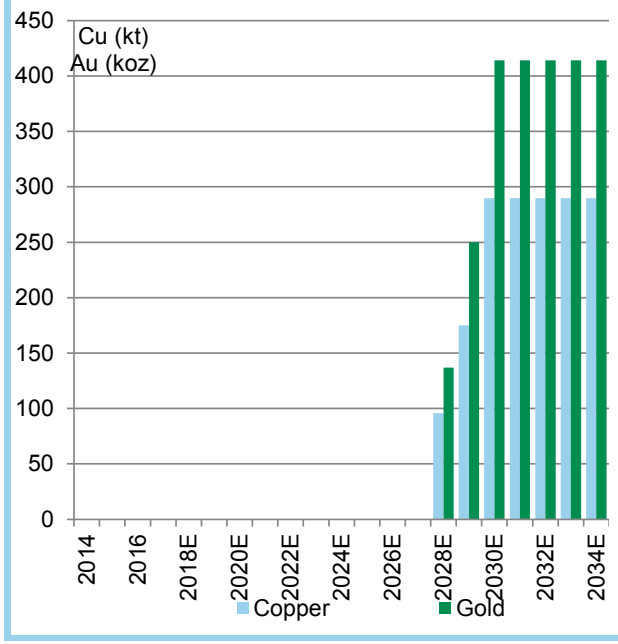
Exhibit 111: Frieda River

Frieda River	PNG	167 ktpa	US$3,800 mn	19% IRR

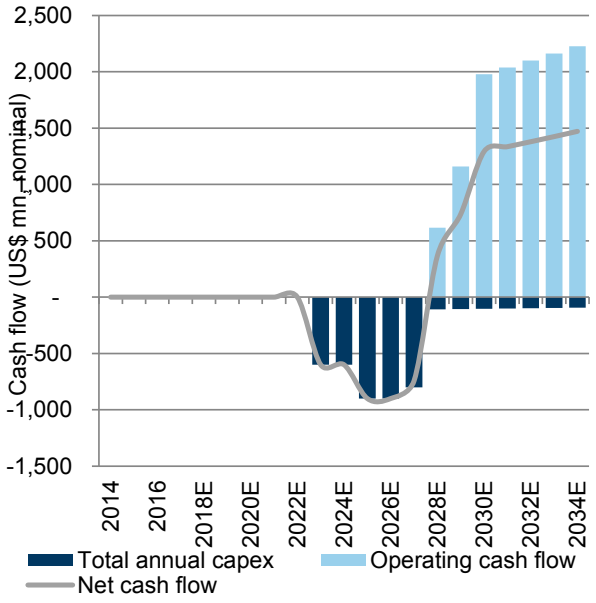
The Frieda River mine is a greenfield copper project located in north-west Papua New Guinea, owned 80% by Guangdon Rising Asset Management and 20% by Highlands Pacific. In May 2016, the feasibility study for the project was completed, and subsequently amended in April 2017. The 2017 feasibility study update envisages an open pit mine and a conventional processing plant with throughout of 40 mtpa. In August 2018 Highlands released a project update with an altered project scope to integrate the Government of PNG's development strategy plan. The revised mine scope supports a mine life in excess of 30 years by leveraging thrid party shared-use infrastructure. It envisages logistics and infrastructure connecting the open-pit mine to the Vanimo Ocean Port with a concentional flotation process plant treating over 40mtpa of ore. A 320 km buried pipeline will transport ore to the port. Peak concentrate production is expected at 290kt copper and 360koz gold. PanAust expects to complete the feasibility study and EIS by December quarter 2018. Hydroelcetric power will help PMG meet its target of 100% renewable enrgy supply by 2050. Given the latest developments, we believe that our previous timeline of capex start by 2021 and first production by 2025 is a bit too optimistic. We delay capex start assumption by 2 years and consequently our production start also gets delayed.



Production profile



Cash flow chart



Economics summary

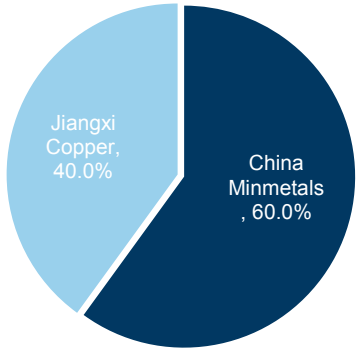
Internal rate of return	19%
NPV (including sunk costs)	US$2,361
NPV (2018+)	US$2,361
Cu required @ 25%	US$8,499 /t
Capex	US$3,800 mn
Capex / t Cu production	US$22,782
Capex / t Cu equ. production	US$17,861
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	686 mt
Copper grade	0.50% Cu
Contained copper	3,430 kt
Commissioning	2027
Peak copper production	290 ktpa
Average LOM production	167 ktpa
Life of mine	17
Gross unit cost	US$3,227 /t
Net unit cost (C1)	US$1,409 /t

Source: Company data, Goldman Sachs Global Investment Research

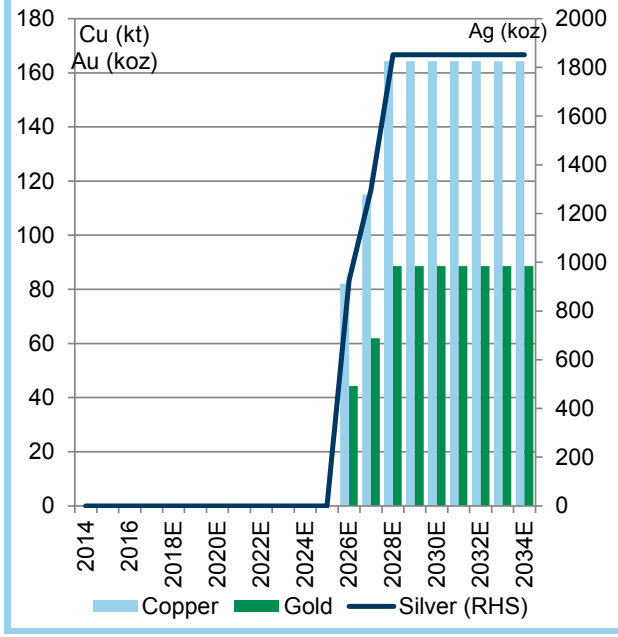
Exhibit 112: Galeno

Galeno	Peru	157 ktpa	US$2,700 mn	15% IRR

The Galeno deposit is a greenfield copper project located in the Yanacocha mining district of northern Peru, with gold as a by-product. Following the purchase of Northern Peru Copper (NPC) by China Minmetals, the ownership of the mine is shared between Jiangxi Copper (40%) and Minmetals (60%). Following the acquisition, Minmetals pledged to invest US$2.5 bn in the project. The company's capex estimate has since been revised upwards to US$3.8-3.9 bn with the mine initially scheduled to start production in 2017 (which includes sustaining capex) . Given the JV partners' ability to commit capital, the main risk for the project, in its current state, is delays in obtaining the necessary permits. The project has faced opposition from local communities which has seen the timeline move backwards. Despite Peru's willingness to see copper projects greenlit, there has been very limited newsflow on this project in particular, with the local communities continuing to oppose the construction of the mine. As such we don't see the mine coming to production before 2026/27.



Production profile



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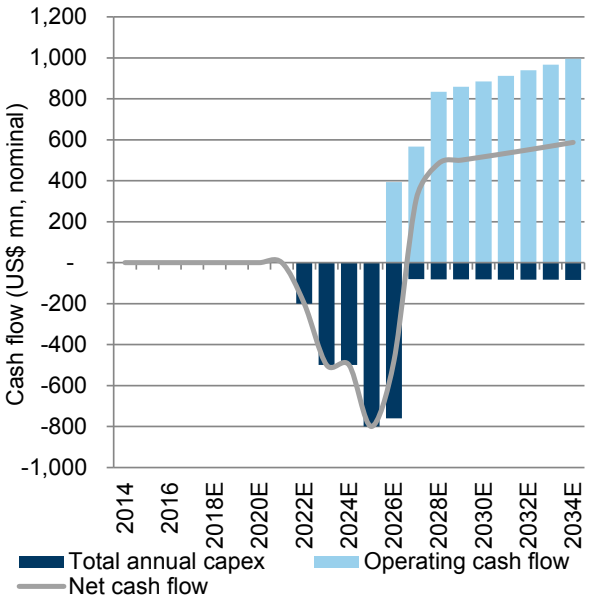


Economics summary

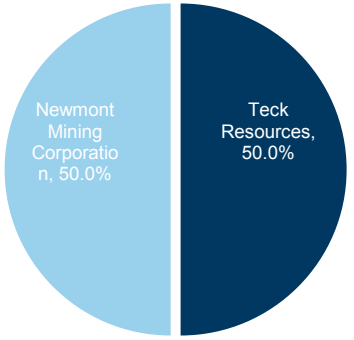
Internal rate of return	15%
NPV (including sunk costs)	US$1,252
NPV (2018+)	US$1,252
Cu required @ 15%	US$6,471 /t
Capex	US$2,700 mn
Capex / t Cu production	US$17,161
Capex / t Cu equ. production	US$14,288
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	661 mt
Copper grade	0.50% Cu
Contained copper	3,305 kt
Commissioning	2026
Peak copper production	164 ktpa
Average LOM production	157 ktpa
Life of mine	19
Gross unit cost	US$3,747 /t
Net unit cost (C1)	US$2,420 /t

Source: Company data, Goldman Sachs Global Investment Research

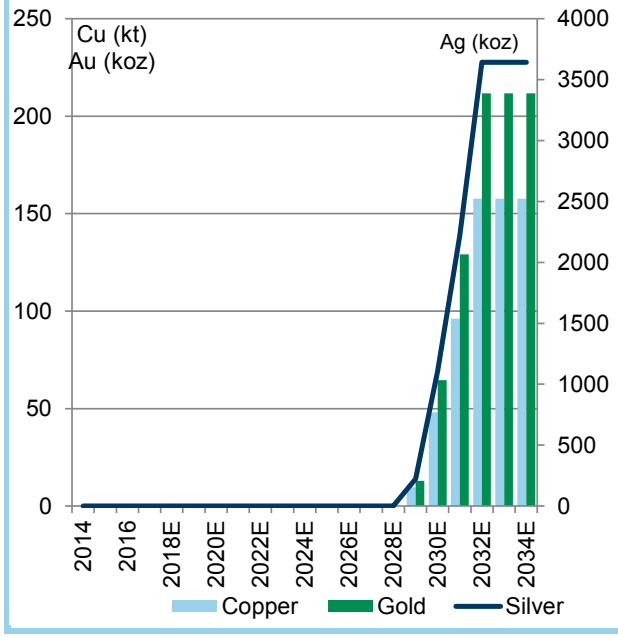
Exhibit 113: Galore Creek

Galore Creek	Canada	142 ktpa	US$5,460 mn	8% IRR

Galore Creek is a copper-gold-silver asset located in Tahltan nation in northwestern British Colombia, Canada. The project is owned by Teck Resources and Newmont Mining Company (following Novagold's sale of its 50% stake in the project in August 2018)- both of which own 50% of the project. According to the 2011 technical report, the mine has a significant resoure base of 4mn tonnes of copper, 8mn oz of gold and 136mn oz of silver. The capex guided to in the 2011 technical report was US$5.1bn (we escalate it by c. US$300mn) and the company expects production to stabalise at around 180Kt of copper, 190Koz of gold and 3.2Moz of silver. There has been limited newsflow on the project recently and given Teck is prioritising other projects in its portfolio whilst our balance sheet analysis suggests Newmont Mining Corporation may not have have sufficient funds to build the project on its own, we believe that the likelihood that the project comes online in the near future is slim. As such, we expect the first capex to be spent in 2021 with first production coming online in 2029. The probability of this project coming online is low, in our view.



Production profile



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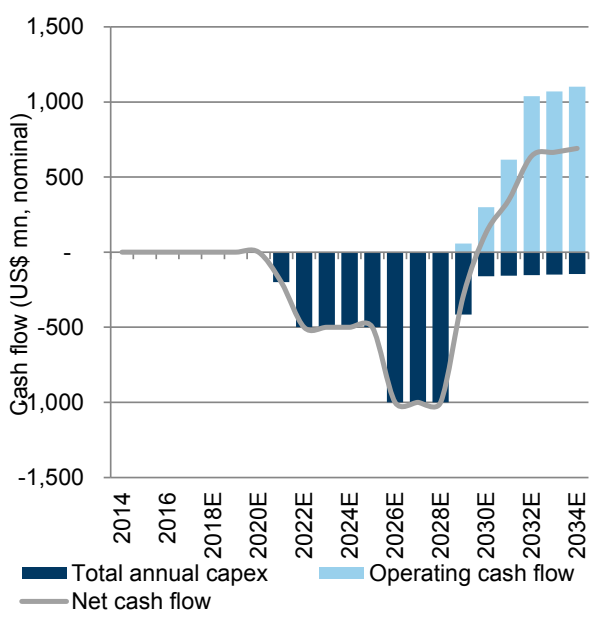


Economics summary

Internal rate of return	8%
NPV (including sunk costs)	-US$169
NPV (2018+)	-US$169
Cu required @ 10%	US$4,870 /t
Capex	US$5,460 mn
Capex / t Cu production	US$38,551
Capex / t Cu equ. production	US$29,614
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	528 mt
Copper grade	0.59% Cu
Contained copper	3,089 kt
Commissioning	2029
Peak copper production	158 ktpa
Average LOM production	142 ktpa
Life of mine	18
Gross unit cost	US$3,970 /t
Net unit cost (C1)	US$1,840 /t

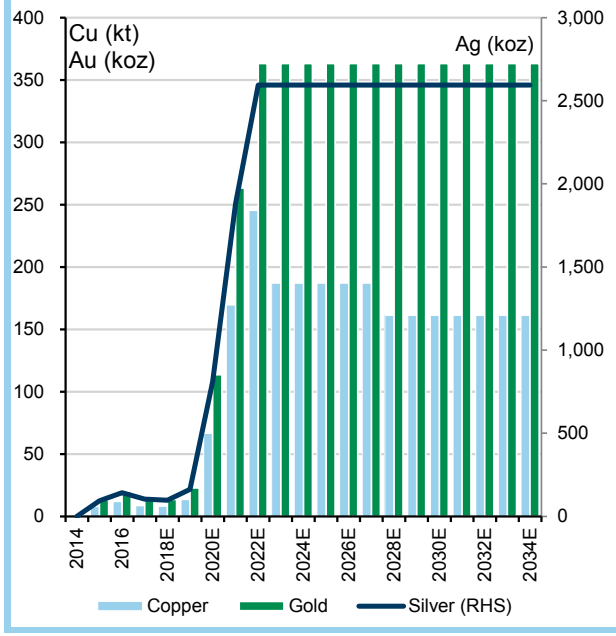
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 114: Grasberg DMLZ

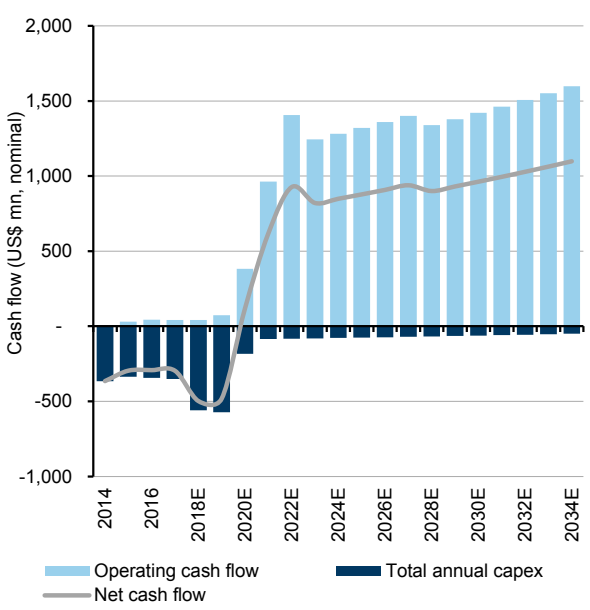
Grasberg DMLZ	Indonesia	125 ktpa	US$3,200 mn	13% IRR

The Grasberg mine is located in the highlands of the Sudirman Mountain Range in the province of Papua, Indonesia. The mine is operated under a 1995 JV between PT Freeport Indonesia (PT-FI), the operator, and Rio Tinto under which Rio Tinto receives 40% of production above specific levels until 2022 and 40% of all production after 2022. PT-FI is owned 90.64% by Freeport and 9.36% by the Government of Indonesia. Production from the open pit is set to come to an end in 2018, which is guided to be offset by the underground mine development. The Deep Mill Level Zone (DMLZ) Ore body lies below the Deep Ore Zone underground mine. Freeport expects the mine to reach its nameplate capacity of 80 ktpd in 2022. During 2018 the mine plan was revised and block cave mining activities are expected to begin at DMLZ in mid-2019. In 2016, the mine average throughput was 4.4 ktpd. Freeport expects the capital costs of the project to be in the order of US$3.2 bn. US$1.8bn aggregate project costs had been incurred through December 31, 2016. Given the latest uncertainties over exporting regulations and requirements by the Indonesian Government, in our view a suspension of the project is possible which could delay production. However, and in line with our view on the Block Cave project, we assume production to ramp-up according to schedule.

Production profile



Cash flow chart



Economics summary

Internal rate of return	13%
NPV (including sunk costs)	US$2,998
NPV (2018+)	US$5,346
Cu required @ 15%	US$7,180 /t
Capex	US$3,200 mn
Capex / t Cu production	US$25,562
Capex / t Cu equ. production	US$18,411
Project type	Brownfield
Project status	Construction
Ore reserves / resources	437 mt
Copper grade	0.92% Cu
Contained copper	4,009 kt
Commissioning	2015
Peak copper production	245 ktpa
Average LOM production	125 ktpa
Life of mine	21
Gross unit cost	US$3,179 /t
Net unit cost (C1)	US$453 /t

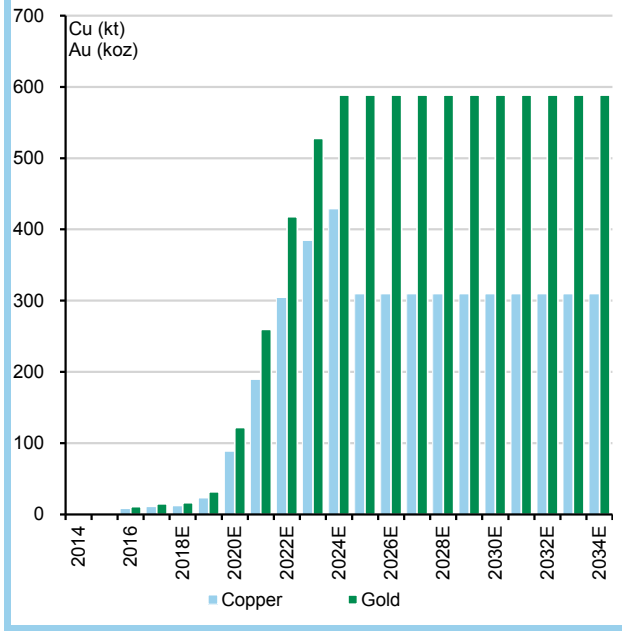
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 115: Grasberg BC

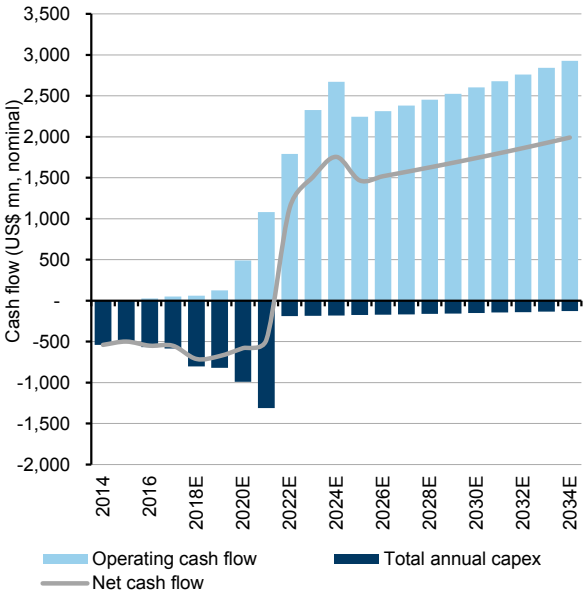
Grasberg BC	Indonesia	246 ktpa	US$6,700 mn	13% IRR

The Grasberg mine is located in the highlands of the Sudirman Mountain Range in the province of Papua, Indonesia (western half of the island of New Guinea). The mine is owned by Freeport (90.64%) and the Government of Indonesia (9.36%). The mine is operated under a 1995 JV between PT Freeport Indonesia (PT-FI), the operator, and Rio Tinto under which Rio Tinto receives 40% of production above specific levels until 2022 and 40% of all production after 2022. Production from the Grasberg Block Cave mine is expected to commence in 1H19 and gradually ramp up to full capacity by 2022, following the end of mining of the Grasberg open pit. In 2016, the mine average throughput was 2.7 ktpd. Freeport expects the capital costs of the project to be in the order of c.US$6.0 bn, we assume inflation (US$2.8 bn has been incurred by the end of December 2016). Current reserves total 964 mn tonnes at a grade of 1.03% copper and 0.78 g/t gold (c.45% of Freeport's reserves in Indonesia). Freeport expects the project to process 160 ktpd of ore at full capacity, producing c.470 ktpa of copper. However, given the latest uncertainties over long-term mining rights, delays to the project could be possible, in our view, while latest company guidance still implies production to start in 1H19.

Production profile



Cash flow chart



Economics summary

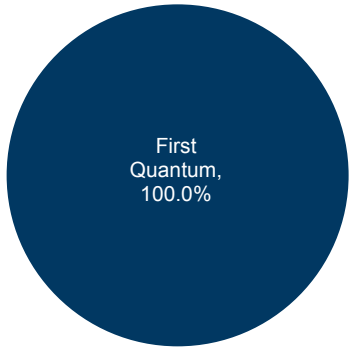
Internal rate of return	13%
NPV (including sunk costs)	US$5,817
NPV (2018+)	US$9,643
Cu required @ 15%	US$7,514 /t
Capex	US$6,700 mn
Capex / t Cu production	US$27,245
Capex / t Cu equ. production	US$20,363
Project type	Brownfield
Project status	Construction
Ore reserves / resources	963 mt
Copper grade	1.01% Cu
Contained copper	9,760 kt
Commissioning	2016
Peak copper production	429 ktpa
Average LOM production	246 ktpa
Life of mine	24
Gross unit cost	US$2,725 /t
Net unit cost (C1)	US$306 /t

Source: Company data, Goldman Sachs Global Investment Research

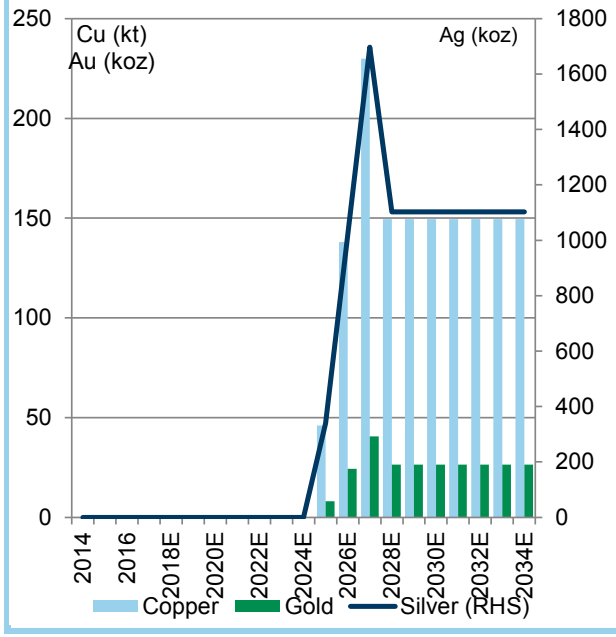
Exhibit 116: Haquira

Haquira	Peru	148 ktpa	US$2,500 mn	14% IRR

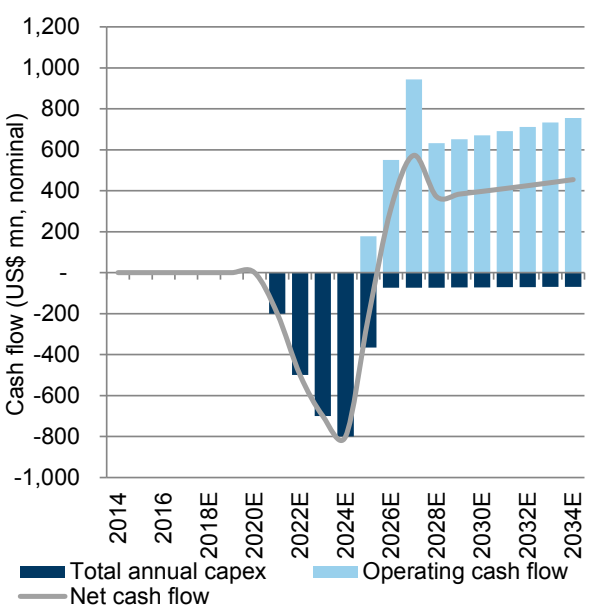
First Quantum owns 100% of the Haquira project through its acquisition of Antares Minerals in December 2010 for US$450 mn. The Haquira mine benefits from having near-surface secondary copper conducive to SX-EW leaching and also a higher grade underlying ore body that can be mineralised using more conventional processing methods. Antares previously estimated capex for the project to total US$2.06 bn; however, we believe there is upside to this estimate. This project was deprioritised, reflecting ongoing permitting delays and the primary focus to deliver the Sentinel and Smelter projects in 2014/15, with Cobre Panama to follow in 2017/18. Exploration activities at Haquira have been put on hold while the company concentrates on the community and environmental aspects of the project development. There has been little newsflow on the project and given that First Quantum is focused on the ramp-up of Cobre Panama - we believe that there is little chance that any progress is made on the project before 2020. We forecast first capex in 2021 with first production in 2025.



Production profile



Cash flow chart



Economics summary

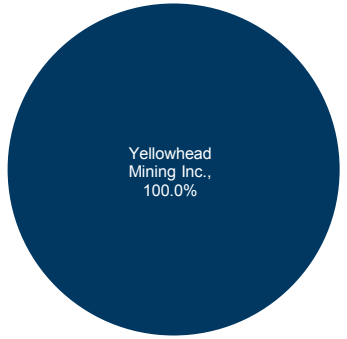
Internal rate of return	14%
NPV (including sunk costs)	US$1,211
NPV (2018+)	US$1,211
Cu required @ 15%	US$6,906 /t
Capex	US$2,500 mn
Capex / t Cu production	US$16,882
Capex / t Cu equ. production	US$15,275
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	569 mt
Copper grade	0.56% Cu
Contained copper	3,186 kt
Commissioning	2025
Peak copper production	230 ktpa
Average LOM production	148 ktpa
Life of mine	25
Gross unit cost	US$3,747 /t
Net unit cost (C1)	US$3,053 /t

Source: Company data, Goldman Sachs Global Investment Research

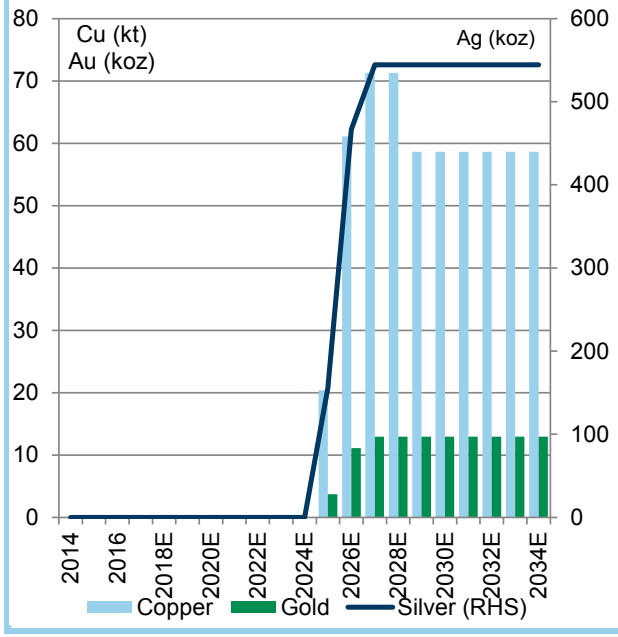
Exhibit 117: Harper Creek

Harper Creek	Canada	54 ktpa	US$960 mn	16% IRR

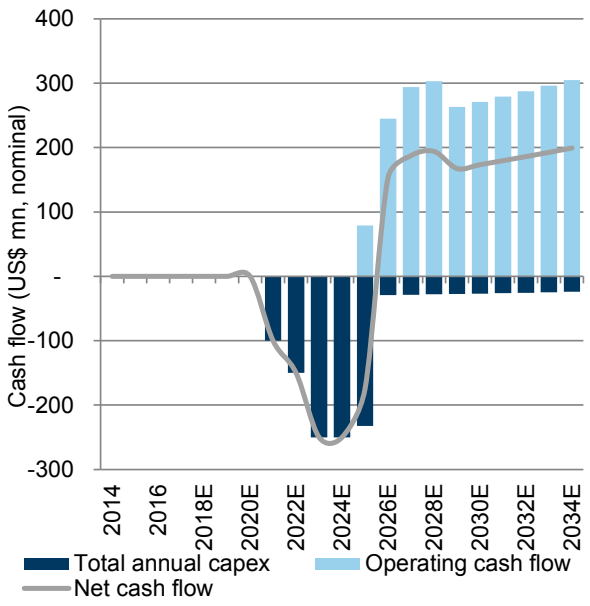
Harper Creek, 100%-owned by Yellowhead Mining Inc, is a proposed 70 ktpd throughput copper mine with a 28-year mine life located in British Columbia, Canada. The company submitted the Environmental Assessment application to the British Columbia Environmental Assessment Office on November 10, 2014. However, on October 1, 2015, the project was put on care and maintenance. The project has a four-year development period, with the first two years focused on environmental and construction permitting and the last two years were dedicated to construction. There has been some newsflow more recently - in mid-2017 the company engaged consultants to determine if the EA Application process could be successfully completed. In April 2018 the company had discussions with the BC EAO and in May 2018 the company requested an extension to April 15, 2019 to complete the environmental permitting. In July 2018 the BC Environment Ministry rejected the company's request for an extension. In August 2018 the company completed a rights offering to pay existing payables and provide working capital for the next 12 months. If the environmental permitting is not complete by April 2019, the entire EA application process will have to be redone. Given the lack of funding and other issues, we delay the start of the project (vs. our previous estimate) by 2 years to 2025.



Production profile



Cash flow chart



Economics summary

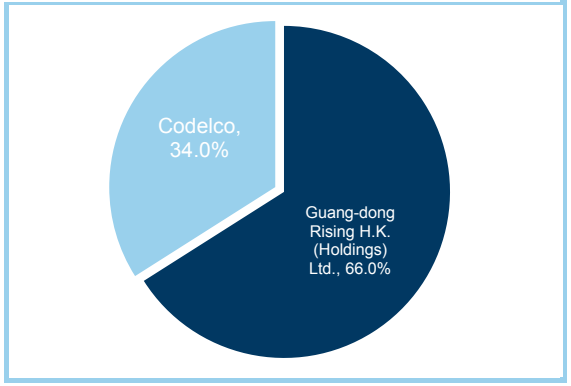
Internal rate of return	16%
NPV (including sunk costs)	US$613
NPV (2018+)	US$613
Cu required @ 10%	US$5,329 /t
Capex	US$960 mn
Capex / t Cu production	US$17,878
Capex / t Cu equ. production	US$16,767
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	716 mt
Copper grade	0.26% Cu
Contained copper	1,862 kt
Commissioning	2025
Peak copper production	71 ktpa
Average LOM production	54 ktpa
Life of mine	28
Gross unit cost	US$3,406 /t
Net unit cost (C1)	US$3,036 /t

Source: Company data, Goldman Sachs Global Investment Research

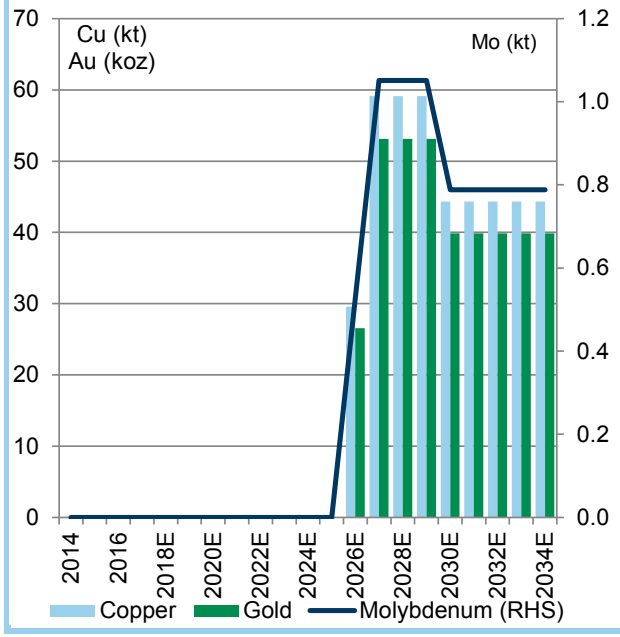
Exhibit 118: Inca de Oro

Inca de Oro	Chile	46 ktpa	US$1,000 mn	11% IRR

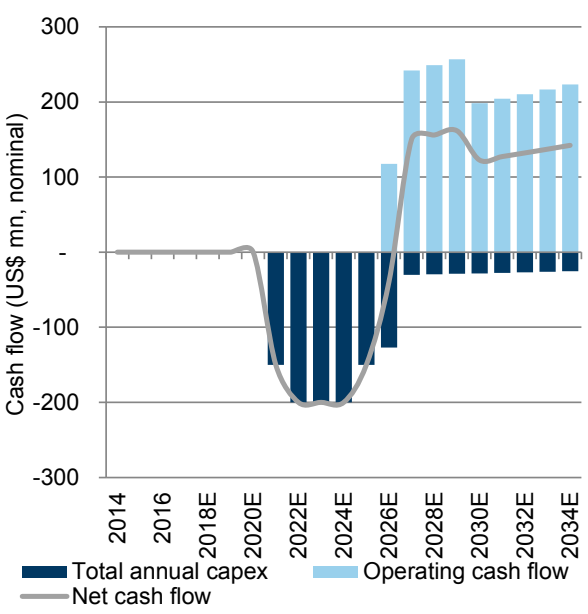
The Inca de Oro mine is located in northern Chile and is owned by Guangdong Rising (66%) and Codelco (34%). A pre-feasibility study demonstrated there was potential for an operation producing 50 ktpa of copper and 40 koz of gold over a 10+ year mine life. Guangdong and its JV partner announced in mid-2012 that they are unlikely to proceed with the development of the mine at a US$3.00 /lb copper price. In June 2015, PanAust was acquired by Guangdong Rising H.K. (Holdings) Ltd. The feasibility study for the project is based on average output of 50 ktpa of copper (60 ktpa in the first five years) and 40 koz of gold, with total capex of US$800 mn for mine and infrastructure and an additional US$107 mn for pre-stripping. A number of commercial matters that could have a material impact on the viability of the project are yet to be resolved with the stakeholders and no activities on the site are planned over the near term. Guangdong has said it is evaluating offers to sell its stake in the mine. Given the uncertainty associated with the project coupled with lack of recent exploration activities we delay the start of the project by 2 years vs our prior estimate and now assume a start in 2026. The probability of the project coming online is low, in our view.



