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European Metals & Mining: US$10,000/t copper & the impact of geological exhaustion. Can anywhere replace Chile?

Ticker	Rating	CUR	9 Aug 2013 Closing Price	Target Price	TTM Rel. Perf.	EPS 2012A	EPS 2013E	EPS 2014E	P/E 2012A	P/E 2013E	P/E 2014E	Yield
GLEN.LN	O	GBp	297.50	525.00	-29.0%	8.83	27.96	41.11	33.7	10.6	7.2	3.3%
AAL.LN	O	GBp	1542.50	2025.00	-41.4%	140.12	137.86	173.23	11.0	11.2	8.9	3.6%
BLT.LN	O	GBp	1963.50	2250.00	-18.3%	186.25	171.95	237.07	10.5	11.4	8.3	3.6%
BBL	O	USD	61.74	68.70	-21.7%	5.86	5.41	7.45	10.5	11.4	8.3	3.6%
BHP	O	USD	67.68	68.70	-23.5%	5.86	5.41	7.45	11.6	12.5	9.1	3.3%
BHP.AU	O	AUD	36.81	34.93	9.7%	3.19	2.94	4.05	11.6	12.5	9.1	3.3%
VALE3.BZ	O	BRL	34.75	46.50	-26.1%	2.38	5.10	5.70	14.6	6.8	6.1	6.6%
VALE	O	USD	15.51	23.32	-39.6%	1.06	2.28	2.55	14.6	6.8	6.1	6.6%
RIO.LN	O	GBp	3167.50	4125.00	-17.3%	319.94	339.01	466.84	9.9	9.3	6.8	3.4%
RIO	O	USD	49.81	65.18	-22.1%	5.03	5.33	7.34	9.9	9.3	6.8	3.4%
MSDLE15			1276.54			94.20	95.30	106.85	13.6	13.4	11.9	3.5%
SPX			1691.42			103.12	109.85	121.99	16.4	15.4	13.9	2.1%
MXAPJ			440.38			32.75	36.14	40.62	13.4	12.2	10.8	3.1%
MXEF			951.37			81.68	89.98	100.67	11.6	10.6	9.5	2.8%

O – Outperform, M – Market-Perform, U – Underperform, N – Not Rated

Highlights

"The total volume of workable mineral deposits is an insignificant fraction of the earth's crust, and each deposit represents some geological accident in the remote past, each deposit has its limits; if worked it must be exhausted. No second crop will materialise. Rich mineral deposits are a nation's most valuable but ephemeral material possession."

T.S. Lovering, "Mineral Resources from the Land", 1969.

We introduced the case for structurally higher long term copper prices in ***European Metals & Mining: Copper for the Craftsman Cunning at His Trade...Summarising the Case for US$10,000 Copper****. In this call, we start moving from this necessarily brief summary to a more thorough analysis of the future for the price of copper. We begin with the first of two calls examining the supply side structure of the copper market. The two critical questions we attempt to answer in this call is 'what are the consequences of Chile's unique geological endowment?' and 'are current copper reserves sufficient to satisfy future copper demand?'. In the first place, we show no other supply location has the potential to mirror the history of Chilean copper growth and that hopes that either the DRC, Zambia or Peru will provide the world with another period of abundant copper supply at low prices are inconsistent with the underlying geology of those locations. We also show how the financial implications of copper mine development link a country's underlying geological endowment to its eventual maximum mined production. Consequently, we show that existing reserves are sufficient to meet only one third of the world's incremental copper demand by 2030. Furthermore, the twenty year plus lead time between new copper discoveries and eventual exploitation means that appeals to as yet undiscovered deposits are not sufficient to make up the shortfall (even if there was evidence of ongoing copper exploration success, which is not the case). Rather, new copper supply will have to come from sources of copper that are currently uneconomic to develop at today's prices. The implication of this is clear – new copper supply is predicated upon higher prices than those that prevail at the moment.*

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- **Chile's geological endowment in unmatched by any other location. Hopes that any country will be able to replicate the growth of Chilean supply and so keep price permanently low are unfounded.** The long term history of the mined output of copper is essentially the story of the transition between the supply of metal from the copper porphyries of the USA to the copper porphyries of Chile. But between them these two locations account for 47% of the world's total geological endowment of copper. The total endowment of the DRC and Zambia and Peru is less than that of the USA and significantly less than half of Chile. As important as these locations are, they will never replicate the impact that Chile had on the copper price between 1983 and 2003.
- **The unique position of Chile is confirmed not just by the endowment of copper but the size of the individual copper deposits within the country.** It is the scale of geology at a mine site that generates the options required for efficient low cost operation. But the average size of a Chilean deposit is more than twice the size of any other country. The average size of a deposit in Peru is just 19% of Chile. In the DRC, it is slightly better at 24%, and in Zambia it is just 14%. Once again, it is clear that these locations will not match the impact that Chile has had so far.
- **There are essentially just two ways that a country can increase its output of mined metal – by increasing the rate of new deposit discovery or accelerating the development of already known deposits.** In the case of Chile, the second lever has seen the mine life of known reserves fall from nearly 100 years in 1935 to just over 30 years today. However, the economics of mine life extension mean that increasing output through reducing life of mine is a process that is value-accretive only down to about thirty year life of mine. Afterwards, it becomes highly value destructive. It is this process that links any country's underlying geology to peak mine production and it explains the stagnation in Chile's mined output over the last decade.
- **Assuming politically unimpeded development of all new supply locations (a highly optimistic assumption), accelerating the exploitation of the reserves in every other location globally adds only one third of the incremental copper required by 2030.** The conclusions of this are clear: either more production will have to come from material currently defined as resources rather than reserves (which will necessitate a price higher today's spot) or new supply will have to come from fresh discoveries.
- **New discoveries could only fill the gap left by reduced supply from existing deposits in the very long run (i.e. pre 2030).** An examination of the recent history of new copper porphyry discoveries shows two things. Firstly, the rate of discovery of massive new ore bodies has declined sharply. Secondly, the lead time for development of the deposits that are actually capable of making a difference to the global supply-demand dynamic has increased dramatically. It took ten years to bring Escondida on line. It will have taken seventeen to develop Oyu Tolgoi (and probably more like twenty to twenty five years for it to realise its full potential), and Pebble is at twenty five years and counting.
- **Consequently, new discoveries are incapable of meeting the world's copper demand. This leaves one alternative – namely, higher prices and the ability to supply the world from deposits that do not meet investment thresholds at today's prices.** There is, of course, more than ample copper in the ground to meet future demand. The only real question is the long run price required to enable this to take place. In the absence of significant technological improvement, moving metal that is uneconomic to exploit to metal that is economic to exploit requires one thing – namely, higher prices. Consequently, we conclude that the call for structurally higher copper prices is a fair reflection of the state of the world's copper supply.

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Investment Conclusion

The breakdown of the contribution of copper to EBITDA for our coverage is shown in **Exhibit 1**. Glencore Xstrata is the most highly exposed to any upside in the copper price followed by Anglo, BHP Billiton, Rio Tinto and, finally, Vale. None of the miners lacks exposure to this commodity and so they all depend on its performance to a degree. In addition, a number of significant organic growth projects in this commodity are ongoing. In particular, we like the decisiveness of Glencore Xstrata in its commitment to the development of the "New World" copper assets in Peru and Central Africa. We also believe that in Los Bronces and Collahuasi, Anglo American has exposure to two of the world's best copper deposits with significant embedded optionality in Los Sulfatos, San Enrique Monolito as well as West Wall (in collaboration with Glencore Xstrata) developments. However, the poor performance from the Los Bronces expansion project and recent operating woes at Collahuasi (not to mention the fallout from the Codelco dispute) are still too fresh in investors' minds for Anglo to get full credit for the upside value in these assets. For us, the most significant new copper development belongs to Rio Tinto with Oyu Tolgoi in Mongolia. We also note that Rio Tinto has a number of further dated growth options in La Granja and especially Resolution (which appears to have the potential to become another genuine "Tier 1" asset in the Rio Tinto's portfolio).

Furthermore, we remain "believers" in the copper price story (**Exhibit 2**). We understand the concern that investors have over the price of iron ore (notwithstanding the fact that some of the exaggerated claims appear somewhat overdone). Nevertheless, there is no commodity whose attractiveness cannot be undone by poor mining company strategy. If the response to having an incumbent position in an attractive market involves an attempt to render that market unattractive, as the fear of a market share loss overwhelms rational economics, then no commodity is safe. That said, in our view, the fundamentals for copper are conducive to the price staying genuinely "stronger for longer" relative to, say, iron ore. This is due to three reasons.

- **Demand**. In our view, copper is a later cycle commodity than steel. Consequently, we have a more positive view on the future demand for copper than for iron ore. There are more drivers behind the demand for copper relative to iron ore, which is heavily skewed towards the two sectors of infrastructure and automotives. Also, whereas China has consumed a significant amount of steel in its development so far, significantly less copper has been embedded in its capital stock to date. The US had peak copper intensity that was well above the intensity we have seen in China so far. This suggests that trend demand growth is more sustainable for copper than for iron ore.
- **Geology**. Relative to the iron ore market, we believe that fewer large-scale copper projects with the potential to disturb the current price dynamic are currently in development (Oyu Tolgoi represents ~2.5% of global copper demand vs. Simandou, Serra Sul and the now postponed Port Headland Outer Harbour, each of which represents ~6% of iron ore demand). As a result, the geological barriers to entry are higher for mining copper than iron ore. Consequently, copper depends less on the big miners displaying the capital discipline required to keep iron ore prices high. Finally, the rate of new copper deposit discoveries is currently at an all time low[1].
- **Incentive**. The EBITDA margin for copper is currently around 40% vs. 65% for iron ore. However, the capital intensity has grown as fast for copper projects as for iron ore projects. Consequently, we believe that more capital will be directed to the development of iron ore deposits than to copper. Hence, for copper we see a lower risk of a supply side overreaction. Moreover, while we see all the new iron ore growth coming from the existing iron ore supply locations (Australia and Brazil), a significant portion of future copper supply will come from the "New Frontier" locations of the DRC, Zambia and Peru. These

[1] Since 1900.

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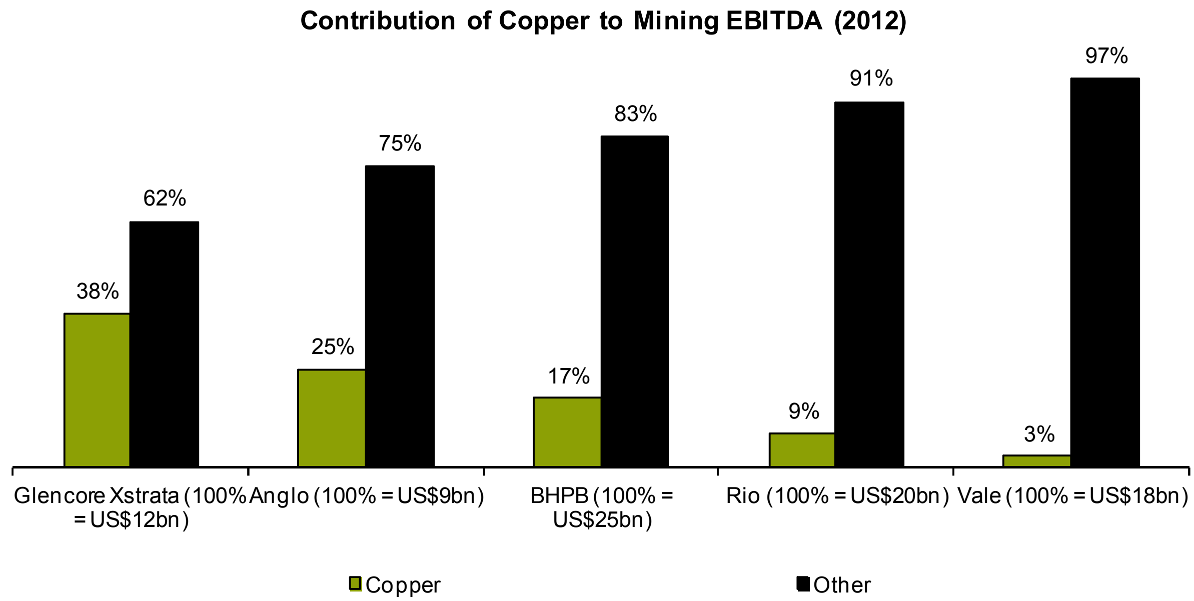
locations attract a significantly higher country risk premium (4.7% vs. 1.0% based on our methodology). Consequently, we think that deploying capital in these regions will be much harder than endlessly sinking capital into, say, the Pilbara.

Our view on copper primarily favours Glencore Xstrata, especially in the immediate short term, and Rio Tinto, once the risk associated with disputes over Oyu Tolgoi with the Mongolian Government begins to subside.

Exhibit 1

Glencore Xstrata is the most highly exposed to any upside in the copper price, followed by Anglo American, BHP Billiton, Rio Tinto and, finally, Vale.



Source: Corporate reports, Bernstein analysis and estimates

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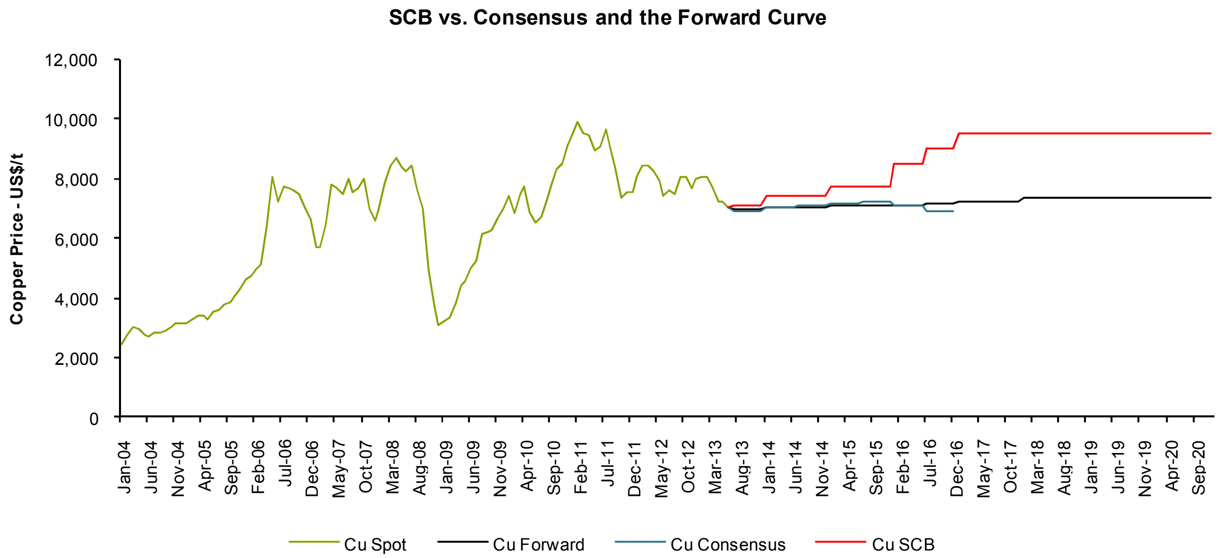
Exhibit 2

We believe that copper price will have to approach US$10,000/t in the medium term to incentivise the next wave of mined copper growth.



Source: Bloomberg, Bernstein analysis and estimates

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Exhibit 3
Summary of our coverage.

09/08/2013	Anglo	BHPB	Glencore Xstrata	Rio Tinto	Vale
	£	£	£	£	BRL
Price	15.43	19.64	2.98	31.68	34.75
Price Target	20.25	22.50	5.25	41.25	46.50
Potential Up/Downside	31%	15%	76%	30%	34%

EV/EBITDA - Current	5.09	5.67	7.27	4.89	4.30
EV/EBITDA - 5 Yr. Avg.	4.9	5.5	7.7	4.8	5.0
EV/EBITDA Target	7.3	8.6	11.2	6.7	8.2

PE - Current	8.9	9.3	10.1	7.1	5.5
PE - 5 Yr. Avg.	9.2	9.4	8.2	8.0	7.6
PE Target	12.9	14.0	11.9	16.8	21.7

2013 EPS - Consensus	1.81	2.45	0.30	4.95	2.07
2013 EPS - SCB	2.10	2.70	0.64	5.27	2.28
% SCB vs. Consensus	16.2%	10.4%	113.4%	6.4%	10.2%

2014 EPS - Consensus	2.15	2.69	0.41	5.76	2.07
2014 EPS - SCB	2.64	3.73	0.85	7.19	2.55
% SCB vs. Consensus	23.2%	38.8%	110.5%	24.8%	23.2%

Source: Bloomberg, Factset, Company reports, Bernstein analysis and estimates.

