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26th March 2018

Mining Journal Article on the Copper Exploration Crisis

Hot Chili Limited (ASX Code: HCH) is pleased to provide a copy of an article published in The Mining Journal on 26th March 2018.

The article details predictions on future copper demand, and the requirement to find and develop new deposits before the projected supply deficit inhibits global growth.

It suggests that long-term thinking needs to start now, as the timelines involved with finding, developing and constructing tier-one copper mines getting longer, taking almost 20 years for a discovery to move into production in the copper space.

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Mining Journal Article

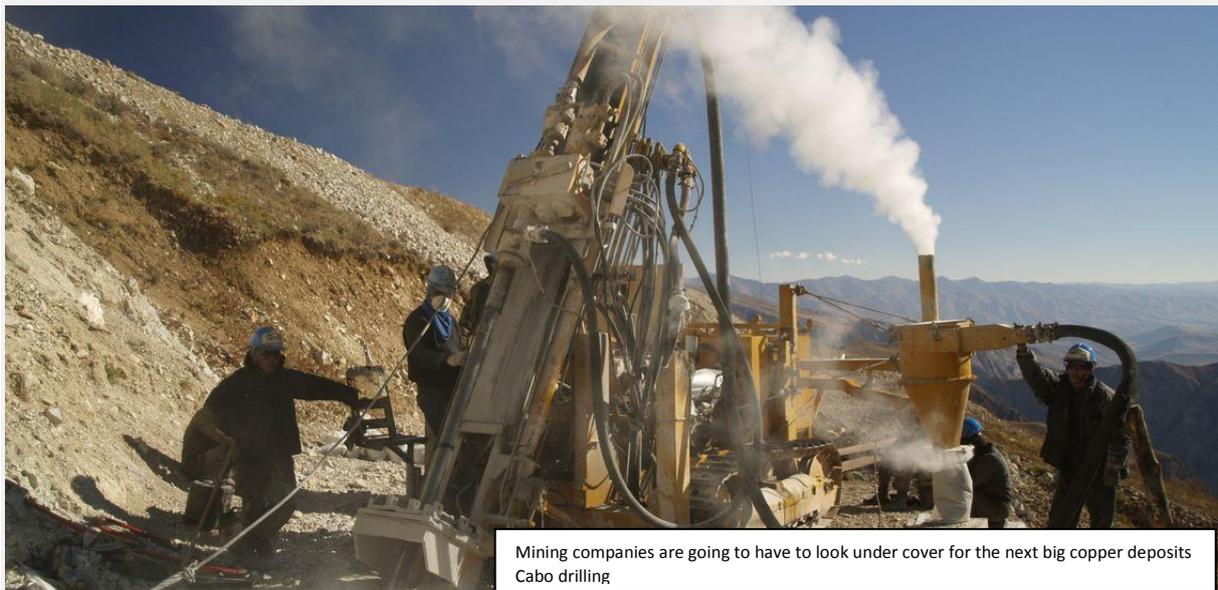
Addressing the copper exploration crisis

Leading copper producers know that to be successful, they need to think long term.

26 March 2018



Daniel Gleeson



Mining companies are going to have to look under cover for the next big copper deposits
Cabo drilling

The current crop of tier-one assets - many of which were discovered in the early 20th century and have been operating for several decades - are becoming uneconomic as grades fall, sustaining capital outlays rise and processing costs step up.

This factor, on top of predictions of continued copper demand into the future, means miners need to find and develop new deposits before the projected supply deficit inhibits global growth.

The long-term thinking needs to start now, as the timelines involved with finding, developing and constructing tier-one copper mines are getting longer.

It takes, on average, just over 10 years for a discovery to move into production across the mining space, but, in copper, it is more than double that.

It can be even longer for a tier-one deposit, which normally involves more drilling, earth movement, consultation and, as a result, capital expenditure.

Cobre Panama, due to move into the commissioning phase next year after a US\$6.3 billion build, was discovered by the United Nations all the way back in 1968. It wasn't until 1997 that operating subsidiary Minera Panamá was granted the mineral concession.

If first copper concentrate comes out next year, it will have taken 22 years to move from licence issue to production.

For the moment, the pressure on copper production is off to some degree - the majors can point their shareholders to a stream of assets set to follow the 350,000 tonne per annum Cobre Panama operation into the producing copper market.

But this is the result of unhelpful short-term thinking, rather than the necessary long termism.