Production profile



Cash flow chart



Economics summary

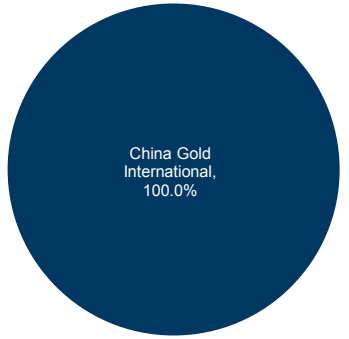
Internal rate of return	11%
NPV (including sunk costs)	US$220
NPV (2018+)	US$220
Cu required @ 15%	US$7,835 /t
Capex	US$1,000 mn
Capex / t Cu production	US$21,914
Capex / t Cu equ. production	US$17,903
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	259 mt
Copper grade	0.46% Cu
Contained copper	1,191 kt
Commissioning	2026
Peak copper production	59 ktpa
Average LOM production	46 ktpa
Life of mine	23
Gross unit cost	US$4,542 /t
Net unit cost (C1)	US$3,063 /t

Source: Company data, Goldman Sachs Global Investment Research

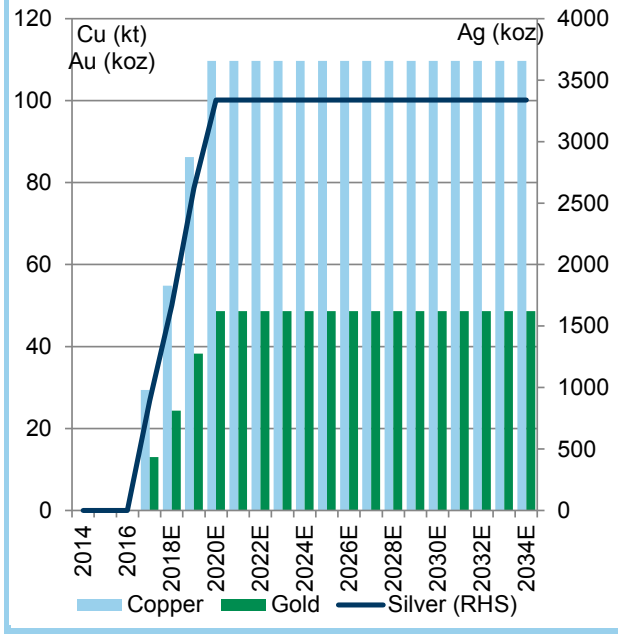
Exhibit 119: Jiama Phase II

Jiama Phase II	China	104 ktpa	US$736 mn	29% IRR

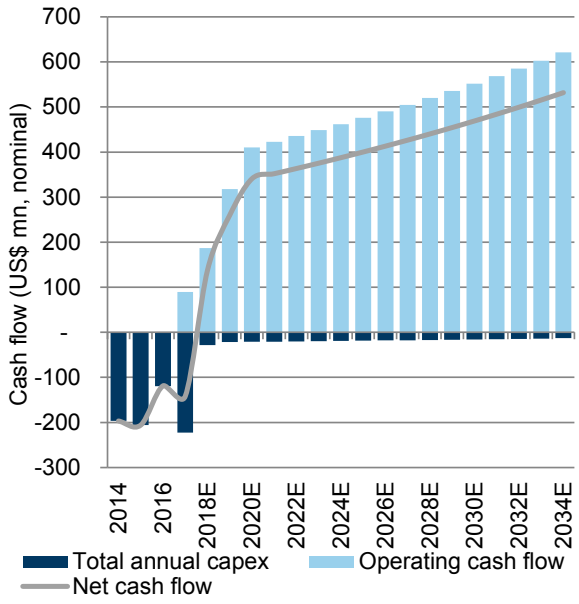
The Jiama Copper Project, owned by China Gold International Resources, is located in the Tibetan Autonomous Region of China. It is a polymetallic deposit containing copper, gold, silver, molybdenum, zinc and lead. The mining is done both on the surface (open-pit) and underground. The project has three types of copper-polymetallic mineralisation viz. Skarn, Hornfels and Porphyry. Phase I of the project started commercial production in September 2010 with a throughput of 6 ktpd. The company has reached commercial production at the mine's Phase II, Series I expansion which has seen processing capacity quardruple. The company continues to advance the mine's phase II Series II expansion - note that this was iced in 2015/16 given the low commodity prices. Construction of Series II is now complete and development and production testing is currently underway. On July 3 China Gold reported that it had achieved first commercial production for the series II expansion ahead of schedule. The company continues to ramp up oprations at Series II to full design capacity of 22kt/d.



Production profile



Cash flow chart



Economics summary

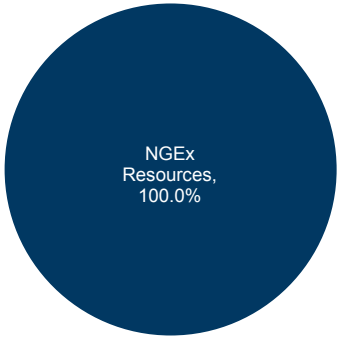
Internal rate of return	29%
NPV (including sunk costs)	US$3,945
NPV (2018+)	US$4,664
Cu required @ 15%	US$4,380 /t
Capex	US$736 mn
Capex / t Cu production	US$7,050
Capex / t Cu equ. production	US$5,495
Project type	Brownfield
Project status	Producing
Ore reserves / resources	429 mt
Copper grade	0.61% Cu
Contained copper	2,618 kt
Commissioning	2017
Peak copper production	110 ktpa
Average LOM production	104 ktpa
Life of mine	30
Gross unit cost	US$4,542 /t
Net unit cost (C1)	US$2,672 /t

Source: Company data, Goldman Sachs Global Investment Research

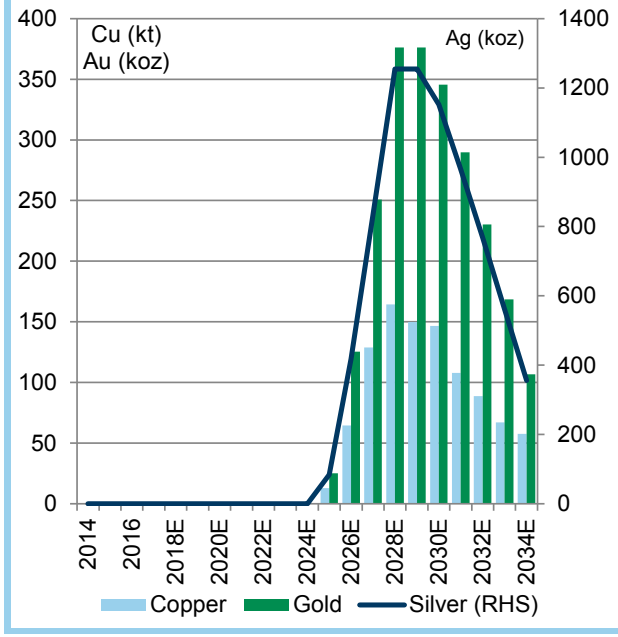
Exhibit 120: Josemaria

Josemaria	Argentina	130 ktpa	US$2,000 mn	11% IRR

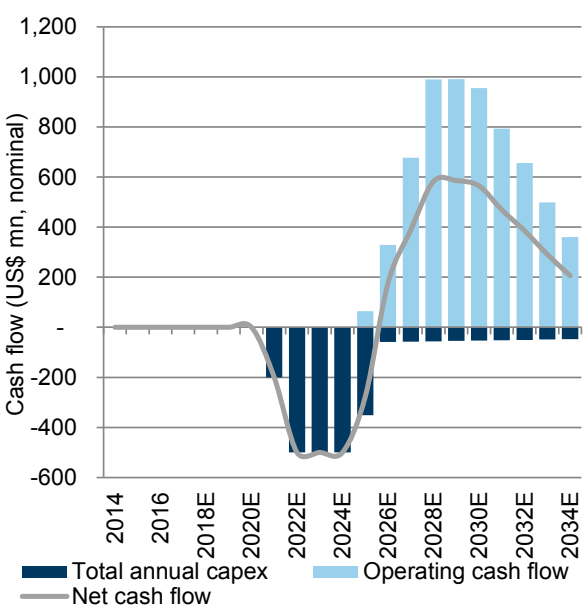
Josemaria, located in San Juan, Argentina, is a greenfield open pit copper-gold-silver mine. It is owned by NGEx Resources - the company acquired the 40% stake from JOGMEC in Nov. 2017. NGEx published a Preliminary Economic Assessment (PEA) in April 2016 for its Project Constellation, which combines Josemaria in Argentina followed by a block cave underground mine, Los Helados in Chile. The two projects are c.10 km apart and material from both deposits will be processed at a centralised facility. The combined LOM of Project Constellation is 48 years while that of Josemaria is 13 years, with average annual production of 130 ktpa of copper. More recently the company has said that it is looking to optimize and de-risk the project and explore options to advance each deposit towards eventual development, including active engagement with potential development partners or acquirers. The company is planning to conduct a pre-feasibility study on a standalone development scenario for Josemaria focusing on a simple open pit scenario with a shallow, high-grade starter pit. The company plans to initiate a pre-feasibility study on this concept, which it expects to be completed in 1Q19.



Production profile



Cash flow chart



Economics summary

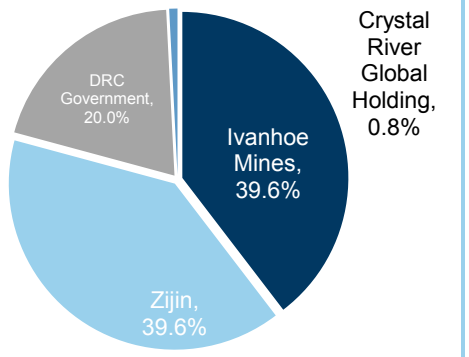
Internal rate of return	11%
NPV (including sunk costs)	US$318
NPV (2018+)	US$318
Cu required @ 25%	US$10,971 /t
Capex	US$2,000 mn
Capex / t Cu production	US$15,385
Capex / t Cu equ. production	US$11,359
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	1,066 mt
Copper grade	0.31% Cu
Contained copper	3,305 kt
Commissioning	2025
Peak copper production	164 ktpa
Average LOM production	130 ktpa
Life of mine	26+
Gross unit cost	US$4,769 /t
Net unit cost (C1)	US$2,174 /t

Source: Company data, Goldman Sachs Global Investment Research

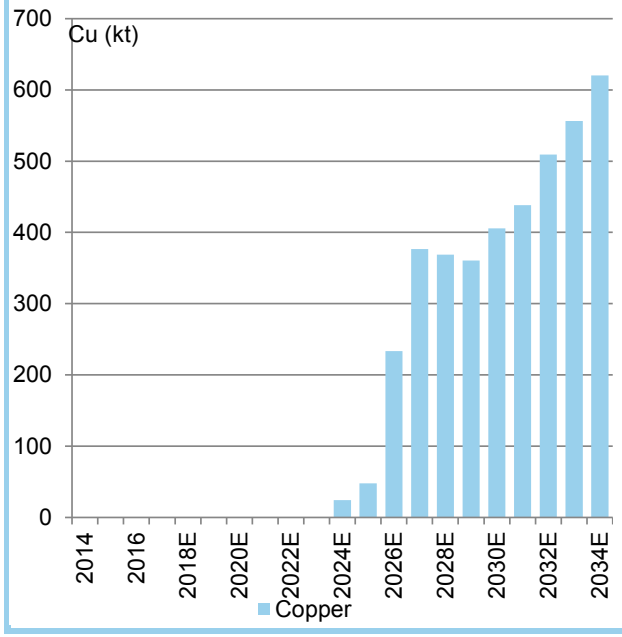
Exhibit 121: Kamoa-Kakula

Kamoa-Kakula	DRC	485 ktpa	US$2,500 mn	29% IRR

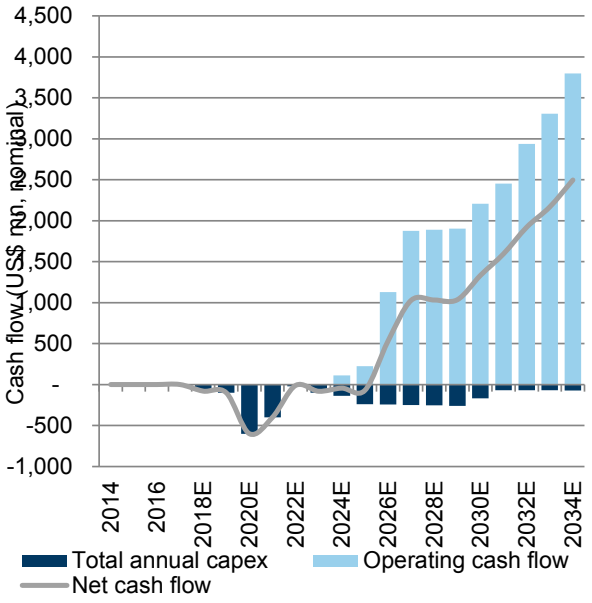
The Kamoa-Kakula deposit is located in the Central African copperbelt, approximately 25 km west of the town of Kolwezi. In November 2016, Ivanhoe and Zijin Mining signed a patnership agreement with the DRC government. The current ownership of the mine is Ivanhoe (39.6%), Zijin Mining (39.6%), DRC Government (20%) and Crystal Global River Ltd. (0.8%). In August 2012, the government granted the mining licences for the project. In May 2017, Ivanohe Mines announced that the company had completed an independently verified, updated Mineral Resource estimate for the high-grade Kakula discovery. The company recently has laid out 3 development scenarios: a) US$1.2bn plan which sees avg. copper production of 246Kt at a C1 cash cost of USc45/lb; b) A further US$1.2bn investment to expand the mine to 12mtpa (from 6mtpa) - this sees copper production rise to 690Kt; c) US$1bn investment to develop the Kansoko mine as a stand alone 6mtpa underground mine which would see copper production of c. 250Kt. Ivanhoe recently got investment from CITIC (if everything gets approved CITIC would own 20% of Ivanhoe) which we believe could expedite the process. We model the first scenario - but see the potential for further development as significant.



Production profile



Cash flow chart



Economics summary

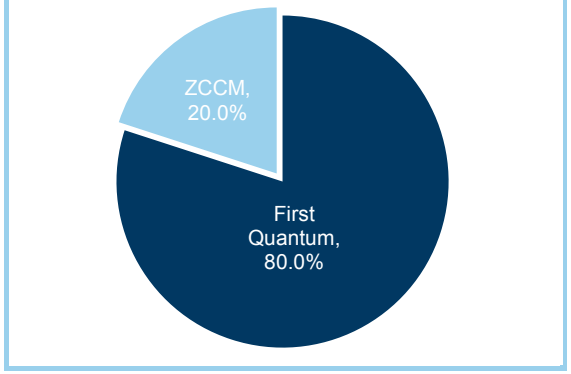
Internal rate of return	29%
NPV (including sunk costs)	US$10,370
NPV (2018+)	US$10,370
Cu required @ 25%	US$5,650 /t
Capex	US$2,500 mn
Capex / t Cu production	US$5,152
Capex / t Cu equ. production	US$5,152
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	1,340 mt
Copper grade	2.72% Cu
Contained copper	36,448 kt
Commissioning	2024
Peak copper production	623 ktpa
Average LOM production	485 ktpa
Life of mine	27+
Gross unit cost	US$2,384 /t
Net unit cost (C1)	US$2,384 /t

Source: Company data, Goldman Sachs Global Investment Research

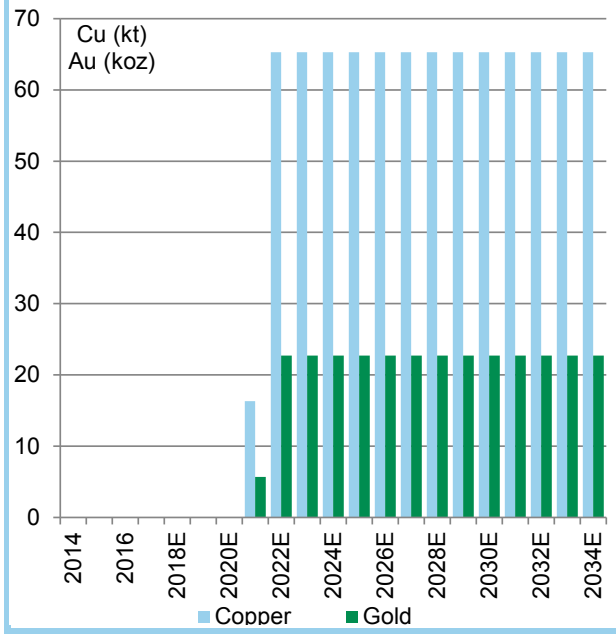
Exhibit 122: Kansanshi Sulpide

Kansanshi Sulphide	Zambia	62 ktpa	US$585 mn	21% IRR

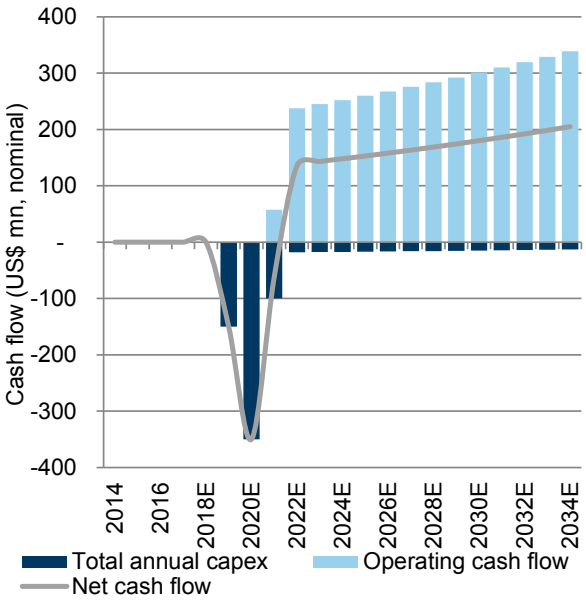
The Kansanshi mine is located in Zambia and has a shared ownership structure between First Quantum (80%) and ZCCM (20%). The sulphide expansion project is part of First Quantum's multi-stage plan for the mine to raise production to c.350-370 kt of copper (2015 253kt). The next step in the project is to commence construction of a new section of the plant capable of treating up to 25 mtpa of sulphide ore. We expect annual production from the expansion not before 2021 and to be in the range of 60-70kt of copper. The plant at Kansanshi already processes sulphide ore via a standard flotation to produce copper in concentrate. The company has guided to total capex of c.US$565 mn; we assume slight inflation given the extended period before first production. The company recently commented that it is looking to spend US$1bn in Zambia for expansion and ongoing mining projects - which we believe is a reference to this project. The project is essential in our vew as not only does it add production, it also could stem the fall in First Quantum's production, which we expect to happen in 2019/20.



Production profile



Cash flow chart



Economics summary

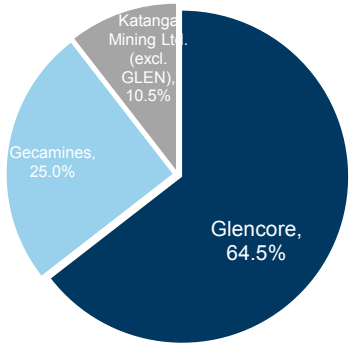
Internal rate of return	21%
NPV (including sunk costs)	US$553
NPV (2018+)	US$553
Cu required @ 15%	US$5,689 /t
Capex	US$585 mn
Capex / t Cu production	US$9,429
Capex / t Cu equ. production	US$8,836
Project type	Brownfield
Project status	Permitting
Ore reserves / resources	140 mt
Copper grade	0.78% Cu
Contained copper	1,092 kt
Commissioning	2021
Peak copper production	65 ktpa
Average LOM production	62 ktpa
Life of mine	15
Gross unit cost	US$3,406 /t
Net unit cost (C1)	US$2,963 /t

Source: Company data, Goldman Sachs Global Investment Research

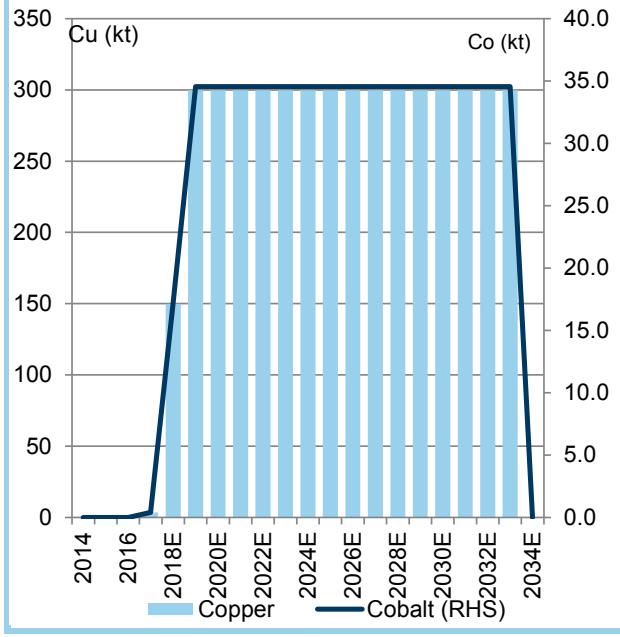
Exhibit 123: Katanga

Katanga	DRC	274 ktpa	US$1,159 mn	198% IRR

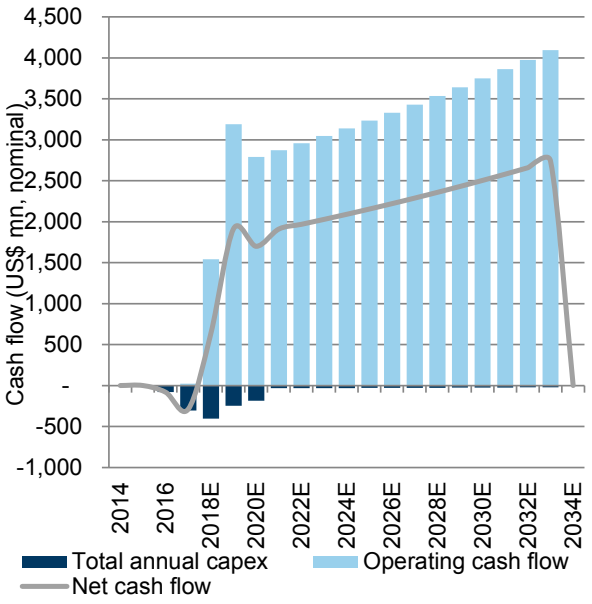
The Katanga operation is located in Democratic Republic of Congo (DRC) and has one of the world's largest contained copper in resources. The project is jointly owned by Katanga Mining Ltd. (Glencore owns 86.33% of KML) and Gecamines. Glencore decided to close the mine in September 2015 given the commodity price environment. Katanga completed its Phase 5 of expansion in December 2014 but given the power availability issues at DRC and the low copper price environment, its owners decided to convert it into a Whole Ore Leach (WOL) project, which started construction in May 2015 and is expected to be completed by 2H17. The mine has now reached commercial production and is ramping-up with the guidance for the full year 2018 being at 150Kt and 300Kt for 2019. The mine has recently faced legal and regulatory issues, including a claim from Gecamines which has now been resolved, yet some issues remain open. We still model the mine to achieve its targeted production.



Production profile



Cash flow chart



Economics summary

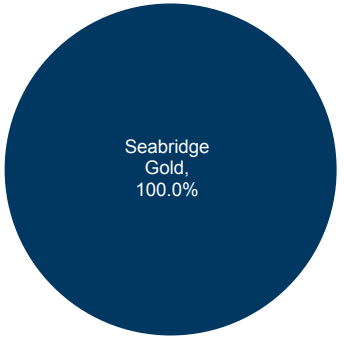
Internal rate of return	198%
NPV (including sunk costs)	US$17,184
NPV (2018+)	US$17,567
Cu required @ 25%	-US$1,243 /t
Capex	US$1,159 mn
Capex / t Cu production	US$4,237
Capex / t Cu equ. production	US$1,866
Project type	Brownfield
Project status	Construction
Ore reserves / resources	138 mt
Copper grade	3.51% Cu
Contained copper	4,847 kt
Commissioning	2017
Peak copper production	300 ktpa
Average LOM production	274 ktpa
Life of mine	17
Gross unit cost	US$6,211 /t
Net unit cost (C1)	-US$2,170 /t

Source: Company data, Goldman Sachs Global Investment Research

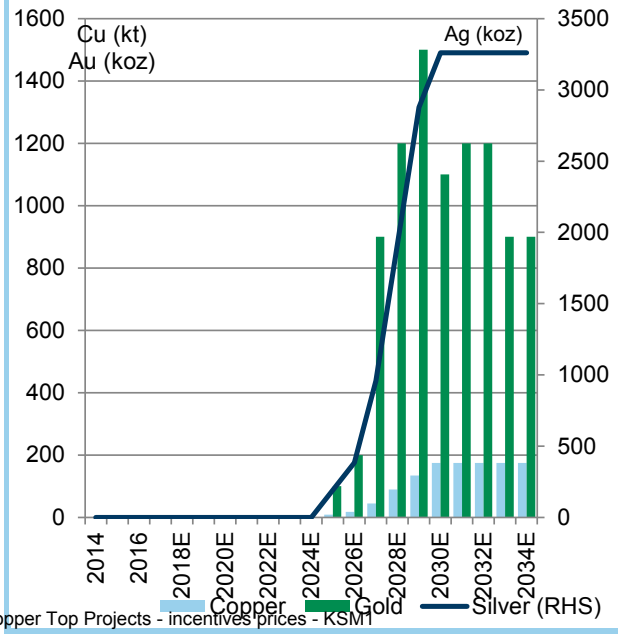
Exhibit 124: Kerr-Sulphurets-Mitchell

Kerr-Sulphurets-Mitchell	Canada	140 ktpa	US$5,800 mn	9% IRR

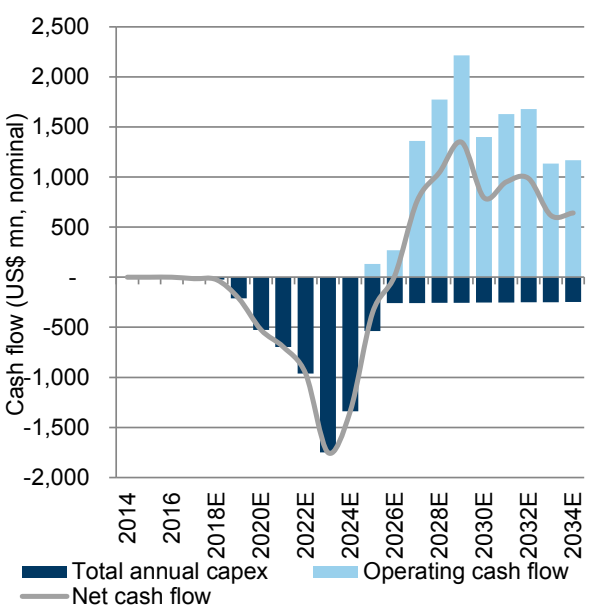
The Kerr-Sulphurets-Mitchell (KSM) project located in northern British Columbia, Canada is a combined open-pit and underground greenfield copper-gold project. The project has four mineral deposit zones: Kerr, Sulphurets, Mitchell and Iron Cap. In November 2016, Seabridge filed a Technical Report incorporating the updated pre-feasibility study and a PEA. According to this, the mine has c.2.2bn tonnes of of ore containing copper grade of 0.21%, 0.55 g/t of gold and 2.6 g/t of silver. The project envisages throughput of 170 ktpd for the first twenty years and 130ktpd for the next fifteen years and average copper and gold production being close to 130 ktpa and 600 koz over a mine life of about 50 years respectively. The first seven years are expected to produce 140 kt of copper and 1.2 mnoz of gold on average. In June 2017, the company received authorization for construction of Tailings Management Facility from the Canadian government. The company has continued to add resources to the project and has a c.US$20mn drilling programme planned for this year. However, given the amount of capex required for the project (US$5.5bn, but we assume inflation) - we believe it is unlikely that this comes online in the next few years.



Production profile



Cash flow chart



Economics summary

Internal rate of return	9%
NPV (including sunk costs)	US$496
NPV (2018+)	US$511
Cu required @ 10%	US$5,967 /t
Capex	US$5,800 mn
Capex / t Cu production	US$41,312
Capex / t Cu equ. production	US$18,852
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	2,198 mt
Copper grade	0.21% Cu
Contained copper	4,616 kt
Commissioning	2025
Peak copper production	175 ktpa
Average LOM production	140 ktpa
Life of mine	26+
Gross unit cost	US$9,083 /t
Net unit cost (C1)	-US$143 /t

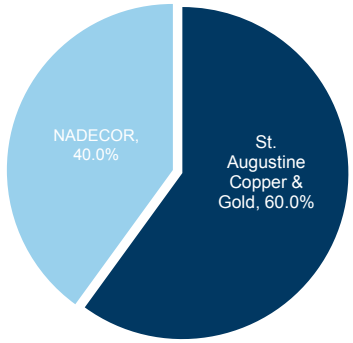
Copper Top Projects - incentives prices - KSM1 01/10/2018

Source: Company data, Goldman Sachs Global Investment Research

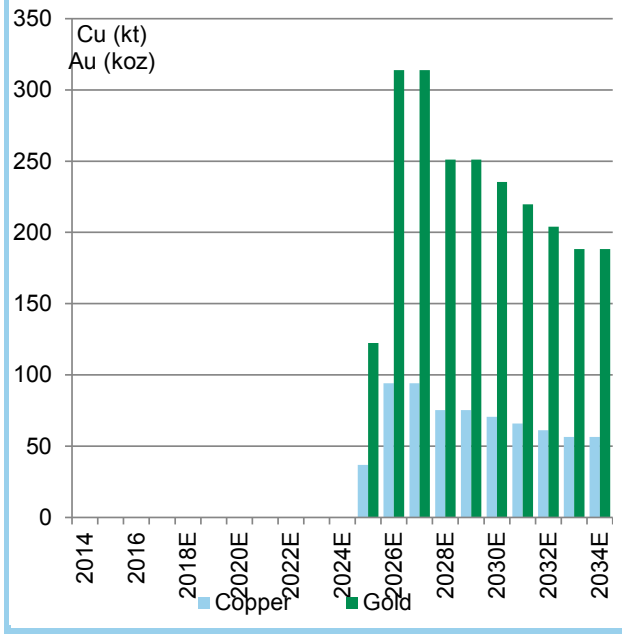
Exhibit 125: King King

King King	Philippines	61 ktpa	US$2,300 mn	12% IRR

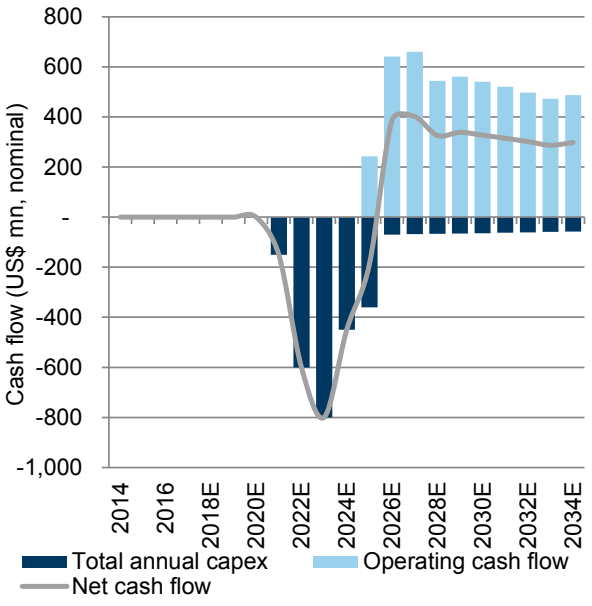
The King King project is a copper-gold project located in the Municipality of Pankutan, near Davao in the Philippines. The project is part of a Mineral Production Sharing Agreement (MPSA) between the Philippine government and Nationwide Development Corporation (NADECOR). St. Augustine Copper-Gold Ltd. (SAGCL) is responsible for the overall development of the project. The Philippines government has a 10% stake in the project through NADECOR and has the option of increasing it to 40%. A pre-feasibility study (PFS) was submitted in February 2013 and the Philippines government granted the project the Declaration of Mining Project Feasibility in January 2016. The MPSA was renewed for 25 years in August 2016. However, in 2017, the Department of Environment and Natural Resources mentioned King-King MPSA as of 75 MPSAs to have been recommended for cancellation. Given that there are considerable uncertainties surrounding the regulatory landscape and lack of any tangible funding for the project (based on company reports), we model first production from the mine in 2025, with the heap leach plant starting first followed by the concentrator and add slight capex inflation to the guided number while awaiting further details. The PFS envisages a 40 ktpd heap leach facility and a 60 ktpd concentrator with development capex of US$2.04 bn with a LOM of 23 years.