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Details

The geology of copper...there is no escape from declining quality of remaining deposits.

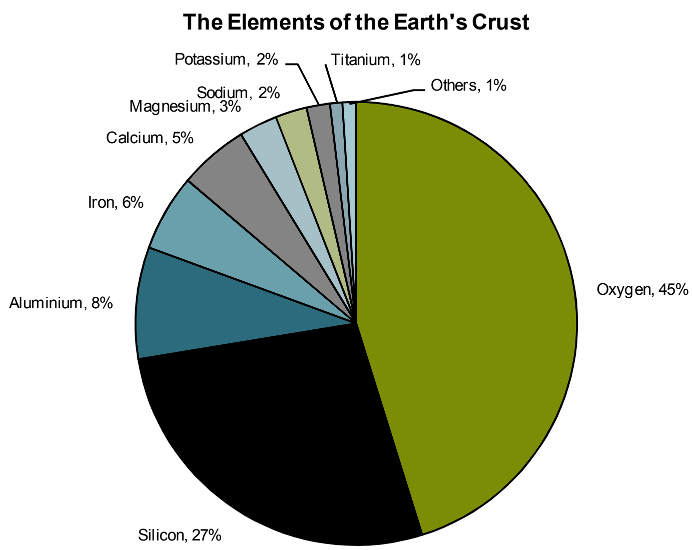
Once exploited a deposit is gone forever, and once discovered a deposit cannot be rediscovered. The Earth's endowment with high grade copper deposits is finite. It is only a question of when (not if) that limitation leads to higher real copper prices to fund copper extraction and development.

The geology and chemistry of metals within the Earth's crust forms the basis of mining and hence all the economic activity of modern industrial society. While over 3,000 different minerals have been identified, only 30 form the basis of most rocks in the planet's crust. The list of chemicals on which these common rocks are based is even shorter and dominated by just nine elements: oxygen, silicon, aluminium, iron, calcium, magnesium, sodium, potassium, titanium and manganese. In fact, these nine elements account for 99% of the Earth's mass (**Exhibit 4**).

Most commonly encountered minerals are silicates (of one form or another) interspaced with oxides, hydroxides and carbonates. These elements collectively constitute a category known as the "geologically abundant elements". Therefore, the geologically abundant metals are aluminium, iron, magnesium, potassium, titanium and manganese. The economics of these metals is not primarily a function of their geological grade. It is fair to say that we will never "run out" of these commodities. (Just to make this clear, the prices of titanium and aluminium relate primarily to the price of the power required to strip oxygen from the metal. In the case of iron ore, it relates to the capital tied up in mass logistics systems in general and deep-water port capacity in particular). However, this class of elements does not include copper – no rock forming mineral contains copper as an essential chemical consistent.

Exhibit 4

Nine elements account for 99% of the mass of the Earth's crust. Iron and aluminium among them. However, copper has a radically different abundance.



Source: Pearson, Bernstein analysis & estimates

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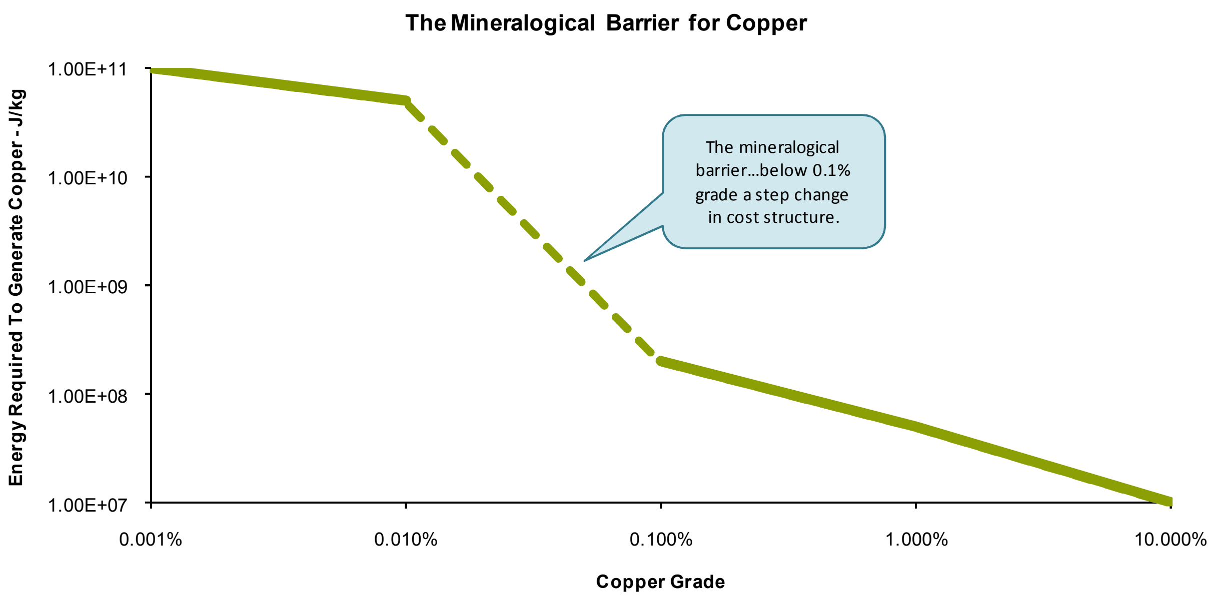
Copper (and a number of other important metals) are classified as geologically scarce. It is within this metal class that geological grade starts to play the decisive role. As we mentioned above, copper does not form part of the chemical composition of any common rock-forming mineral. Rather, copper exists as individual atoms substituting for other metals at an atomic level within a host rock. For example, copper will substitute out iron in the silicate mineral pyroxene ($FeSiO_3$). It will do so without altering the fundamental nature of the mineral in bulk. However, there is a fundamental limit to the solubility of copper in any solid solution. The evidence suggests that this limit is much lower than the lowest grades of any copper ore that has ever been encountered. When we observe a rock with a grade of above ~0.1% Cu, we actually see a copper rich sulphide (or oxide) mineral with a grade of 30%+ (**Exhibit 8**) disseminated through a copper barren host rock, thus giving rise to the average 0.1% grade. However, no common rock has ever been encountered (and the sampling of common rocks is pretty exhaustive) with a grade of copper as high as 0.1%. Furthermore, the crustal abundance of copper is somewhere close to 0.007%. This implies that there is a sharp discontinuity between copper ores, wherein copper exists in a concentrated sulphide or oxide form and where copper exists dissolved within a silicate matrix. As copper concentrations approach their saturation levels in the silicate host, there is the generation a new material form rather than any "super saturation" effect. Put another way, the highest copper grades observed in common rock do not overlap with the lowest grades observed in ores. Now, there is an order of magnitude difference in the energy required to liberate copper metal from a silicate rather than a sulphide. This then gives rise to the famous mineralogical barrier for copper (**Exhibit 5**). We cannot go on indefinitely dropping the grade of mined copper; there is a hard stop at grades approaching 0.1%, at which there is a radical rather than continuous change in the cost structure of mined copper.

In addition, this suggests the equally famous bimodality of copper ore distributions versus the uni-modality that is more typically associated with the geologically abundant metals (**Exhibit 6** and **Exhibit 7**).

Exhibit 5

Below copper grade of 0.1% a step change emerges in the cost structure of copper extraction. Consequently, we face a hard stop in our ability to exploit this metal, once high grade deposits are exhausted.



Source: Bernstein analysis & estimates

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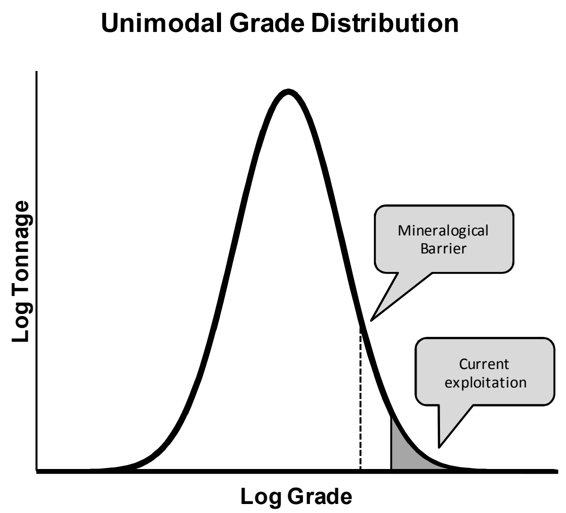
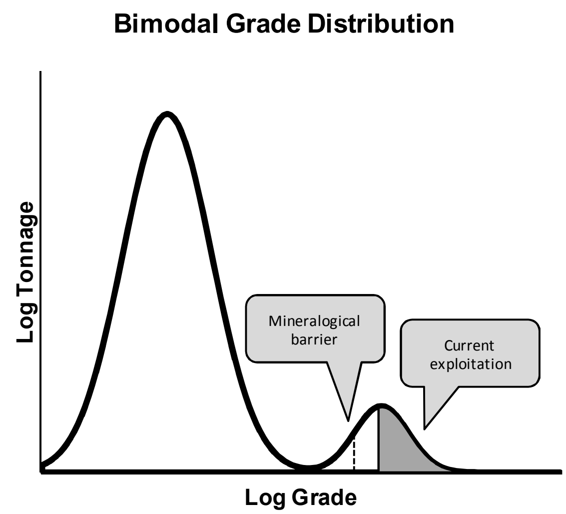
Exhibit 6
Under a uni-modal distribution, grade and tonnage are continuous.



Source: Bernstein analysis & estimates

Exhibit 7
Under a bi-modal distribution, grade and tonnage are discontinuous, with clear implications for cost and availability of new material.



Source: Bernstein analysis & estimates

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Exhibit 8

Copper ores represent the dissemination of high grade copper bearing minerals within a barren matrix. Copper mining is the process that separates these valuable minerals from the worthless gangue.

Mineral	Chemical Composition	% Cu by Mass	Ore Type
Cuprite	Cu_2O	89	Oxide
Tenorite	CuO	80	Oxide
Atacamite	$Cu_2Cl(OH)_3$	60	Oxide
Malachite	$Cu_2O(OH)_2CO_3$	58	Oxide
Azurite	$Cu_3(OH)_2(CO_3)_2$	55	Oxide
Chrysocolla	$Cu_2H_2OSiO_3$	36	Oxide
Chalcocite	Cu_2S	80	Secondary Sulphide
Covellite	CuS	67	Secondary Sulphide
Bornite	Cu_5FeS_4	63	Primary Sulphide
Digenite	Cu_9S_5	78	Primary Sulphide
Enargite	Cu_3AsS_4	48	Primary Sulphide
Tetrahedrite	$Cu_{12}Sb_4S_{13}$	58	Primary Sulphide
Chalcopyrite	$CuFeS_2$	35	Primary Sulphide

Source: Wood Mackenzie, Gordon, Bernstein analysis & estimates

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An overview of the copper mining process. Efficient copper mining involves bulk material movement which, in turn, requires a high degree of capitalisation and a corresponding quality and scale in the underlying geology.

Value maximisation in many mining processes involves scaling of capital equipment to the underlying geology. Consequently, efficient low cost copper production is predicated upon the existence of massive high quality ore bodies. Remove this feature and mining costs rise exponentially.

Mining is essentially a process of efficient material movement in pursuit of separating valuable from valueless minerals. There are two basic mechanisms at work by which this separation is achieved. The first one occurs at the mine site, where waste material is separated from the valuable ore. The second one occurs at the processing site, where the valuable metal containing mineral in the ore is separated from the worthless host rock or gangue. **Exhibit 9** presents a highly schematic illustration of this process.

Within the mining step, the most important division is between underground and open-pit mining methods. The main advantage of underground mining is the selectivity of the mining method, which enables one to focus extraction on high grade mineralised zones while leaving waste and low grade ore in situ. However, this selectivity comes at a cost. Underground mines must be ventilated and dewatered. Blasting is necessarily rather small scale and the process of hauling material to the surface is very energy intensive. By contrast, open-pit mining does not have the expense of ventilation, while dewatering costs are often a fraction of those incurred in underground operations. Moreover, the process lends itself to economies of scale, with efficiencies gained through the utilisation of ever larger haul trucks and mining shovels and through the use of scalable blasting programmes.

The difference in the cost structures of these two methods is evident in the amount of energy required to move a tonne of rock. While this varies considerably from operation to operation, the energy in an underground mine may be ~300MJ per tonne vs. less than 40MJ per tonne in an open-pit mine. Clearly, the open-pit mining methods lend themselves to the development of massive low grade copper deposits, such as are currently the mainstay of the world's copper production.

Within the mined supply of copper, the most important division occurs between the conventional milling route and what is termed SxEw (or solvent extraction and electro-winning). The milling route accounts for ~80% of the current mine supply. It seeks to exploit sulphide copper minerals. The basic steps of this process are laid out below and illustrated schematically in **Exhibit 10**.

- **Mining** involves separating ore, containing the valuable metal bearing mineral, from waste rock. The distinction between valuable and worthless rock is achieved via the cut-off grade, which delineates the minimum contained metal that a volume of material needs to contain to render its further treatment economical.
- **Comminution** is the crushing and grinding of the ore in order to achieve physical liberation of the particles containing valuable mineral from the gangue matrix of worthless material in which those particles reside.
- **Beneficiation** involves separation of the particles liberated by comminution in order to maximise the resulting concentration of the valuable mineral. For copper, this is achieved through the process of froth flotation. Firstly, a solution consisting of the ground ore, water and a mix of various chemical reagents is created. These reagents bind preferentially to the surface of copper containing sulphides, so that when the solution is agitated, these particles float to the top of the liquid while the waste particles fall. This difference in effective density in water then enables the concentration of copper to take place. In this step the first revenue generating material is produced (copper concentrate), which is typically what is sold by miners rather than the metal itself.

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- **Pyrometallurgical reduction**. Further treatment of copper concentrate needs to take place to achieve two ends: the reduction of the ore to metal and the removal of further gangue material. In the first step, copper concentrate is mixed with various fluxes and fuels. The mix is then heated to a temperature of around 1,200C, at which point a copper matte is separated of from a silicate slag in which any residual gangue dissolves.
- **Conversion**. The copper matte is blown with oxygen in a converter. This step realises copper metal for the first time, with the sulphur in the matte being released as sulphur dioxide and the resulting blister copper achieving a purity of between 97% and 99% Cu.
- **Electrolytic refining**. The blister copper is taken to a refinery where it will serve as the anode in an electrolytic refining process. The anode is immersed in a solution of sulphuric acid and copper sulphate. A current is then passed through the anode causing it to dissolve into solution. The copper ions are then deposited in a pure form (99.99% Cu) at the copper cathode, while any residual impurities from the anode are left behind.

The alternative to the traditional milling route was first developed at the Bluebird mine in the US in 1980s. It was introduced as a way, at least initially, to exploit oxide materials that had hitherto been considered a waste material in the process of mining sulphide ores to be treated through the milling route. Copper oxide materials arise as a result of the natural weathering of a sulphide outcrop. Alternatively, they can emerge as a consequence of the weathering achieved as low grade waste copper sulphides are stock pilled and so exposed to the elements or they can arise under the action of bacterial agents such as Thiobacillus Ferrooxidans. Rather than simply being a mechanism to exploit waste material, SxEw copper production now accounts for ~20% of mined production. Again the main elements in this process are described below and shown schematically in **Exhibit 11**.