Instead of carrying out major greenfield exploration programmes in new locations, an investor-focus on dividends in the recent past has limited efforts towards brownfield exploration or the restoration of projects previously in hibernation.

Codelco, the world's largest producer, can reel off a number of underground expansions and sulphide projects under its copper 'growth' plans, Freeport can talk about two stages of future underground development at Grasberg and an extension to its Safford mine (Lone Star) and Glencore can talk up the Mutanda sulphides project.

For BHP, there is the Spence expansion, the Olympic Dam growth project and, in tandem with Rio Tinto, the Resolution project in the pipeline. Southern Copper, meanwhile, can talk about making a permitting breakthrough at Tia Maria and pushing forward with a project Anglo American previously passed on, Michiquillay.

Yet, these are not the sort of projects that are going to mean a copper market deficit is avoided; they are developments that will keep the companies on a level playing field for another decade.

CRU copper analyst Hamish Sampson put the requirement in simple terms.

"Miners have prioritised investment in near-term mine expansions and brownfield developments, which may boost supply beyond expectations in the short term," he told *Mining Journal*.

"However, to ensure copper demand is met beyond the next few years, there needs to be more investment in greenfield projects."

Tried and tested

So, where should these companies be looking for these greenfield discoveries?

Brent Cook, of Exploration Insights, said: "The simple answer is where the big ones already are."

That doesn't mean to say miners should be staking and drilling land 500m away from one of their existing mines - the typical brownfield tactic - they should be testing out belts or regions known to host rich copper deposits.

Richard Sillitoe, a porphyry copper expert who has been all over the world looking for tier-one copper potential, agrees.

"I always favour the tried and tested spots because they have demonstrated they have the credentials of being top copper producers," he told *Mining Journal*.

These opinions would appear to be backed up by companies' exploration budgets.

Copper exploration budgets by country (top 20, US\$ million)				
Country	Exploration budget	Global budget share (%)	Companies count (actual)	2017 change from 2016 (%)
Chile	404.4	24.52	41	29.57
Peru	155.5	9.43	36	-1.52
Australia	152.7	9.26	109	2.00
USA	119.8	7.27	39	-2.36
Democratic Republic of the Congo	75.1	4.55	15	-24.45
Brazil	67.2	4.08	9	40.59
China	63.4	3.84	20	5.49
Canada	61	3.70	78	-10.82
Russia	51.2	3.10	8	4.92
Indonesia	50.8	3.08	5	188.64
Papua New Guinea	46.6	2.83	8	-15.12
Mexico	42.5	2.58	15	-4.92
Ecuador	41.8	2.53	10	74.17
Zambia	40.9	2.48	15	0.74
Kazakhstan	37.3	2.26	8	15.48
Serbia	28.1	1.70	5	165.09
Iran	24.7	1.50	2	6.93
Argentina	18.6	1.13	12	-5.58
Sweden	18.1	1.10	4	-15.42
Finland	15.5	0.94	2	84.52
Total	1515.2	91.88	441	

Source: S&P Global Market Intelligence

The world's biggest producer, Chile, which the US Geological Survey pegged at 5.33 million tonnes of copper output last year, accounted for 24.5% of global copper exploration budgets in 2017, according to S&P Global Market Intelligence (see table).

Peru was the second-largest red metal producer in 2017, with 2.39Mt and was also runner up in the exploration stakes with 9.43% of the global total.

Australia, the fifth-biggest red metal producer in 2017, was just behind with 9.3% and the US, fourth by 2017 copper production, accounted for 7.27% of the budget.

The politically-tricky Democratic Republic of the Congo even managed to get in the top five, most likely thanks to an uptick in copper-cobalt exploration.

One has to go pretty far down the rankings to find a jurisdiction considered 'new' in the copper space.

In fact, 13 places down.

Ecuador is considered the hottest new place in 'Copper Porphyry Town' at the moment, with SolGold's Cascabel deposit making the most noise.

The country's 74.2% jump in exploration budgets in 2017 was mostly down to Chile's Codelco splashing the cash, according to S&P.

The state-owned company signed an agreement with fellow SOE, Enami, in November 2011 and has since evaluated more than 20 prospects, with the Llurimagua project the most noteworthy.

BHP also has a presence there, cutting the ribbon on its new office at the end of last year.

Yet, the country is still a long way behind its more established peers.

Just \$41.8 million was set aside for exploration in the country in 2017, according to S&P Global Markets Intelligence: about a 10th of what companies allocated for work in Chile.

Major exploration

It is hard to tell just how much of these budgets are for greenfield exploration.