Production profile



Cash flow chart



Economics summary

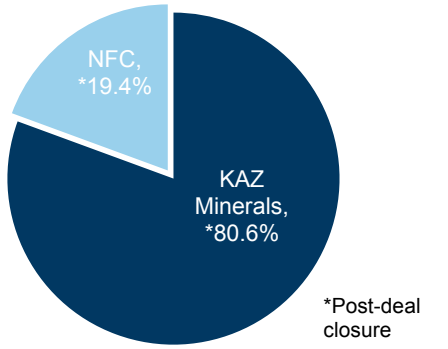
Internal rate of return	12%
NPV (including sunk costs)	US$683
NPV (2018+)	US$683
Cu required @ 25%	US$12,706 /t
Capex	US$2,300 mn
Capex / t Cu production	US$37,597
Capex / t Cu equ. production	US$22,900
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	618 mt
Copper grade	0.30% Cu
Contained copper	1,854 kt
Commissioning	2025
Peak copper production	94 ktpa
Average LOM production	61 ktpa
Life of mine	23
Gross unit cost	US$5,064 /t
Net unit cost (C1)	US$823 /t

Source: Company data, Goldman Sachs Global Investment Research

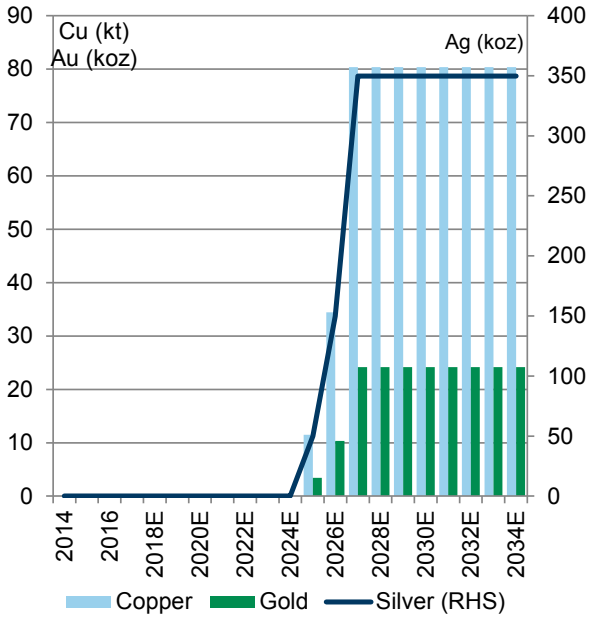
Exhibit 126: Koksay

Koksay	Kazakhstan	76 ktpa	US$1,700 mn	12% IRR

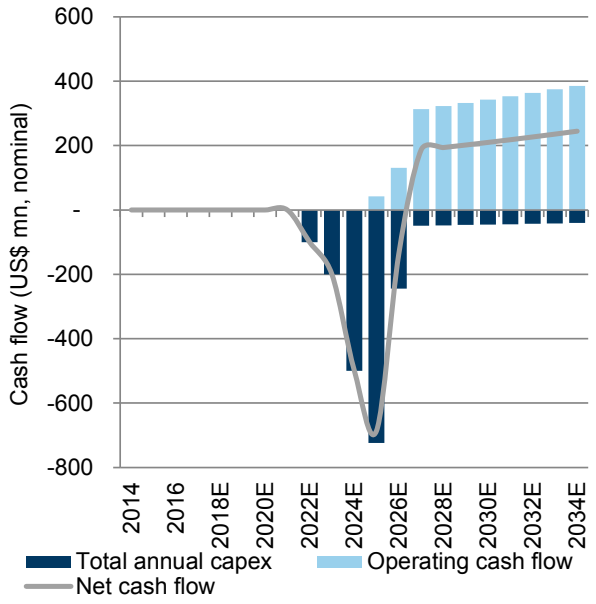
The Koksay copper project, located in southeastern Kazakhstan, was acquired by KAZ Minerals in June 2014 for US$260 mn and is currently being explored. According to the most recent estimates available, the annual production is c.80 ktpa of copper concentrate along with gold, silver and molybdenum by-products. The project had not received much attention. Newsflow from KAZ on the project had been thin until very recently when China Nonferrous Metal Industry's foreign engineering and construction company (NFC) announced it would invest US$70mn into the project. Following the closure of the deal (which is subject to regulatory approvals) NFC will own c. 20% stake in the mine. This investment will be ring-fenced for the development of the mine including a feasibility study which will determine the detailed design for mining and processing operations and the associated capital budget. The transaction is expected to be completed by 1H19 (according to the company) post which there will be a feasibility study conducted. Given this we don't expect a start date before 2025.



Production profile



Cash flow chart



Economics summary

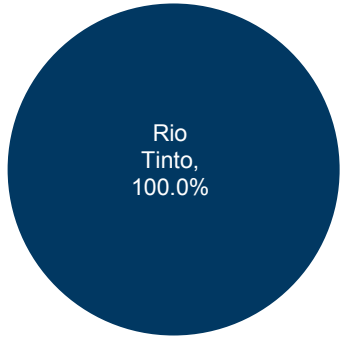
Internal rate of return	12%
NPV (including sunk costs)	US$413
NPV (2018+)	US$413
Cu required @ 12%	US$6,686 /t
Capex	US$1,700 mn
Capex / t Cu production	US$22,431
Capex / t Cu equ. production	US$20,411
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	587 mt
Copper grade	0.43% Cu
Contained copper	2,525 kt
Commissioning	2025
Peak copper production	80 ktpa
Average LOM production	76 ktpa
Life of mine	25
Gross unit cost	US$3,860 /t
Net unit cost (C1)	US$3,207 /t

Source: Company data, Goldman Sachs Global Investment Research

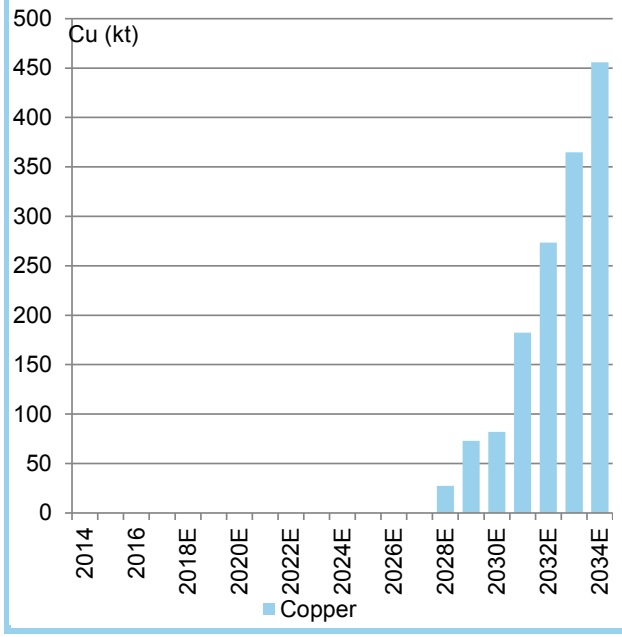
Exhibit 127: La Granja

La Granja	Peru	412 ktpa	US$7,500 mn	12% IRR

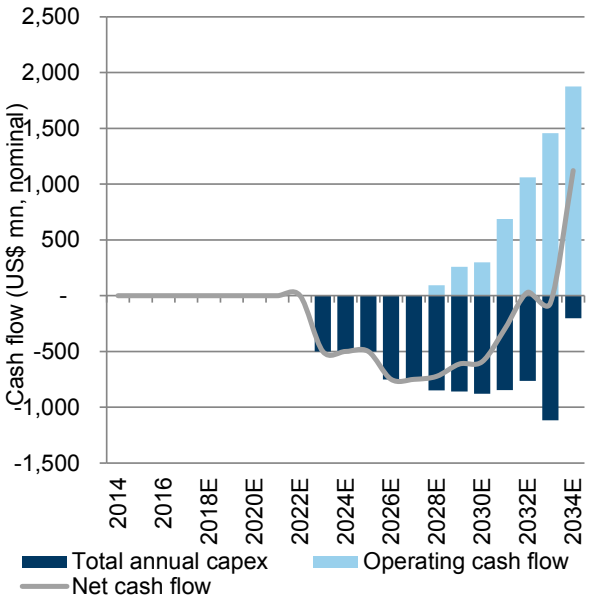
The La Granja project is one of the largest undeveloped copper deposits located in northeastern Peru. Rio Tinto obtained the La Granja concession in December 2005 and is currently in the pre-feasibility stage. The project has potential to produce 500 ktpa of copper with a mine life greater than 40 years. However, given the early stage of the project, we see risks to its timing as this relates to progressing through the engineering studies, obtaining the required permits and construction. La Granja will be an open pit operation and is planned to be developed in stages. Phase 1 will see an initial leach operation of c.80 ktpa, with phase 2 involving an expansion of the leach operation to c.140 ktpa. Phase 3 is expected to see the construction of a concentrator adding c.120 ktpa of capacity, with a second concentrator in phase 4 raising output to c.380 ktpa. A final phase further expanding the leaching operations could see output raised to 500 ktpa. There is no official capex guidance currently and we assume a capital intensity of c.US$14,150/t of production (average from our GS Copper Top Projects analysis) at this stage and delay the start date to 2027 as we expect the company to prioritise projects with lower capex requirements until we receive additional details from the company post completion of the pre-feasibility.



Production profile



Cash flow chart



Economics summary

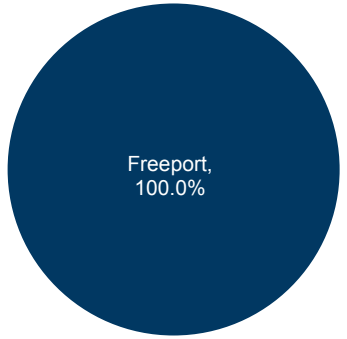
Internal rate of return	12%
NPV (including sunk costs)	US$1,612
NPV (2018+)	US$1,612
Cu required @ 15%	US$7,431 /t
Capex	US$7,500 mn
Capex / t Cu production	US$18,195
Capex / t Cu equ. production	US$18,195
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	4,320 mt
Copper grade	0.51% Cu
Contained copper	22,032 kt
Commissioning	2028
Peak copper production	501 ktpa
Average LOM production	412 ktpa
Life of mine	23+
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$3,633 /t

Source: Company data, Goldman Sachs Global Investment Research

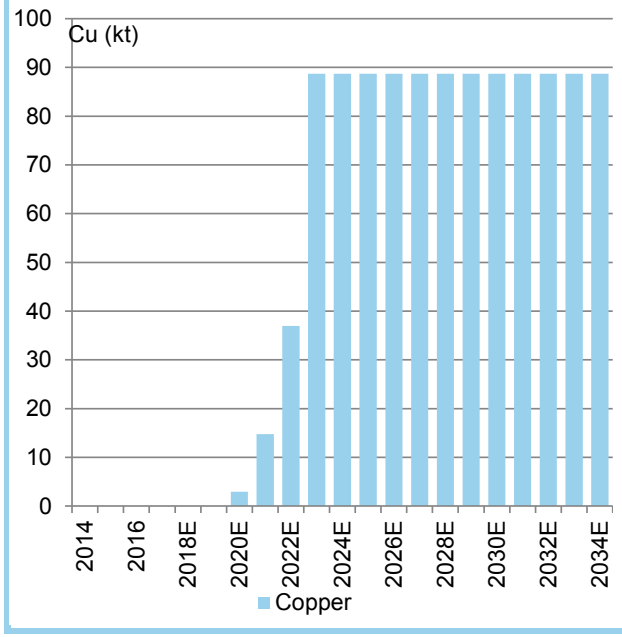
Exhibit 128: Lone Star

Lone Star	USA	82 ktpa	US$900 mn	13% IRR

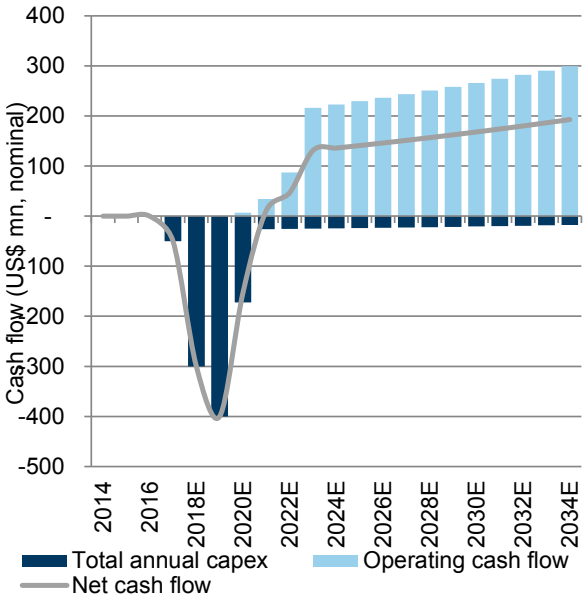
Lone Star is a 100% Freeport owned deposit near the Safford mine in Arizona, US. The company is currently in the process of advancing a project to develop the Lone Star oxide ore. Initial project aiming at 90Ktpa of copper production has been started with pre-stripping activities commencing as of 1Q18. The capex is estimated to be US$850mn (we assume US$900mn including our capex escalation) and will benefit from from the utilisation of existing infrastructure at the adjacent Safford operation. At March 31, 2018, approximately US$35mn has been incurred for this project. The project also advances the potential for development of a larger scale district opportunity. Freeport is also conducting additional drilling to follow up on positive exploration results as they continue to evaluate longer term opportunities available from the significant long-term sulfide potential in the Lone Star/Safford minerals district. We forecast the project to come online in 2020 - in line with the company guidance.



Production profile



Cash flow chart



Economics summary

Internal rate of return	13%
NPV (including sunk costs)	US$632
NPV (2018+)	US$683
Cu required @ 10%	US$4,870 /t
Capex	US$900 mn
Capex / t Cu production	US$10,992
Capex / t Cu equ. production	US$10,992
Project type	Greenfield
Project status	Construction
Ore reserves / resources	662 mt
Copper grade	0.45% Cu
Contained copper	2,979 kt
Commissioning	2020
Peak copper production	89 ktpa
Average LOM production	82 ktpa
Life of mine	20
Gross unit cost	US$4,094 /t
Net unit cost (C1)	US$4,094 /t

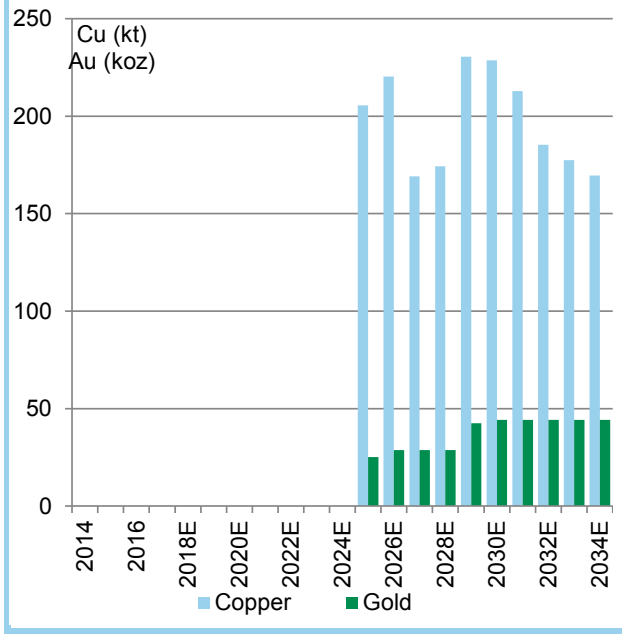
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 129: Los Azules

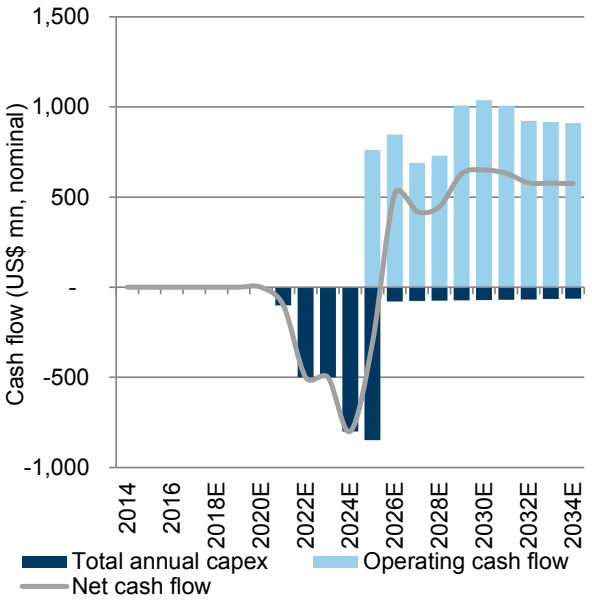
Los Azules	Argentina	168 ktpa	US$2,691 mn	19% IRR

Los Azules is 100% McEwen Mining-owned copper-gold-silver project in San Juan region of Argentina. The project area is remote and there is no infrastructure present nearby. There are no nearby towns, indigenous residents, or settlements which makes the project development a bit difficult. The company released a PEA in Sept. 2017 where it was envisaged that the mine had the potential to produce upwards of 150Ktpa of copper and c. 40Koz of gold with an initial capex investment of c. US$2.4bn. The company is still in exploration phase and has planned an exploration spend of c. US$5mn for this financial year. While the economics of the mine do look compelling, we believe that it is unlikely anything meaningful is done on the project before 2021 given that: a) there is no arrangement of funding for the project and b) political and fiscal conditions in Argentina remain fluid and as such we expect the significant infrastructure requirement for the project is unlikely to be met in the near term.

Production profile



Cash flow chart



Economics summary

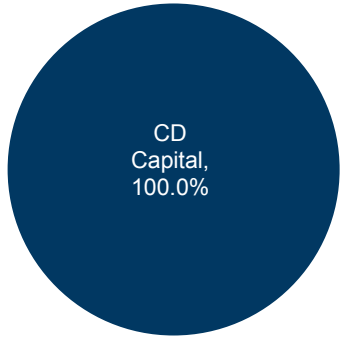
Internal rate of return	19%
NPV (including sunk costs)	US$2,104
NPV (2018+)	US$2,104
Cu required @ 25%	US$4,870 /t
Capex	US$2,691 mn
Capex / t Cu production	US$16,054
Capex / t Cu equ. production	US$14,795
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	962 mt
Copper grade	0.48% Cu
Contained copper	4,618 kt
Commissioning	2025
Peak copper production	230 ktpa
Average LOM production	168 ktpa
Life of mine	26+
Gross unit cost	US$3,474 /t
Net unit cost (C1)	US$3,184 /t

Source: Company data, Goldman Sachs Global Investment Research

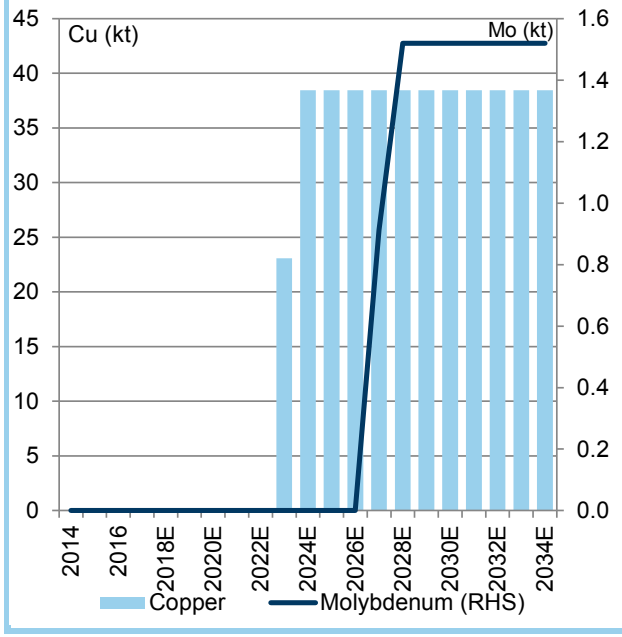
Exhibit 130: Los Calatos

Los Calatos	Peru	38 ktpa	US$705 mn	15% IRR

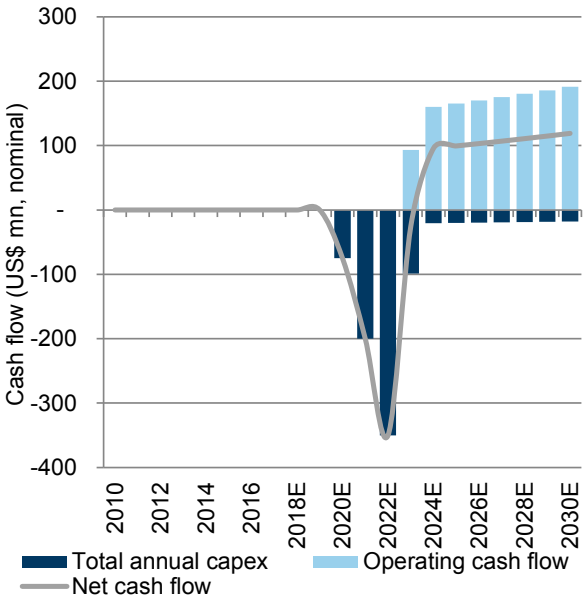
Los Calatos, located in Southern Peru, is a greenfield copper-molybdenum project. Metminco Ltd. sold the majority stake in the project to CD Capital in 2016 and sold the remaining 49% stake in June 2017. As per the latest scoping study (which was released in September 2015) the project is envisaged to have a throughput of 6.5 mtpa producing an average 50 ktpa of copper concentrate over the LOM for a period of 22 years. The company is guiding for total capex of US$655 mn for the project, with a short lead time to production and a forecast construction period of 18-24 months. The mine has total resources of 136 mt with a copper grade of 0.79%. The company is currently conducting an environmental baseline study and is positioned to initiate a development programme that progresses the Los Calatos project to feasibility study, subject to available funding. We currently assume start of construction of the mine in 2020 with first production in 2023 and add inflation expectations to the guided capex while awaiting further details from the company.



Production profile



Cash flow chart



Economics summary

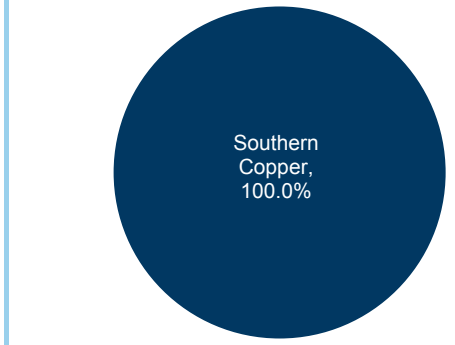
Internal rate of return	15%
NPV (including sunk costs)	US$462
NPV (2018+)	US$462
Cu required @ 15%	US$6,848 /t
Capex	US$705 mn
Capex / t Cu production	US$18,598
Capex / t Cu equ. production	US$16,345
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	136 mt
Copper grade	0.79% Cu
Contained copper	1,074 kt
Commissioning	2023
Peak copper production	38 ktpa
Average LOM production	38 ktpa
Life of mine	28+
Gross unit cost	US$3,452 /t
Net unit cost (C1)	US$2,706 /t

Source: Company data, Goldman Sachs Global Investment Research

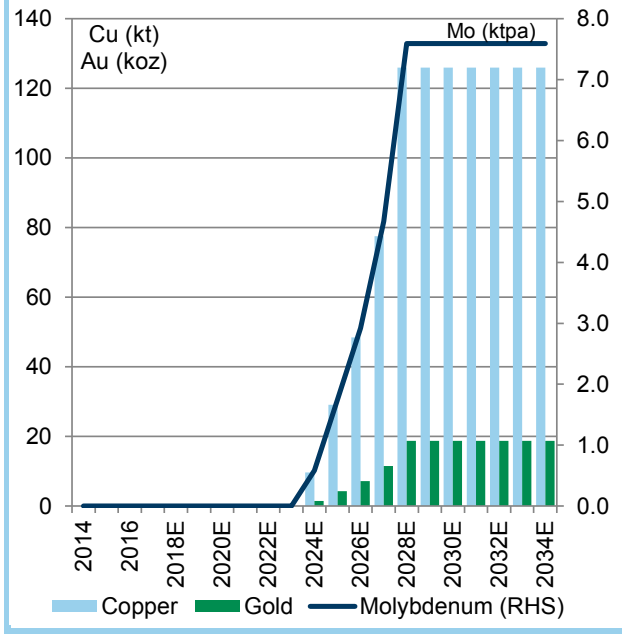
Exhibit 131: Los Chancas

Los Chancas	Peru	113 ktpa	US$2,900 mn	10% IRR

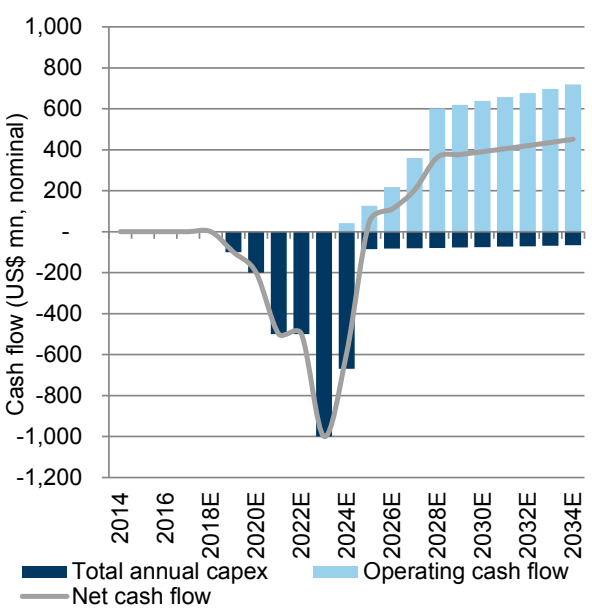
Los Chancas is a greenfield project located in Apurimac area of Peru. It is a copper and molybdenum porphyry deposit. Current estimates indicate the presence of 545 million tons of mineralized material with a copper content of 0.59%, molybdenum content of 0.04% and 0.039 grams of gold per ton, as well as 181 million tons of mineralized leachable material with a total copper content of 0.357%. According to Southern Copper, the mine could be an open-pit mine with a combined operation of concentrator and SX-EW processes to annually produce 130Kt of copper and 7.5Kt of molybdenum with some gold by-product. The company's estimated capital investment is US$2,800 mn (we add a slight inflation adjustment in our estimate) and the company guided that the mine should be operational in 2022. Given that the company is still conducting the environmental impact assessment (due this year) we believe that the 2022 target is likely to be too optimistic. We expect the mine to start production in 2024, reaching full production in 2027.



Production profile



Cash flow chart



Economics summary

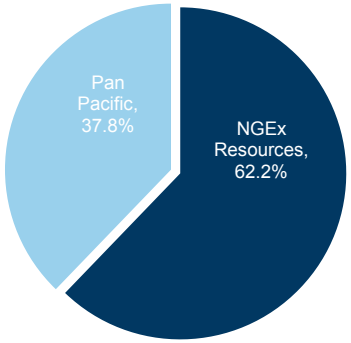
Internal rate of return	10%
NPV (including sunk costs)	US$543
NPV (2018+)	US$543
Cu required @ 15%	US$4,870 /t
Capex	US$2,900 mn
Capex / t Cu production	US$25,679
Capex / t Cu equ. production	US$20,729
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	545 mt
Copper grade	0.59% Cu
Contained copper	3,216 kt
Commissioning	2024
Peak copper production	126 ktpa
Average LOM production	113 ktpa
Life of mine	26
Gross unit cost	US$3,970 /t
Net unit cost (C1)	US$2,645 /t

Source: Company data, Goldman Sachs Global Investment Research

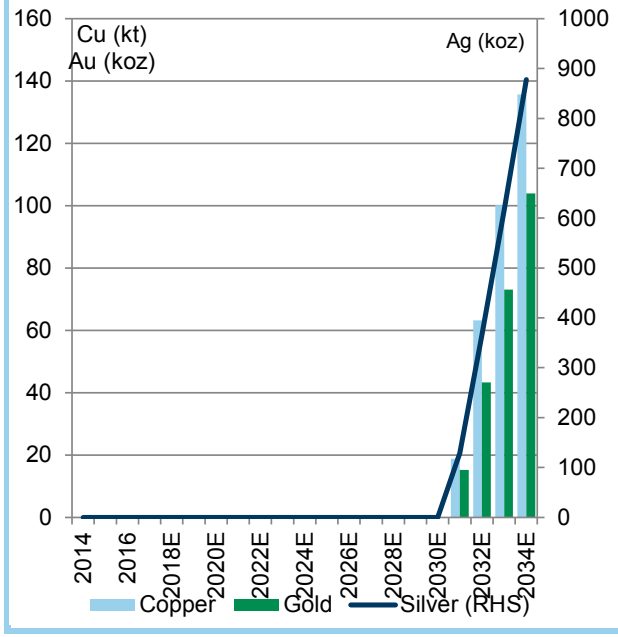
Exhibit 132: Los Helados

Los Helados	Chile	156 ktpa	US$1,325 mn	16% IRR

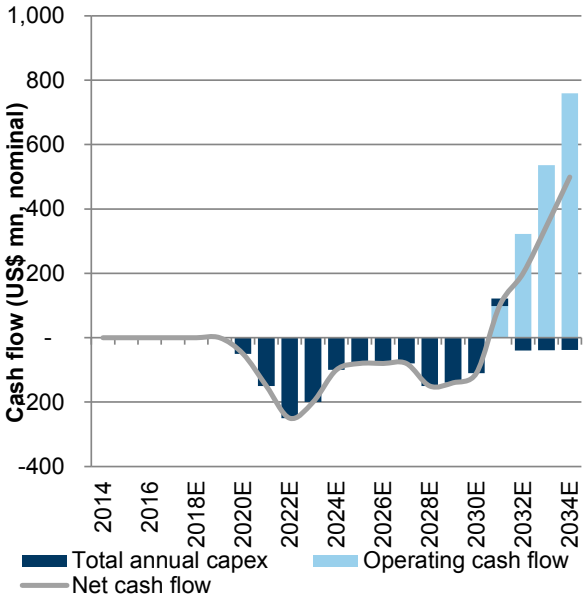
Los Helados, located in Northern Chile, is a greenfield underground copper-gold-silver mine. It is owned by NGEx Resources (c.60%) and Pan Pacific (c.40%). NGEx published a Preliminary Economic Assessment (PEA) in April 2016 for its Project Constellation, which combines Josemaria in Argentina followed by a block cave underground mine, Los Helados in Chile. The two projects are c.10 km apart and material from both deposits will be processed at a centralised facility. The combined LOM of Project Constellation is 48 years while that of Los Helados is 35 years, with average annual production of 150 ktpa of copper. The total guided pre-production capex for Project Constellation is US$3 bn. We believe these costs exclude certain mine development costs for Los Helados which will be incurred post starting production at Josemaria. We add these costs to the assumed split of the pre-production costs for Los Helados. In 2016, an agreement was completed which provides surface rights covering Los Helados deposit. The environmental baseline study is ongoing while the company evaluates lower cost development options including testing the heap leach potential of oxide cap at Josemaria. We currently assume first production from the mine in 2031 and add inflation expectations to the guided capex while awaiting further details from management.



Production profile



Cash flow chart



Economics summary

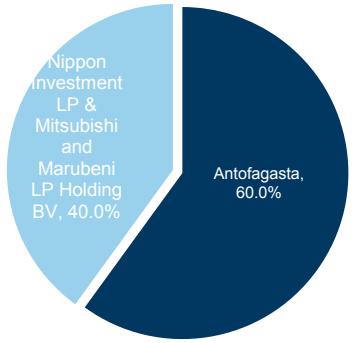
Internal rate of return	16%
NPV (including sunk costs)	US$1,727
NPV (2018+)	US$1,727
Cu required @ 15%	US$5,817 /t
Capex	US$1,325 mn
Capex / t Cu production	US$8,520
Capex / t Cu equ. production	US$7,025
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	2,926 mt
Copper grade	0.36% Cu
Contained copper	10,623 kt
Commissioning	2031
Peak copper production	200 ktpa
Average LOM production	156 ktpa
Life of mine	20+
Gross unit cost	US$3,804 /t
Net unit cost (C1)	US$2,652 /t

Source: Company data, Goldman Sachs Global Investment Research

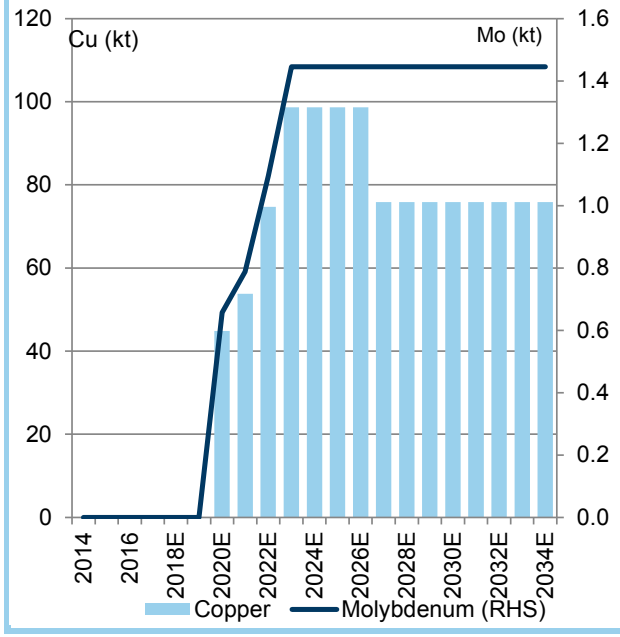
Exhibit 133: Los Pelambres 205

Los Pelambres 205	Chile	78 ktpa	US$1,950 mn	8% IRR

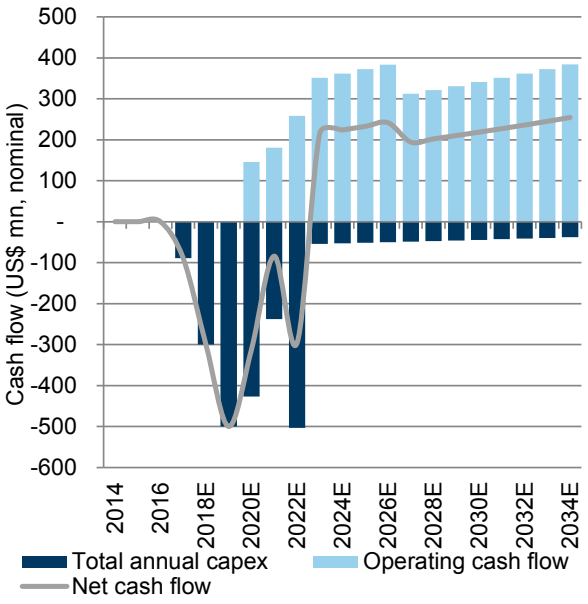
Los Pelambres is Antofagasta's key operation, contributing c.350 kt of the group's total 700 kt of copper production. There have already been two brownfield expansions in the last decade, first raising concentrator throughput to 140 ktpd, completed in 2007, followed by a further expansion to 175 ktpa, completed in 2010. A further expansion to 205 ktpd is envisaged, which could add a further 90 ktpa of gross copper production to the operation. The project is being progressed in 2 stages: 1) Phase 1 is designed to optimise throughput. During this phase, Los Pelambres will operate at an average throughput of 190Ktpd. The company received EIA approvals in Feb 2018. The capex for the project is US$1.3bn and it will add c. 55Kt from 2021; b) Phase 2 of the project will increase the throughput from 190Kt/d to 205Kt/d and add 35Kt of copper and a capex of US$500mn. The project will only proceed following a decision on Phase 1 and will require the submission of extensive permit applications, including the new EIA. First production from this phase would be in 2022 at the earliest and is expected to increase copper production by 35Ktpa. We assume that the company will start to spend capex on the phase 2 from 2021 with first production from this phase coming in 2023.