- **Mining**. As in the sulphide milling route, this process involves the separation of ore containing sufficient quantities of a valuable metal bearing mineral from waste rock.
- **Crushing**. Rather than requiring the physical liberation of different mineral types within a volume of ore, the SxEw route can proceed with coarser sized material. Consequently, only initial crushing rather than grinding is required.
- **Acid leaching**. The crushed oxide ore is placed on a leach pad and is treated with a weak acid solution into which copper then dissolves. The copper rich solution, rather appealingly known as pregnant liquor, is then collected and sent to the solvent extraction stage of the process.
- **Solvent extraction**. This process aims to increase the concentration of copper in solution to such a level that electrolysis and deposition of copper can be achieved. To this end, the pregnant liquor is first contacted with an organic solvent, into which the copper passes restoring the original acid which is recycled to the leach site. This organic solution is then itself stripped of its copper by reacting it with a concentrated acid solution. This returns the organic reagent which, again, can be recycled. The concentrated copper/acid solution then has a copper concentration high enough to proceed to the final phase of production.
- **Electrowinning** is equivalent to the electrolytic refining process described above except that the copper is contained in solution rather than having to be introduced via the anode. A current is passed through the copper solution extracted previously, and pure copper is deposited at the cathode.

As mentioned previously, copper oxide materials are often found as a weathered cap at the outcropping of a primary copper ore body. But this weathering process is also responsible for another – arguably more important – feature of mined copper production, i.e. secondary or supergene enrichment. The action of water on an outcropping of sulphide material oxidises but also leaches that material (through the process of naturally forming acid solutions as the water reacts with sulphide minerals). This leaching results in copper

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dissolving out of the oxide layer and travelling down through the ore body, until it hits the water table. At this point the copper in solution is re-precipitated out, resulting in the enrichment of the ore at the level of the water table. This enrichment creates a target for the miners. Specifically, targeting the secondary sulphide zone enables generation of higher cash flows early in a mine's life before moving on to the lower grade primary sulphide. This can have a very significant impact on the economics of any mine development. Again, we give a simplified schematic of the supergene enrichment process in **Exhibit 12**.

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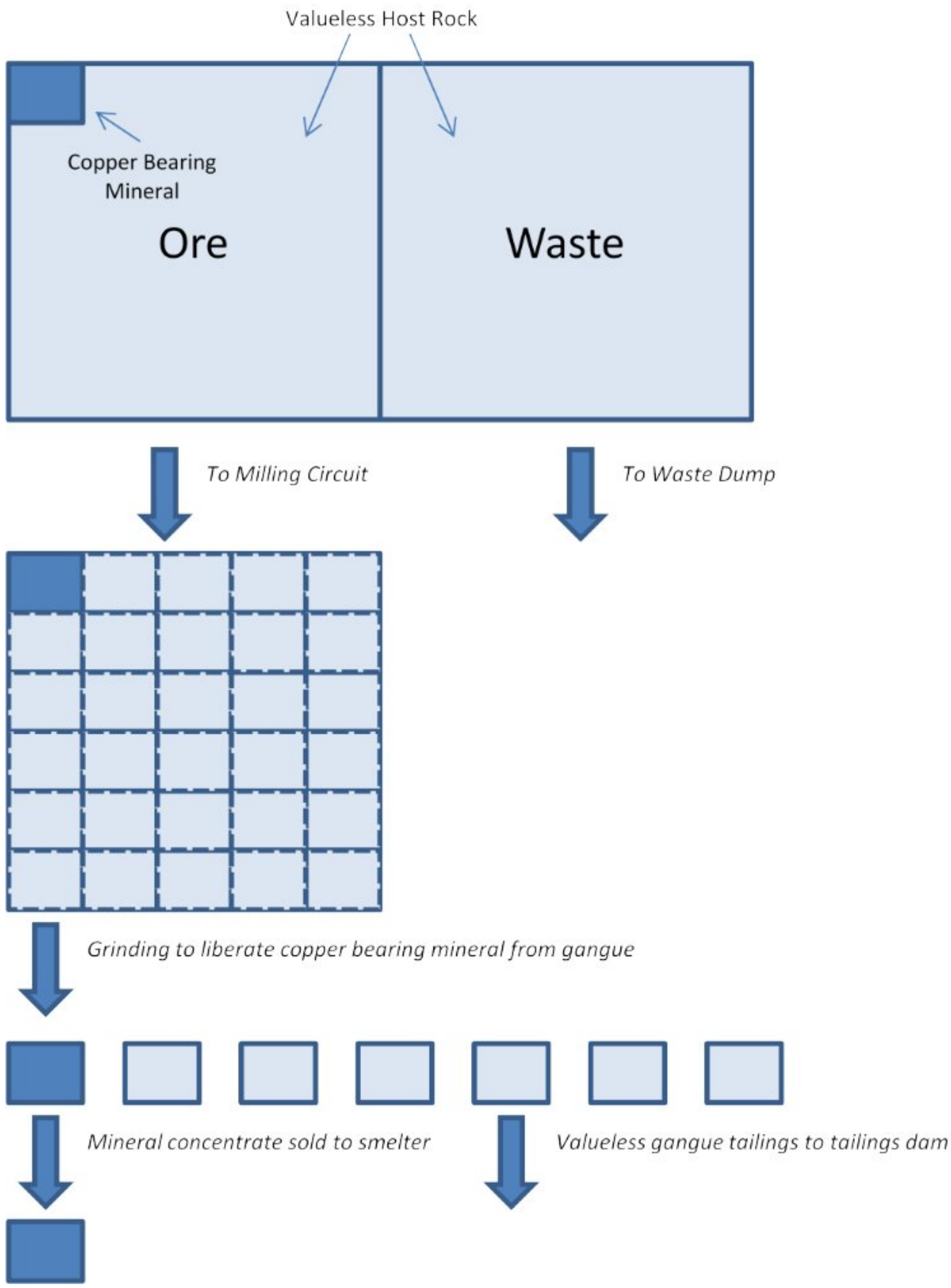
Exhibit 9

Copper mining involves the identification, liberation and sale of copper bearing minerals. This is achieved through two processes of waste removal. The first one occurs at the mine site where ore is separated from waste. The second one happens at the milling/flotation site where concentrate is separated from tailings.



Source: Bernstein analysis & estimates

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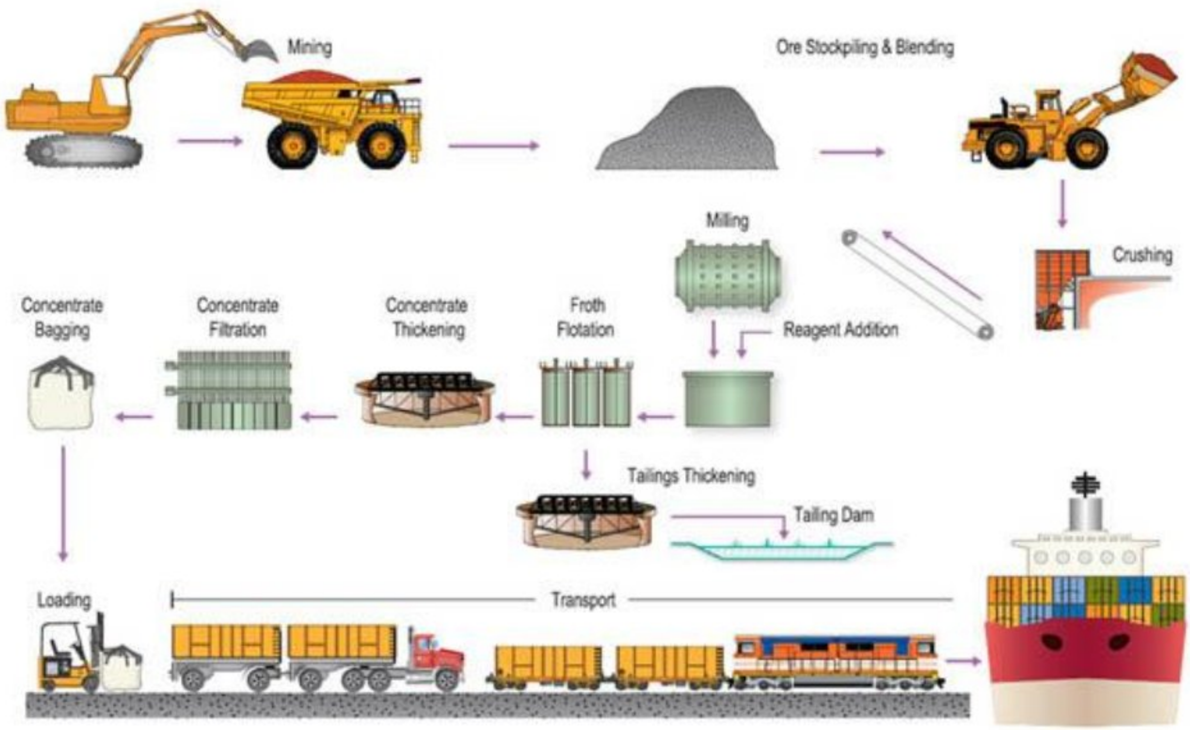
Exhibit 10

The traditional mining route involving the concentration of sulphide ores drives the vast majority of mined copper production (~80%).



Source: Corporate reports

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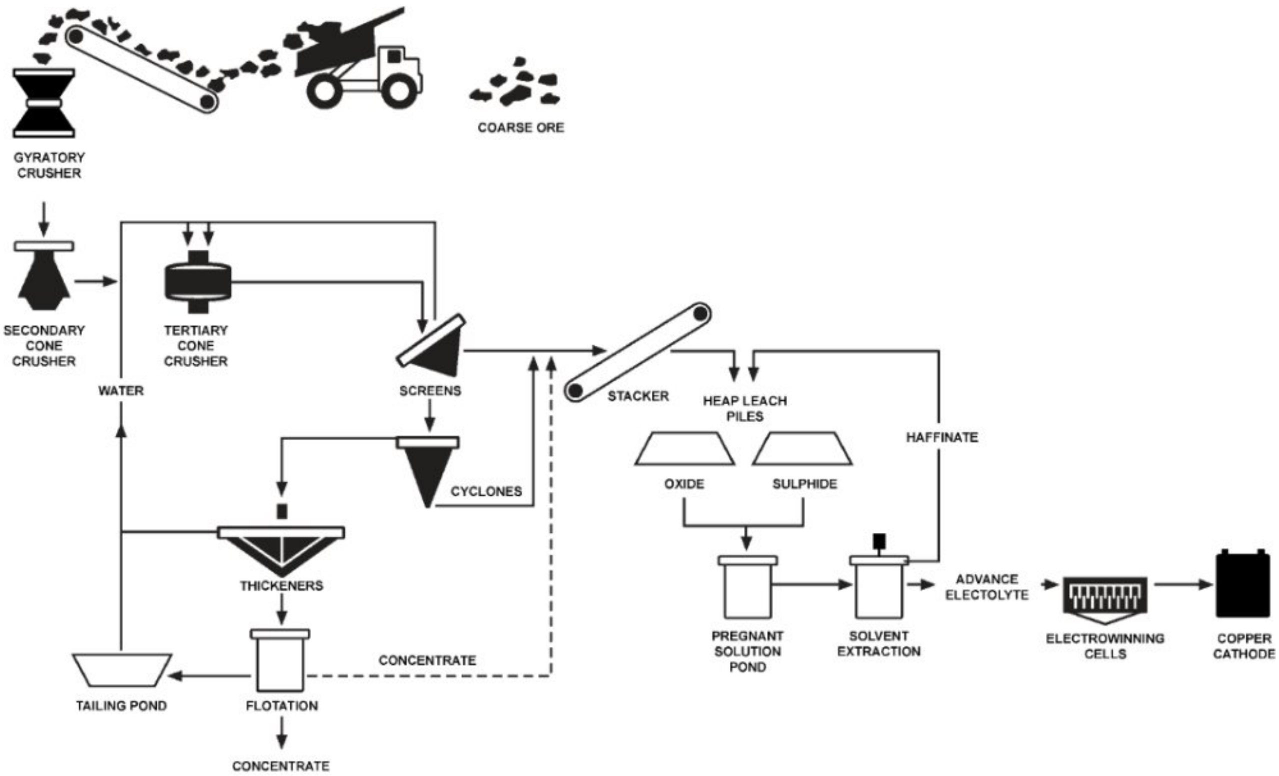
Exhibit 11

The Sx-Ew (solvent extraction & electro-winning) route exploits oxide ores and accounts for the residual 20% of the mined copper production.



Source: Corporate reports

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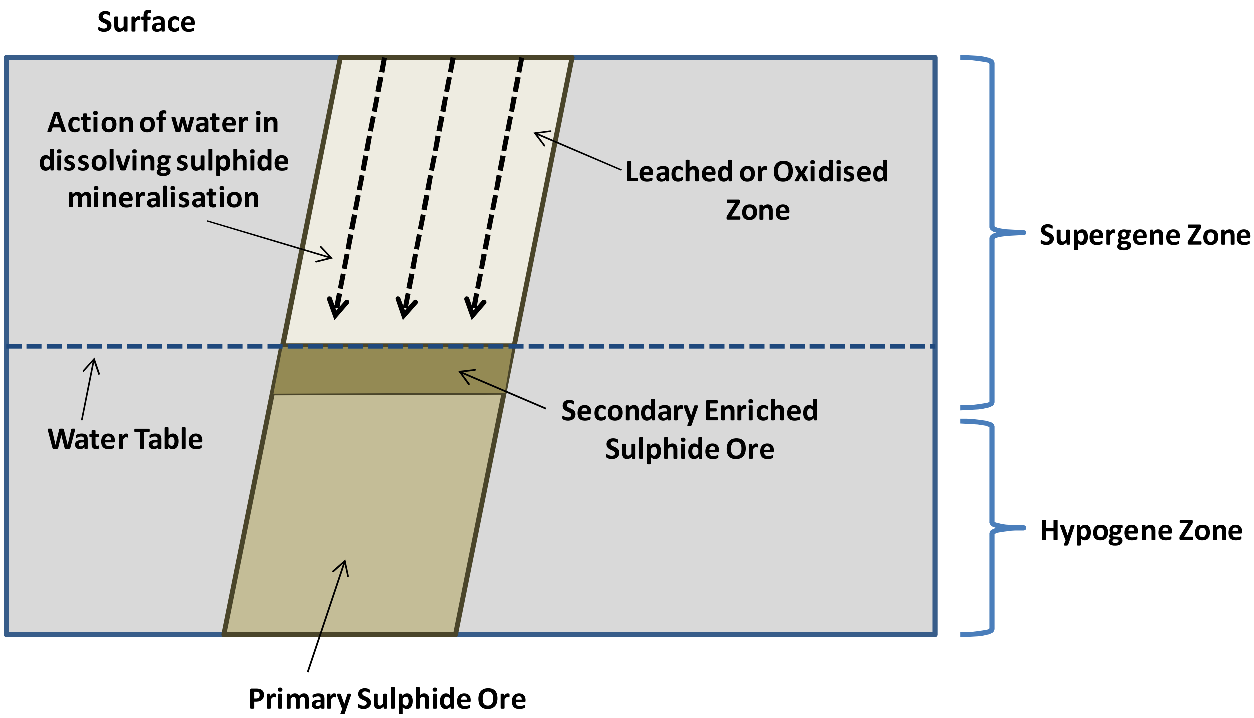
Exhibit 12

An important feature of the sulphide route is the ability to take advantage of high grade copper ores in secondary or supergene enrichment zones. These locations can provide significant additional early stage cash flows for a miner.



Source: Bernstein analysis & estimates

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Copper occupies a unique role in the industrial society. It is the most overexploited of the main metals.

There is a very strong correspondence between a metal's geological abundance and its use - this is unsurprising. What is surprising is departures from this relationship, as they tell us something about the relative demand for a commodity. In this respect, copper is unique.

Exhibit 13 shows how the consumption of major industrial commodities varies with their geological abundance (we show this on a log-log basis where several orders of magnitude variation can be compressed). Clearly, the world's economic system has adapted to use those materials that are most readily accessible. However, it is also worth noting that economic role played by any metal depends upon its physical and chemical characteristics (for example, mass to strength ratio), which are not easily substitutable. The high geological abundance of iron in the Earth's crust stands as one of the key forces that enabled the mankind's industrial development. Even the use of aluminium – the closest metallic industrial substitute for steel and closest element in terms of geological abundance – is predicated upon the prior development of steel. Without the metallurgical properties of steel, the process of electrification and power generation necessary to develop aluminium as an economic metal would not have taken place.