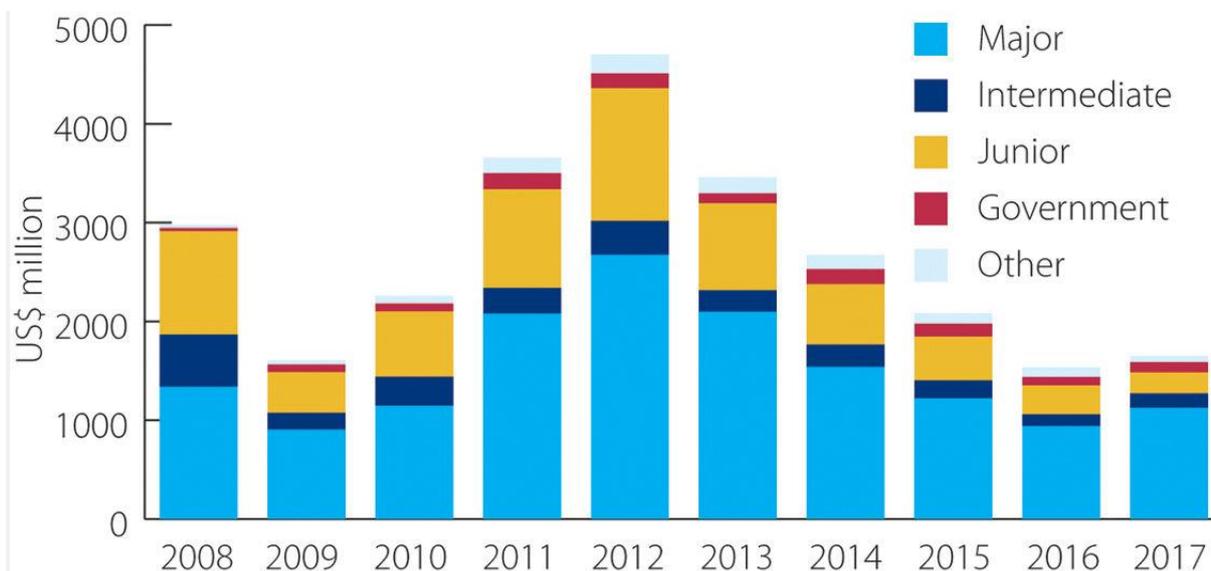
S&P estimates the major miners allocated just 0.5% of their revenues for such work across all commodities in 2016. This is one quarter of the 2% of cashflow they set aside in 1997.

Yet, ask a major what they are looking to find with their minimal greenfield exploration spend and one receives a unified answer: big, long-life copper mines able to justify the billions of dollars in development spend that will inevitably be needed.

Jean des Rivieres, vice president of exploration for BHP, said: "When you look at what BHP wants and needs, there are very few deposit types that can deliver this - it is really only porphyry copper, sedimentary-hosted copper and, to a certain extent, IOCGs."

The problem is finding these.

Recent developments such as Cobre Panama and Las Bambas would indicate there are still sizeable deposits close to surface that could become tier-one copper mines. BHP itself is looking for openpit potential in Peru and Ecuador.



Copper exploration budgets by company type: A junior is categorised as a company with metals and mining revenues of less than US\$50 million. An intermediate is \$50 million-\$500 million and a major is over \$500 million. Each company is assessed individually, with each company required to consistently earn above a threshold to be considered a higher tier. Source: S&P Global Market Intelligence

But, the majority of miners are slowly coming to terms with the idea that the copper mines of the future are buried at depth.

The strategy of building a close-to-surface openpit mine and, thereafter, moving underground has changed. They are skipping the former and going straight to the latter.

SolGold's potential block-cave operation in Ecuador, the Rio-BHP Resolution joint venture in Arizona and, of course, Ivanhoe Mines' Kamoakakula development in the Democratic Republic of the Congo, are all set to go underground.

"We need to be mindful that the near-surface search space is quickly disappearing ... Any world-class orebody that was partially exposed has, most likely, been discovered," des Rivieres told *Mining Journal*.

That is why some 85% of BHP's current exploration budget is focused on looking at deposits under cover - concealed orebodies that start anywhere from 100m to 1,000m below what can be volcanic ash or post-mineral gravels.

Undercover exploration is not just necessary because near-surface discoveries are becoming rare.

It is becoming increasingly hard to permit major openpit mines in any part of the world - let alone a new jurisdiction that just happens to have copper cropping out at surface.