Production profile



Cash flow chart



Economics summary

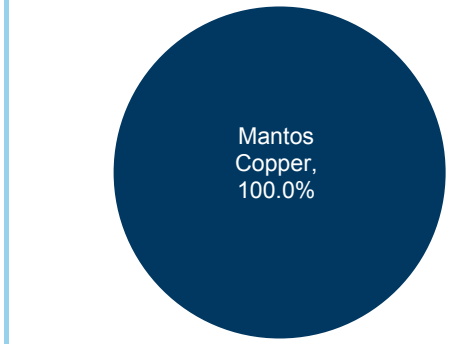
Internal rate of return	8%
NPV (including sunk costs)	US$27
NPV (2018+)	US$118
Cu required @ 15%	US$8,246 /t
Capex	US$1,950 mn
Capex / t Cu production	US$25,023
Capex / t Cu equ. production	US$23,847
Project type	Brownfield
Project status	Feasibility
Ore reserves / resources	205 mt
Copper grade	0.61% Cu
Contained copper	1,248 kt
Commissioning	2020
Peak copper production	99 ktpa
Average LOM production	78 ktpa
Life of mine	18
Gross unit cost	US$3,406 /t
Net unit cost (C1)	US$3,130 /t

Source: Company data, Goldman Sachs Global Investment Research

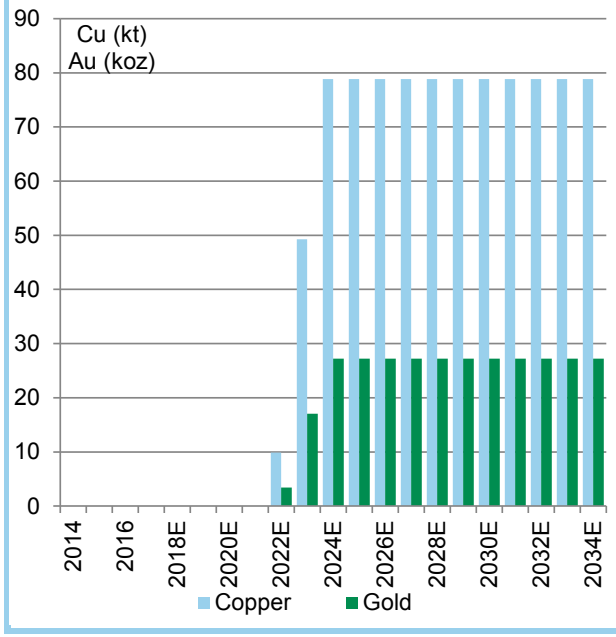
Exhibit 134: Mantoverde

Mantoverde	Chile	73 ktpa	US$850 mn	11% IRR

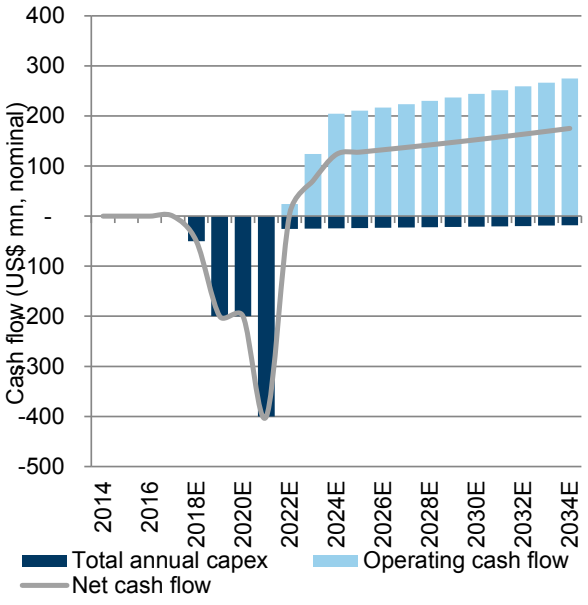
Mantoverde consists of a number of distinct ore bodies located in the Atacama region of Chile. The project is 100% owned by Mantos Copper. The project, with an estimated capex guidance of c. US$800mn (plus our inflation escalations), involves the extraction of sulphide ore and production of copper in concentrates commencing in 2021, according to the company. However, we estimate that there are likely to be some delays and expect first production in 2022. The mine at its peak will produce 80Ktpa of copper and 28Koz of gold. The company completed the pre-feasibility study this year (2018). As of now the Mantoverde mine has a limited mine life but this project will add c. 19 years to the mine life. The focus in 2018 is to finish engineering, construction contracts and finalize the structuring of project financing, before beginning construction in 2019.



Production profile



Cash flow chart



Economics summary

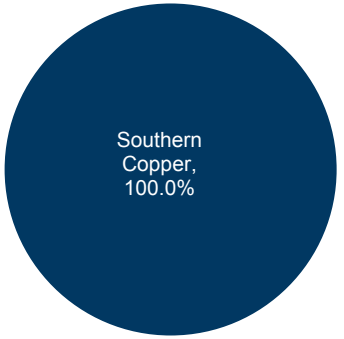
Internal rate of return	11%
NPV (including sunk costs)	US$234
NPV (2018+)	US$234
Cu required @ 15%	US$4,870 /t
Capex	US$850 mn
Capex / t Cu production	US$11,586
Capex / t Cu equ. production	US$10,863
Project type	Brownfield
Project status	Pre-feasibility
Ore reserves / resources	230 mt
Copper grade	0.60% Cu
Contained copper	1,380 kt
Commissioning	2022
Peak copper production	79 ktpa
Average LOM production	73 ktpa
Life of mine	18
Gross unit cost	US$4,466 /t
Net unit cost (C1)	US$4,027 /t

Source: Company data, Goldman Sachs Global Investment Research

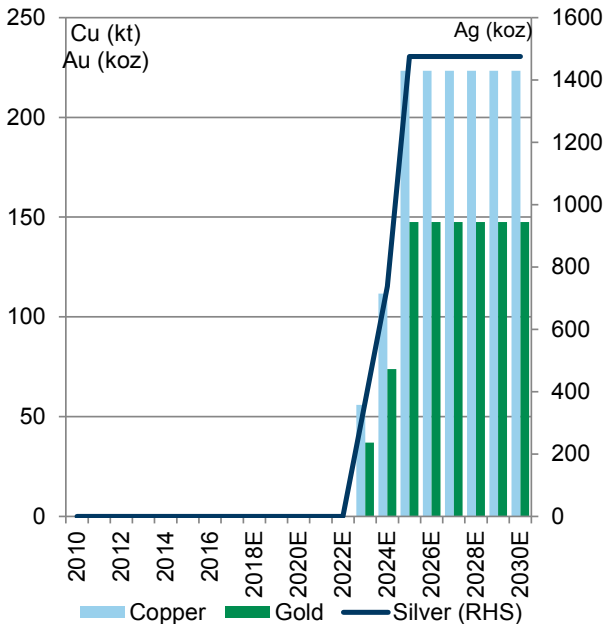
Exhibit 135: Michiquillay

Michiquillay	Peru	209 ktpa	US$2,700 mn	16% IRR

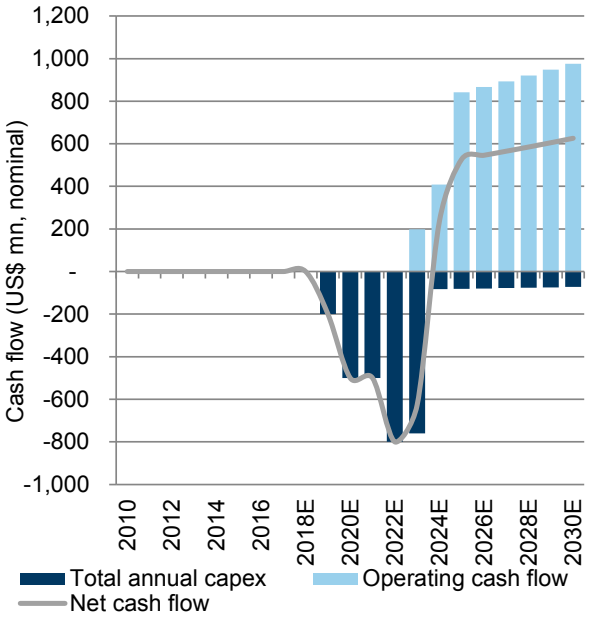
Southern Copper in Feb. 2018 won the bidding process for the Michiquillay project in Cajamarca, Peru, at a purchase price of US$400mn and a 3% royalty rate. This comes after Anglo American returned its contract for operating the mine in late 2014 due to capital constraints. The mine is located somewhere between 3 km and 3.6 km above sea level. Michiquillay has mineral resources of 1,150 million tons and a copper grade of 0.63%. The mine has the potential to produce 225Kt of copper per year (along with such by-products as molybdenum, gold and silver) for an initial mine life of more than 25 years, at a very competitive cash cost. Southern Copper said the capex will be US$2.5bn (our estimate US$2.7bn includes inflation). The initial plan was to start production in 2025, however recently the company commented that it will start the construction of the mine next year with the mine likely starting operations in 2022. The company still needs to reach detailed agreements with residents near the deposit before construction can begin - the talks are likely to take up to a year with construction taking another 3. Given the number of approvals still needed, we expect the mine to start producing a year later than guided to by SCCO, i.e. in 2023, and reach full production by 2025. Also worth noting is that the project has a higher level of arsenic impurities.



Production profile



Cash flow chart



Economics summary

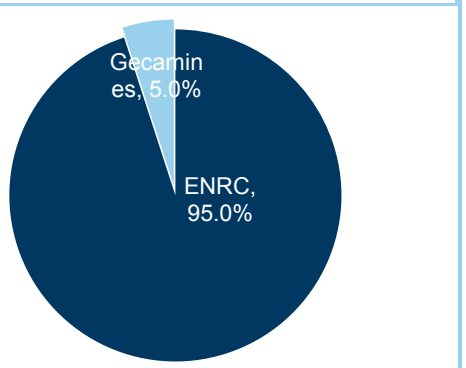
Internal rate of return	16%
NPV (including sunk costs)	US$569
NPV (2018+)	US$631
Cu required @ 15%	US$6,863 /t
Capex	US$2,700 mn
Capex / t Cu production	US$12,893
Capex / t Cu equ. production	US$11,314
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	544 mt
Copper grade	0.63% Cu
Contained copper	3,427 kt
Commissioning	2023
Peak copper production	223 ktpa
Average LOM production	209 ktpa
Life of mine	25
Gross unit cost	US$4,278 /t
Net unit cost (C1)	US$429 /t

Source: Company data, Goldman Sachs Global Investment Research

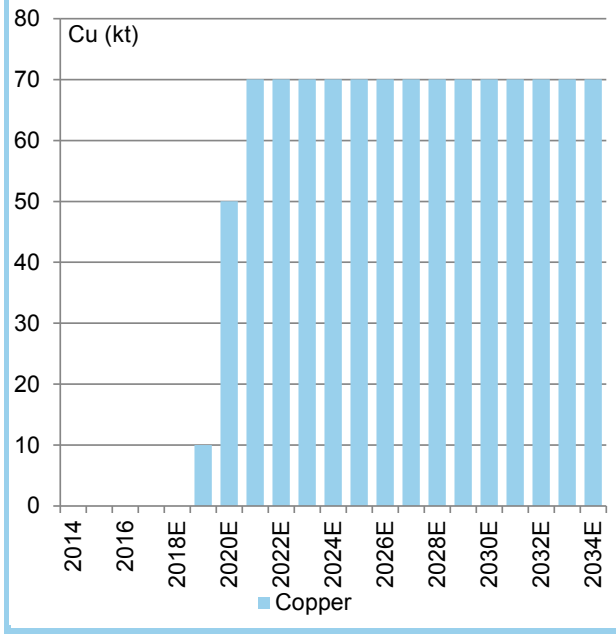
Exhibit 136: Metalkol

Metalkol	DRC	67 ktpa	US$900 mn	30% IRR

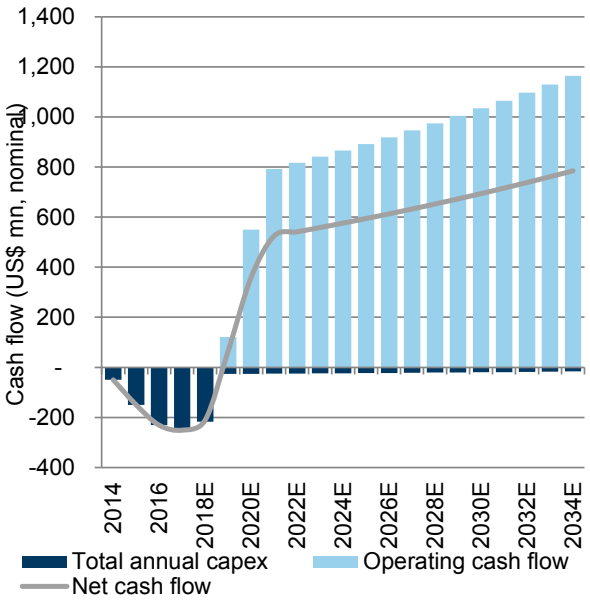
Metalkol is an open pit brownfield copper-cobalt project located in Katanga province of Democratic Republic of Congo. The project is owned by Eurasian Natural Resources Group (95%) and Gecamines (5%). ENRC (formerly known as ERG) bought Metakol from Camrose in 2010. The Tailings Reclamation Project is expected to have a throughput of 5mtpa and is expected to produce 70ktpa of copper along with c. 15 ktpa of cobalt over a life of mine of 20 years. We estimate the capex for the project to be US$900 mn after incorporating slight inflation to Wood Mackenzie's estimate of US$820 mn with C1 cash costs expected to be about -54c/lb. ENRC announced in 2015 that it had signed an agreement with China's NFC to complete construction of the Kolwezi Tailings project. Financing worth US$700 mn had been secured and NFC was to be the contractor responsible for the construction. In July 2016, NFC announced signing of a US$654 mn contract to complete the construction of the RTR Copper leach plant with a timescale for completion of 24 months. We expect production to begin in FY19. In August 2018 Metalkol signed an agreement to secure electricity supply for the mine for up to 10 years.



Production profile



Cash flow chart



Economics summary

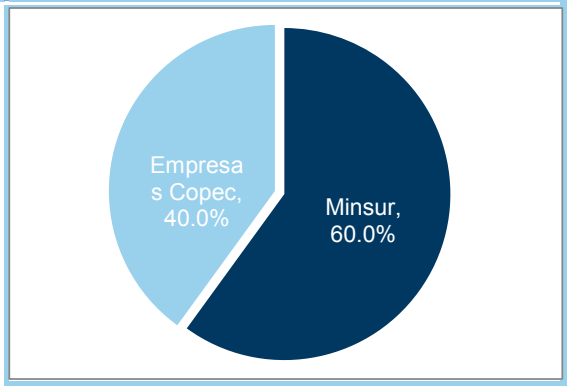
Internal rate of return	30%
NPV (including sunk costs)	US$4,884
NPV (2018+)	US$5,608
Cu required @ 25%	US$3,820 /t
Capex	US$900 mn
Capex / t Cu production	US$13,514
Capex / t Cu equ. production	US$5,764
Project type	Greenfield
Project status	Construction
Ore reserves / resources	113 mt
Copper grade	1.49% Cu
Contained copper	1,681 kt
Commissioning	2019
Peak copper production	70 ktpa
Average LOM production	67 ktpa
Life of mine	24
Gross unit cost	US$3,270 /t
Net unit cost (C1)	-US$4,158 /t

Source: Company data, Goldman Sachs Global Investment Research

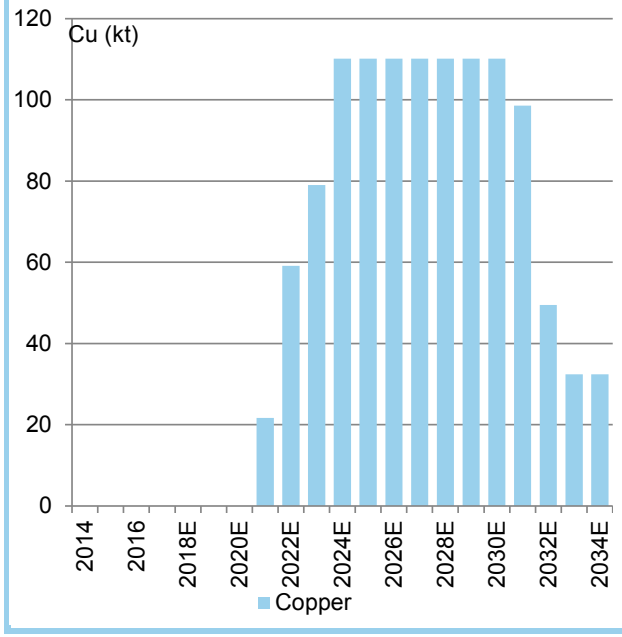
Exhibit 137: Mina Justa

Mina Justa	Peru	78 ktpa	US$1,500 mn	11% IRR

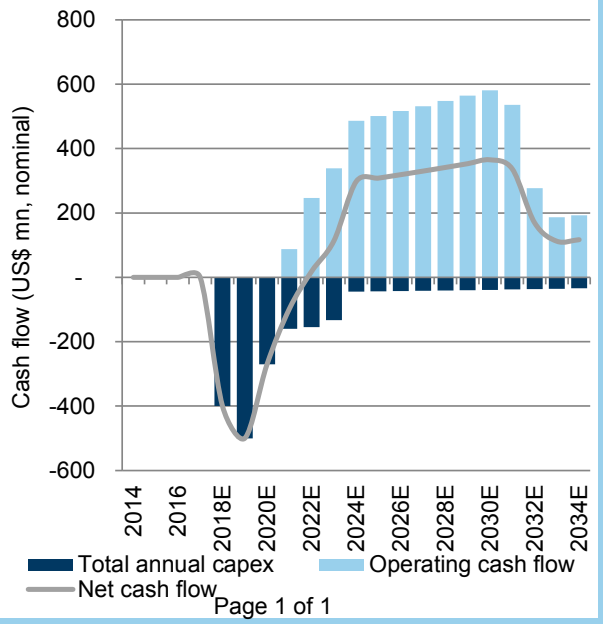
Mina Justa, located in Nazca, Peru, is a long-life copper deposit being developed by Marcobre S.A.C. (solely owned by Minsur). Minsur, which originally had a 70% stake, then bought the remaining stake it did not own from Korea Resources Corporation (KORES) and LS-Nikko (LS-Nikko) Copper in September 2016. Mina Justa has two types of minerals: (1) a superficial layer of copper oxide expected to start production in 2020 and have a LOM of 11 years; and (2) a deep layer of copper sulphides expected to start production in 2022 and have a LOM of ten years. More recently, Empresas Copec via its subsidary Alxar took a 40% stake in the project for a cash payment of US$168.5mn (with Minsur now holding 60%). According to latest company estimates, the capex of the mine is estimated to be US$1.4bn (we add inflation of US$100mn). The construction is slated to being in 2H18 and we expect the project to reach full production by 2021. Studies of the mine show the mine could produce c. 110Ktpa of copper (concentrate + cathode). Minsur (which owns 60% of the mine) announced that it is looking to secure c. US$800-900mn in financing from a group of banks in August which will put it on track to begin construction.



Production profile



Cash flow chart



Economics summary

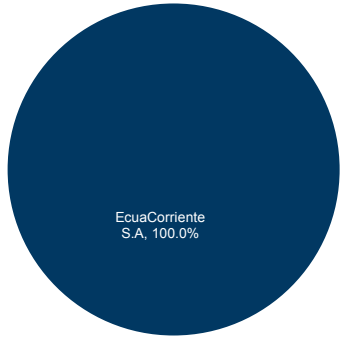
Internal rate of return	11%
NPV (including sunk costs)	US$336
NPV (2018+)	US$336
Cu required @ 15%	US$7,438 /t
Capex	US$1,500 mn
Capex / t Cu production	US$19,130
Capex / t Cu equ. production	US$19,130
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	374 mt
Copper grade	0.71% Cu
Contained copper	2,655 kt
Commissioning	2021
Peak copper production	110 ktpa
Average LOM production	78 ktpa
Life of mine	15
Gross unit cost	US$2,498 /t
Net unit cost (C1)	US$2,498 /t

Source: Company data, Goldman Sachs Global Investment Research

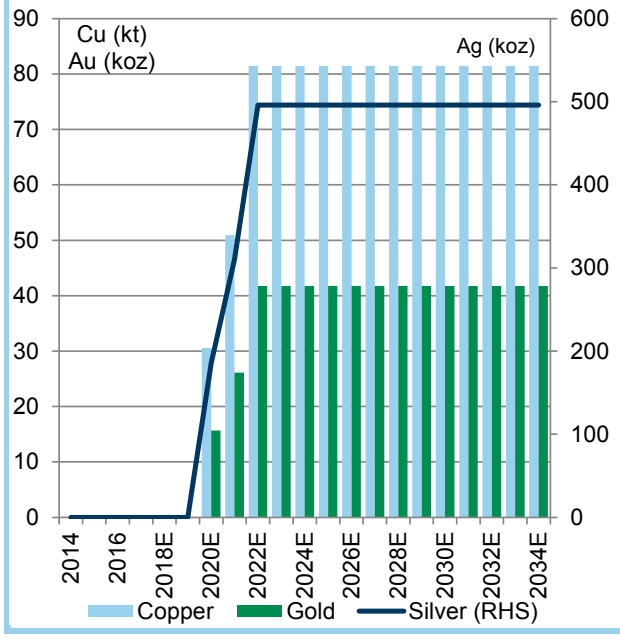
Exhibit 138: Mirador

Mirador	Ecuador	79 ktpa	US$1,500 mn	15% IRR

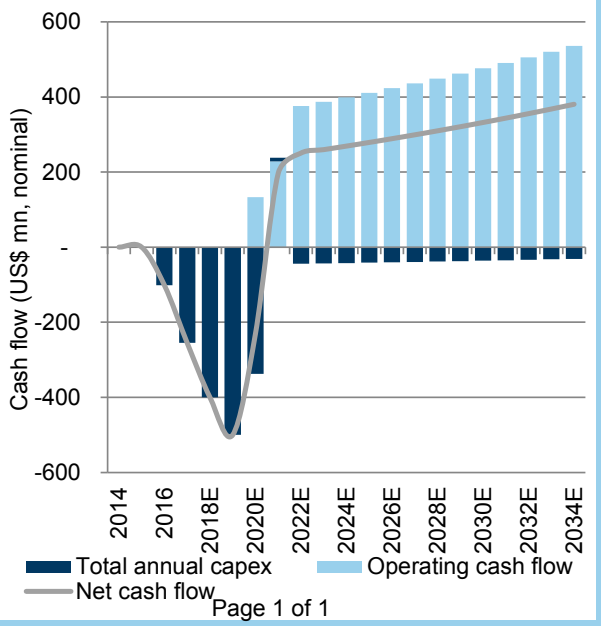
The Mirador project, located in Zamora-Chinchipe province of Ecuador is an open-pit copper mine. It is the first large scale copper mine in the country. Corriente Resources, Ecuacorriente's parent company, was bought by two Chinese state owned enterprises, China Railway Construction Company (CRCC) and Tongling Nonferrous, in 2010. The mine obtained the EIA in December 2015 and construction began at the same time. The project is expected to produce 79ktpa of copper and about 40koz of gold per annum in steady-state for a total capex of US$1.5bn (including our inflation assumptions). Whilst the project was slated to come online in 4Q18, it has faced delays due to heavy rainfall and environmental challenges during the construction of the open pit and tailing facility. We now see this project coming online in 2020. The initial plan was to start with milling capacity of 30kt/d and ramp to 60kt/d. By 1Q17 this had changed to start-up at 60kt/d. However, tailings constraint has obliged the company to maintain the intial plan.



Production profile



Cash flow chart



Economics summary

Internal rate of return	15%
NPV (including sunk costs)	US$1,696
NPV (2018+)	US$2,067
Cu required @ 25%	US$10,303 /t
Capex	US$1,500 mn
Capex / t Cu production	US$19,026
Capex / t Cu equ. production	US$17,139
Project type	Greenfield
Project status	Construction
Ore reserves / resources	436 mt
Copper grade	0.62% Cu
Contained copper	2,700 kt
Commissioning	2020
Peak copper production	81 ktpa
Average LOM production	79 ktpa
Life of mine	31+
Gross unit cost	US$2,861 /t
Net unit cost (C1)	US$2,098 /t

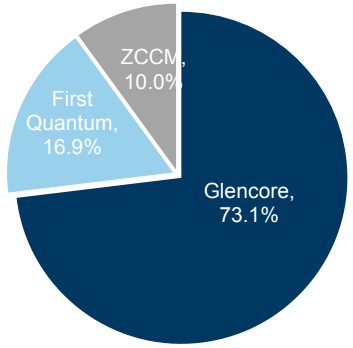
Page 1 of 1

Source: Company data, Goldman Sachs Global Investment Research

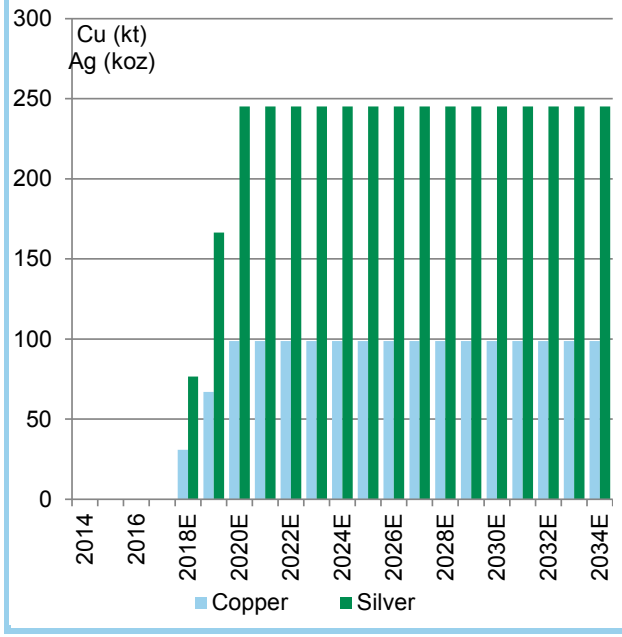
Exhibit 139: Mopani

Mopani	Zambia	95 ktpa	US$1,025 mn	19% IRR

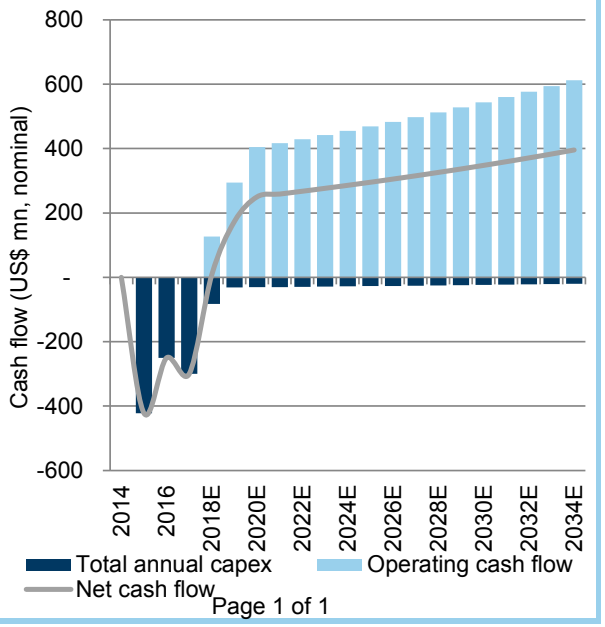
Mopani Deeps is an underground brownfield copper-cobalt project in Zambia. The mine has been in production since 1930s. It is majority owned by Glencore (73%) with First Quantum (17%) and Zambia Consolidated Copper Mines Limited- Investment Holdings (ZCCM-IH), a Zambian government agency, holding minority stakes. Mopani consists of the Nkana and Mufulira underground mines. In 2H2015, Glencore announced suspension of Mopani mines due to prevailing low copper prices and also estimated US$1 bn plan for expansion. Glencore has spent over US$1 bn since 2014 at Mufulira, Synclinorium Shaft at Nkana and Mindola for development of new shafts. The new shafts are expected to increase the life of the mine by c.25 years. The expansion is slated to add c. 90Ktpa of copper production with first production expected in 2H18 and full ramp-up to the name-plate capacity by 2020. With the majority of the capex having being spent at the mine, we believe that the likelihood of the project reaching full capacity by 2020 is high.



Production profile



Cash flow chart



Economics summary

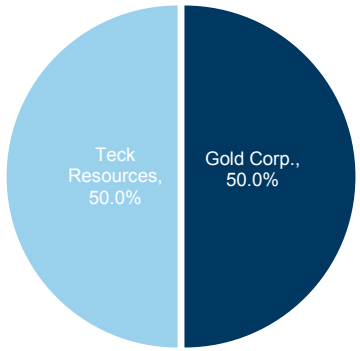
Internal rate of return	19%
NPV (including sunk costs)	US$2,126
NPV (2018+)	US$3,161
Cu required @ 15%	US$5,489 /t
Capex	US$1,025 mn
Capex / t Cu production	US$10,807
Capex / t Cu equ. production	US$10,757
Project type	Brownfield
Project status	Construction
Ore reserves / resources	144 mt
Copper grade	1.92% Cu
Contained copper	2,765 kt
Commissioning	2018
Peak copper production	99 ktpa
Average LOM production	95 ktpa
Life of mine	26
Gross unit cost	US$4,337 /t
Net unit cost (C1)	US$2,333 /t

Source: Company data, Goldman Sachs Global Investment Research

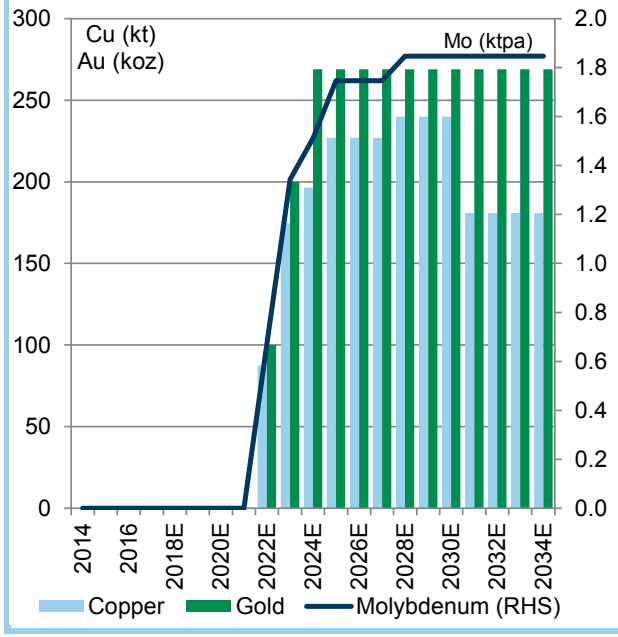
Exhibit 140: Nueva Union

Nueva Union	Chile	174 ktpa	US$3,800 mn	16% IRR

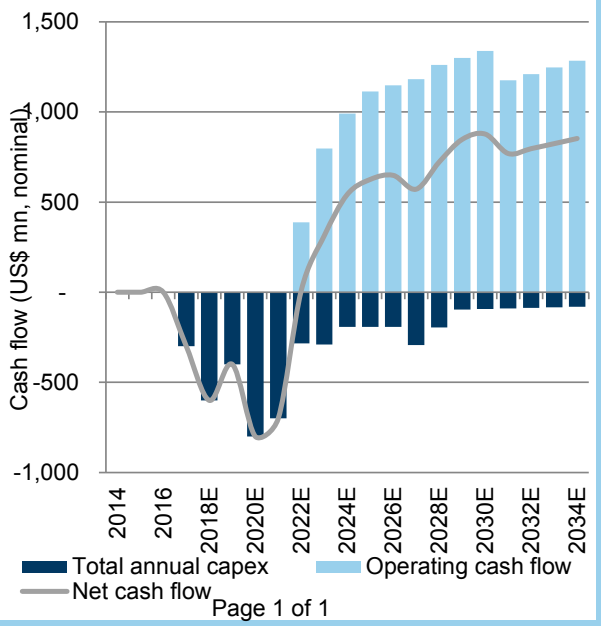
Nueva Union (formerly Project Corridor) is a JV between Teck Resources and Goldcorp. A pre-feasibility study was completed in 1Q18 according to which the capex is expected to be US$3.5-US$3.5bn (we add an inflation expectation). Note that this is for the first phase. The second phase will require more capex but we think the company is likely to proceed with it after phase 1 using the project cash flows. The PFS contemplates average annual production of 224kt of copper, 269Koz of gold and 1.7Kt of of molybdenum for the first full five years. The Relincho and La Fortuna deposits will be bulk open-pit mining operations that will be developed in three production phases. A feasibility study is expected to start in 3Q18 requiring 12 months to complete. Phase 1 (years 1-3) sees mining activities and construction of processing and ancillary facilities at the Relincho site. The proposed nominal ore-processing rate in Phase 1 is 104Ktpd. In Phase 2 (years 4-18), mining activities transfer to the La Fortuna site utilizing an ore conveyance system to transport ore to the processing facilities at Relincho. The proposed nominal ore-processing rate is 116Ktpd in Phase 2. Phase 3 (years 19-36) sees mining activities transfer back to Relincho with an expansion to the processing and ancillary facilities increasing the nominal ore processing rate to 208Ktpd.