Perhaps more interesting is not the relationship between commodity abundance and its use in itself, but rather the departures from this relationship. For example, a low geological abundance and yet high use would tell us that the metal in question is relatively more important for the world economy than a metal with a high abundance and low use[2]. Consequently, all other things being equal, a higher and stronger price should result for an over-exploited metal and vice versa. In other words, incentivising an increase in the supply of a metal with little availability and an already high rate of exploitation (absent improvements in mining productivity) requires prices to move upwards. In contrast, for metals whose exploitation is low relative to abundance, any increase in price will simply trigger a wave of new supply and so sustained high prices will be hard to achieve.

In **Exhibit 14**, we show the relative over-exploitation of the main industrial metals. The higher the figure, the more over exploited a commodity is. In this context, copper stands out as the most over-exploited metal with a production of 16.4 times as great as the underlying relationship between abundance and use would suggest. Likewise, iron ore is 7.4 times over-exploited and aluminium is significantly under-exploited. This relative exploitation suggests that despite its high geological abundance, growing iron ore production is not as trivial a matter as many seem to think. This is even truer for copper. We already use these metals at an incredible rate. Consequently, growing their production necessarily involves accessing more challenging geology.

[2] Of course, geological abundance is not the same as a metal's reserves or resources, which add an economic filter to the underlying geological endowment. In order to be economically accessible, all elements require some further geological process of enrichment and concentration. So, while iron ore has an average abundance of 5.6%, it requires an approximately tenfold concentration of that abundance to generate the 60% Fe grade ores exploited in Australia and Brazil. Likewise, copper has a geological abundance of 0.006%, thus requiring an approximately hundred fold concentration to 0.6% to be economically viable.

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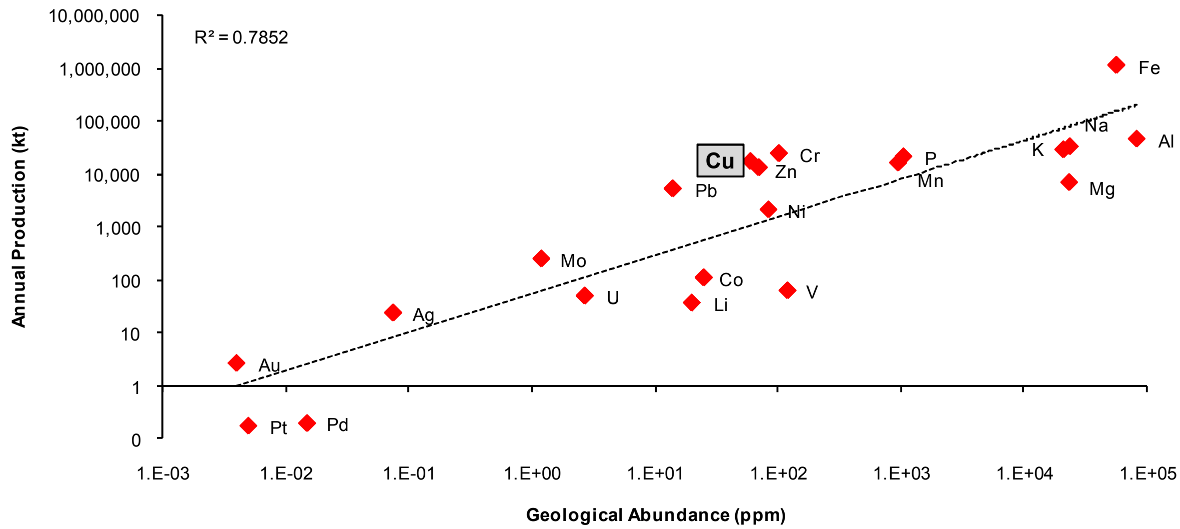
Exhibit 13

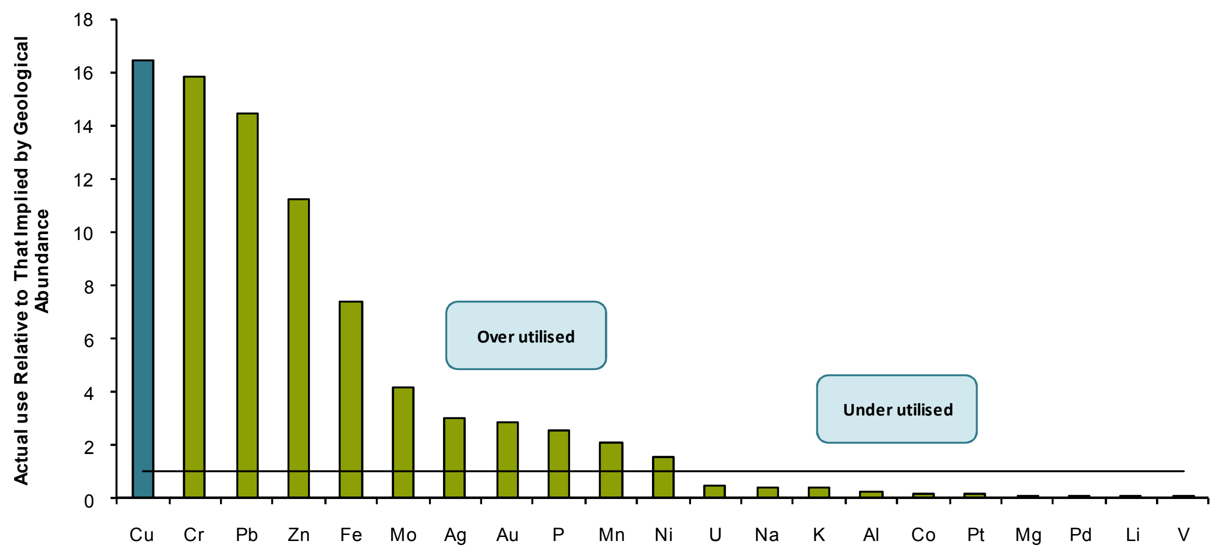
There is a very strong relationship between geological abundance and industrial use. The most useful commodities in terms of economic application also happen to be the most geologically abundant.



Source: USGS, Bernstein analysis and estimates

Exhibit 14

Copper stands out as the most over-utilised commodity relative to its underlying geological endowment. This testifies to the industrial importance of this metal and the difficulty in growing supply in anything other than a supportive price environment.



Source: USGS, Bernstein analysis and estimates

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The supply of the world's copper is critically dependent on the unique geology of Chile. There are no new Chiles and this fact must be factored in to expectations about the viability of future supply growth.

The ability to supply the massive demand for copper at a low price was dependent on the exploitation of the massive copper porphyries of Chile. But Chile's geology is unique and radically different from the second largest copper miner, China. Expectations that there will ever be a repeat of the Chilean copper boom are misplaced.

The geology of copper deposits is highly technical with a huge variety of physical and chemical process at work in the development of the ore bodies that stand behind today's industrial production of copper. Very broadly, however, the deposits of economic interest may be grouped into three types.

- **Porphyry deposits.** These are deposits associated with volcanism in general and in particular with the tectonic subduction zones (one continental plate moving beneath another) along the Eastern edge of the Americas and around the entire perimeter of the Pacific Basin. These deposits are hydrothermal in nature and rely on the mineral solvency and concentrating abilities of water under pressure and temperature. Hot aqueous solutions circulating through the earth's crust dissolve the minerals contained in the host rocks through which they circulate. As these solutions cool the dissolved minerals are precipitated out of the solution and when the hydrothermal solution was rich in an economically interesting (that is scarce) metal the precipitated concentration results in a mineable ore body. Porphyry deposits consist of numerous fractures (typically these fractures being millimetres in width separated by centimetres in the host deposit) resulting from a magmatic intrusion into a host rock. These fractures form the veins through which hydrothermal solutions were able to escape from the earth's crust and in so doing undergo the process of cooling and mineral precipitation. The economic implication of the porphyry form is that selective mining whereby individual high grade veins are extracted is impossible. Rather bulk mining techniques must be employed. It is this step that marks the breakthrough from small scale labour intensive copper mining to the large scale capital intensive mining techniques employed today. As a piece of trivia, it was at Rio's Bingham Canyon that the first ever demonstration of economic bulk copper mining was made. It is the existence of low grade but massive copper porphyry deposits mined by bulk techniques that stands behind the use of copper on the scale that we see in industrial societies today (**Exhibit 16**). Indeed without this step the intensity of use of power and electricity that fuels modern society would be impossible.
- **Massive sulphide deposits.** These are a second class of hydrothermal deposits and again rely on the enrichment properties of hydrothermal solutions for their ultimate origin. However the mechanism by which the precipitation of minerals occurs is markedly different. Massive sulphide deposits are created in submarine environments where a volcanic phenomenon leads to the direct expulsion of a sulphide and metal enriched hydrothermal solution into the ocean. The rapid cooling of the hot solution leads to mineral precipitation and the formation of a "blanket" of sulphide material around the vent. Those portions of the oceans crust where this process has taken place and that are now above sea level can be mined for copper and other minerals. The fact that the hydrothermal solution is expelled directly into the ocean explains why there is very little gangue material present in these deposits and the term "massive" is intended to reflect this mineral concentration rather than the size of the deposit *per se*. This process of ore formation is ongoing today on the ocean's floor through the medium of "black smokers" whose name arises as a consequence of the fact that the sulphide precipitation in the process has the appearance of soot. As another piece of trivia, the word copper derives ultimately from the Greek word (and island) Cyprus where copper was mined in ancient times from a massive sulphide ore body.
- **Sediment hosted deposits**. The last broad class of ore bodies is that of sediment hosted copper or stratiform sedimentary deposits. Unlike the previous two types of deposits mentioned above that have an intrusive nature and are associated with volcanic activity sedimentary hosted deposits are found in marine

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sedimentary rocks and have a characteristic flat or layered nature that can extend over horizontally over a very significant area. (The most famous stratiform deposit, the Kupferscheifer of Northern Europe which has been mined continuously since the 14th century, extends over 6,000 square kilometres but averages just 20cm in depth!) The origin of these deposits is controversial but the most likely explanation is the leaking of hydrothermal fluids into sediments in the process of deposition either at or before the consolidation of the sediment into rock. The Zambian copper belt and DRC deposits fall within this classification.

There are two further types of copper deposits that we include more for completeness sake at this point than for any economic significance.

- **Vein deposits.** These deposits are tabular in nature with sharply defined boundaries marking valuable ore from the worthless host rock. They arise as a consequence of the presence of a clear fracture within a host rock through which hydrothermal fluid flows with the action that over time the fracture is filled with ore through the deposition of dissolved sulphides. These deposits can be incredibly rich but are quantitatively speaking very small. This class of ore bodies includes those found in Cornwall from which played a pivotal role in the early industrial history of the UK but are now of historical interest only.
- **Magmatic Segregation Deposits.** These deposits are unusual in not having anything to do with the circulation of hydrothermal solutions and their ability to concentrate copper bearing minerals. These deposits are instead the result of a dynamic whereby certain magmas upon rising through the earth's crust become saturated with iron sulphide (FeS). As the magma begins to cool this iron sulphide forms into droplets that sink through the less dense host magmatic solution forming a molten iron sulphide solution at the bottom of the magma chamber. As this solution solidifies it forms a mass of pyrrhotite (FeS) dotted with grains of chalcopyrite ($CuFeS_2$) but also nickel bearing minerals. The Sudbury basin is an example of this type of deposit where copper exists as a fairly significant by-product of the nickel mining operations.

Returning to the three most important types of copper deposit, we show the grade to tonnage distribution of the 1,400 known copper deposits in **Exhibit 15**. The very clear inverse relationship between grade and size is readily apparent. Here we see massive sulphide deposits fairly evenly distributed at the higher grades, sedimentary hosted deposits in the middle of the grade tonnage distribution and copper porphyry deposits at the far end of the distribution being the largest but lowest grade of the three types. **Exhibit 16**, **Exhibit 17** and **Exhibit 18** summarise this data. The most important chart here is probably **Exhibit 18** which shows that scale overwhelms quality as far as the availability of metal is concerned, 80% of the copper identified for possible exploitation sits within the lowest grade ore bodies (and it should be remembered that costs are inversely related to grade!). Given that the world's copper relies on the economic exploitation of copper porphyry's then it follows that it must be uniquely reliant on one country in particular. This, of course, is Chile.

Exhibit 19 sets out the endowment of copper by country and by ore type. The total cumulative copper that this represents is laid out in **Exhibit 20**. The purpose of this analysis is to make the unique position of Chile as clear as possible. Not only is Chile by far the world's largest producer of mined copper metal (nearly 4,000ktpa more than the second largest producer, China) but it is uniquely well endowed with metal. The industrial scale consumption of copper on the back of mass electrification programmes was permitted first by the exploitation of the USA's copper endowment (second only to Chile) and subsequently on a more global scale by the development of Chile post the market reforms of the 1970s and 1980s. But this analysis also highlights a few further features of note. The first of which is that as rich as the deposits of the DRC and Zambia are, they cannot possibly support the world's copper needs. The contained metal of these locations is simply too small. It is not only political risk but geological endowment that will limit the contribution that these countries can play. So while there will be significant value created for those that can enter and operate in these jurisdictions and take advantage of the incredible high grade on offer (Glencore

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Xstrata within or coverage) this does not imply that Africa will ever be able to challenge the position currently occupied by Latin America. The second point is that Peru is not a new Chile; Peru is at best a "Chile lite". Despite the grandiose claims in some quarters as to what Peru may be capable of delivering, these ultimate output of any location depends on its geology, and while Peru has significant room for expansion this does not imply that it will ever be able to replicate the impact that Chile's development had on global copper prices.

But there is more to Chile that just the absolute magnitude of its total endowment, there is the individual scale of the deposits within the country. This is shown in **Exhibit 21**. Not only is Chile blessed with the lion's share of the world's copper but the copper that it has comes readily packaged in the most convenient possible form, namely massive ore bodies with high inherent mining optionality. Scale in mining creates options and the possibility of numerous exploitation and development patterns. All other things being equal, it makes mining easier. Once again, no other location will present as much in the way of "low hanging fruit" as was on offer during the development of Chile's copper industry, the future is going to be far harder than the history of the last few decades might suggest. All of these factors indicate that an analysis of the history of the development of the Chile's copper industry will offer some important conclusions for how the future development of global copper supply will proceed.

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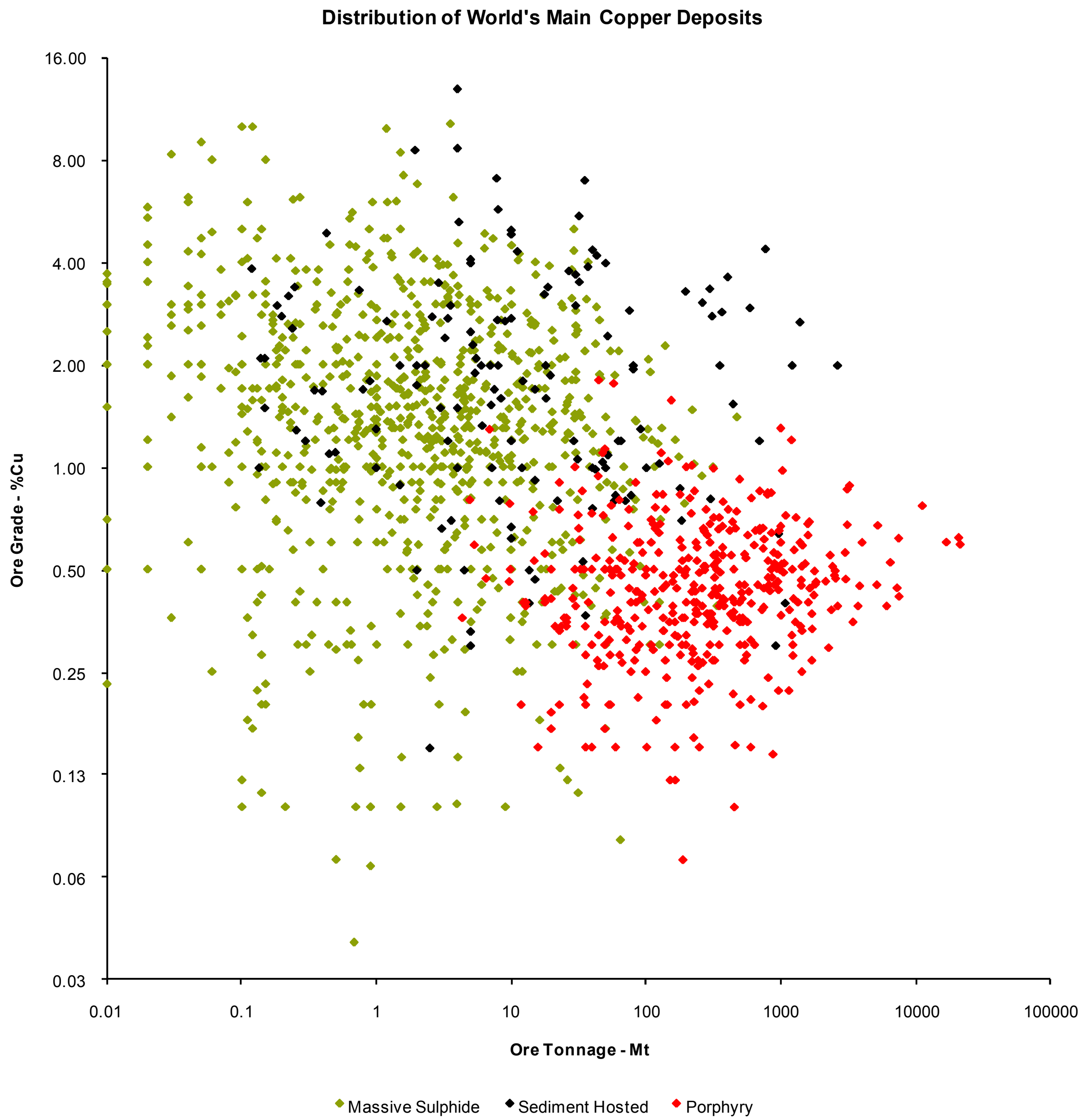
Exhibit 15

In the distribution of known copper deposits shows the typical inverse relationship between grade and size with copper porphyry's occupying a place of privilege at one end of that distribution.