Pebble in Alaska, Tia Maria in Peru, Rosemont in Arizona, Ajax in British Columbia, Tampakan in the Philippines are all suffering similar fates as environmental concerns hold up development.

The processing throughputs involved with tier-one openpit copper mines today are such that they can drain local water and energy resources, which understandably does not go down well with local communities.

Permitting a smaller, higher-grade underground mine, in theory, should be easier.

Still, as soon as companies settle on this type of deep exploration, the grade-profile requirements increase.

Sillitoe thinks companies would be looking for at least 1.2-1.3% copper-equivalent for potential new underground mines, some increase on the 0.37% Cu grade First Quantum plans to mine from Cobre Panama.

Cook echoes similar numbers when talking about developing underground block caves - the likely blueprint for future copper mines: "We need about three times the grade than we do if you work in an openpit."

This is possibly why copper watchers look to the Rio-BHP jointly-owned Resolution copper project in Arizona as the underground benchmark.

Resolution currently has 1.79 billion tonnes of resources grading 1.54% Cu and 0.035% Mo.

The underground expansions of Oyu Tolgoi, in Mongolia, and Grasberg, in Indonesia, come with similar copper-equivalent grades.

Rare resources

But greenfield discoveries don't come along often. The majority of discoveries through cover occur after an intrepid geologist gets a budget to drill a few deeper holes once the openpit mine is operating.

All of the three underground examples above were found after an openpit resource was, at least, defined.

According to Sillitoe, the last major undercover greenfield discovery was in 1996 by Rio Algom (now part of BHP) at the Spence project in Chile's Atacama.

There are known reasons for the scarcity.

Land access is one: much of the main copper belt in the richest parts of Chile has, until recently, been locked up by companies that have tended to sit on strategically-located concessions. The majors have a monopoly on other well-known copper districts across the globe.

Another is the amount of money and different approach one has to take when looking for copper through cover.

Des Rivieres said: "This approach is quite different from traditional boots on the ground work.

"We need to rely immensely on geoscience data and technology ... to help us try to predict where the deposits are and detect them," he said.

"Each project we look at - the big ones in Chile, the US, Peru, for example - all have their own characteristics. One recipe is not necessarily going to fit everything," he said.

This is why, to come back to an earlier point, Sillitoe and Cook were so keen on companies going back to tried and tested locations to find the copper deposits of the future.

We need to be mindful that the near-surface search space is quickly disappearing ... Any world-class orebody that was partially exposed has, most likely, been discovered

They weren't saying companies should just drill stepout holes 1km away from existing mineralisation, they were implying companies should stick to geology that, on the surface at least, they know.

People may think northern Chile has been peppered with deep drill holes testing for mineralisation, but a large percentage of that prospective region is calling out for some substantial geological, geochemical and geophysical work through cover.

Many of the majors' geologists know the rocks above and can help when it comes to identifying what could be below.

The same is the case for less mature regions that have previously only been touched by prospectors, their picks and the odd RC drill rig.