Production profile



Cash flow chart



Economics summary

Internal rate of return	16%
NPV (including sunk costs)	US$3,458
NPV (2018+)	US$3,767
Cu required @ 15%	US$6,105 /t
Capex	US$3,800 mn
Capex / t Cu production	US$21,881
Capex / t Cu equ. production	US$16,593
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	1,838 mt
Copper grade	0.41% Cu
Contained copper	7,517 kt
Commissioning	2022
Peak copper production	240 ktpa
Average LOM production	174 ktpa
Life of mine	29+
Gross unit cost	US$3,860 /t
Net unit cost (C1)	US$2,207 /t

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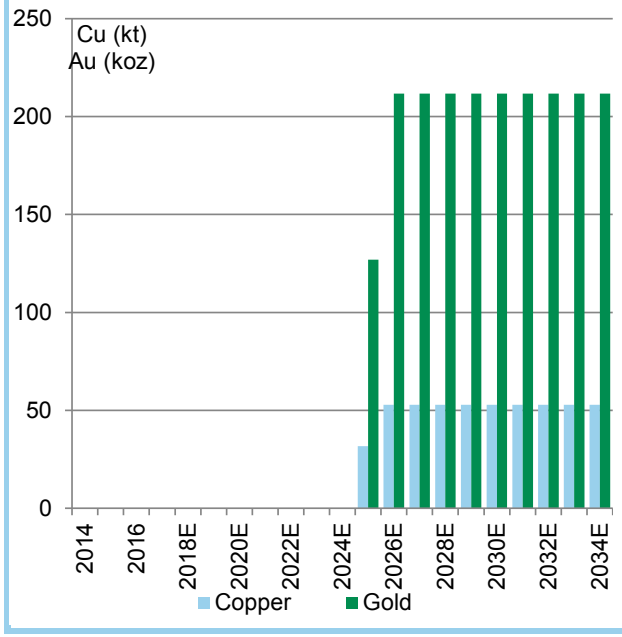
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 141: New Prosperity

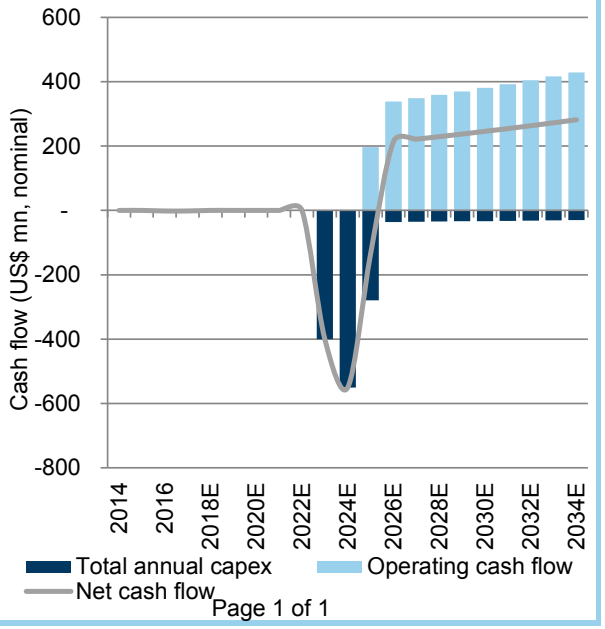
New Prosperity	Canada	51 ktpa	US$1,200 mn	18% IRR

New Prosperity is a greenfield open-pit copper-gold mining project in the Cariboo-Chilcotin region of British Columbia, Canada. Taseko Mines Ltd. is the sole owner of the project. Taseko has been carrying out exploration programmes for a couple of decades. The project has run into hurdles as there are questions raised by the Federal government over the economic benefits of the project versus the social and environmental costs. Taseko's attempt to sue the Federal Government over the delay in the project was rejected by a court. In January 2017, the company again sought a judicial review of the decision to reject the mine. Most recently the company lost judicial review applications to the Federal Court of Canada over the federal government's rejection of the company's New Prosperity Mine near Williams Lake. Instead of the mine a Tribal Park is being developed and as such we believe that the likelihood of this project coming online is very small.

Production profile



Cash flow chart



Economics summary

Internal rate of return	18%
NPV (including sunk costs)	US$995
NPV (2018+)	US$999
Cu required @ 10%	US$3,557 /t
Capex	US$1,200 mn
Capex / t Cu production	US$23,509
Capex / t Cu equ. production	US$13,274
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	831 mt
Copper grade	0.23% Cu
Contained copper	1,120 kt
Commissioning	2025
Peak copper production	53 ktpa
Average LOM production	51 ktpa
Life of mine	26+
Gross unit cost	US$6,245 /t
Net unit cost (C1)	US$1,150 /t

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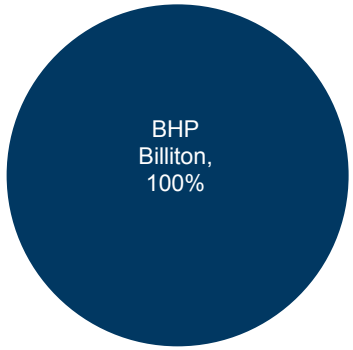
Source: Company data, Goldman Sachs Global Investment Research

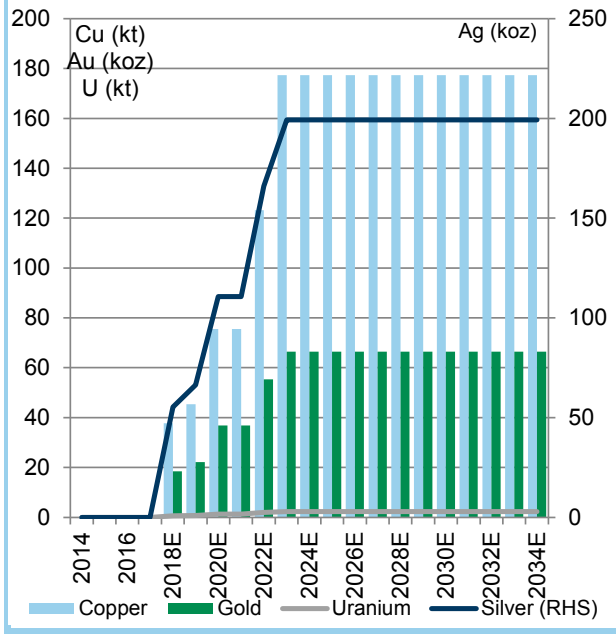
Exhibit 142: Olympic Dam BFX

Olympic Dam BFX	Australia	161 ktpa	US$3,040 mn	40% IRR

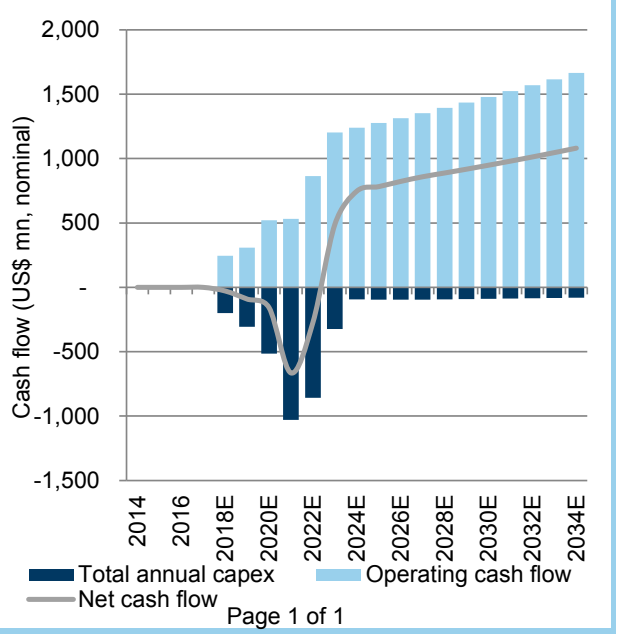
BHP, in Nov. 2017 as part of its site visit, put the expansion to 450Kt on the backburner; instead the company is going for the US$2.1bn brownfield expansion (BFX) which will see production at the mine increase to 330ktpa by 2023. As part of the BFX, the company will expand its processing capacity to handle high-grade ore from the southern area of the mine. The project will be put forth for board approval by mid 2020 with production targeted in late 2021. According to the company, as they move into the southern area of the mine, they expect to see copper grades increase to 3% (by 2023). The mine has had some issues recently and the company had a long shutdown to improve smelter, work on refinery and concentrator and other pieces of infrastructure. However, the production rebounded strongly in C1Q18 - which means the mine is on track in our view. Note that we are just forecasting additional production from the mine, the base production is not part of this analysis. Also, the capex estimate for BFX is c.US$2.3bn; the additional capex is the US$800mn being spent on the mine in terms of surface infrastructure to provide stability to the mine.



Production profile



Cash flow chart



Economics summary

Internal rate of return	40%
NPV (including sunk costs)	US$6,681
NPV (2018+)	US$6,681
Cu required @ 10%	US$2,653 /t
Capex	US$3,040 mn
Capex / t Cu production	US$18,842
Capex / t Cu equ. production	US$17,499
Project type	Brownfield
Project status	Permitting
Ore reserves / resources	540 mt
Copper grade	1.90% Cu
Contained copper	10,260 kt
Commissioning	2018
Peak copper production	177 ktpa
Average LOM production	161 ktpa
Life of mine	33+
Gross unit cost	US$2,271 /t
Net unit cost (C1)	US$349 /t

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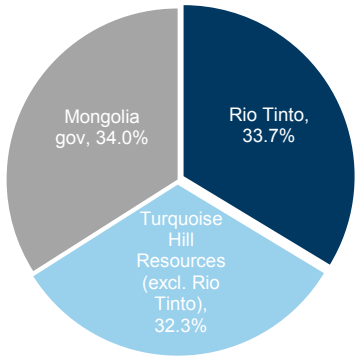
Source: Company data, Goldman Sachs Global Investment Research

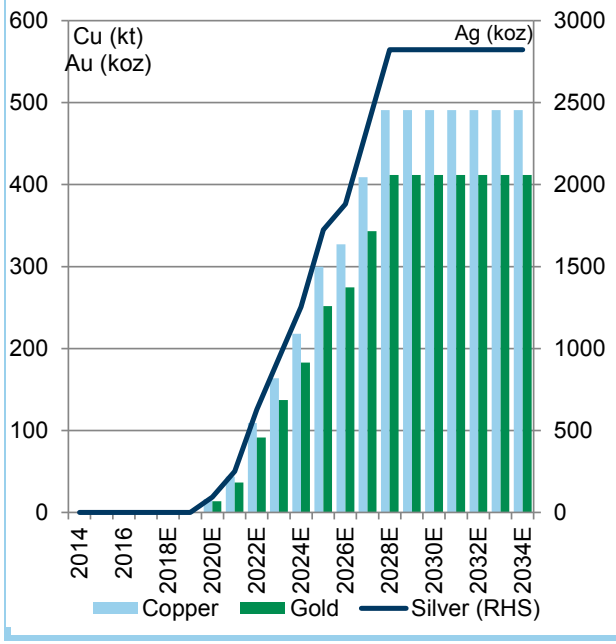
Exhibit 143: Oyu Tolgoi Block Cave

Oyu Tolgoi Block Cave	Mongolia	343 ktpa	US$5,395 mn	14% IRR

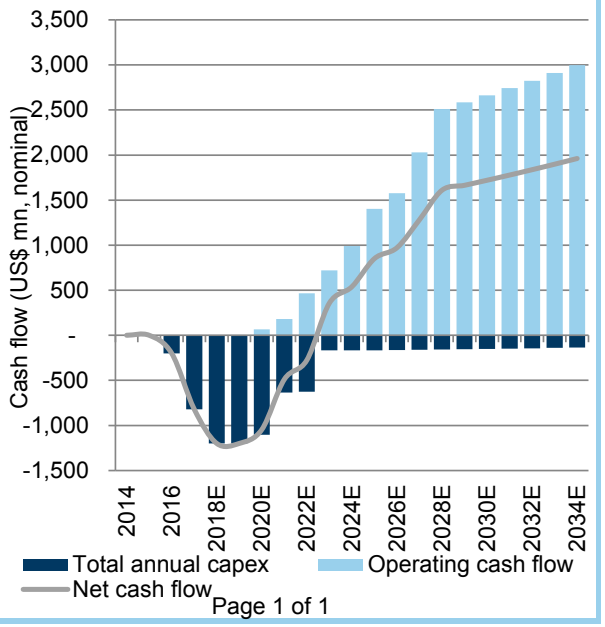
Phase 2 of the Oyu Tolgoi project consists of a 95 ktpd block cave operation at the Hugo North deposit. Oyu Tolgoi is the largest mining undertaking in Mongolia's history, with the mine (open pit and underground) expected to produce c.500 ktpa of copper and 400 kozpa of gold, as well as strong silver production for the first ten years. This is based on total concentrator capacity of 100 ktpd, with a decision to expand to 160 ktpd not required in the near future. A technical report was released in October 2016. Under this, ore from the open pit will be mostly displaced by higher grade ore from the underground operation until the latter ceases. The project was approved by the partners in May 2016. The latest capex estimate by Rio Tinto is US$5.1bn for the underground development in Phase 2 with US$4.3bn left to be spent as of 1H18, we assume inflation. First production from the mine is expected in mid 2020 with sustainable first production in 2021 with the full ramp-up expected by 2027. More recently there have been some discussions with the government, including differences over the amount of taxes owed and a power contract. The government has reinstated a decade-old agreement ordering the mining company to source electricity locally, which could be highly inflationary in our view.



Production profile



Cash flow chart



Economics summary

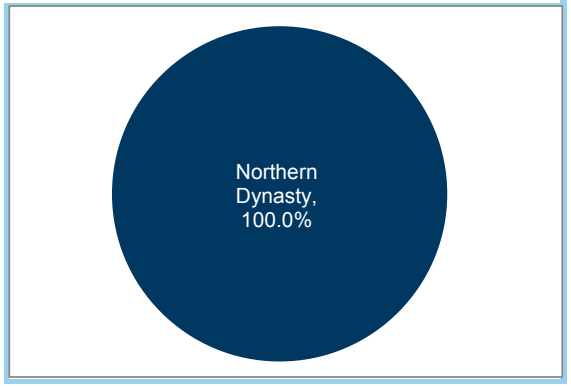
Internal rate of return	14%
NPV (including sunk costs)	US$4,073
NPV (2018+)	US$5,130
Cu required @ 15%	US$6,791 /t
Capex	US$5,395 mn
Capex / t Cu production	US$15,749
Capex / t Cu equ. production	US$13,374
Project type	Brownfield
Project status	Construction
Ore reserves / resources	499 mt
Copper grade	1.66% Cu
Contained copper	8,283 kt
Commissioning	2020
Peak copper production	491 ktpa
Average LOM production	343 ktpa
Life of mine	22
Gross unit cost	US$3,565 /t
Net unit cost (C1)	US$2,393 /t

Source: Company data, Goldman Sachs Global Investment Research

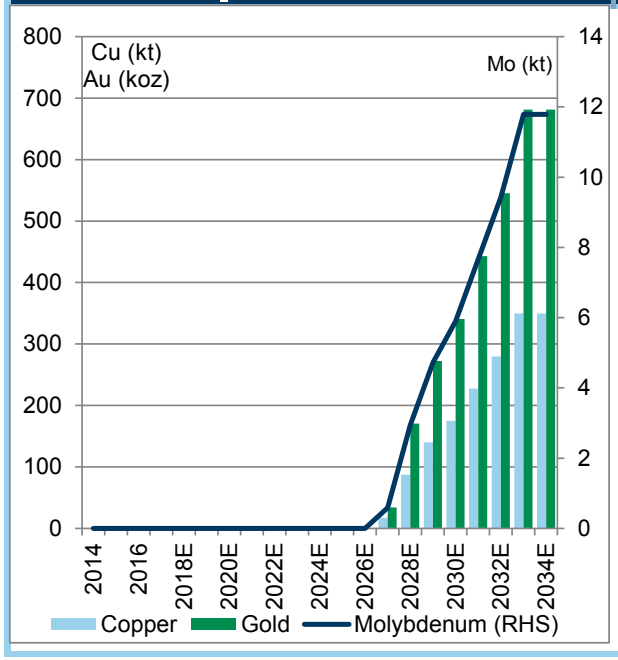
Exhibit 144: Pebble

Pebble	USA	301 ktpa	US$5,800 mn	13% IRR

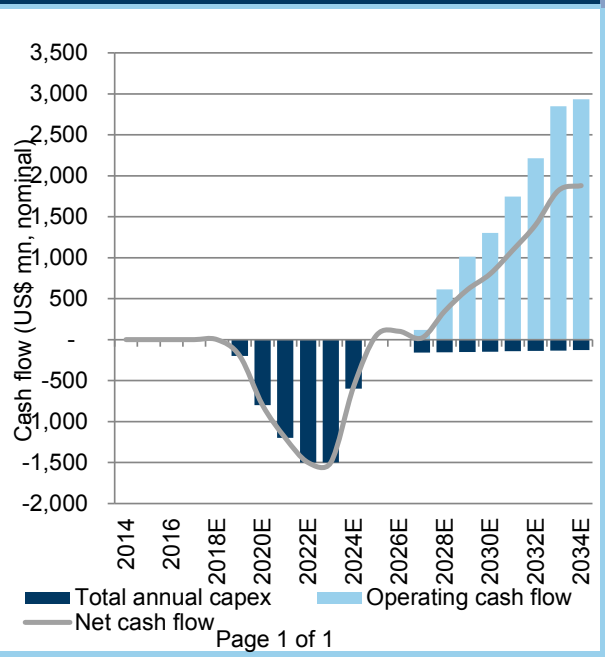
Located in Alaska, the Pebble deposit is 100% owned by Northern Dynasty Minerals Ltd. The project was previously owned by a 50/50 JV between Anglo American and Northern Dynasty, but Anglo pulled out in September 2013. Rio Tinto divested its 19.1% stake in Northern Dynasty in April 2014. Since Northern Dynasty acquired the Pebble asset in 2001 from Teck Resources, it has expanded the resource base by more than 1000% after launching an extensive exploration programme. About US$800 mn has been spent on the project so far. In April 2017, the company received land use permit from the Alaskan government paving way for further development. The project received a lot of media attention after the Trump administration announced that it would look to go ahead with the project. In July 2018 the US Army Corps of Engineers announced that a draft EIS will be completed in January 2019. First Quantum late last year also announced a partnership with Northern Dynasty to invest in the project but subsequently withdrew in May 2018 post an EPA announcement that the project is not viable given the amount of damage it estimated it could have on the local environment. While Northern Dynasty said that it remains confident the project can come online, we believe the timeline is likely to get extended.



Production profile



Cash flow chart



Economics summary

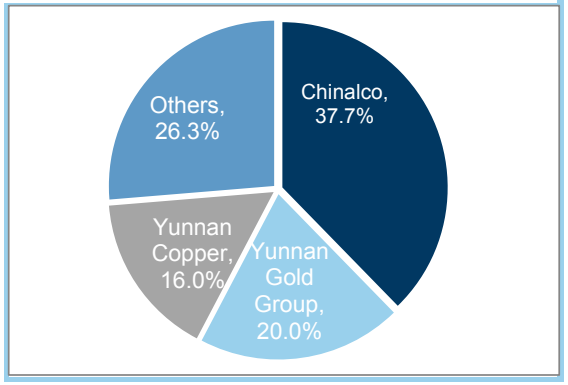
Internal rate of return	13%
NPV (including sunk costs)	US$4,306
NPV (2018+)	US$4,306
Cu required @ 10%	US$4,604 /t
Capex	US$5,800 mn
Capex / t Cu production	US$19,265
Capex / t Cu equ. production	US$13,089
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	6,456 mt
Copper grade	0.40% Cu
Contained copper	25,824 kt
Commissioning	2027
Peak copper production	350 ktpa
Average LOM production	301 ktpa
Life of mine	24+
Gross unit cost	US$4,087 /t
Net unit cost (C1)	US$974 /t

Source: Company data, Goldman Sachs Global Investment Research

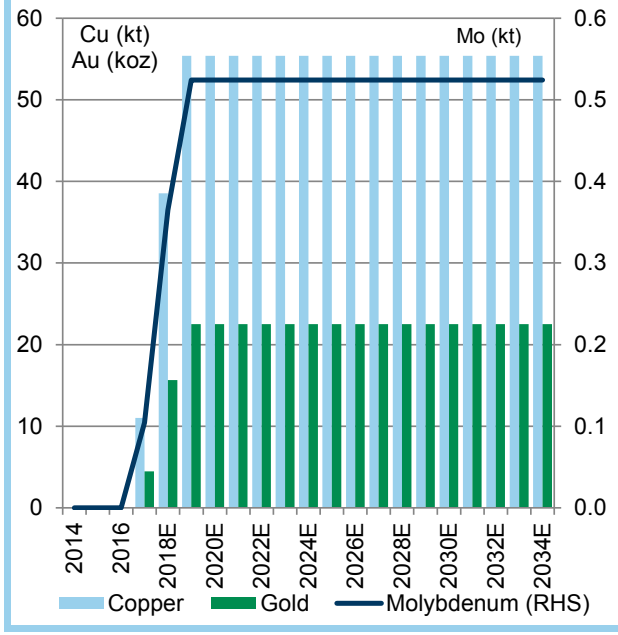
Exhibit 145: Pulang

Pulang	China	53 ktpa	US$950 mn	9% IRR

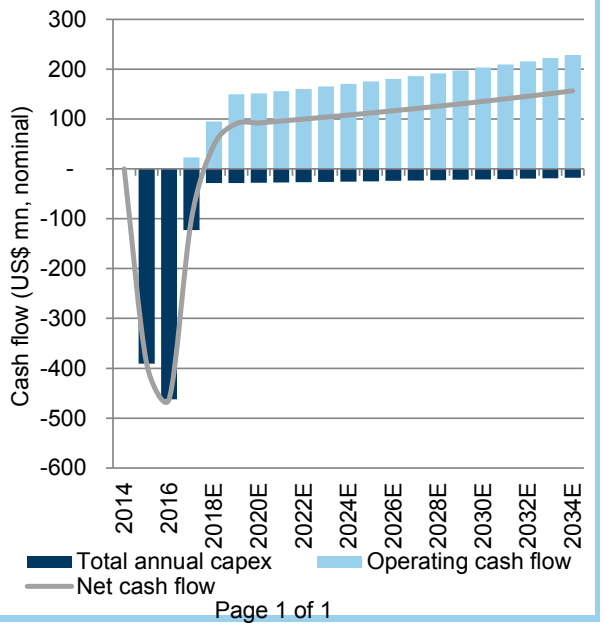
Pulang is a greenfield copper mine located in Shangri-la County in Yunnan province of China. It is an underground mine containing copper-molybdenum deposit. It is owned by Yunnan Diqing Nonferrous Metals Co. Ltd which is in turn owned by Yunnan Copper Group (65%) (a subsidiary of Chinalco), Yunnan Gold Mining Group (20%) and Diqing Tibetan Autonomous Prefecture Developing Investment Group (15%). Yunnan Copper announced in 2016 that it would acquire 100% of Yunnan Diqing Nonferrous Metals but the transaction is not complete yet. Yunnan Copper said earlier this year that it was planning to acquire a 50.01% stake in Diqing Nonferrous for US$230mn. The Pulang mine was commissioned in March 2017 and is projected to the be largest undeground mine in China once fully ramped. The throughput of the mine is 12.5mtpa and is expected to produce an average of 50ktpa of copper over a mine life of 19 years. The concentrate from the mine is to be shipped to an integrated smelter in Kunming for refining. The pre-production capex for the mine is c.US$950 mn. Yunnan Copper has plans for a Phase II expansion but we currently model only Phase I while awaiting further information on Phase I ramp-up and feasibility study for Phase II.



Production profile



Cash flow chart



Economics summary

Internal rate of return	9%
NPV (including sunk costs)	US$174
NPV (2018+)	US$1,194
Cu required @ 15%	US$8,221 /t
Capex	US$950 mn
Capex / t Cu production	US$17,988
Capex / t Cu equ. production	US$16,061
Project type	Greenfield
Project status	Producing
Ore reserves / resources	280 mt
Copper grade	0.51% Cu
Contained copper	1,426 kt
Commissioning	2017
Peak copper production	55 ktpa
Average LOM production	53 ktpa
Life of mine	24
Gross unit cost	US$4,405 /t
Net unit cost (C1)	US$3,625 /t

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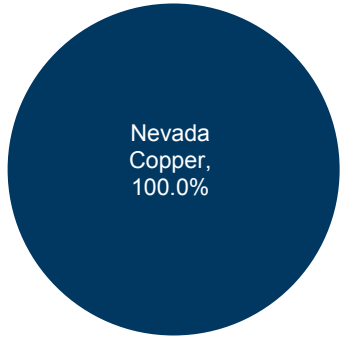
Source: Company data, Goldman Sachs Global Investment Research

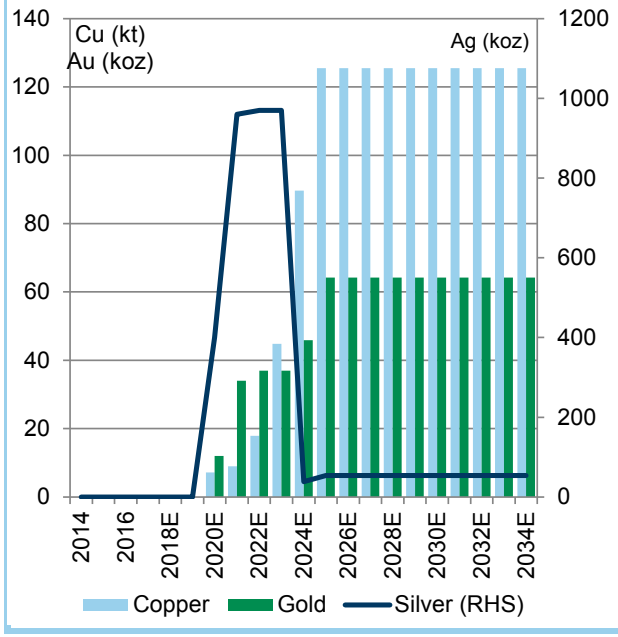
Exhibit 146: Pumpkin Hollow

Pumpkin Hollow	USA	90 ktpa	US$1,100 mn	17% IRR

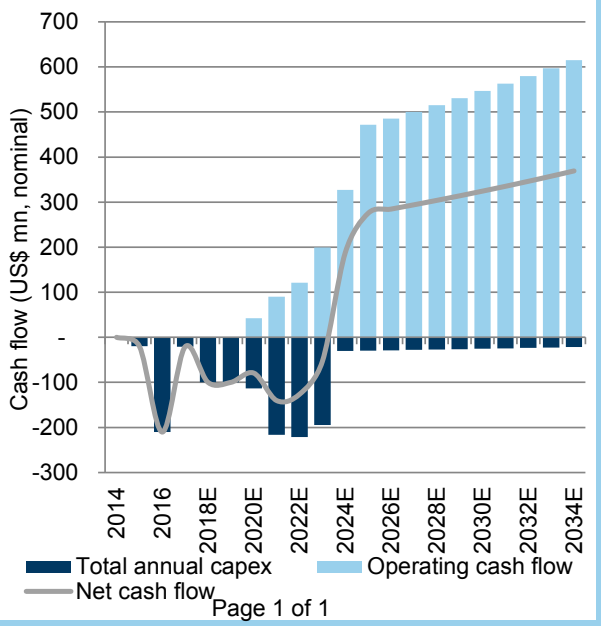
Pumpkin Hollow, acquired by Nevada Copper in 2005, is a high-grade iron oxide-copper-gold deposit located near Nevada, USA. In September 2017 Nevada Copper completed a Technical Report which comprised a Pre-feasibility Study for a 5ktpd underground project and a Feasibility study for a 70ktpd open pit/underground project to improve economics. The two projects are mutually exclusive and both viable development options. We model the smaller 6ktpd project first and expect the company to embark on the larger project post 2021. The expansion contemplates a 63.5ktpd open pit mine and 6.5ktpd underground mine, feeding a single 70ktpd concentrator with an initial mine life of 23 years and an initial capex US$1.04bn. The project is fully permitted and construction ready. Nevada Copper recently signed a pre-works contract with Cementations USA Inc. and secured key long-lead times which should de-risk the re-start of contruction of the company's 5ktpd underground project, targeting first production in 2019. In December, Nevada Copper announced it had entered into arrangement for a US$378mn construction financing and recapitalisation package which will enable it to start production. We model first production in 2020 vs. the company's guidance of 2019.



Production profile



Cash flow chart



Economics summary

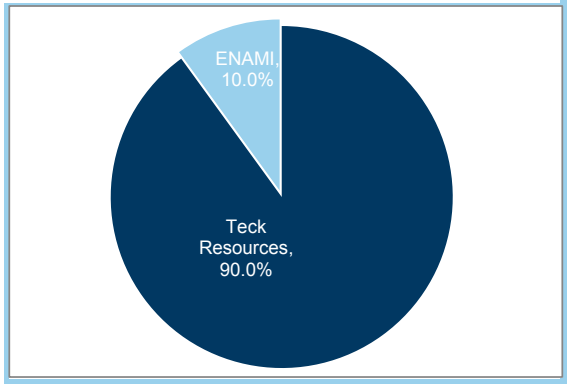
Internal rate of return	17%
NPV (including sunk costs)	US$1,330
NPV (2018+)	US$1,596
Cu required @ 10%	US$4,938 /t
Capex	US$1,100 mn
Capex / t Cu production	US$12,197
Capex / t Cu equ. production	US$10,884
Project type	Greenfield
Project status	Construction
Ore reserves / resources	572 mt
Copper grade	0.44% Cu
Contained copper	2,516 kt
Commissioning	2020
Peak copper production	125 ktpa
Average LOM production	90 ktpa
Life of mine	24
Gross unit cost	US$3,804 /t
Net unit cost (C1)	US$3,144 /t

Source: Company data, Goldman Sachs Global Investment Research

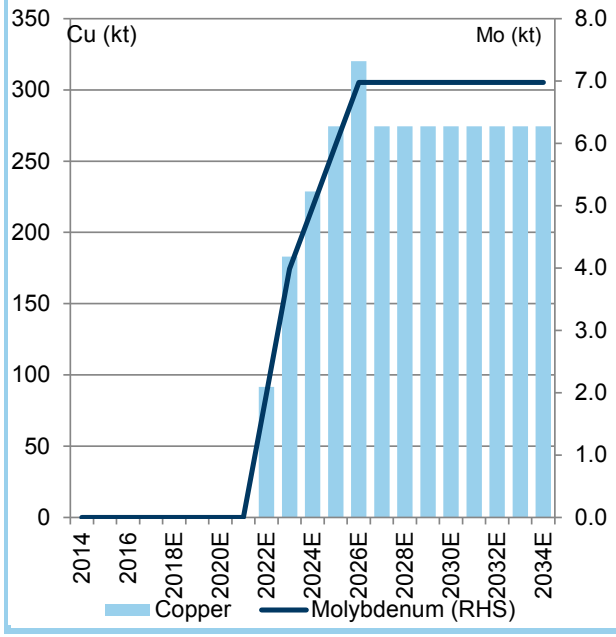
Exhibit 147: Quebrada Blanca II

Quebrada Blanca II	Chile	264 ktpa	US$4,900 mn	14% IRR

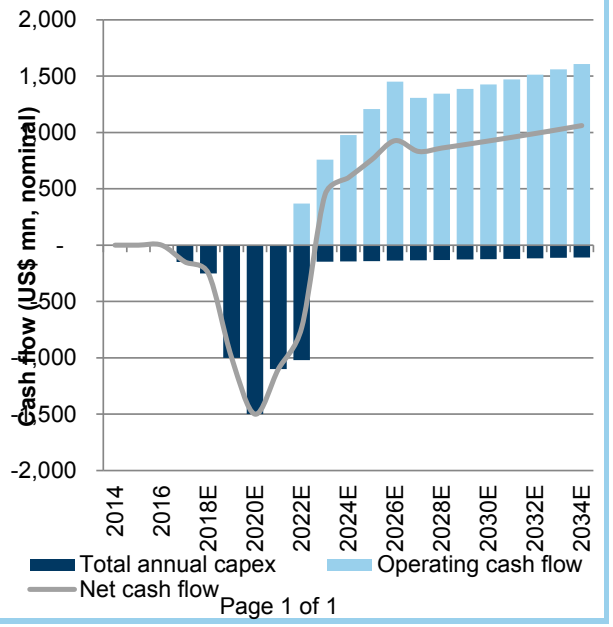
The Quebrada Blanca mine is an open pit operation located in Region I in Northern Chile. Teck recently increased its stake to 90% for US$162.5mn. The remaining stake is held by Empresa Nacional de Mineria (10%). The project is expected to have an annual production capacity of 300ktpa of copper equivalent for the first 5 years of mine life. The project entails the construction of a 140 ktpd concentrator along with concentrate and desalinated water pipelines connecting to a new port facility 165 km away. In February 2017, the company released a technical report on the updated feasibility study. The Social and Environmental Impact Assessment (SEIA) for the project was submitted in September 2016 and in August 2018 Teck announced it had received regulatory approval from the Environmental Committee of Tarapaca with the potential to sanction the project in 2H18 and a c.3 year production schedule. Teck guided to a total project capex bill of c.US$4.7 bn in 2016 dollars as per the latest feasibility study. We currently model a start in 2022 assuming the Environmental Assessment Service (SEA) is approved soon and the board sanctions it in 2H18 - note according to the company the first production is expected by mid-2021. In July 2018 Teck's CEO said they are seeking a partner for the project ahead of a final decision on moving forward with construction.