Source: USGS, Bernstein analysis & estimates

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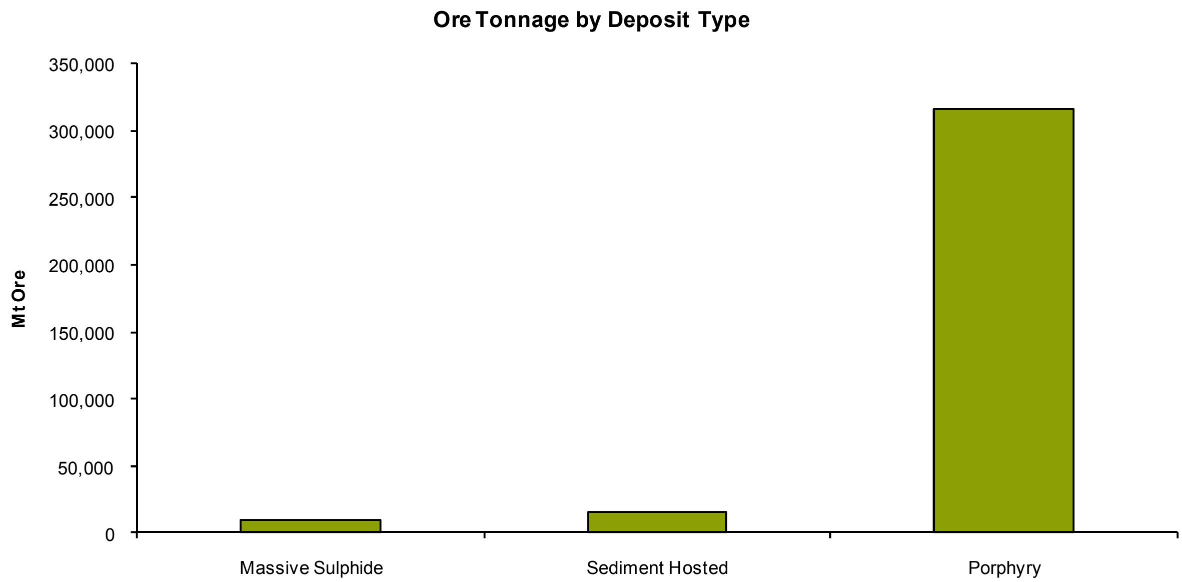
Exhibit 16

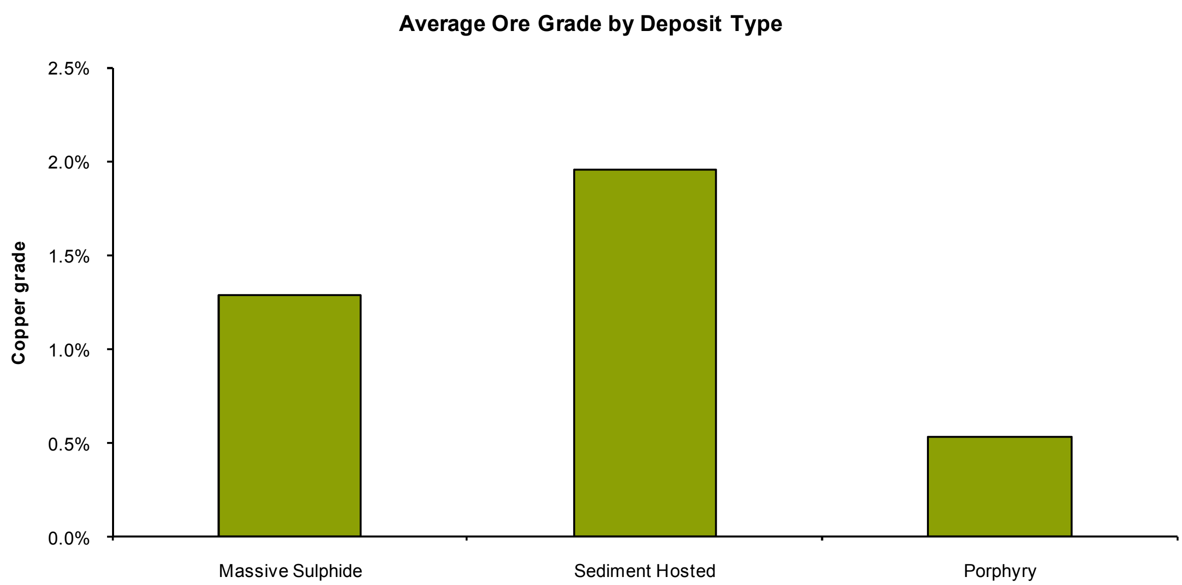
Copper porphyries represent the lowest grade but the most abundant source of copper supply, it is their exploitation by bulk mining methods that has allowed the development of modern power intensive industrial society.



Source: USGS, Bernstein analysis & estimates

Exhibit 17

The average in situ geological abundance in copper porphyry's is 0.5%, this has important implications for the long term grade profile of copper production. Anything higher than this must be temporary.



Source: USGS, Bernstein analysis & estimates

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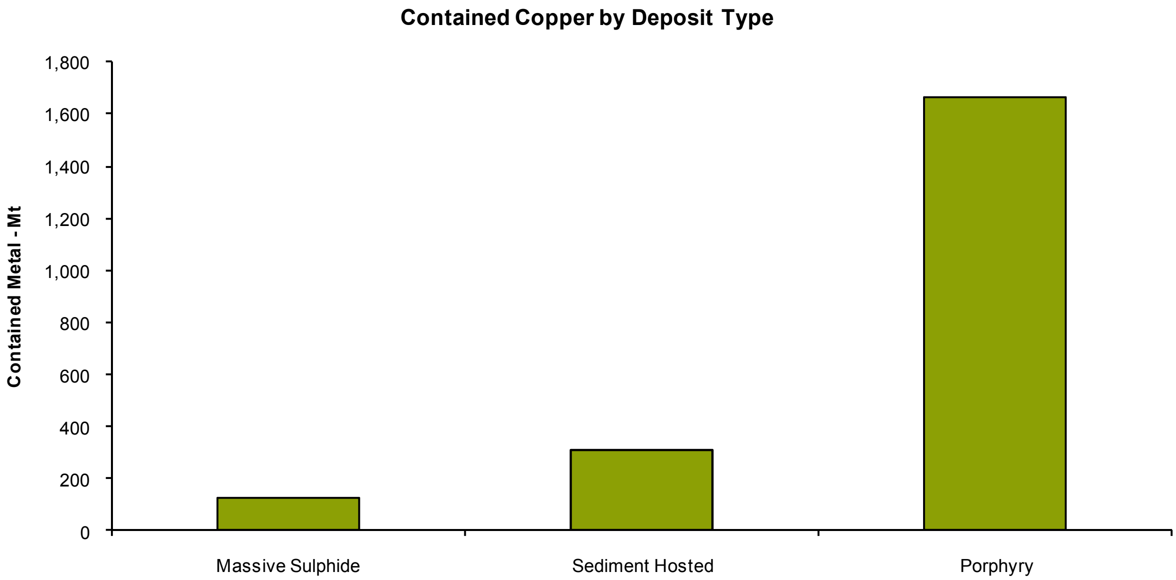
Exhibit 18

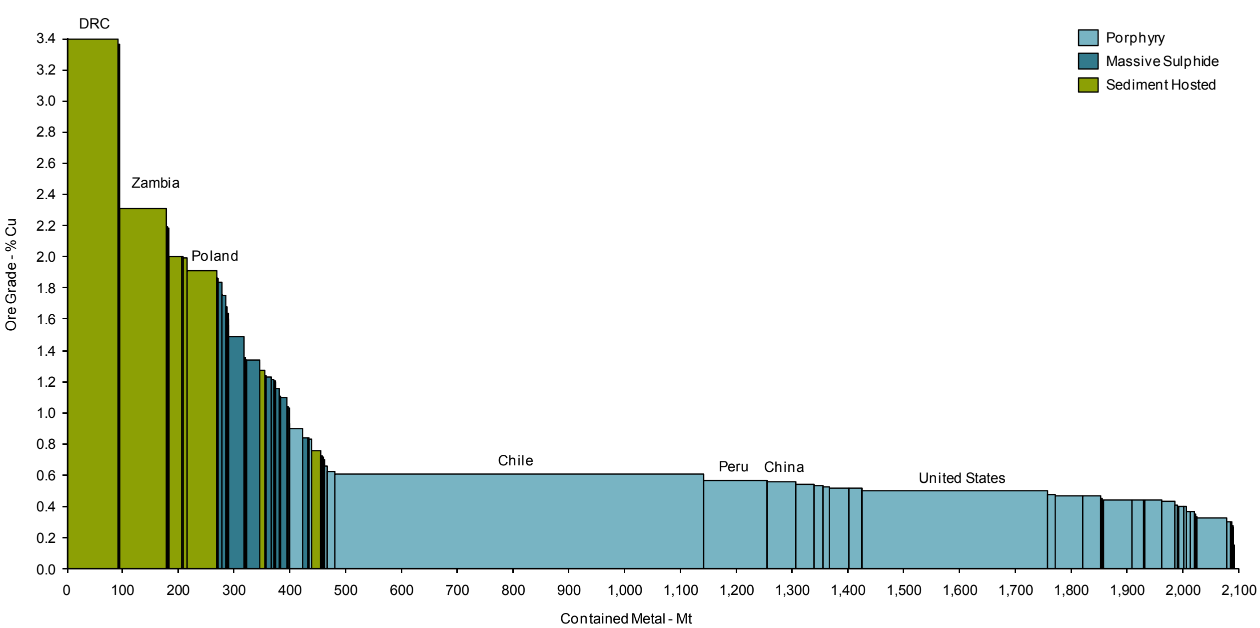
So the world's consumption of copper is predicated upon the exploitation of the lowest grade copper deposits.



Source: USGS, Bernstein analysis & estimates

Exhibit 19

Poland, Zambia and the DRC are high grade but too small to displace American pre-eminence.



Source: USGS, Bernstein analysis & estimates

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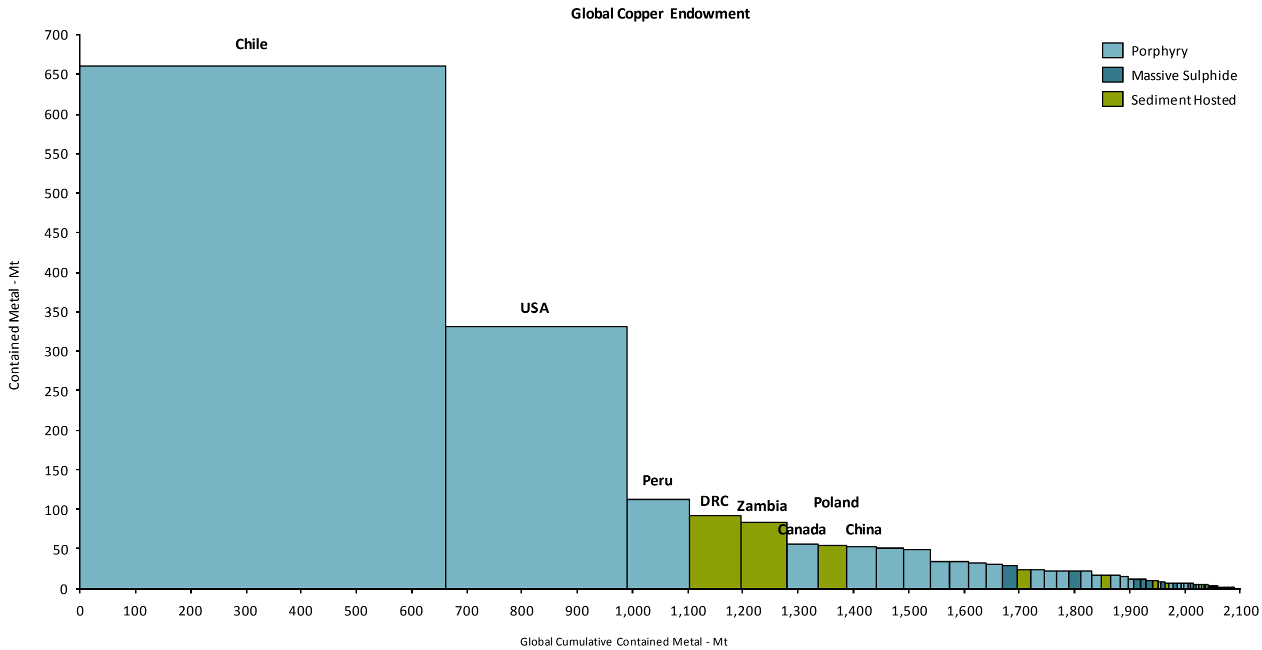
Exhibit 20

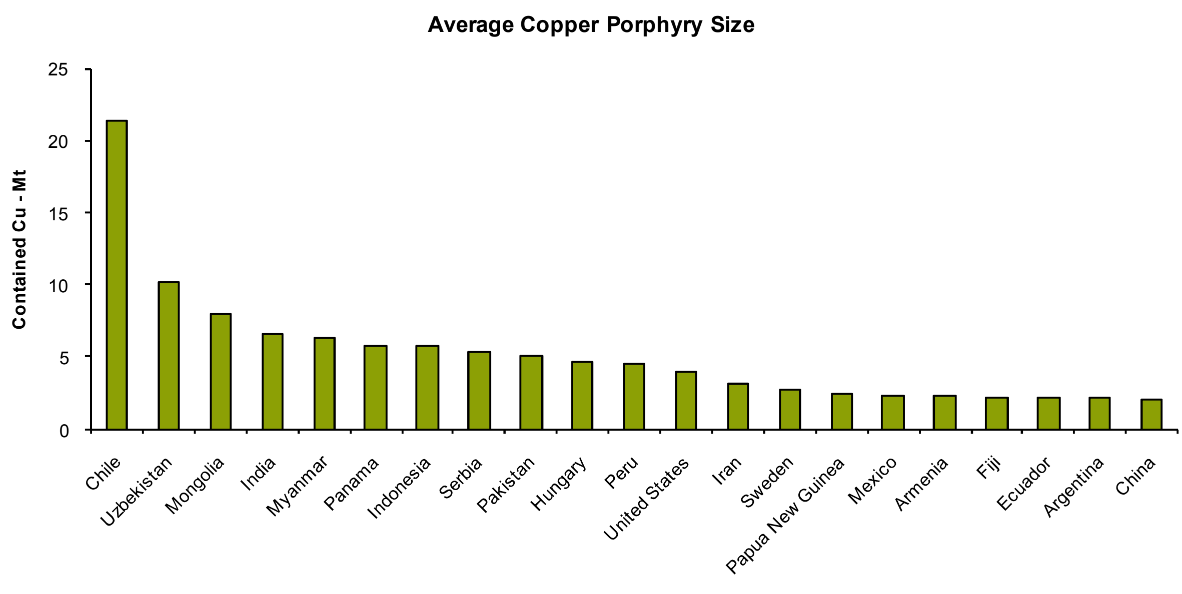
Chile's position of dominance in terms of ability to supply the world's copper demand is clear.