Junior dilemma

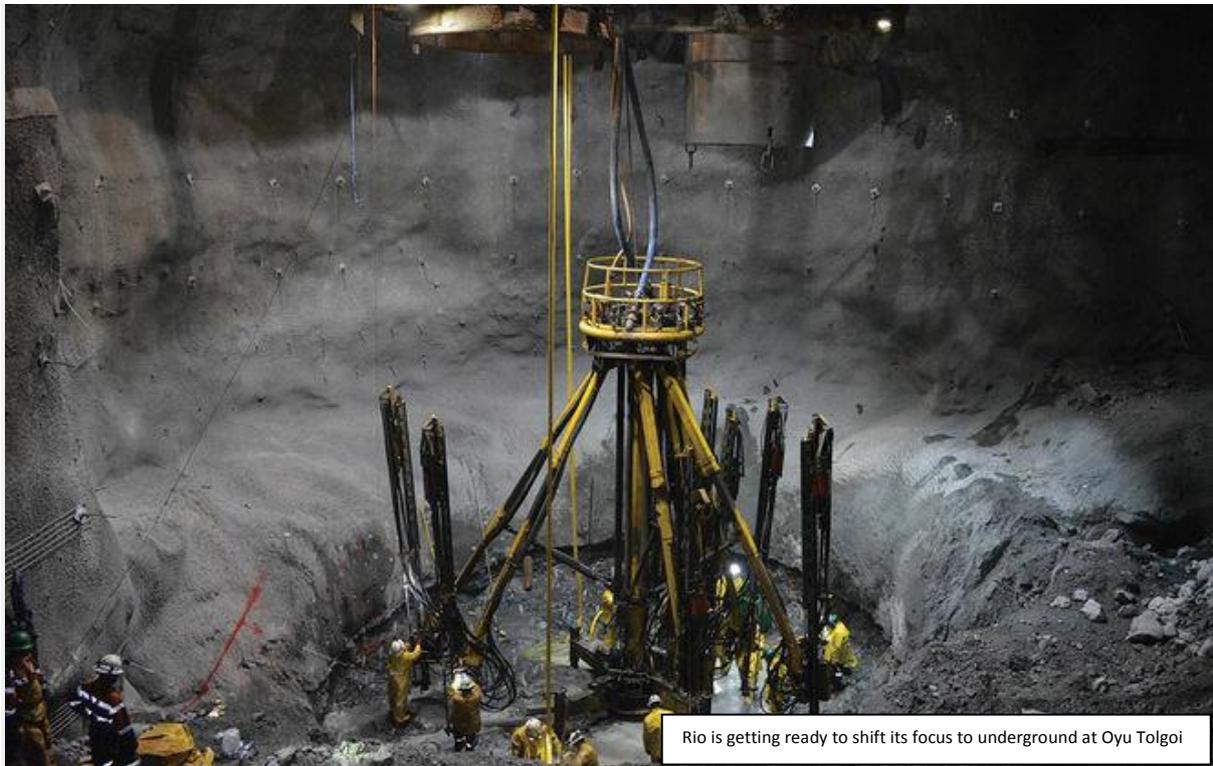
So, now the question is: who should be carrying out this work?

Junior explorers have traditionally been seen as the lifeblood of the exploration industry, making the sort of discoveries that can result in a 'tenbagger' investors will never forget, even after they are taken out by bigger peers that can put the projects into production.

Juniors are nimble in the respect that they can stake land, carry out surveys and start drilling at a cost and speed that puts most of their major peers to shame. Thanks to an influx of new, affordable technology they are also able to look for copper at depth.

One would think they are the obvious choice, yet investor expectations tend to get in the way.

"To actually explore under cover is a rather onerous proposition for a junior. It is something that is difficult to push past most investors in the junior market," Sillitoe said.



Rio is getting ready to shift its focus to underground at Oyu Tolgoi

SolGold is the company most refer to as an example of a junior successfully carrying out such exploration, but it is far from your average junior. It spent A\$26.6 million (US\$20.5 million) on exploration over the six months to the end of December - more than BHP spent across its entire copper exploration portfolio - carrying out 38,250m of drilling, preparing a maiden resource estimate and conducting other studies and administrative duties associated with the planned underground mine.

SolGold can count on Newcrest Mining, DGR Global, Cornerstone Capital and Guyana Goldfields for long-term financial support - again not your average junior company share register.

Unlike the gold space, retail investors - the core shareholder base for junior explorers - have little appetite for big copper exploration.

SolGold started drilling Cascabel in September 2013 and took more than four years to generate a maiden resource. It is likely to require almost another year before a scoping study comes out, with production not following until the next decade.

This schedule does not fit with the typical retail investor's returns timeline, according to Cook.

But, letting the majors go it alone is not the answer either. The amount of internal and external red tape they have to get through means they move too slowly and cautiously to quickly push discoveries into developments.

This is where the two should combine, with the majors allocating their minimal exploration budgets to their much more sprightly and smaller peers.

There are a few examples of this already happening - Freeport has had success following this model in Serbia recently, First Quantum has a number of agreements in place in the Americas; recently adding Northern Dynasty and the Pebble project to that list; and Rio has junior joint venture exposure in Mongolia and elsewhere.

More are required to meet that expected future uptick in copper demand.

Spreading the majors' exploration budgets across a number of project generators could be the answer, according to Cook.

These companies are almost as ruthless as their bigger peers when it comes to allocating capital - dispassionately dropping assets that offer little exploration potential before moving onto the next.

"To me, if I was a major mining company, that is what I would be doing - finding the smartest guys and the smartest belts and doing something with them," he said.

Armed with a major brief - and the budget to go with it - they could be exactly what the big copper producers need to quickly find the next crop of tier-one deposits.

Yet, if the status quo continues, the number of real copper explorers will continue to fall and the majors' own production profiles will follow suit.

A sustained copper deficit and higher prices will emerge from that, but so too could metal substitution and constrained global growth.