Production profile



Cash flow chart



Economics summary

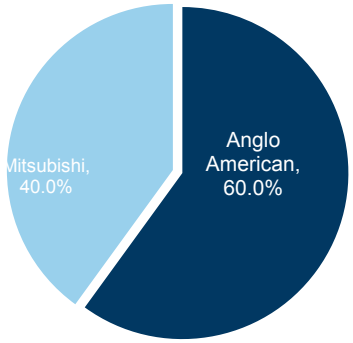
Internal rate of return	14%
NPV (including sunk costs)	US$3,387
NPV (2018+)	US$3,540
Cu required @ 15%	US$7,083 /t
Capex	US$4,900 mn
Capex / t Cu production	US$18,543
Capex / t Cu equ. production	US$17,314
Project type	Brownfield
Project status	Permitting
Ore reserves / resources	1,259 mt
Copper grade	0.51% Cu
Contained copper	6,420 kt
Commissioning	2022
Peak copper production	320 ktpa
Average LOM production	264 ktpa
Life of mine	27
Gross unit cost	US$3,429 /t
Net unit cost (C1)	US$3,018 /t

Source: Company data, Goldman Sachs Global Investment Research

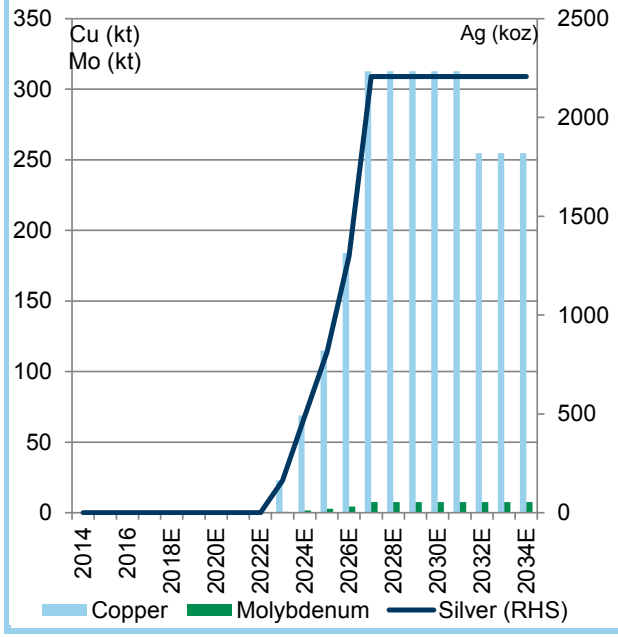
Exhibit 148: Quellaveco

Quellaveco	Peru	243 ktpa	US$5,400 mn	11% IRR

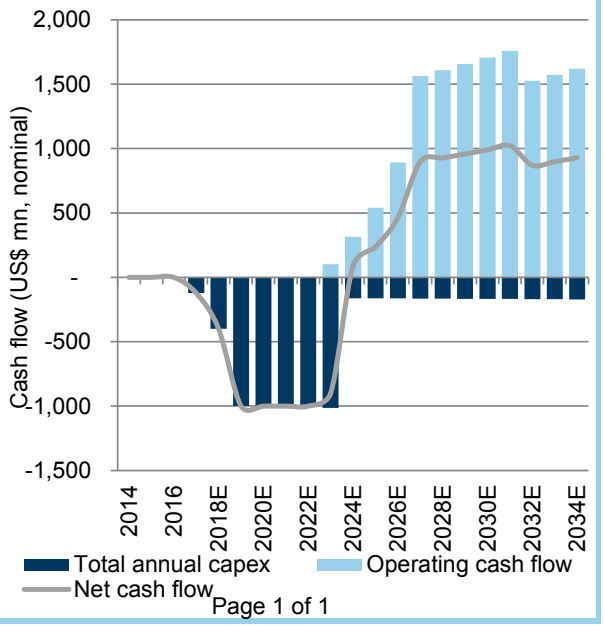
The Quellaveco mine is a greenfield asset located in southern Peru. The project has received support from the local community for its water plan and is now waiting for construction permits from the Peruvian government. Quellaveco is one of the most advanced copper projects currently in the development phase. The project is likely to be presented to board for approval soon according to Anglo American, with approvals expected with the 1H18 results. More recently, Mitsubishi increased its stake in the project from 18.1% to 40% for a total consideration of US$600m with Anglo diluting its stake down to 60%. The project was greenlit by Anglo with the 1H18 results. The company has guided to c. 300Ktpa of copper eq. production. According to the company the first production is expected to be in 2022 with production ramping up in 2023. During the first ten years the mine is slated to produce c. 300Ktpa of copper at a cash cost of US$1.05/lb of copper.



Production profile



Cash flow chart



Economics summary

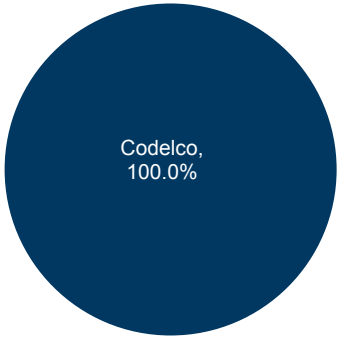
Internal rate of return	11%
NPV (including sunk costs)	US$1,775
NPV (2018+)	US$1,901
Cu required @ 15%	US$8,750 /t
Capex	US$5,400 mn
Capex / t Cu production	US$22,258
Capex / t Cu equ. production	US$20,184
Project type	Greenfield
Project status	Construction
Ore reserves / resources	1,333 mt
Copper grade	0.57% Cu
Contained copper	7,687 kt
Commissioning	2023
Peak copper production	313 ktpa
Average LOM production	243 ktpa
Life of mine	28+
Gross unit cost	US$2,952 /t
Net unit cost (C1)	US$2,369 /t

Source: Company data, Goldman Sachs Global Investment Research

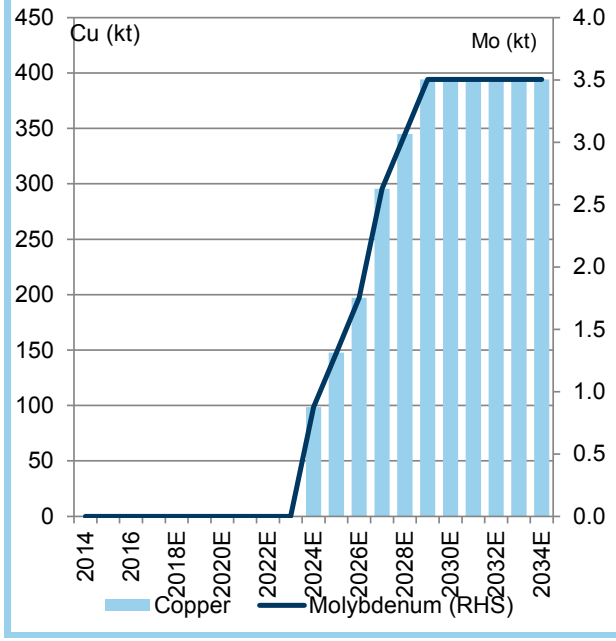
Exhibit 149: Radomiro Tomic

Radomiro Tomic	Chile	343 ktpa	US$5,900 mn	15% IRR

The 100% Codelco-owned Radomiro Tomic mine is located in Chile and is currently undergoing Phase 2 of development. The intial Phase 2 plan was mining the sulphide ore reserves, which were estimated at 2.8 bn tonnes, grading 0.5% copper with annual production expected to average 343 kt of copper from a planned 200 ktpd concentrator plant, offsetting expected sharp declines from the existing copper oxide production from 2018. However, due to water/capital constraints the company is now planning 2 dedicated 100kt/d concentrators. Stage 1 will include a 100kt/d concentrator which will use desalinated sea water. The second concentrator is also expected to operate with deslainated water. The project is in feasibility stage and the company has recieved EIA approvals in Jan 2016. The next stage of the project is approval by Codelco board and Cochilco. Recent newsflow suggests that Codelco is prioritising other project over Radomiro Tomic. Total capital investment for Stage 1 is estimated by Codelco at US$3.5bn and for phase 2 is expected to be US$2.5bn. Given the lack of any meaningful newsflow on the project, we see this as a low probablity project.



Production profile



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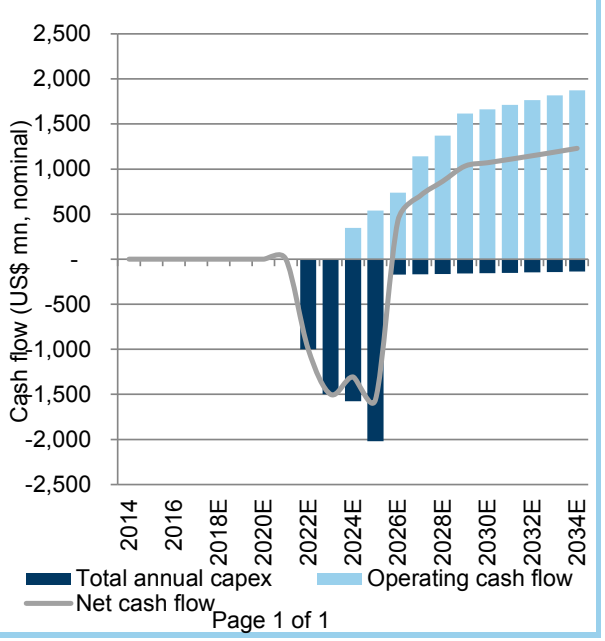


Economics summary

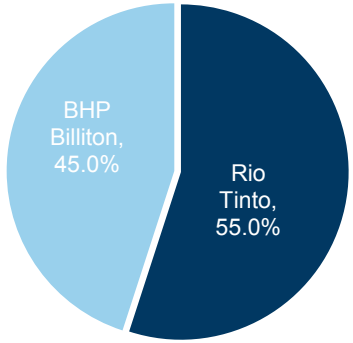
Internal rate of return	15%
NPV (including sunk costs)	US$3,654
NPV (2018+)	US$3,654
Cu required @ 15%	US$6,553 /t
Capex	US$5,900 mn
Capex / t Cu production	US$17,201
Capex / t Cu equ. production	US$16,714
Project type	Brownfield
Project status	Feasibility
Ore reserves / resources	2,125 mt
Copper grade	0.50% Cu
Contained copper	10,625 kt
Commissioning	2024
Peak copper production	394 ktpa
Average LOM production	343 ktpa
Life of mine	27+
Gross unit cost	US$3,406 /t
Net unit cost (C1)	US$3,239 /t

Source: Company data, Goldman Sachs Global Investment Research

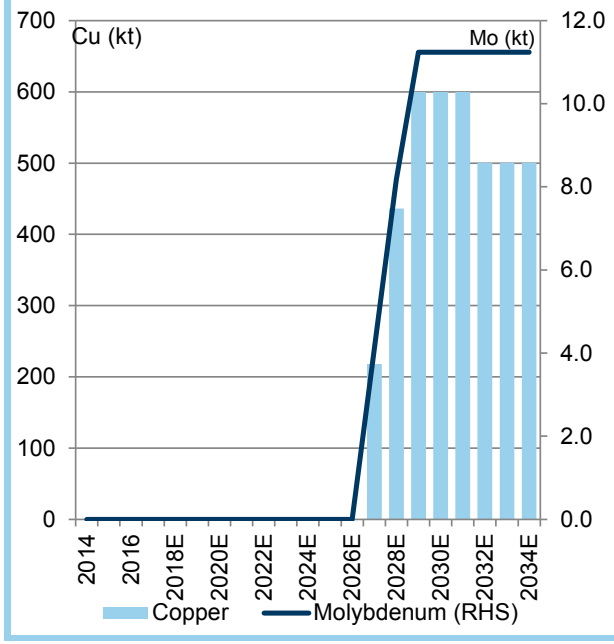
Exhibit 150: Resolution

Resolution	USA	498 ktpa	US$6,500 mn	15% IRR

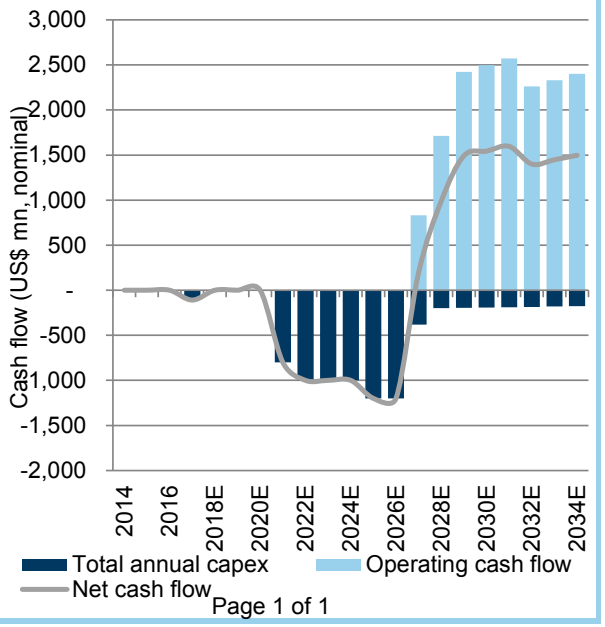
The Resolution copper project is located in Superior, Arizona, USA. Rio Tinto has a 55% stake, while BHP holds 45%. Drill results suggest a large ore body ranging 1,500-2,130 metres below the surface, which Rio expects will support an underground block caving operation processing 120 ktpd (up to 150 ktpd) of ore and which will produce an average 500 ktpa of copper for at least 40 years, on our estimates. A general plan of operations was published in November 2013 by the JV company, suggesting that underground development work and surface facility construction would take up to ten years. In December 2014, the US Federal government agreed to a land swap, which is currently undergoing environmental and regulatory review. The project is currently nearing the end of the prefeasibility phase. In December 2017 Rio approved a US$368mn commitment to further advance the Resolution Copper project. The funding will improve infrastructure and facilitate mine planning as part of the pre-feasibility study. We expect first production no sooner than 2027 (compared with previous guidance from the company of a 2021 start) and estimate capex at c.US$6.5 bn (excluding more than US$1.3 bn already spent) pending further guidance from the company.



Production profile



Cash flow chart



Economics summary

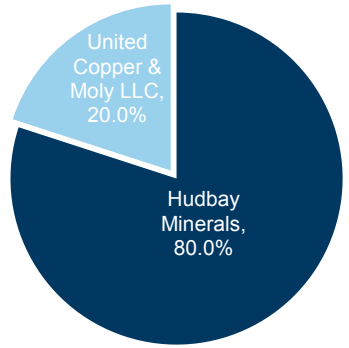
Internal rate of return	15%
NPV (including sunk costs)	US$4,197
NPV (2018+)	US$4,309
Cu required @ 10%	US$5,500 /t
Capex	US$6,500 mn
Capex / t Cu production	US$13,040
Capex / t Cu equ. production	US$12,279
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	1,787 mt
Copper grade	1.54% Cu
Contained copper	27,520 kt
Commissioning	2027
Peak copper production	600 ktpa
Average LOM production	498 ktpa
Life of mine	24+
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$3,280 /t

Source: Company data, Goldman Sachs Global Investment Research

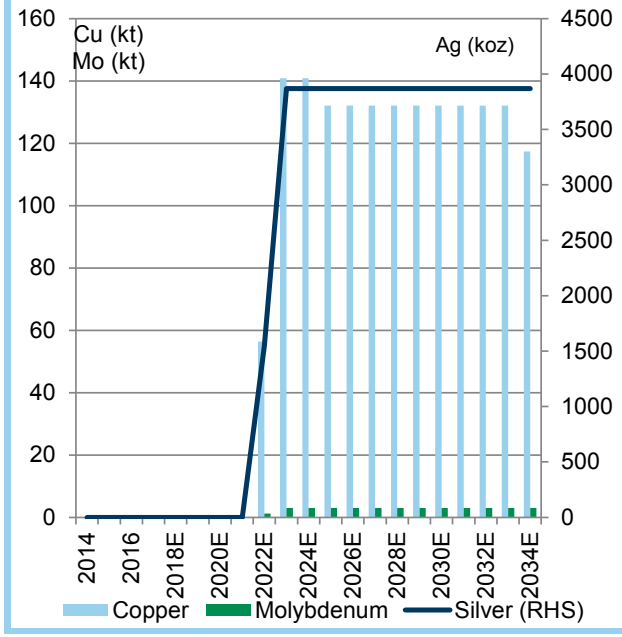
Exhibit 151: Rosemont

Rosemont	USA	125 ktpa	US$2,021 mn	13% IRR

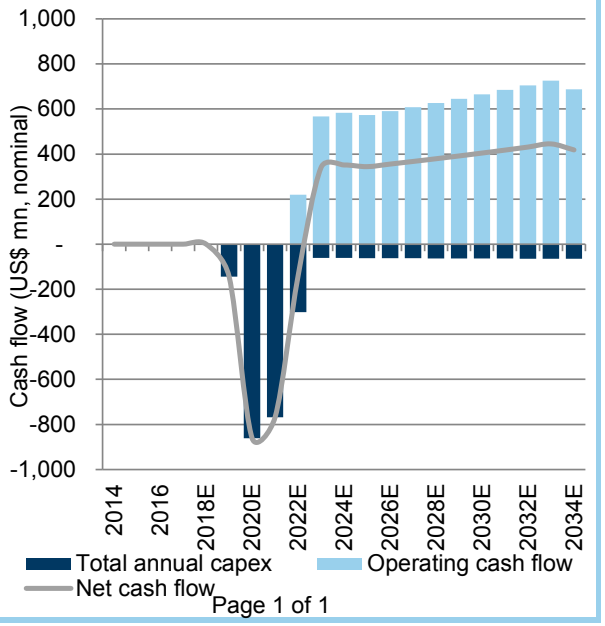
The Rosemont copper mine is located in Arizona, US, 50 km southeast of Tucson. The mine is currently 92.05% owned by Hudbay Minerals (after it acquired Augusta Resources in June 2014) subject to a 20% joint venture with United Copper and Moly LLC. A feasibility study was released in March 2017. The company had initially guided to US$1.3 bn capex, which was then raised to US$1.9 bn. The mine will produce c. 110Ktpa of copper over its LOM with 127Kt over the first 10 years. The project received a Final Record of Decision from the U.S. Forest Service in June 2017 and is preparing to receive Section 404 Water Permit and complete the Mine Plan of Operations. The project is shovel ready and the company is currently engaged in permitting and community engagement. Construction of the project can begin as soon as the permitting is compete.



Production profile



Cash flow chart



Economics summary

Internal rate of return	13%
NPV (including sunk costs)	US$685
NPV (2018+)	US$685
Cu required @ 10%	US$6,005 /t
Capex	US$2,021 mn
Capex / t Cu production	US$16,136
Capex / t Cu equ. production	US$14,058
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	537 mt
Copper grade	0.45% Cu
Contained copper	2,417 kt
Commissioning	2022
Peak copper production	141 ktpa
Average LOM production	125 ktpa
Life of mine	19
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$2,669 /t

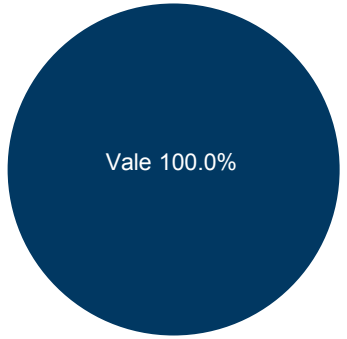
Page 1 of 1

Source: Company data, Goldman Sachs Global Investment Research

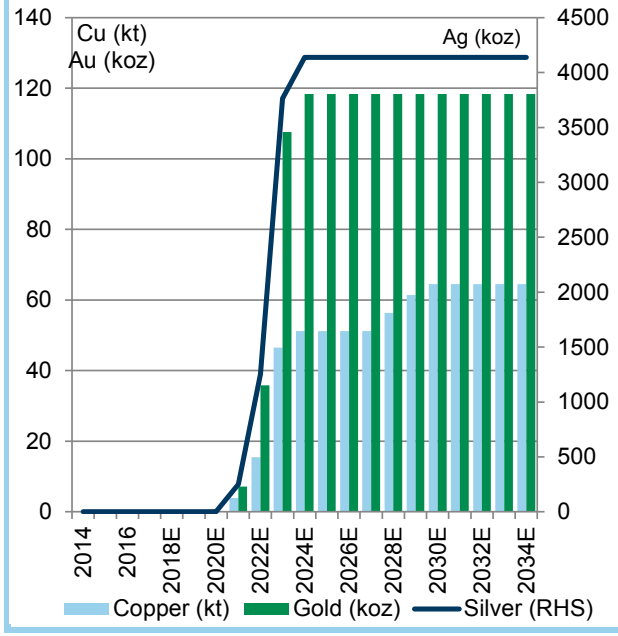
Exhibit 152: Salobo 3

Salobo 3	Brazil	60 ktpa	US$1,100 mn	20% IRR

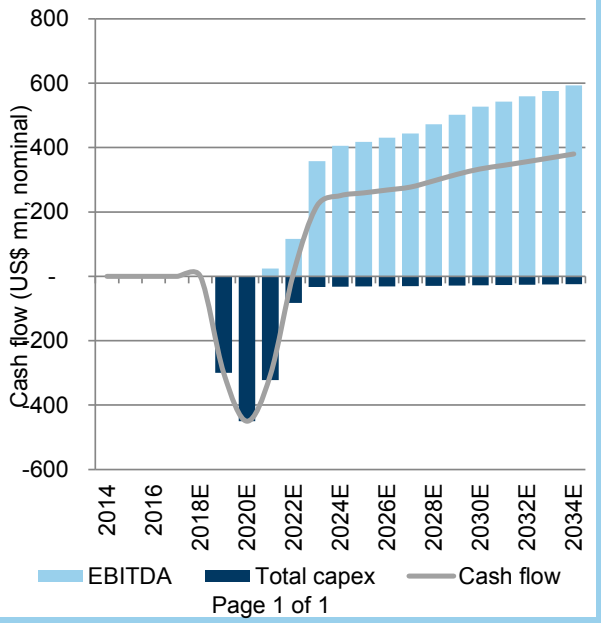
Salobo 3 is the next addition to the Salobo mine in Brazil. The mine as of now operates at a 24Mt/a ore conventional open pit mine and concentrator. In June 2012 Salobo started Phase I (Salobo I) with a mill capacity of 12Mt/a ore. The initial capex of this was US$2,507mn. In June 2014, Vale brought into production the Salobo II project, which doubled the nameplate milling capacity from 12Mt/a to 24Mt/a. Both Salobo I & II operate just as one open pit. Vale in 1Q18 said that it was studying the possibility of carrying out the Salobo III expansion. This will involve the expansion of the concentrator from 24Mt/a to 36Mt/a. Wood Mackenzie estimates the capex to be c. US$1.5bn (to which we add our capex inflation estimate) and expects the decision to start construction being taken soon. Given the high copper prices and the reduced leverage of Vale - we believe that a decision for the expansion is likely to be taken soon. We expect capex to be started to spend in 2019 with first production in 2022. Full production is likely to be reached in 3-4 years and we estimate the full production of the new expansion at c. 65Kt.



Production profile



Cash flow chart



Economics summary

Internal rate of return	20%
NPV (including sunk costs)	US$1,817
NPV (2018+)	US$1,817
Cu required @ 25%	US$4,870 /t
Capex	US$1,100 mn
Capex / t Cu production	US$18,343
Capex / t Cu equ. production	US$12,272
Project type	Brownfield
Project status	Pre-feasibility
Ore reserves / resources	1,178 mt
Copper grade	0.63% Cu
Contained copper	7,421 kt
Commissioning	2022
Peak copper production	65 ktpa
Average LOM production	60 ktpa
Life of mine	30+
Gross unit cost	US$3,970 /t
Net unit cost (C1)	-US$442 /t

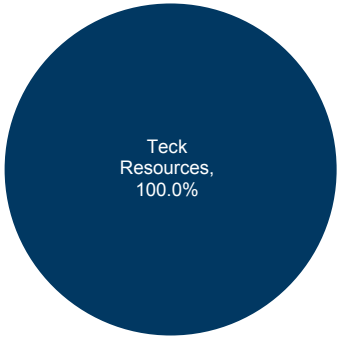
Page 1 of 1

Source: Company data, Goldman Sachs Global Investment Research

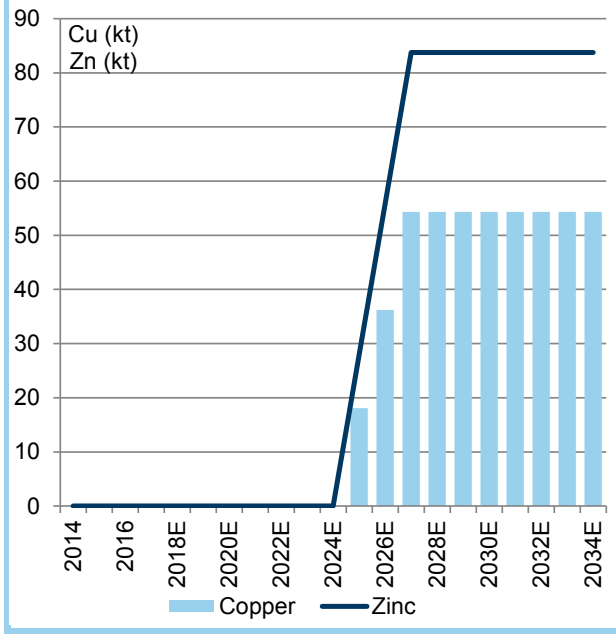
Exhibit 153: San Nicolas

San Nicolas	Mexico	51 ktpa	US$750 mn	24% IRR

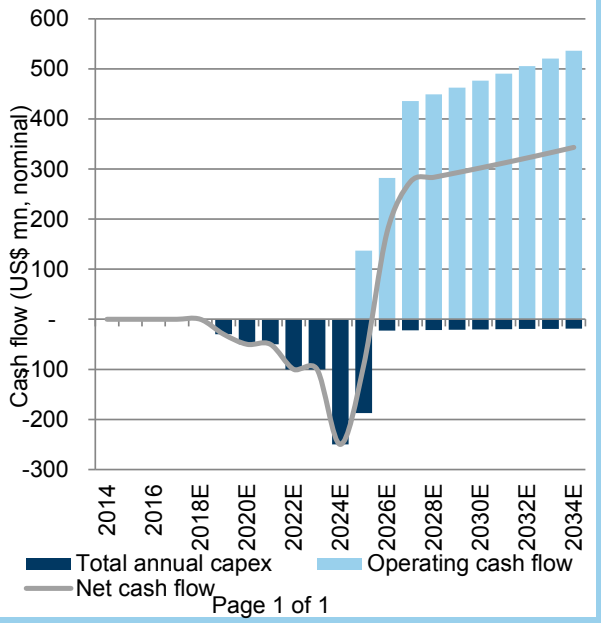
San Nicolas is a copper-zinc project owned by Teck Resources in Mexico. Teck increased its shareholding in the project from 79% to 100% by buying out GoldCorp's minorities for US$50mn last year. While the details around the project have been scant - the last full set of details (resources etc.) released was in 2001 - we believe that the recent commetnary by the company around the project has been encouraging. In 3Q17, Teck initiated the environmental and social baseline studies, preliminary hydrogeological studies, and project engineering programs were initiated in the third quarter of 2017 in support of a prefeasibility study and an SEIA which it is looking to finish by 2H19. The company in 2015 estimated capex to be c. US$585mn (we increase that number to reflect the recent inflation). Teck plans to spend US$30mn in exploration expenditure at the mine. We estimate the project to come online in 2025, but given the smaller size of the project there is upside risk to this project coming online sooner in our view.



Production profile



Cash flow chart



Economics summary

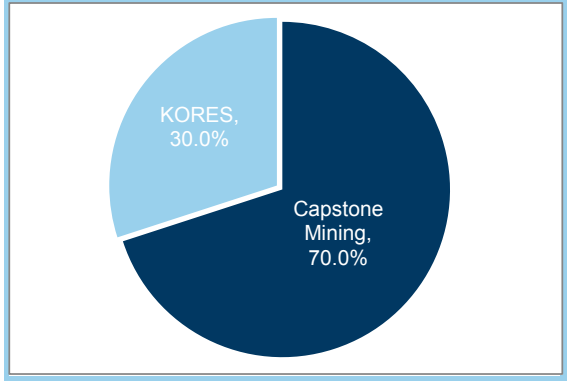
Internal rate of return	24%
NPV (including sunk costs)	US$1,140
NPV (2018+)	US$1,140
Cu required @ 12%	US$4,870 /t
Capex	US$750 mn
Capex / t Cu production	US$14,621
Capex / t Cu equ. production	US$8,641
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	92 mt
Copper grade	1.24% Cu
Contained copper	1,137 kt
Commissioning	2025
Peak copper production	54 ktpa
Average LOM production	51 ktpa
Life of mine	18
Gross unit cost	US$3,970 /t
Net unit cost (C1)	US$45 /t

Source: Company data, Goldman Sachs Global Investment Research

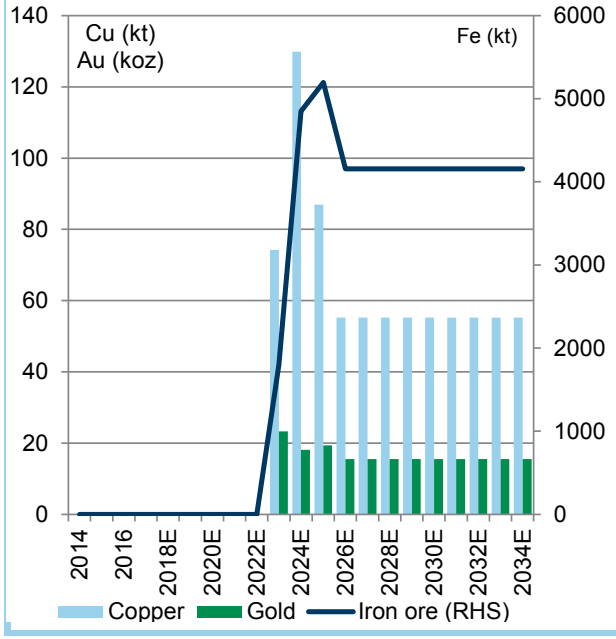
Exhibit 154: Santo Domingo

Santo Domingo	Chile	62 ktpa	US$1,850 mn	17% IRR

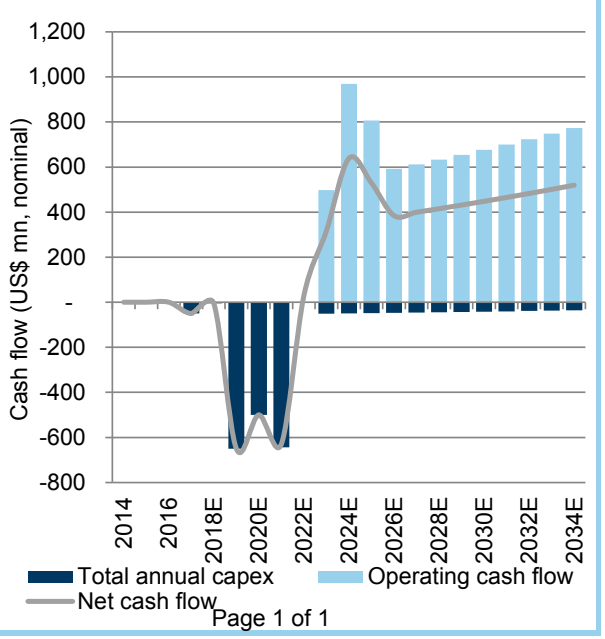
The Santo Domingo Project, owned 70% by Capstone and 30% by Korea Resources Corp (KORES), is located c.800 km north of Santiago, Chile. It is 60 km from the Pacific coast, providing seawater to the site and access to deep water port facilities and infrastructure such as rail, power lines and a smelter. Results of the 2014 feasibility study indicated an avg. annual production of 58 kt of copper (113 ktpa for the first five years), 4.2 mt of iron concentrate and 16 koz of gold, and estimated capex to be US$1.7 bn (we inflate that number). KORES acquired a 30% interest for US$194 mn. Under the agreement, it is responsible for arranging debt financing for 65% of the capital costs but in return has an offtake agreement for 50% of the copper and iron concentrate over the LOM. The Environmental Impact Assessment (EIA) for the project was approved in July 2015. In 2017, size long-lead permits were submitted and are pending approval. Current focus is on securing power for the project at an economical price and the owners are also looking to reach an agreement on sharing infrastructure which may reduce the capital cost of the project. The owners are currently updating costs for current conditions and evaluating opportunities which could eliminate the need for a port, as well as exploring interest from other parties to potentially reduce the owner's interest. We estimate start up in 2023.