Source: USGS, Bernstein analysis & estimates

Exhibit 21

But not only is Chile uniquely well endowed in absolute tonnes but the size of those deposits is unmatched.



Source: USGS, Bernstein analysis & estimates

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The low real price of copper over the 1980s and 1990s was predicated on the emergence of Chile – a feat that will be hard to repeat.

Between 1983 and 2003, the average real price of copper was just US$3,250/t. At the same time, Chile increased copper production by 3,700ktpa. Since 2003 the largest source of copper growth has been China – a country with an endowment just 8% of that of Chile!

Chile's contribution to the supply of copper metal is hard to exaggerate (**Exhibit 22**). It is 260% larger than its nearest rival China. As the previous analysis has made clear, it is Chile's unsurpassed geological endowment that makes this possible. However, in terms of growth, the last decade has seen Chile stall and China emerge as the fastest growing sources of supply (**Exhibit 23**). The history of the last 100 years of supply from the ten most important supply locations today is given in **Exhibit 24**, **Exhibit 25**, **Exhibit 26**, **Exhibit 27**, **Exhibit 28**, **Exhibit 29**, **Exhibit 30**, **Exhibit 31**, **Exhibit 32** and **Exhibit 33**. The importance of these charts is to highlight that in five of the top ten producing countries mined growth has stalled and in some cases even declined. Moreover, the countries wherein growth has stalled (Chile, USA, Australia, Canada and CIS) contain all of the "easy" political locations for mining investment. This is highly suggestive of the fact that the mining industry invested in and developed the easiest from a risk-return perspective geology first, which makes perfect sense. But it also serves as yet another reminder of the difficulty that future mined growth will encounter, as the copper industry is forced to take on ever higher risk to secure new sources of supply. These graphs also help to contextualise the recent growth we have seen out of Africa. In both the DRC and Zambia, copper production growth has been strong but only in so far as it corresponds to the recovery from the effects of catastrophic political disruptions. In the DRC, this was the Great Lakes conflict. In the case of Zambia, it was the nationalisation of the copper belt. Production today has only just surpassed the levels reached prior to these political events.

It is also possible to chart the history of global copper mining somewhat differently than the simple chronology of the last few exhibits and that is as the tale of two countries alone – namely, the USA and Chile. It is interesting to note that for the first 80 years of the 20th century, the USA was the world's largest producer of copper. In fact, it was so by a greater degree than that seen with Chile today. In 1900, the USA produced over 400% more copper than its nearest rival Spain (**Exhibit 34**). The subsequent history of copper can be thought of as the transition between the USA and Chile as the world's copper hegemon. We chart this process of transformation in **Exhibit 35**, **Exhibit 36**, **Exhibit 37**, **Exhibit 38** and **Exhibit 39**.

The first feature of the last century of copper mining has been the movement of production from the geology of the world's second most endowed country (the USA) to the world's most endowed country (Chile). The second feature has been the change in how technically that geology has been accessed, which is again intimately tied up with the nature of copper porphyry deposits. In **Exhibit 40**, we show one of the first uses of industrial capital equipment on a copper mine in Australia at the start of the 19th century. Prior to this point, copper mining was far more frequently an underground activity with human labour chasing rich seams – an activity which is inherently less productive and economic only insofar as labour is abundant and cheap. In **Exhibit 41**, we show the modern day equivalent of the early steam shovel capable of moving 110t tonnes of material in each movement. The most striking feature of the modern vehicle versus its predecessor (apart from the improvement in colour scheme) is size. A vast increase in scale and accompanying mechanical efficiency has been achieved over the hundred years or so from the introduction of mechanical shovels into mining. However, as important as the increase in scale is the fact that the basic process or concept has remained unchanged. The radical and discontinuous transition in mining took place when capital displaced labour and with it bulk mining displaced selective mining. Since then, mining has witnessed marginal improvement of the same basic underlying idea.

We can summarise both of these trends in **Exhibit 42**, which just looks at the history of copper porphyry discovery and the impact of the discoveries in the USA and subsequently in Chile on the real copper price. We can see the real price of copper halved in a decade on the back of an explosion in copper porphyry

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exploitation at the start of the 20th century. The demonstration of the economic viability of low grade copper mining encouraged the delineation and discovery of significant numbers of very large deposits that had hitherto been thought un-mineable using human muscle power alone. In the post war period, as the scale of new copper porphyries began to decline, so to the real price of copper began to rise. Against a rising demand environment (supported by electrification programmes in the West), the technological and geological step-change of new porphyry discovery began to run its course. An observer in the 1970s would have been forgiven for thinking that real terms price increases for copper were likely to continue indefinitely. However, two things intervened to change this. In the first place was the step change in Western World copper demand growth post the oil shocks. In the second place was Chile. The economic reforms of the late 1970s and 1980s in Chile and the return of foreign investment saw the discovery of a new wave of copper deposits. This new wave is exemplified by Escondida (discovered 1981) but is also seen in deposits like Collahuasi Rosario (1985). The supply of new material from Chile was enough to lead to two decades of negative price performance for copper. However, since that time the rate of new large copper porphyry discoveries has ground to a halt. Demand, on the back of Chinese industrialisation, has accelerated and we are back in the territory of real price increases. Or rather, we are back at where the trend line of price increases would have been if extrapolated out from the end of the 1980s, if the impact of Chile is taken out. Clearly, this very high level argument is insufficient for any price forecast, but it does help set the scene for the arguments to come. However, as we have seen, there is no new Chile on the horizon. Peru is the closest comparison. Even then, it has a geological endowment of much less than half that of Chile and while Zambia and the DRC have undoubtedly high grade deposits, they are simply not large enough to play the role of Chile in the global supply of copper.

Considered over a very long term, there have been two periods of significant real terms price declines in copper driven by two discrete supply side events (there are, of course, demand side events as well and we will turn to these in subsequent calls).

- Introduction of bulk mining techniques on the copper porphyry's of the USA at the start of the 20th century.
- The exploitation of Chile's superior geology using these bulk mining techniques during the 1980s and 1990s.

These two supply side events first established the USA as the world' leading copper producer and subsequently displaced the USA in favour of Chile. In both cases the transition was achieved through the supply of significant new low cost volumes of metal and so was mirrored by a period of sustained low copper prices. However, this twofold transition was also one that may be thought of as establishing Chile's rightful place (given its geology) as the world's premier copper producer. In any event, the history of copper over the last century is the history of production from the world's two most well endowed supply locations; all subsequent history will be from regions with inferior geology and more challenging political and technical environments. We struggle to see how this can be achieved with stagnant or declining copper prices.

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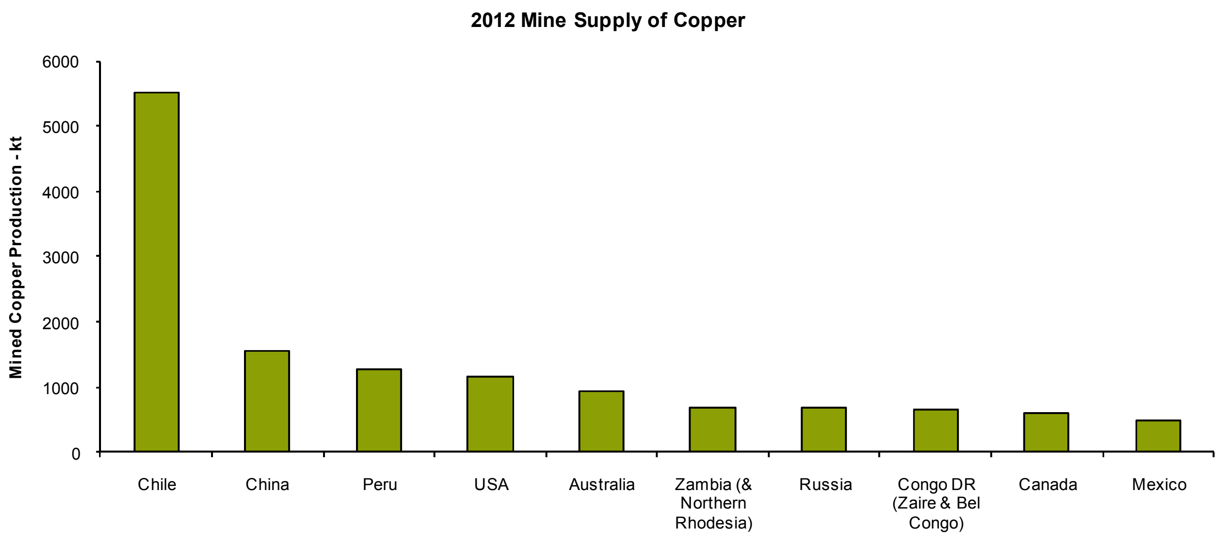
Exhibit 22

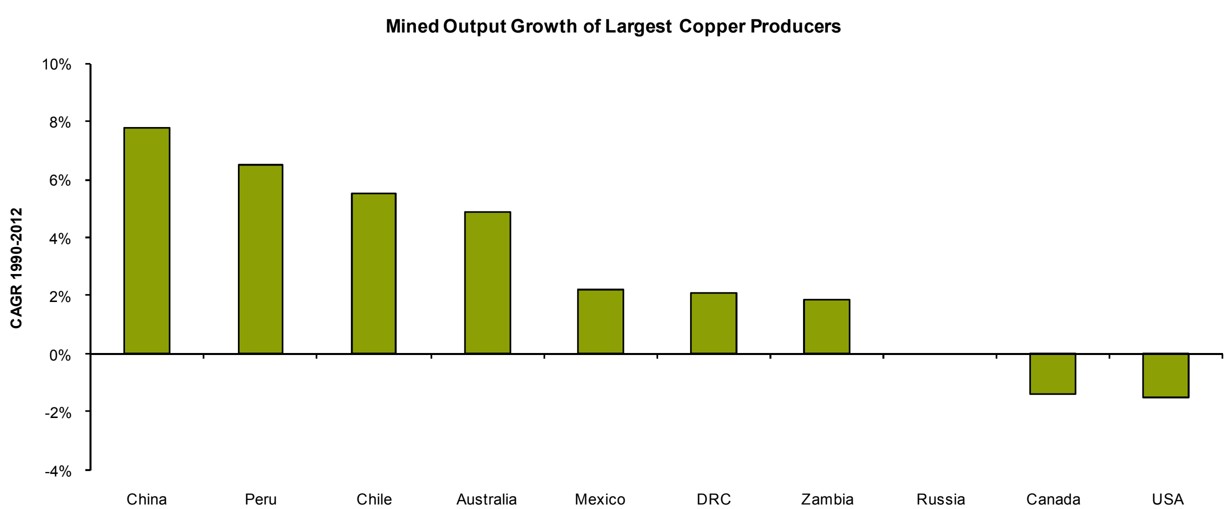
Chile stands out as being by far the most important source of copper supply. But this was not always the case and the study of Chile's development is critical to an understanding of the copper price.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 23

But while Chile's growth has slowed over the last decade, China's has accelerated.



Source: Wood Mackenzie, Bernstein analysis & estimates

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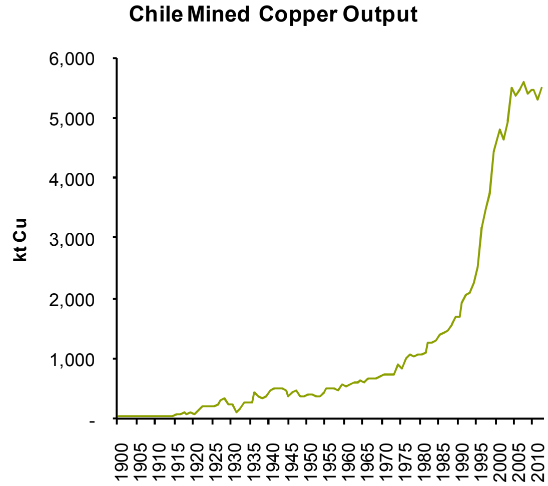
Exhibit 24

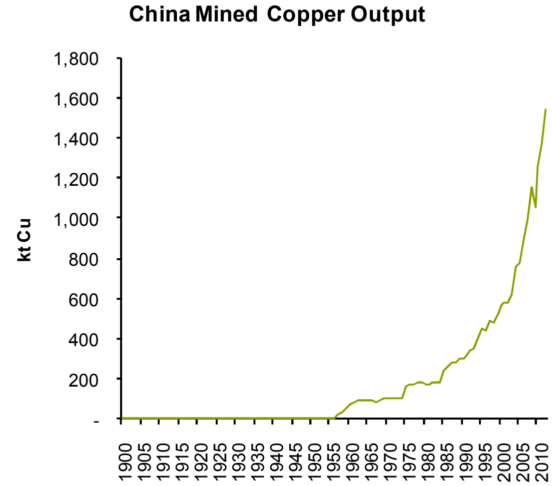
It was the twenty years from 1980 to 2000 that saw Chilean copper growth explode.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 25

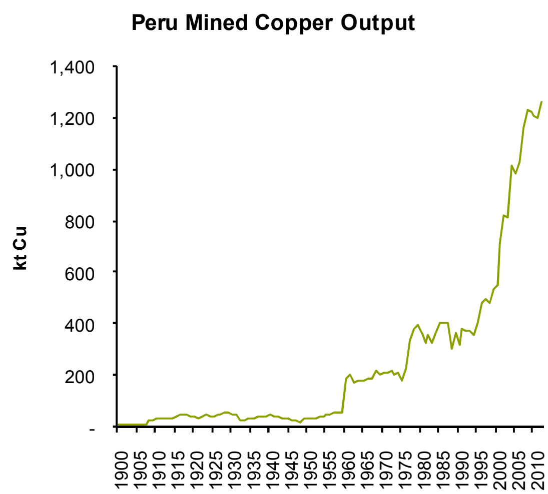
But since 2000 Chile has stagnated, and China emerged as the second largest producer of mined copper.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 26

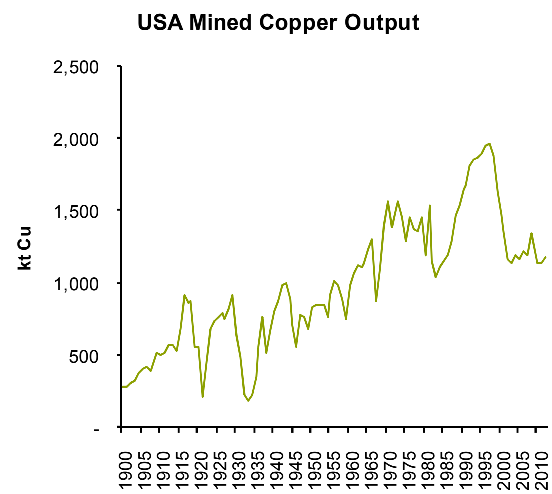
While Peru's growth has been sporadic.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 27

The USA has played a critical role in the copper industry and was, for a long while, the world's largest producer.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

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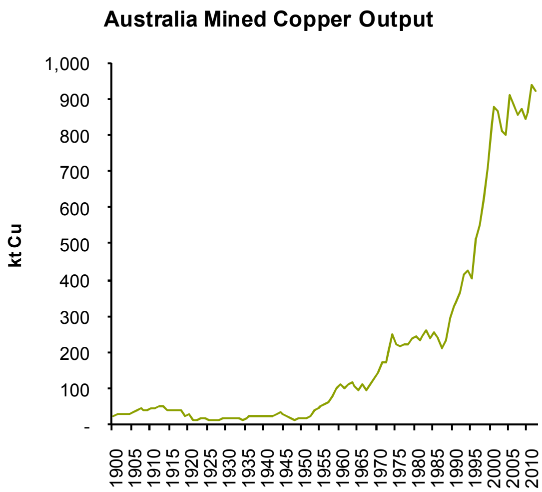
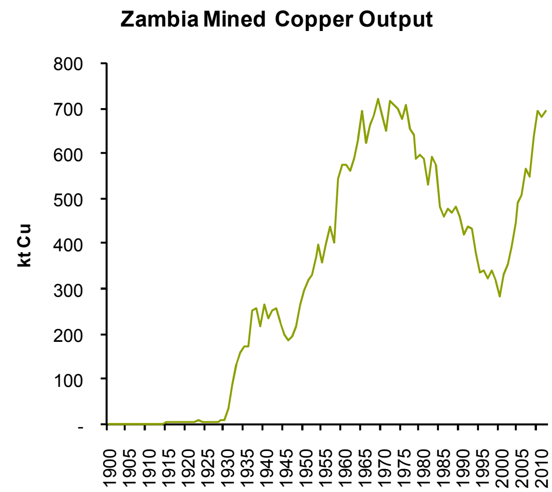
Exhibit 28
As with Chile, Australian output has plateaued.