Production profile



Cash flow chart



Economics summary

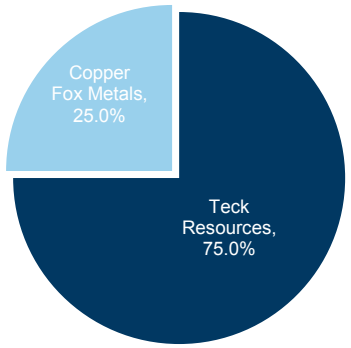
Internal rate of return	17%
NPV (including sunk costs)	US$1,610
NPV (2018+)	US$1,662
Cu required @ 15%	US$5,476 /t
Capex	US$1,850 mn
Capex / t Cu production	US$29,959
Capex / t Cu equ. production	US$17,588
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	392 mt
Copper grade	0.30% Cu
Contained copper	1,175 kt
Commissioning	2023
Peak copper production	130 ktpa
Average LOM production	62 ktpa
Life of mine	18
Gross unit cost	US$2,044 /t
Net unit cost (C1)	-US$1,341 /t

Source: Company data, Goldman Sachs Global Investment Research

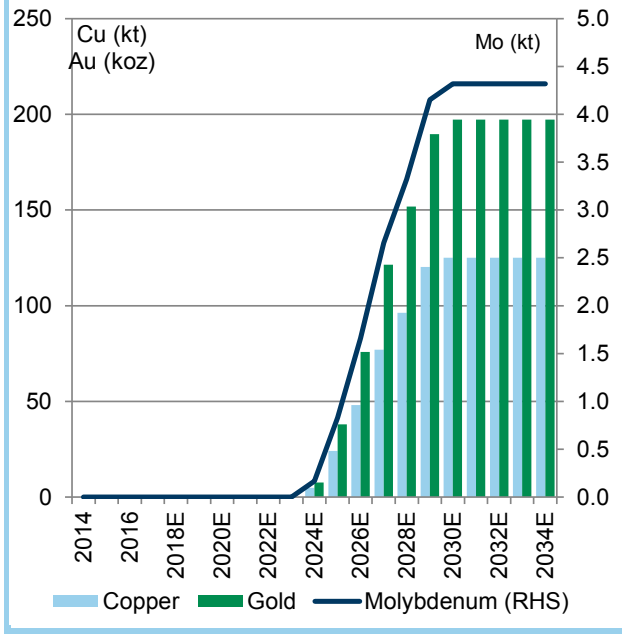
Exhibit 155: Schaft Creek

Schaft Creek	Canada	109 ktpa	US$3,700 mn	8% IRR

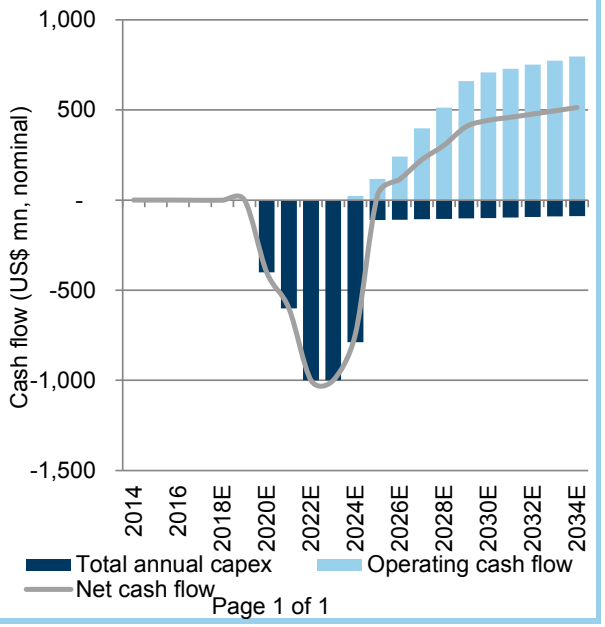
The Schaft Creek deposit is located in northwest British Columbia, Canada. The project was previously wholly owned by Copper Fox Metals; however, in July 2013, Copper Fox formed a JV with Teck Resources to further develop the project with Teck taking the majority share in the mine. A feasibility study was completed in January 2013 indicating an initial mine life of 21 years at a 130 ktpd milling rate from the open pit mine. Total capex for the project guided by the company is US$3.26 bn, but we add our capex escalation expectations to the guided number. In February 2018 Copper Fox Metals announced the 2018 Schaft Creek programme. The programme has a budget of US$0.8 mn and includes desktop studies to understand which scenarios add the best value to the project, collection of environmental data by external consultants and permitting/social activities which include ongoing consultation with the Tahltan First Nations on social and cultural matters. The Multi-Year Area Based Permit ("MYAB") has been filed with the Ministry of Mines for British Columbia. The main activities covered include approval for up to 50 diamond drill holes, 5 km of new drill road and 20 km of line cutting, none of which are planned at this stage.The focus for 2018 will be to: a) consultation with the Tahltan First Nations on social and cultural matters and evaluate development alternatives with potentially improved economics.



Production profile



Cash flow chart



Economics summary

Internal rate of return	8%
NPV (including sunk costs)	US$7
NPV (2018+)	US$8
Cu required @ 10%	US$7,428 /t
Capex	US$3,700 mn
Capex / t Cu production	US$34,071
Capex / t Cu equ. production	US$23,834
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	941 mt
Copper grade	0.27% Cu
Contained copper	2,550 kt
Commissioning	2024
Peak copper production	125 ktpa
Average LOM production	109 ktpa
Life of mine	23
Gross unit cost	US$5,064 /t
Net unit cost (C1)	US$2,230 /t

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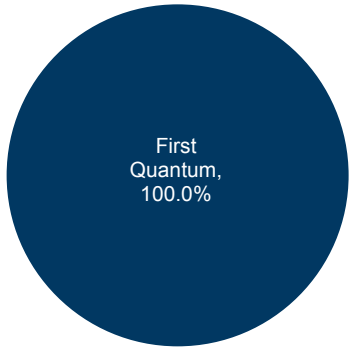
Source: Company data, Goldman Sachs Global Investment Research

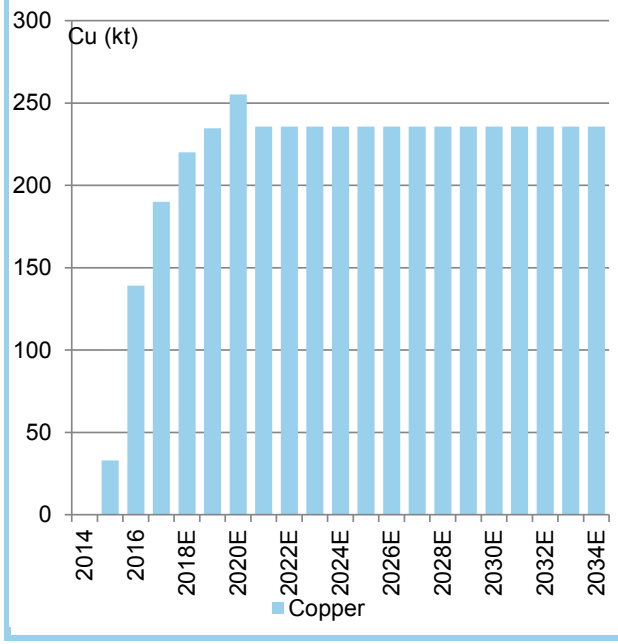
Exhibit 156: Sentinel

Sentinel	Zambia	220 ktpa	US$2,000 mn	20% IRR

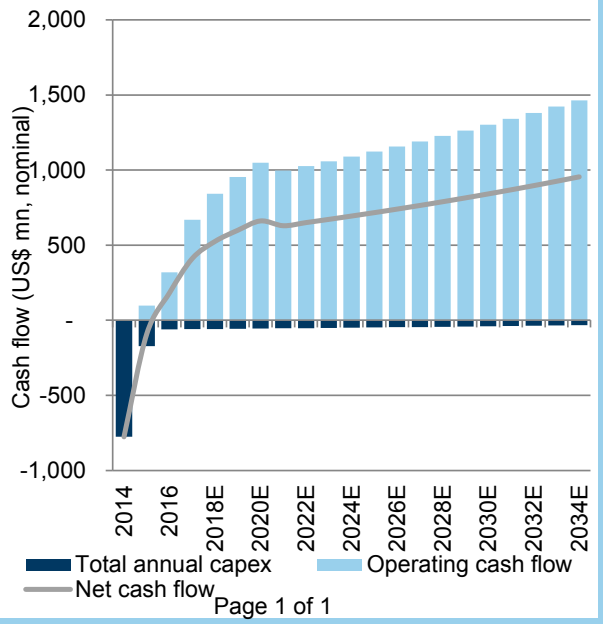
The Sentinel deposit is located in Zambia and is one of three mines that make up the Trident project. The project was commissioned in December 2014, 30 months from the start of full-scale construction. The project produced 190kt of copper in concentrate in 2017. The mine faced significant challenges in ramp-up given low copper prices and power issues in Zambia at the time. An agreement was reached with ZESCO and the Government of the Republic of Zambia in September 2017, whereby the company has accepted an increase in power tariffs under the stipulation that both Sentinel and Kansanshi can import a portion of their power and with a commitment from ZESCO to improve the stability and quality of power provided to the company's operations. First Quantum changed the mining layout and is transitioning to a terraced mining which is going to slow the ramp-up; guidance for 2019 is 235kt and for 2020 it is 250Kt+. The mine was initially ear-marked to produce c. 300Ktpa but given the smelting capacity constraints in Zambia we believe that 250Ktpa is likely going to be the upper limit until a decision is taken on building a new one.



Production profile



Cash flow chart



Economics summary

Internal rate of return	20%
NPV (including sunk costs)	US$5,275
NPV (2018+)	US$6,929
Cu required @ 15%	US$5,239 /t
Capex	US$2,000 mn
Capex / t Cu production	US$9,086
Capex / t Cu equ. production	US$9,086
Project type	Greenfield
Project status	Producing
Ore reserves / resources	894 mt
Copper grade	0.48% Cu
Contained copper	4,292 kt
Commissioning	2015
Peak copper production	255 ktpa
Average LOM production	220 ktpa
Life of mine	22
Gross unit cost	US$2,725 /t
Net unit cost (C1)	US$2,725 /t

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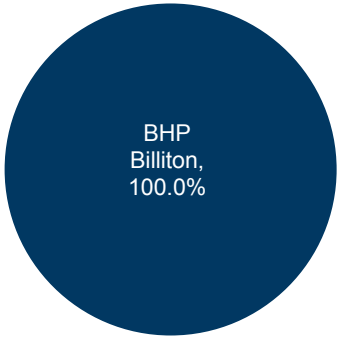
Source: Company data, Goldman Sachs Global Investment Research

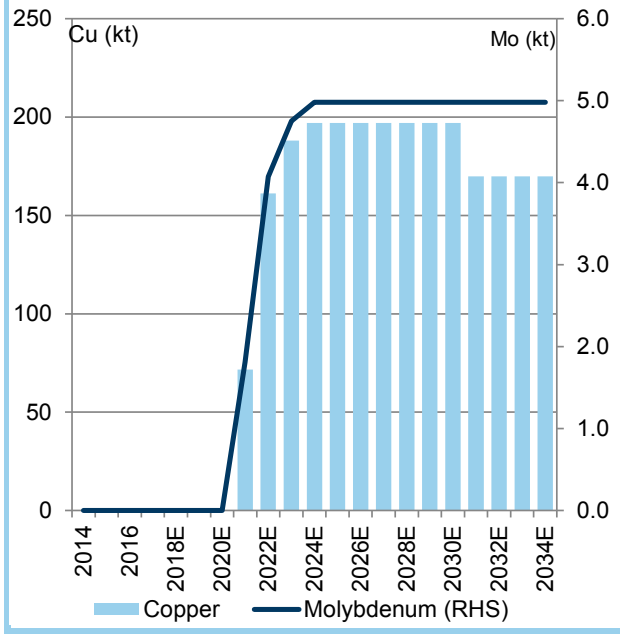
Exhibit 157: Spence growth option

Spence growth option	Chile	173 ktpa	US$2,510 mn	19% IRR

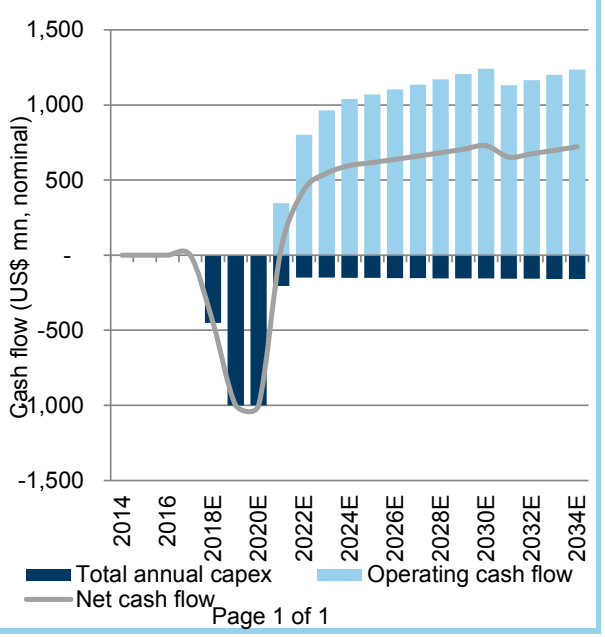
Spence Hypogene is an expansion project located in Chile. The project had been suspended in 2012 since BHP decided to first support its larger projects; however, it decided to restart the project in January 2013. The project was approved by the board in August 2017 with expected capex of US$2.46bn. The project will convert 1.3 Bt of Measured and Indicated Mineral Resources to hypogene sulphide Ore Reserves. BHP sees potential to exploit the hypogene resource through a 95 ktpd concentrator with longer-term expansion potential. BHP is guiding for capex of US$2.46bn. However, the desalination plant which is to be built at a capex of US$1.43bn will be paid for over the next 20 years. The decision to outsource the building of the desalination plant under a Build, Own, Operate and Transfer contract is unique - while it doesn't reduce the overall capex, it does reduce the initial outlay which makes the project screen better. The company expects first production in FY2021 - in line with our expectations - and anticipates the project to average production of ~185kt of copper in concentrate over the first 10 years. We expect the ramp-up to full capacity of c. 200Ktpa by 2025.



Production profile



Cash flow chart



Economics summary

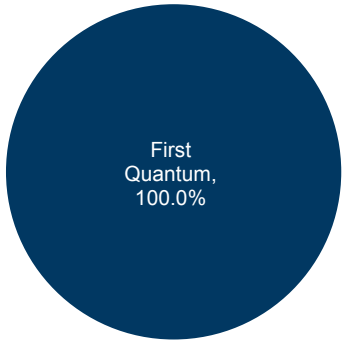
Internal rate of return	19%
NPV (including sunk costs)	US$3,851
NPV (2018+)	US$3,851
Cu required @ 15%	US$5,697 /t
Capex	US$2,510 mn
Capex / t Cu production	US$14,492
Capex / t Cu equ. Production	US$12,933
Project type	Brownfield
Project status	Construction
Ore reserves / resources	1,300 mt
Copper grade	0.60% Cu
Contained copper	7,760 kt
Commissioning	2021
Peak copper production	197 ktpa
Average LOM production	173 ktpa
Life of mine	30+
Gross unit cost	US$2,498 /t
Net unit cost (C1)	US$1,778 /t

Source: Company data, Goldman Sachs Global Investment Research

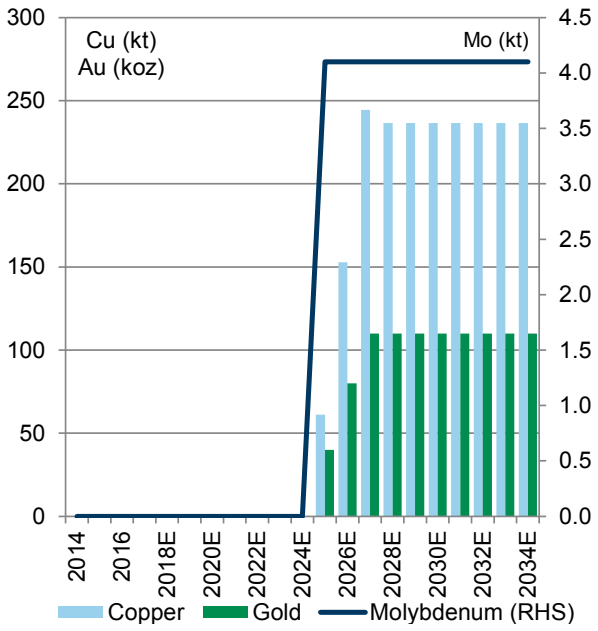
Exhibit 158: Taca Taca

Taca Taca	Argentina	227 ktpa	US$3,900 mn	16% IRR

Taca Taca is wholly owned by First Quantum (which acquired the mine from Lumina Copper Corp. in 2014) and is a porphyry copper-gold-molybdenum deposit located in the Puna region of northwestern Argentina, approximately 230 km west of the provincial capital of Salta. A Preliminary Economic Assessment (PEA) was completed in April 2013. The project envisages a mine operating over a 26-year life delivering 120 ktpd of throughput to a concentrator comprising two milling and flotation lines in the first seven years, expanding to 180 ktpd in the eighth year through the addition of a third line. The increase in throughput corresponds with a decline in head grade as higher-grade supergene mineralisation is replaced by lower-grade primary mineralisation as the predominant material mined. Initial capex is estimated by the company at c.US$3.5 bn including the addition of a third milling and flotation line; we see potential upside to this estimate and assume US$3.9 bn. The company is still evaluating the best way to develop the project. Given the other preferences of the company - primary being ramping-up Cobre Panama - we believe that any decision on this mine is likely to be taken post 2020 - hence our estimate of first capex spend in 2021 and start-up in 2025.



Production profile



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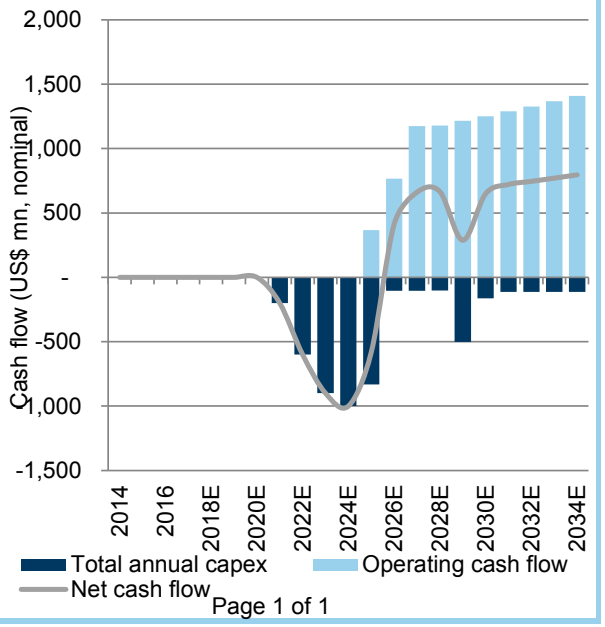


Economics summary

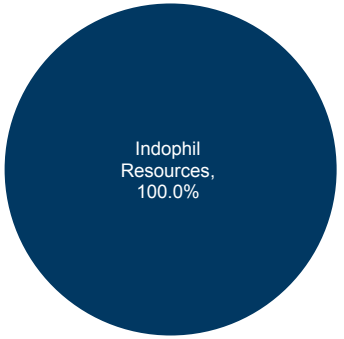
Internal rate of return	16%
NPV (including sunk costs)	US$2,456
NPV (2018+)	US$2,456
Cu required @ 25%	US$9,437 /t
Capex	US$3,900 mn
Capex / t Cu production	US$17,192
Capex / t Cu equ. production	US$15,056
Project type	Greenfield
Project status	Scoping
Ore reserves / resources	2,165 mt
Copper grade	0.44% Cu
Contained copper	9,526 kt
Commissioning	2025
Peak copper production	244 ktpa
Average LOM production	227 ktpa
Life of mine	26+
Gross unit cost	US$3,406 /t
Net unit cost (C1)	US$1,308 /t

Source: Company data, Goldman Sachs Global Investment Research

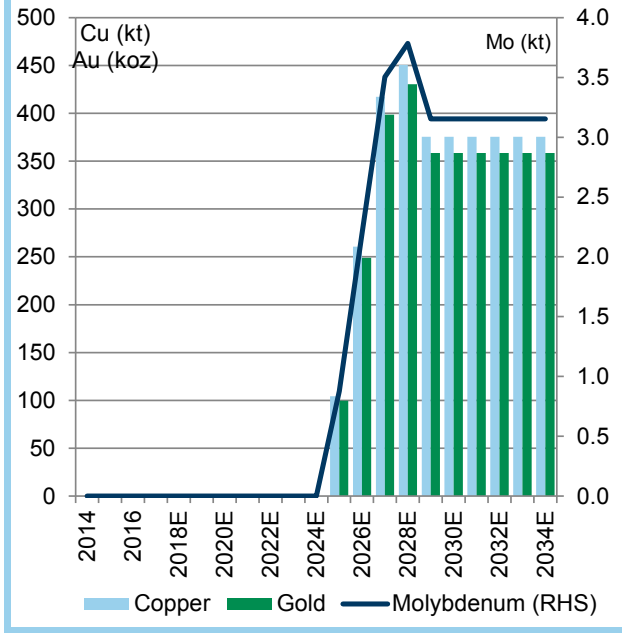
Exhibit 159: Tampakan

Tampakan	Philippines	361 ktpa	US$6,100 mn	16% IRR

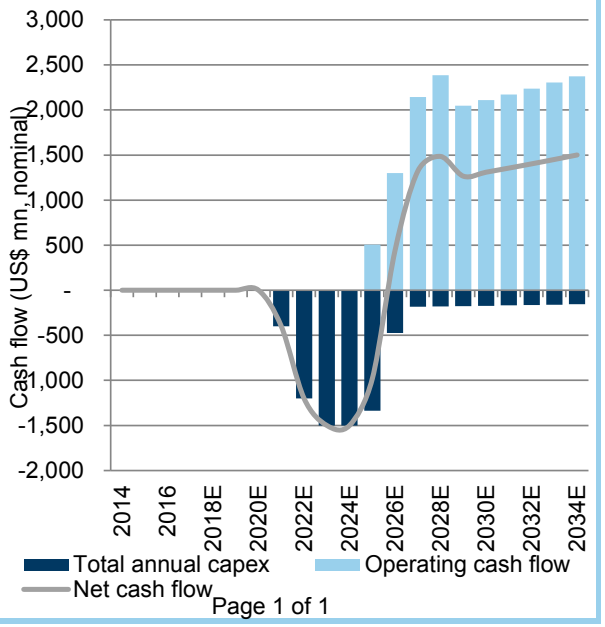
The Tampakan project, now 100% owned by Indophil Resources, is a greenfield open pit mine located on the Southern Philippines island of Mindanao. In June 2015, Glencore sold its stake in the project to Indophil Resources, consistent with the company's policy not to develop large greenfield projects. Previously, in 2007, Xstrata Copper assumed management control of the Tampakan copper-gold project through its subsidiary Sagittarius Mines Inc (SMI). The pre-feasibility study completed in 2009 was submitted to the Philippines government with average annual production of 375 ktpa of copper and 360 koz of gold over the initial 17-year mine life, and considerable growth potential. The latest provided estimated capital cost is US$5.9 bn, inclusive of US$900 mn for a power plant (up from an estimated US$4.8 bn). In February 2017 the ECC for the project was cancelled by the Mines Minister. With the change in ownership and given the size of the project, we see significant risks associated with the timing and capex of the project and now expect the project to commence production in 2025, with slight inflation to guided capex. We highlight that given the ban on open pit mining (which was upheld late last year) we see the probability of the project coming online as low.



Production profile



Cash flow chart



Economics summary

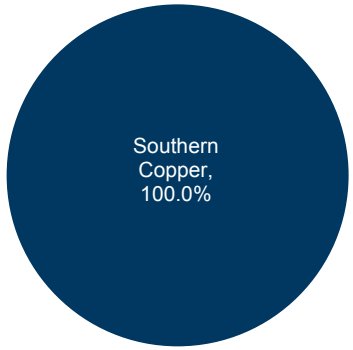
Internal rate of return	16%
NPV (including sunk costs)	US$3,406
NPV (2018+)	US$3,406
Cu required @ 25%	US$9,007 /t
Capex	US$6,100 mn
Capex / t Cu production	US$16,920
Capex / t Cu equ. production	US$14,004
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	1,117 mt
Copper grade	0.51% Cu
Contained copper	14,994 kt
Commissioning	2025
Peak copper production	451 ktpa
Average LOM production	361 ktpa
Life of mine	18
Gross unit cost	US$3,633 /t
Net unit cost (C1)	US$2,260 /t

Source: Company data, Goldman Sachs Global Investment Research

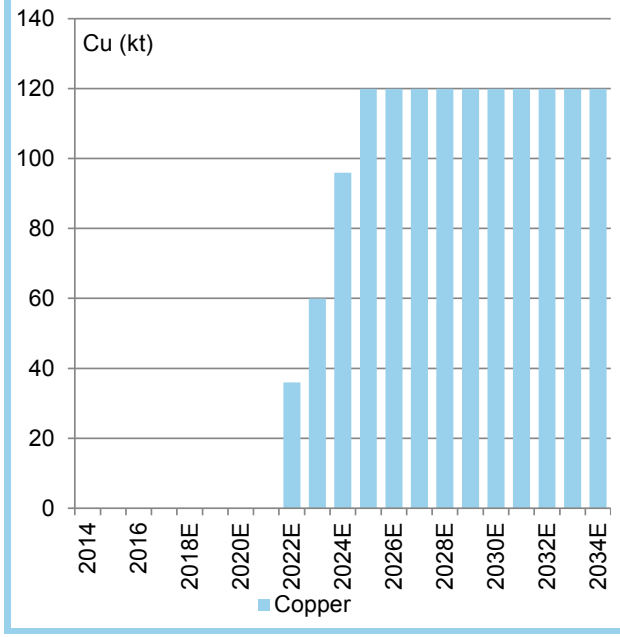
Exhibit 160: Tia Maria

Tia Maria	Peru	112 ktpa	US$1,500 mn	13% IRR

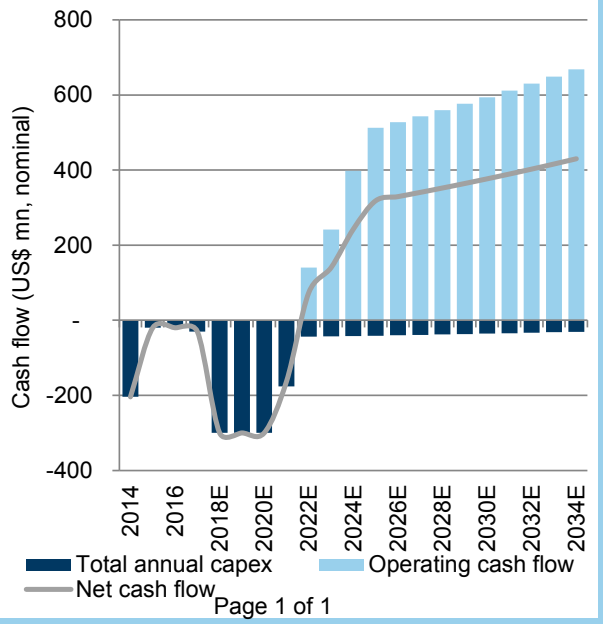
The Tia Maria project is located in the Peruvian region of Arequipa and is wholly owned by Southern Copper. The development of the mine has also been a contentious issue with local residents. After a number of protests, the company redesigned the mine and has now revived the project and has guided to a total capex of US$1.4 bn. However, the project seems to be moving in the right direction now as the company has been working with the local residents and has reached settlement with a company in Peru which had been blocking the project. The company has completed the engineering and after having complied with all environmental requirements it has received approvals for the environmental impact assessment. The company is hoping to get construction license by as soon as the end of this year which could allow construction to begin. While the project is in advanced stages and if the approvals were to be granted the mine could begin as soon as 2021, there have continued to be some local communitites which oppose the building of the project. We forecast the project to come online in 2022 and reach full production by 2025.



Production profile



Cash flow chart



Economics summary

Internal rate of return	13%
NPV (including sunk costs)	US$1,179
NPV (2018+)	US$1,657
Cu required @ 15%	US$7,632 /t
Capex	US$1,500 mn
Capex / t Cu production	US$13,360
Capex / t Cu equ. production	US$13,360
Project type	Greenfield
Project status	Permitting
Ore reserves / resources	721 mt
Copper grade	0.36% Cu
Contained copper	2,590 kt
Commissioning	2022
Peak copper production	120 ktpa
Average LOM production	112 ktpa
Life of mine	20
Gross unit cost	US$2,725 /t
Net unit cost (C1)	US$2,725 /t

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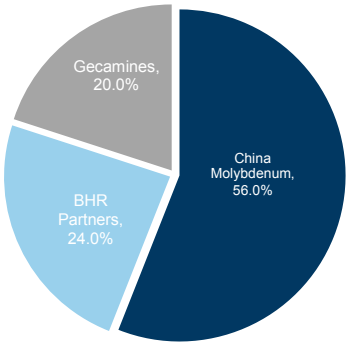
Source: Company data, Goldman Sachs Global Investment Research

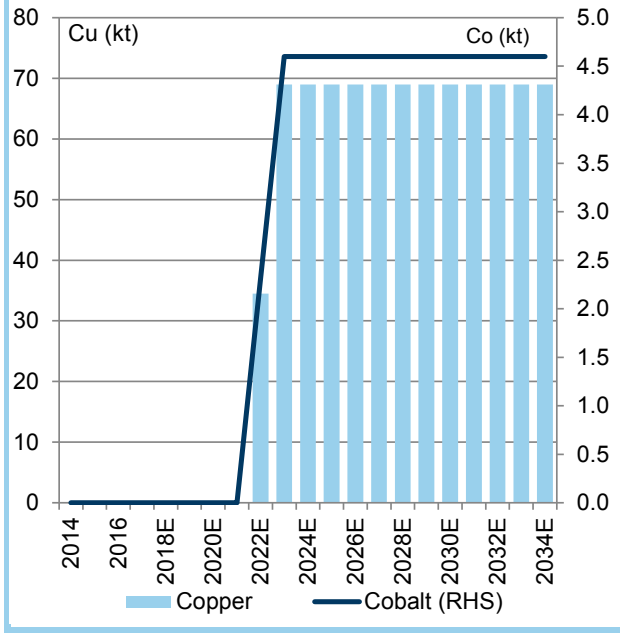
Exhibit 161: Tenke Phase 3

Tenke Phase 3	DRC	66 ktpa	US$600 mn	43% IRR

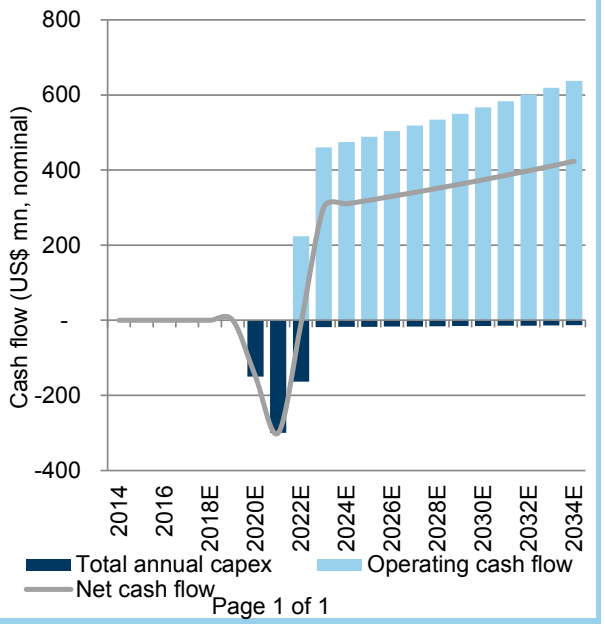
The Tenke-Fungurume mine is located in the Katanga province of the DRC. In May 2016, Freeport announced the sale of its 56% stake in Tenke to China Molybdenum Co. Ltd. for US$2.65bn and Lundin Mining sold its 24% stake to BHR Partners in November 2016 for US$1.14bn. Phase 2 expansion of the project was completed in 2H12, which expanded mill throughput to 14 ktpd (from 8 ktpd) to enable an increase in copper production by 68 ktpa to c.200 ktpa. Before Freeport sold, it continued exploration at Tenke to evaluate future opportunities for expansion including a third phase expansion to raise output by a further c.70 ktpa of copper and c.5 ktpa of cobalt. The existing operations have about 200 ktpa of capacity at the front-end of the plant, but plating capacity is already at c.270 ktpa, implying that the Phase 3 expansion would not require an expansion of the entire plant, reducing the capital intensity. Phase 3 would require additional crushing capacity, mine trucks and we estimate construction would take c.18-20 months. Official capex guidance has not been provided yet; we estimate a total US$600mn capex, slightly lower than c.US$700mn for Phase 2, reflecting the lower expected capital intensity partly offset by inflationary pressures while awaiting updates from the new operator. Any expansion requires increased grid power access - as such we don't see the likelihood of that happening in the near future.



Production profile



Cash flow chart



Economics summary

Internal rate of return	43%
NPV (including sunk costs)	US$1,443
NPV (2018+)	US$1,443
Cu required @ 25%	US$4,117 /t
Capex	US$600 mn
Capex / t Cu production	US$9,045
Capex / t Cu equ. production	US$5,214
Project type	Brownfield
Project status	Feasibility
Ore reserves / resources	98 mt
Copper grade	3.27% Cu
Contained copper	3,205 kt
Commissioning	2022
Peak copper production	69 ktpa
Average LOM production	66 ktpa
Life of mine	13
Gross unit cost	US$3,747 /t
Net unit cost (C1)	US$837 /t

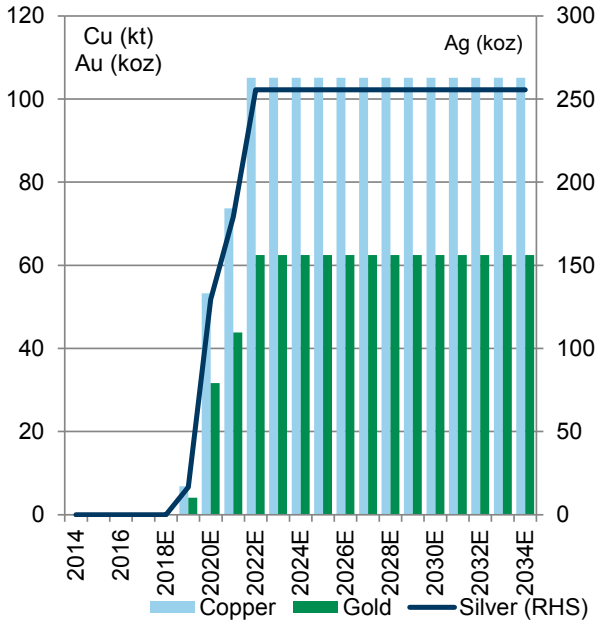
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 162: Tominsky

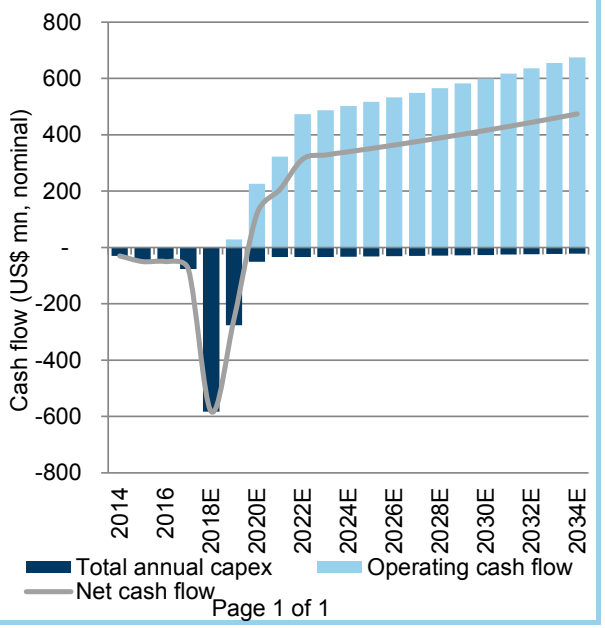
Tominsky	Russia	80 ktpa	US$1,283 mn	19% IRR

The Tominsky copper project, 100% owned by Russian Copper Company (RCC), is located in the Chelyabinsk region of the Russian Federation. The project is expected to have an open pit mine and a concentrator with a throughput of up to 28 mtpa. Construction of the Tominsky project is planned in two stages (14 mtpa each, target launch dates within 6 months of each other). The company has started mine construction in mid 2017 and in spring 2018 secured all necessary funding for the remaining capex. By end 2019 the company expects the construction of a covered mine, underground infrastructure and phase 1 of the processing plant with an estimated output of 14mt of ore per year. Phase 2 will be completed in 2020 to reach 28mtpa of ore producing ~105ktpa of copper concentrate.