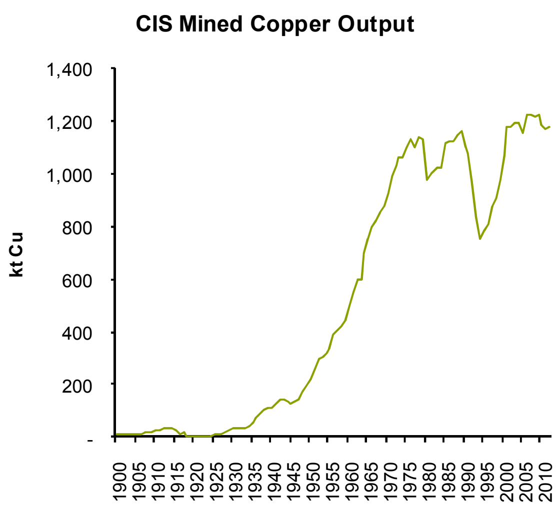
Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 29
Meanwhile Zambia has only just recovered from the disaster of nationalisation.



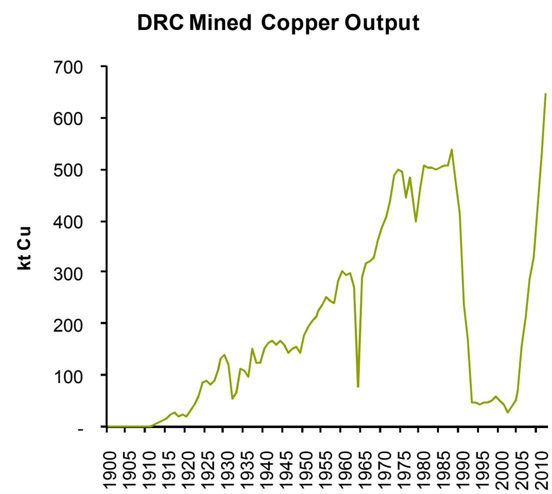
Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 30
The same stagnation that we see in output once the limits of geology are reached is seen in the CIS.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 31
The impact of the Great Lakes conflict on DRC output is painfully clear.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

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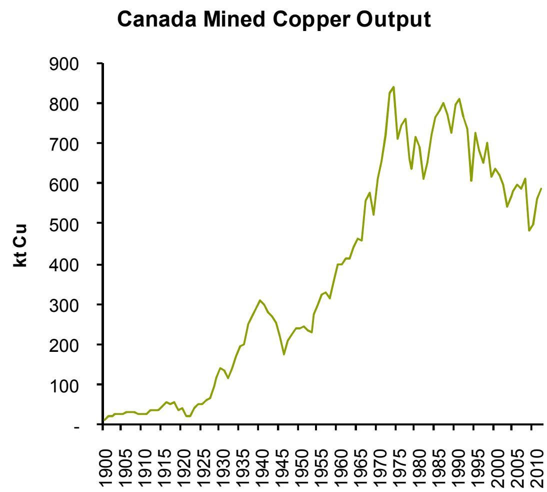
Exhibit 32

And Canada, while still a significant producer, is in decline.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

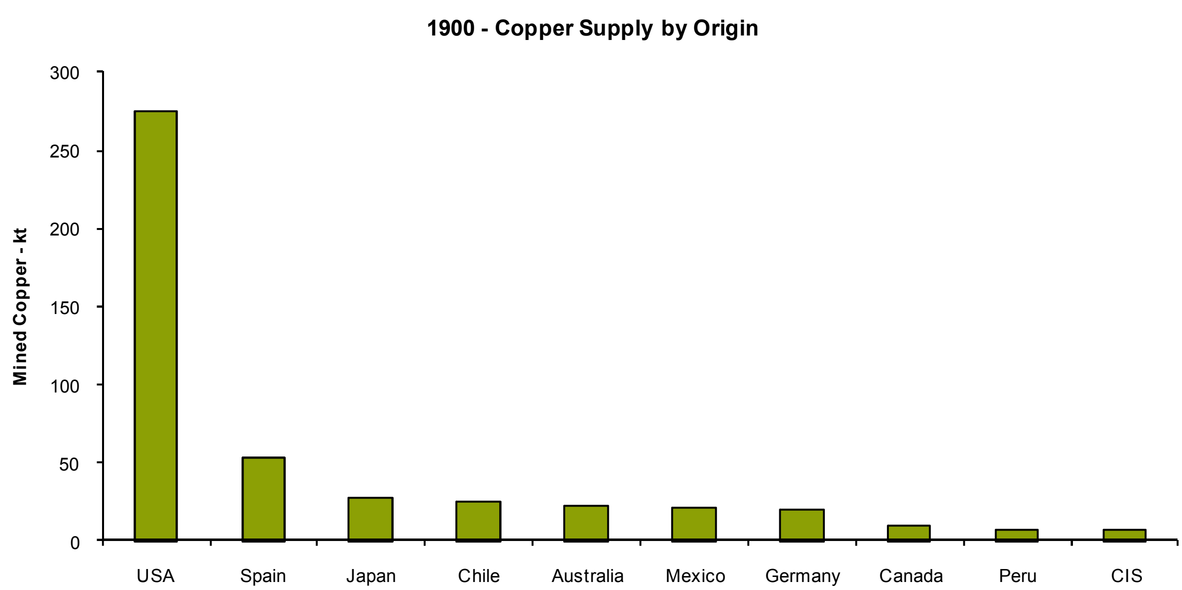
Exhibit 33

Mexico is likely to become a more important producer over time.

Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 34

USA in 1900 occupied a very similar role to that of Chile today. The development of the supply side of the copper industry over the last 100 years is the history of the transition from the USA to Chile.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

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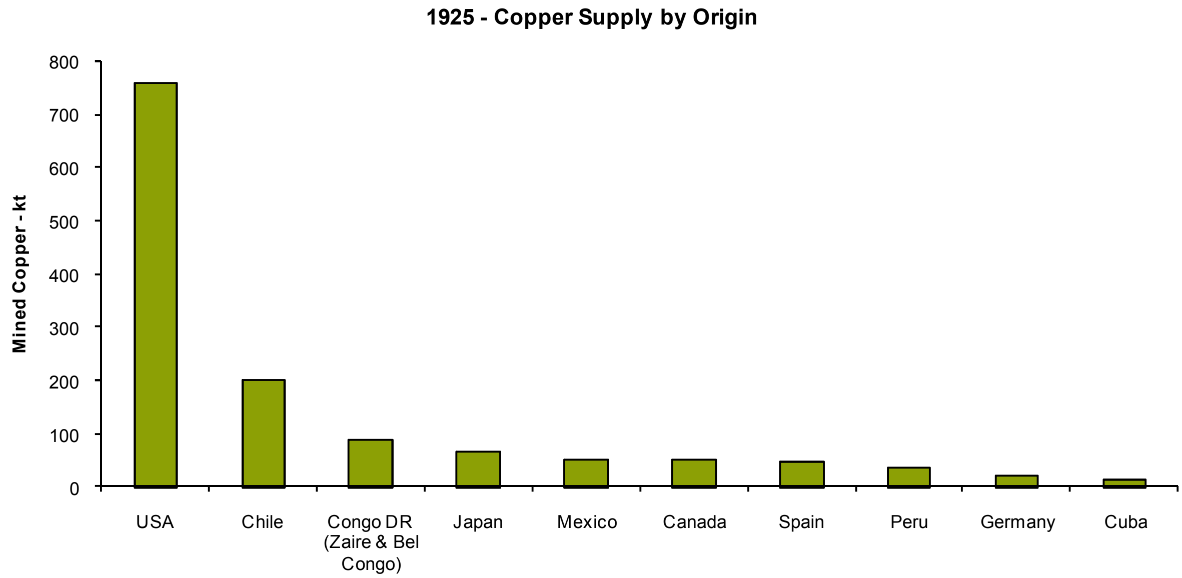
Exhibit 35

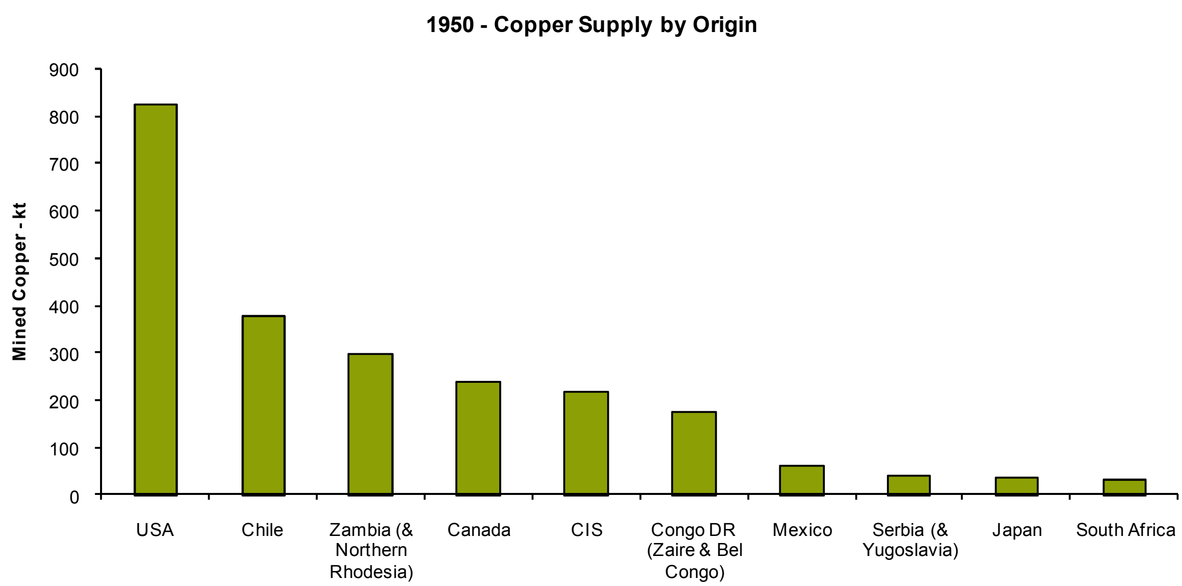
By 1925, the importance of Chile was starting to become clear.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 36

Though Africa (Zambia and DRC) have always had a role to play in the supply of copper.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

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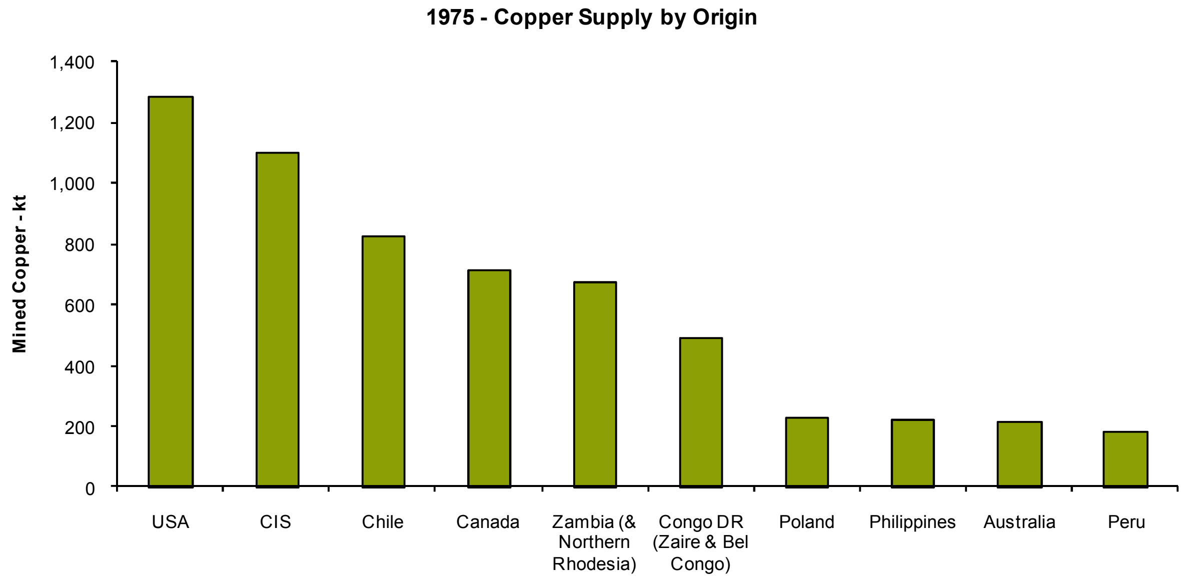
Exhibit 37

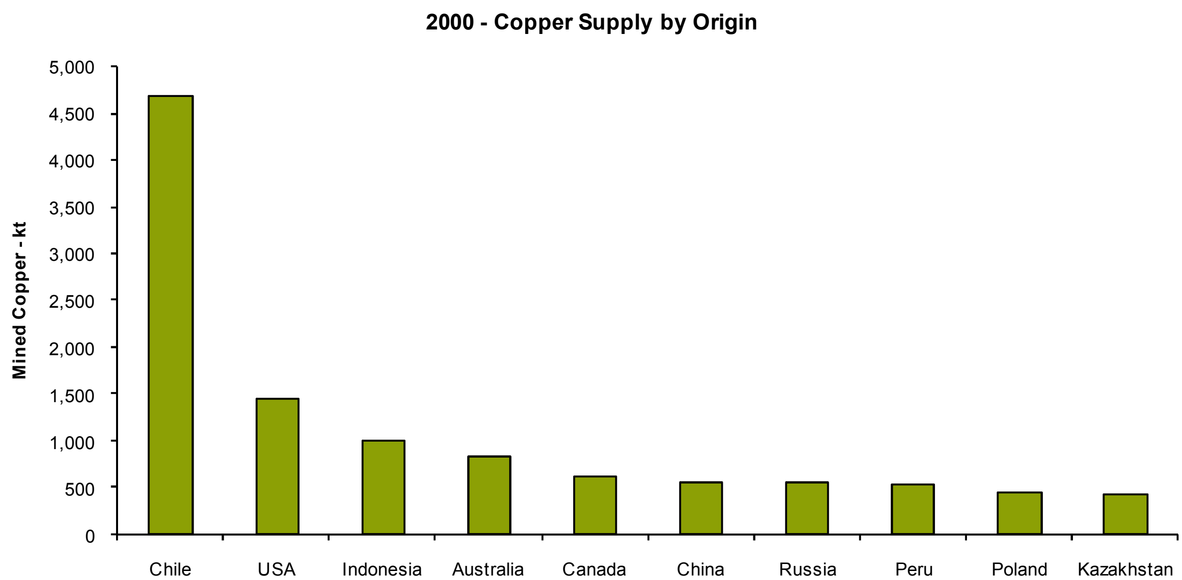
By 1975, the dominance of the USA in the supply of copper was under challenge.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

Exhibit 38

But it was the market reforms that inaugurated the "Miracle of Chile" that saw the USA finally toppled as the superior geology (and lower labour costs) established Chile as the leading global copper producer.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

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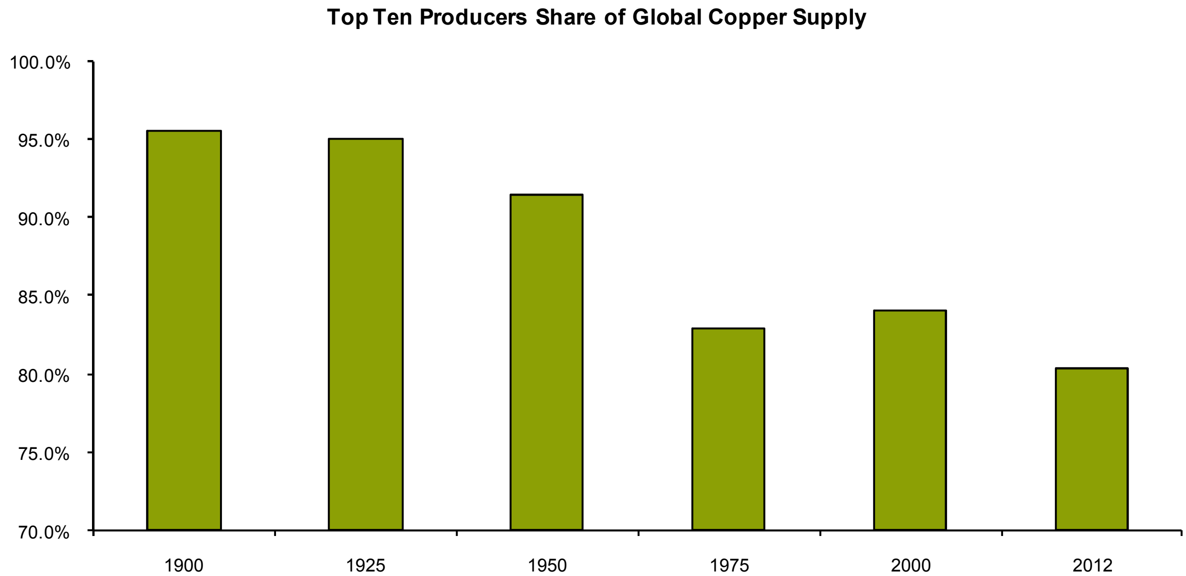
Exhibit 39

Despite all of these changes, copper production remains highly concentrated in very few regions.