Production profile



Cash flow chart



Economics summary

Internal rate of return	19%
NPV (including sunk costs)	US$2,058
NPV (2018+)	US$2,375
Cu required @ 12%	US$4,846 /t
Capex	US$1,283 mn
Capex / t Cu production	US$16,042
Capex / t Cu equ. production	US$16,042
Project type	Greenfield
Project status	Construction
Ore reserves / resources	580 mt
Copper grade	0.44% Cu
Contained copper	2,552 kt
Commissioning	2018
Peak copper production	105 ktpa
Average LOM production	80 ktpa
Life of mine	23
Gross unit cost	US$2,997 /t
Net unit cost (C1)	US$2,197 /t

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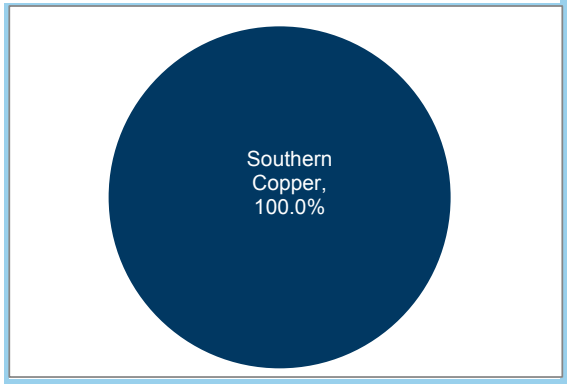
Source: Company data, Goldman Sachs Global Investment Research

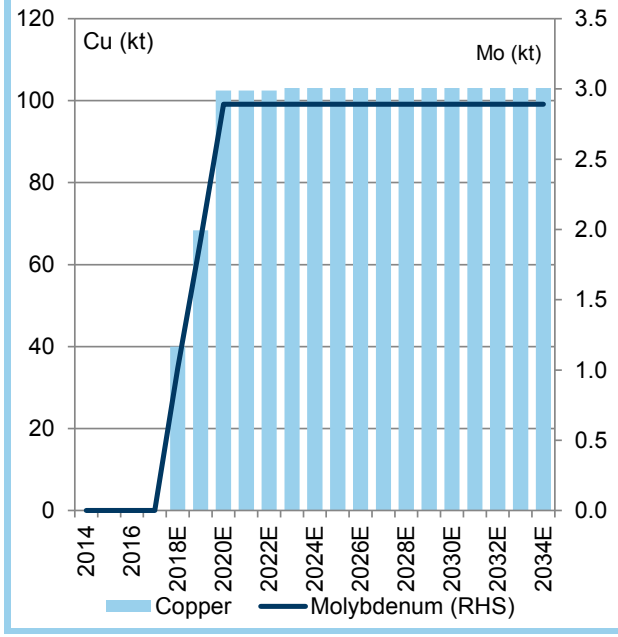
Exhibit 163: Toquepala

Toquepala	Peru	100 ktpa	US$1,310 mn	16% IRR

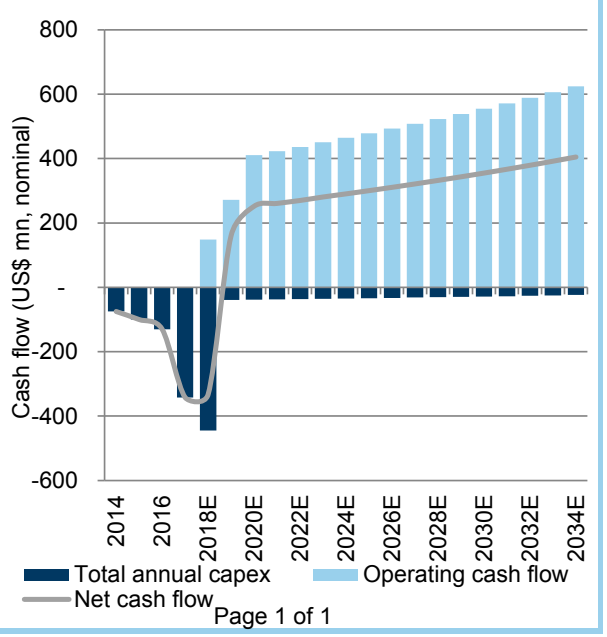
The Toquepala mine consists of a large porphyry copper deposit in the Tacna Province, Peru. The mine is an open pit operation producing copper with by-products of molybdenum, rhenium and silver. Southern Copper has 100% ownership of the mine. Midway through 2009, Southern Copper reinitiated expansion plans for the mine following a significant rise in the copper price. The company is guiding for the Toquepala concentrator expansion to increase copper production by 100 ktpa and molybdenum production by 3.1 ktpa - the copper concentrator capacity is being increased from 60Ktpa to 120Ktpa. The latest estimate of approved capital expenditure for the expansion is US$1,300 mn, we add inflation. The company received the EIA approval for the project in December 2014 and approval to commence construction in April 2015. The construction is expected to be finished in 2Q 2018 with ramp-up and production from the mine commencing in 3Q18 producing 40ktpa of copper in 2018 and ramping up to 100ktpa by 2020.



Production profile



Cash flow chart



Economics summary

Internal rate of return	16%
NPV (including sunk costs)	US$2,343
NPV (2018+)	US$3,318
Cu required @ 15%	US$6,325 /t
Capex	US$1,310 mn
Capex / t Cu production	US$13,091
Capex / t Cu equ. production	US$12,121
Project type	Brownfield
Project status	Construction
Ore reserves / resources	2,502 mt
Copper grade	0.52% Cu
Contained copper	13,085 kt
Commissioning	2018
Peak copper production	103 ktpa
Average LOM production	100 ktpa
Life of mine	33+
Gross unit cost	US$2,952 /t
Net unit cost (C1)	US$2,423 /t

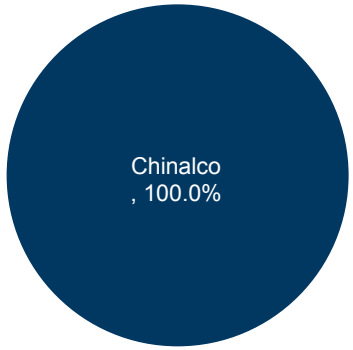
Page 1 of 1

Source: Company data, Goldman Sachs Global Investment Research

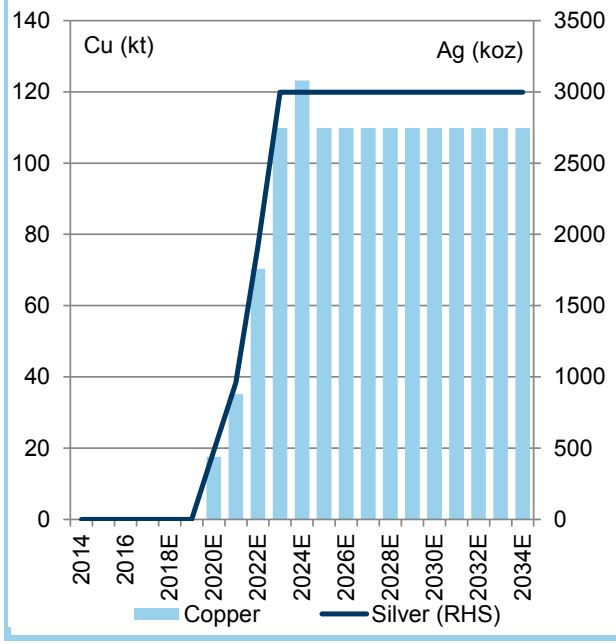
Exhibit 164: Toromocho expansion

Toromocho expansion	Peru	104 ktpa	US$1,400 mn	21% IRR

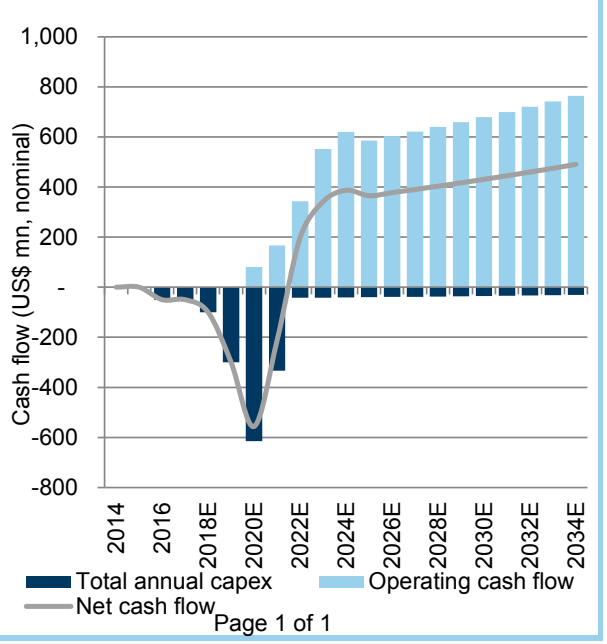
The Toromocho deposit is situated 140 km east of Lima, Peru, and is 100% owned by China's Chinalco following its purchase of Peru Copper Inc on July 11, 2007. The first phase of the project was commissioned in end 2013 with ramp-up expected to be completed by 2H2017. Chinalco approved an expansion to the Toromocho mine in mid-2013, proposing an additional 62.5Ktpd of concentrator capacity which would add c.100Ktpa of copper. Construction of the project was initially expected to start in January 2016 but was delayed indefinitely owing to issues faced at the Toromocho mine. In June 2018, Chinalco announced it had begun the second phase of the project - which it estimated to be at c. US$1.4bn. The project is pegged for completion in 2020. We expect first production at the mine in 2020, with the mine reaching full production by 2023.



Production profile



Cash flow chart



Economics summary

Internal rate of return	21%
NPV (including sunk costs)	US$2,634
NPV (2018+)	US$2,738
Cu required @ 15%	US$5,130 /t
Capex	US$1,400 mn
Capex / t Cu production	US$13,512
Capex / t Cu equ. production	US$11,601
Project type	Brownfield
Project status	Construction
Ore reserves / resources	1,526 mt
Copper grade	0.48% Cu
Contained copper	7,325 kt
Commissioning	2020
Peak copper production	123 ktpa
Average LOM production	104 ktpa
Life of mine	31+
Gross unit cost	US$2,952 /t
Net unit cost (C1)	US$1,861 /t

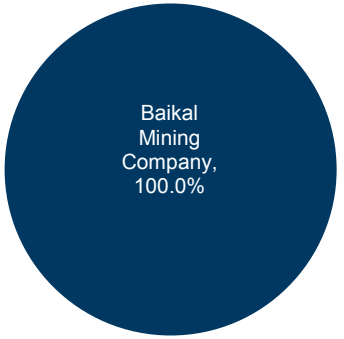
Page 1 of 1

Source: Company data, Goldman Sachs Global Investment Research

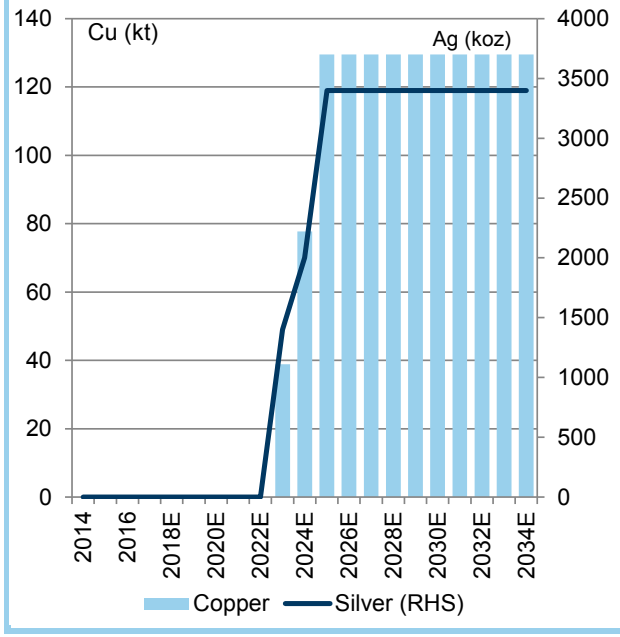
Exhibit 165: Udokan

Udokan	Russia	128 ktpa	US$2,695 mn	11% IRR

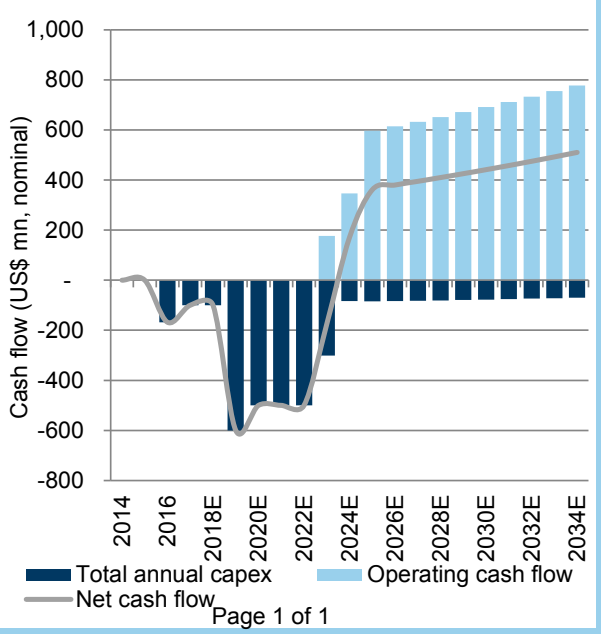
The Udokan mine is located in eastern Russia and is wholly owned by Baikal Mining Company (BMC) which was spun-off by Metalloinvest. Metalloinvest holds 54.25% of BMC. The project entails open pit mining, stage 1 of project development includes processing of 12 mtpa of copper ore producing 134ktpa of copper on average in the first ten years. Processing of Udokan ores is based on flotation-hydrometallurgical flowsheet. The plant shall produce cathode copper and sulphide concentrate. Further expansion to 48 mtpa of ore could be undertaken. Power supply infrastructure has been approved in the investment program of Russian Federal Grid Company and commissioning of the power transmission line (220 kV) is aligned with project schedule. During 2018 BMC is completing engineering of all complexes and infrastructure of Udokan MMP. Start of preparatory works at the plant site commenced in Sept 2018, full-fledged construction of major facilities is targeted for June 2019. Start of production aimed at 2022 (we model a more conservative start date of 2023). Total capex is estimated by company at US$2.4 bn for the Stage 1.



Production profile



Cash flow chart



Economics summary

Internal rate of return	11%
NPV (including sunk costs)	US$1,141
NPV (2018+)	US$1,422
Cu required @ 12%	US$6,799 /t
Capex	US$2,695 mn
Capex / t Cu production	US$21,117
Capex / t Cu equ. production	US$20,029
Project type	Greenfield
Project status	Construction
Ore reserves / resources	1,440 mt
Copper grade	1.05% Cu
Contained copper	15,115 kt
Commissioning	2023
Peak copper production	130 ktpa
Average LOM production	128 ktpa
Life of mine	28+
Gross unit cost	US$3,156 /t
Net unit cost (C1)	US$2,679 /t

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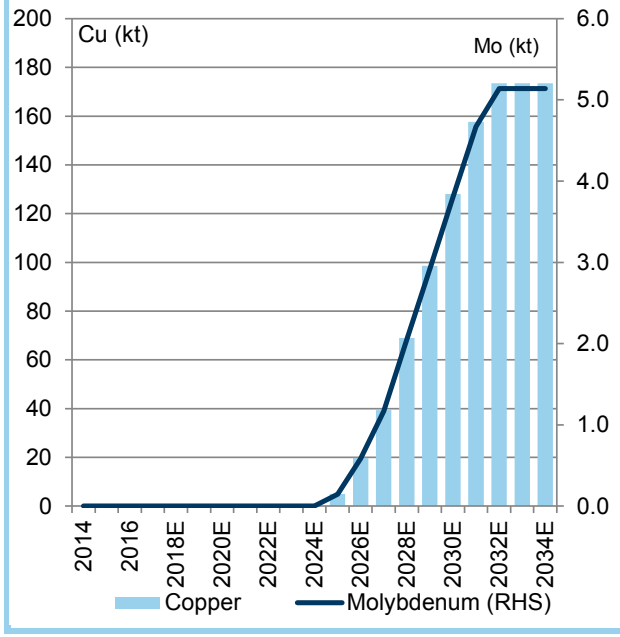
Source: Company data, Goldman Sachs Global Investment Research

Exhibit 166: Vizcachitas

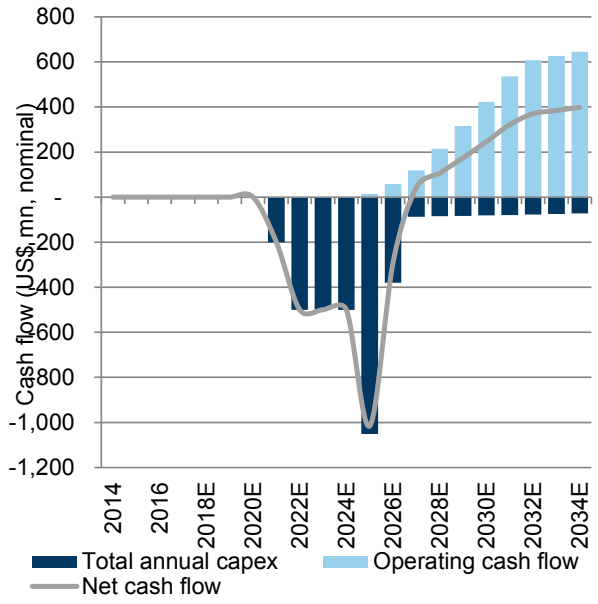
Vizcachitas	Chile	140 ktpa	US$3,000 mn	7% IRR

Vizcachitas is a copper-molybednum project located in Chile. It is owned by Los Andes. As part of the 2014 PEA, the company said that at an initial capex of US$2.9bn it would look to construct a 175ktpd mill which would see an average annual production of 179kt of copper and c. 5-6kt of molybdneum at a cost of c.USc170/lb. Since 2014, the company had been conducting exploration activities at the mine as part of which it has found higher grade mineralisation to the north of the existing mines. The mine is located at a low elevation with excellent infrastructure which makes it ideal for the project to start production. According to the company, the project is ready to enter the pre-feasibility stage. The company recently commented that it would update the PEA soon and the new parameters are likely to indicate a smaller mine at a much lower capex than the one for which it currently forecasts. The timeline according to the company is: 2018-20 it is looking to progress the PFS and environmental permits; by 2021 the company expects the environmental approval and and a decision on construction taken with construction starting in 2021-23. The company expects the copper production to begin in 2023 - we however take a slightly more conservative view and forecast first production in 2025 with full ramp-up by 2030.

Production profile



Cash flow chart



Economics summary

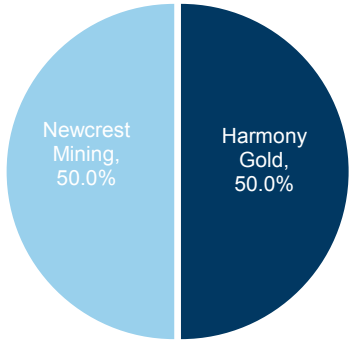
Internal rate of return	7%
NPV (including sunk costs)	-US$182
NPV (2018+)	-US$182
Cu required @ 15%	US$4,870 /t
Capex	US$3,000 mn
Capex / t Cu production	US$21,387
Capex / t Cu equ. production	US$19,384
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	1,038 mt
Copper grade	0.37% Cu
Contained copper	3,841 kt
Commissioning	2025
Peak copper production	173 ktpa
Average LOM production	140 ktpa
Life of mine	21
Gross unit cost	US$4,442 /t
Net unit cost (C1)	US$3,883 /t

Source: Company data, Goldman Sachs Global Investment Research

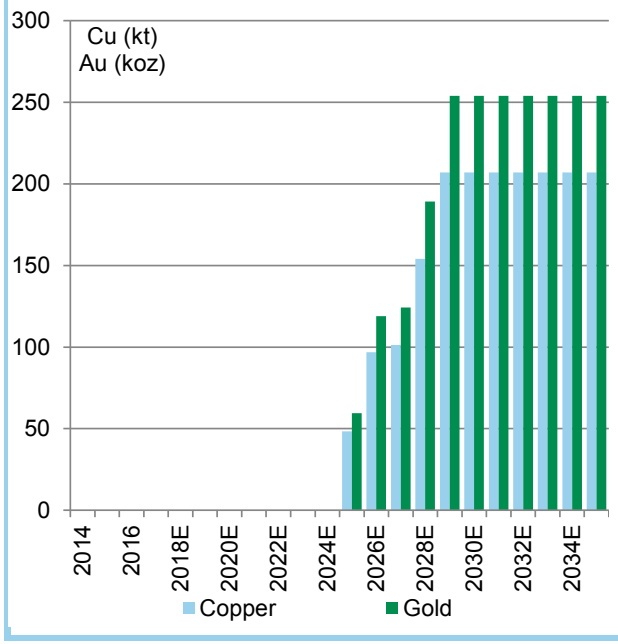
Exhibit 167: Wafi Golpu

Wafi Golpu	PNG	191 ktpa	US$3,000 mn	18% IRR

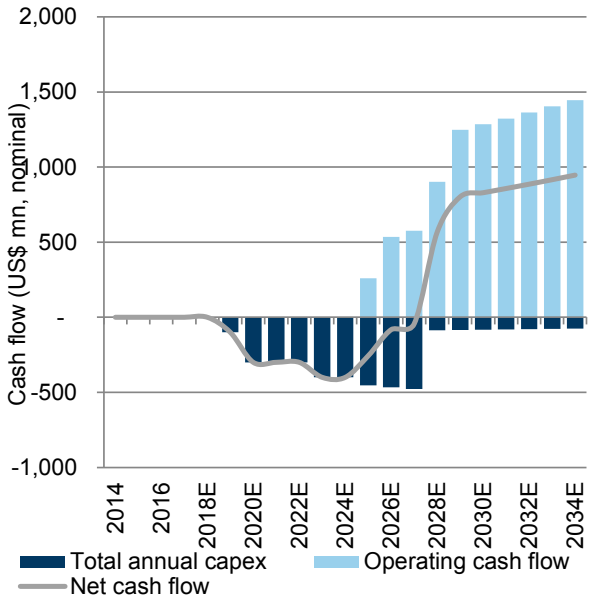
The Golpu deposit, located in Papua New Guinea (PNG), is a copper-gold deposit. The project is a joint venture between Harmony Gold Mining Company Ltd. (Harmony) and Newcrest Mining. In March 2018, Harmony released an updated feasibility study. The key changes are that the project now consists of three block caves (versus two previously) and the starter block cave is larger and deeper operating at 16mtpa (versus 3mtpa prior). The proposed 17mtpa processing plant will now include onsite-self generation of bulk power and associated fuel handling while Deep Sea tailings Placement (DSTP) has been identified as the preferred method of tailings management. First ore milled is expected 4.75 years from the grant of Special mining Lease (SML) which the JV applied for in August 2016 - the amended supporting documentation was submitted in March 2018. The JV plans to submit the EIS (Environmental Impact Statement) soon.The updated total initial capital for the project is expected to be US$2.8 bn compared to the initial pre-feasibility study capex guidance of US$4.8 bn and LoM capex is expected to be lower by US$1 bn. We model capex of US$3bn, as we adjust for inflation, and expect initial capex spend to start in 2019 with first production in 2025. In July 2018 the local Morobe government announced they wanted an equity stake of no less than 20% in the Wafi Golpu mine and want to be an active partner in the mine development.



Production profile



Cash flow chart



Economics summary

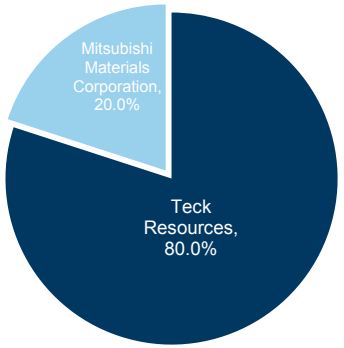
Internal rate of return	18%
NPV (including sunk costs)	US$3,388
NPV (2018+)	US$3,388
Cu required @ 25%	US$9,171 /t
Capex	US$3,000 mn
Capex / t Cu production	US$15,744
Capex / t Cu equ. production	US$12,732
Project type	Greenfield
Project status	Feasibility
Ore reserves / resources	380 mt
Copper grade	1.27% Cu
Contained copper	4,826 kt
Commissioning	2025
Peak copper production	207 ktpa
Average LOM production	191 ktpa
Life of mine	26+
Gross unit cost	US$1,703 /t
Net unit cost (C1)	US$922 /t

Source: Company data, Goldman Sachs Global Investment Research

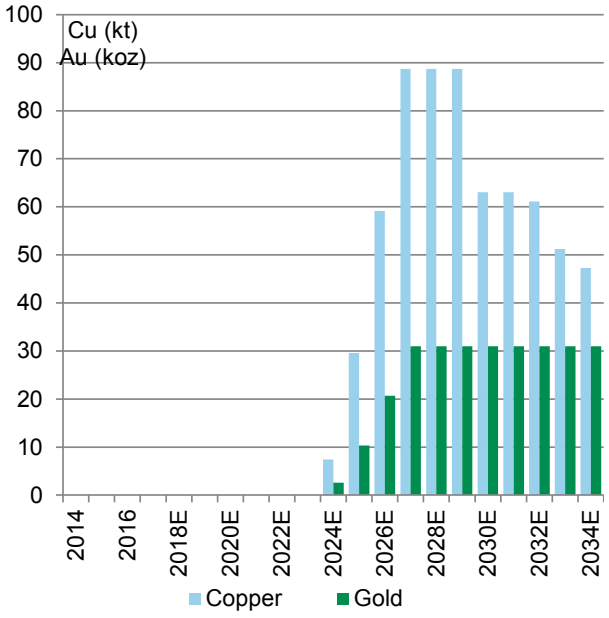
Exhibit 168: Zafranal

Zafranal	Peru	39 ktpa	US$1,270 mn	7% IRR

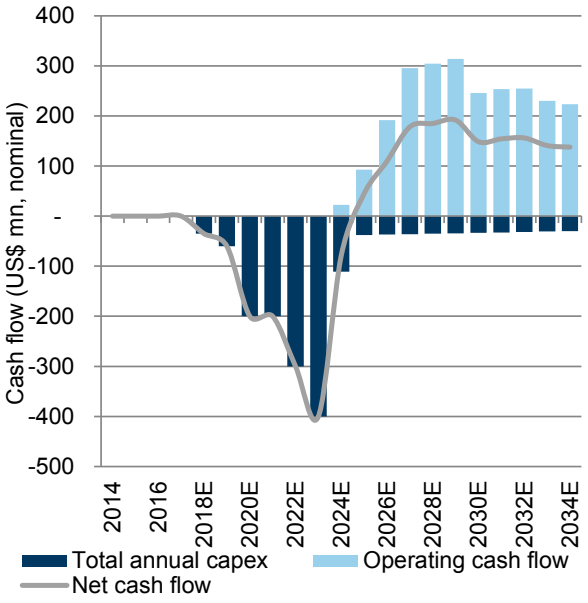
Zafranal, located in the Arequipa region in Peru, is a copper-gold greenfield open-pit mining project. The project was originally a 50/50 JV between its current operator, AQM, MAQM, and Teck Resources. In January 2017, Teck acquired AQM's share in MAQM and the effective ownership of the mine is now Teck Resources (80%) and MMC (20%). A Pre-Feasibility Study (PFS) was released in June 2016 which estimates resources of 467 mt with an average copper grade of 0.38%. The pre-production capex according to the PFS is US$1.16 bn with a mine life of 28 years and throughput averaging c.60ktpd. The environmental and social base line field studies for the project were delayed during 2015 as a result of local demands to sign a framework for long-term social investment programmes. During 2018 the focus will be on producing a feasibility study along with expanding community engagement activities and permitting work that is ncessary to prepare a Social and Environmental Impact Assessment (SEIA). The company expects to complete the feasibility study and submit the SEIA during 4Q18. Construction is expected to start in 1Q2019 with production to start at the end of 2021; we add slight capex inflation to the guided capex number and model first production from 2022.



Production profile



Cash flow chart



Economics summary

Internal rate of return	7%
NPV (including sunk costs)	-US$93
NPV (2018+)	-US$93
Cu required @ 15%	US$9,148 /t
Capex	US$1,270 mn
Capex / t Cu production	US$32,523
Capex / t Cu equ. production	US$29,983
Project type	Greenfield
Project status	Pre-feasibility
Ore reserves / resources	401 mt
Copper grade	0.40% Cu
Contained copper	1,604 kt
Commissioning	2024
Peak copper production	89 ktpa
Average LOM production	39 ktpa
Life of mine	27+
Gross unit cost	US$4,087 /t
Net unit cost (C1)	US$3,643 /t

Source: Company data, Goldman Sachs Global Investment Research

Share prices in this report are based on the market close of October 3, 2018.

EPS change summary

Exhibit 169: Summary of EPS changes

Company	EPS						% Change		
	2018E		2019E		2020E		*2018E*	*2019E*	*2020E*
Diversifieds	**New**	**Old**	**New**	**Old**	**New**	**Old**			
BHP - LSE	1.24	1.24	1.56	1.40	1.30	1.24	*0%*	*11%*	*5%*
BHP - ASX	1.24	1.24	1.56	1.40	1.30	1.24	*0%*	*11%*	*5%*
Rio -LSE	5.22	5.03	4.83	4.84	4.30	4.27	*4%*	*0%*	*1%*
Rio Tinto - ASX	5.22	5.03	4.83	4.84	4.30	4.27	*4%*	*0%*	*1%*
Glencore	0.53	0.54	0.51	0.60	0.40	0.48	*-1%*	*-15%*	*-17%*
Anglo American	2.26	2.24	2.23	2.23	1.77	1.73	*1%*	*0%*	*2%*
Norilsk Nickel	2.45	2.56	2.55	2.76	2.43	2.63	*-4%*	*-8%*	*-7%*
Teck Resources Ltd.	4.46	4.92	3.63	4.16	3.04	3.58	*-9%*	*-13%*	*-15%*
Copper									
Antofagasta	0.39	0.42	0.80	1.17	0.93	1.24	*-7%*	*-31%*	*-25%*
Boliden	25.73	26.12	25.63	29.29	23.95	26.78	*-1%*	*-12%*	*-11%*
First Quantum Minerals	0.52	0.55	1.00	1.33	1.46	1.81	*-6%*	*-25%*	*-19%*
Lundin Mining Corp.	0.34	0.35	0.57	0.73	0.70	0.85	*-3%*	*-21%*	*-18%*
KAZ Minerals Plc	0.94	0.97	0.76	1.18	0.73	1.10	*-3%*	*-35%*	*-34%*
Aurubis AG	5.19	5.19	3.86	4.40	4.67	5.32	*0%*	*-12%*	*-12%*
KGHM Polska Miedz SA	9.25	10.01	11.09	6.02	8.15	2.69	*-8%*	*84%*	*202%*
Freeport-McMoRan Inc.	1.58	1.78	0.74	1.39	0.94	1.60	*-11%*	*-47%*	*-41%*
MMG Ltd	0.03	0.05	0.06	0.09	0.07	0.09	*-30%*	*-33%*	*-25%*
Jiangxi Copper	0.73	0.83	0.79	0.98	0.83	1.00	*-12%*	*-19%*	*-17%*
Zijin Mining	0.18	0.20	0.19	0.24	0.21	0.26	*-9%*	*-20%*	*-17%*

Source: Goldman Sachs Global Investment Research

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We, Eugene King, Abhinandan Agarwal, Trina Chen, Matthew Korn, CFA, Joy Zhang and Nina Dergunova, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

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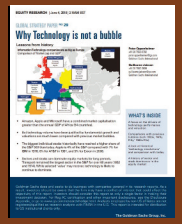

Space

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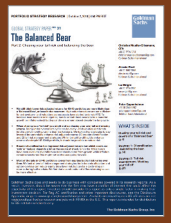
Balanced Bear 2



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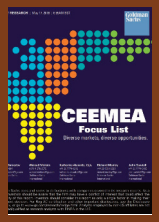
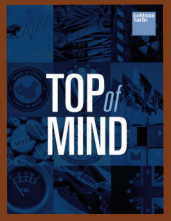


European Conviction List

European Passport

Top of Mind



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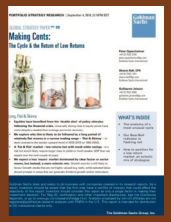

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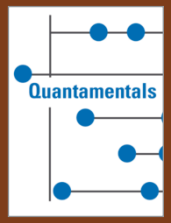
Quantamentals



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Top Oil & Gas Projects

Zinc Top Projects

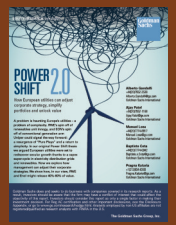
Oil: Age of Restraint

The Low Carbon Economy

Offshore Opportunity

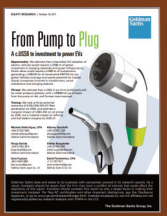
IMO 2020

Power Shift 2.0



More Lean, More Green

Pump to Plug



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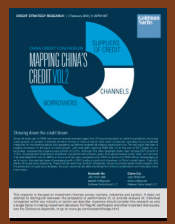

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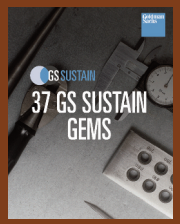

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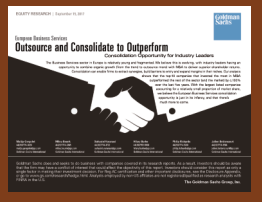
Supermarket Shift: Expect Measured Disruption

World of Games: Consoles

European Business Services



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