Source: Wood Mackenzie, Mitchell, Bernstein analysis & estimates

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Exhibit 40

An early steam shovel at Mt. Morgan copper mine in Australia at the turn of the twentieth century.

Source: Wikimedia Commons

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Exhibit 41

An electric rope shovel at the turn of the 21st century. Same idea, slightly bigger scale.

Source: Rio Tinto

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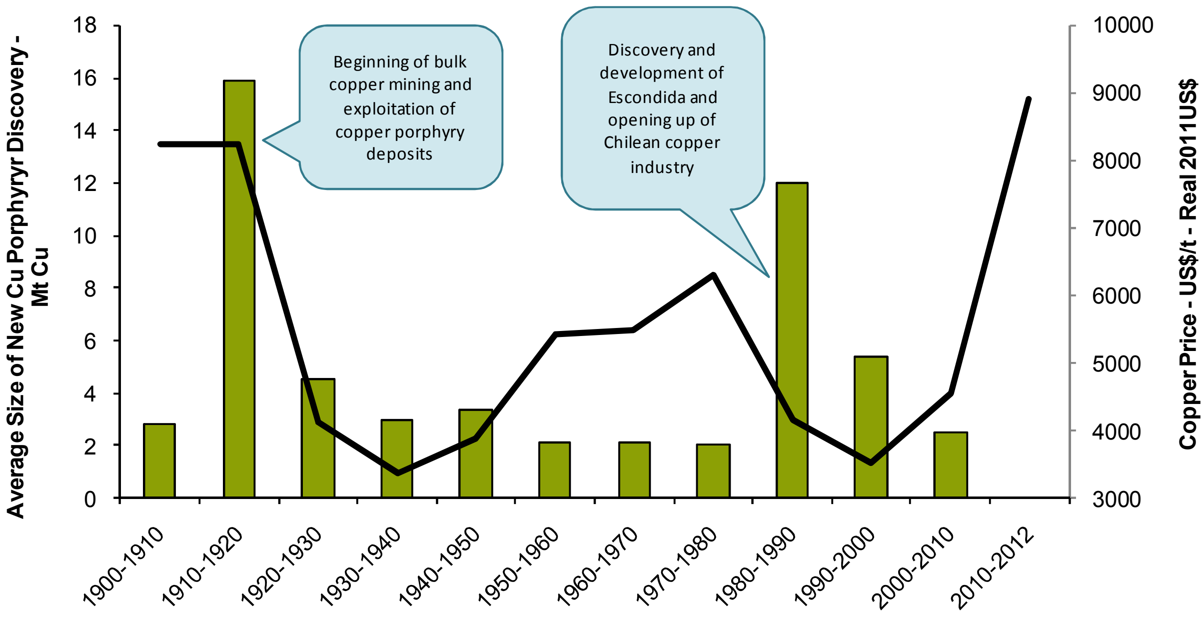
Exhibit 42

If we look at the long term history of copper porphyry discovery it shows the marked impact that these deposits have had on the real copper price. Structurally falling prices have been associated with increased finds of relatively few massive ore bodies. We are not currently in such a situation; there is no new Chile on the horizon.



Source: USGS, Bernstein analysis & estimates

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China's development as the world's second largest producer of copper is unstable and further growth from Chile will be very difficult to achieve.

There is a very strong relationship between the geological endowment of a country and its production of copper, but this suggests that China is producing far too much metal and that there is very limited upside from Chile.

To begin to understand just how difficult the future of copper mining will be, outside of the USA and Chile, we can perform another piece of analysis looking at endowment and production of copper. We show this in **Exhibit 43**, this chart shows the percentage of the world's output that is attributable to a particular location versus the percentage of the world's copper that is present in that location. Understandably there is a very strong relationship between these two variables, a country tend to produce more metal to the extent that the metal is in the ground waiting to be developed. But as important as the fact that the relationship exists is the where departures from that relationship also exist. Again these tell us either where a country is producing too much metal relative to its geological endowment (in which case the production must be under threat if costs in that location begin to rise). Or it tells us which locations have potential headroom for further expansion. These departures are shown in **Exhibit 44**.

This exhibit highlights the anomalous position occupied by China, where the production of metal is significantly out of proportion with the underlying geology of the country. We believe that this situation has arisen only as a consequence of the recent high copper prices and the low wage environment in China relative to other mining jurisdictions. If this interpretation is correct, it highlights the fragility of the world's current mine supply to falling prices. The majority of growth in mined supply observed the last decade has come from a country with a very limited endowment of the metal and one that will faces increasing mining costs as the returns to labour (and away from capital) begin to take effect as the Lewis tipping point is reached and the rate of capital formation begins to slow.

However, so far the discussion of Chile has focused on a description rather than an explanation of the growth that the country has enjoyed. In order to really understand the implications of the Chilean story for other regions, we must now move to the explanation of growth.

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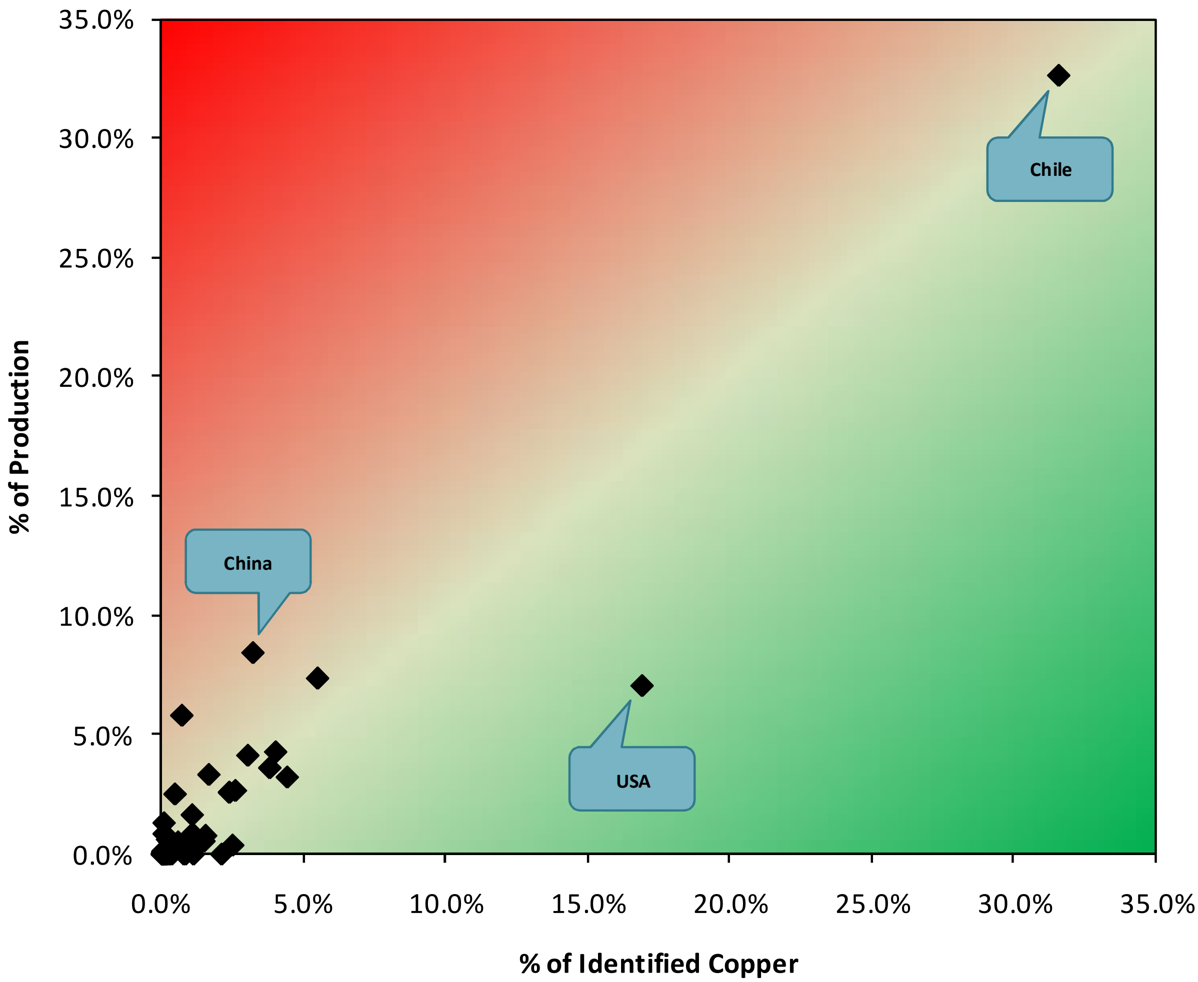
Exhibit 43

If we chart the current supply of copper versus the underlying endowment of copper there is an understandably strong relationship. Good geology tends to imply easy mining.



Source: USGS, Wood Mackenzie, Bernstein analysis & estimates

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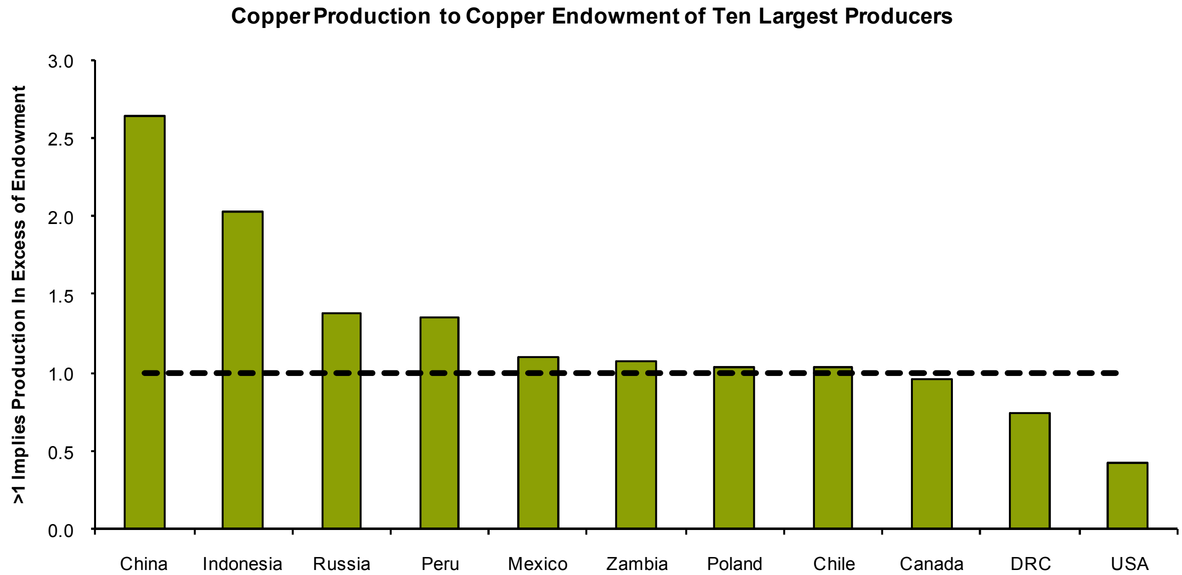
Exhibit 44

But again it is the departures from this relationship that are interesting, Chile is no longer an easy win and the largest source of mined copper growth over the last ten years (China) is producing at more than twice the level that its geology would suggest.



Source: USGS, Wood Mackenzie, Bernstein analysis & estimates

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The history of Chile's copper development holds some powerful lessons for how new copper development will prove harder than many anticipate.

Chile was able to increase the production of copper through two mechanisms: more rapid exploitation of deposits already known and the discovery of new deposits. The application of this first process to the world outside Chile yields only 1/3rd the required copper and the second process is not working.

There are two basic mechanisms by which a country can increase its output of any mined commodity:

- **Discovery**. In the first place, a country can discover more of the commodity in question and so increase its geological endowment and relative production at the same time. The classic example of this must be Escondida – the world's largest copper mine discovered in 1981 and commissioned in 1990. It increased both the reserve base and production of Chile.
- **Development**. As opposed to discovering more of a commodity, a country can choose to accelerate the development of the resources that it has. In this case, production increases beyond the geological endowment of the country. This is what has happened in China where production has moved well in advance of the underlying geology.

If we go back to the very beginnings of the Chilean copper industry, we can see both these effects in operation. In **Exhibit 45** and **Exhibit 46**, we see the enormous increase in exploitable material occasioned by the ability to attack the lower grades of material contained in copper porphyry deposits through the application of capital rather than labour. As with copper porphyries in general, the increase in ore tonnage more than offsets the decreases in grade and the contained metal increases sharply (**Exhibit 47**). But the increase in production out of Chile has been greater than the increase in contained metal, as is shown in **Exhibit 48**. Between 1935 and 2012, Chile's exploitable metal increased 630% while production increased 1970%. The increase in available metal clearly indicates the significant role that exploration and the discovery of new deposits have had on Chile's output. However, the greater increase in output tells us that output was also increased through the accelerated exploitation of existing reserves. This is seen most clearly in the reserve life of Chile, which was sufficient to support nearly one hundred years of output in 1935 and has fallen to just over thirty years today.

The fundamental reason for the acceleration in mined output above the rate of new discoveries, with the corresponding reduction in mine life, is that it makes economic sense. In any discounted cash flow model of mine value, the far out years are so highly discounted as to be of very little value today. From a value perspective, there is precious little point in having 100 years worth of mine supply above, say, 50 years. However, if those extra years can be brought forward so that they count towards today's production, then very significant value is unlocked. Investing capital to double the rate of exploitation (say through increasing milling capacity) while reducing the mine life enables shareholders to benefit today from tomorrow's production. This is clearly what has happened in Chile. However, this process cannot continue indefinitely. Once there is roughly 30 year life of mine left, all the years of production are relevant to the value proposition of the mine. It is no longer the case that some years are so far in the future as to be essentially worthless. Consequently, the expenditure of capital to attempt to bring those years forward destroys rather than creates value. Clearly, the amount of value creation or destruction depends on the intensity of capital that must be expended to accelerate production. **Exhibit 50** shows how this trade-off works. The lower the capital intensity, the easier it is to create value through accelerating production. The critical point is that when the reserve life of a country reaches between 25 and 35 years, there is no value to be gained from increasing the rate of exploitation of existing deposits. This is illustrated again in **Exhibit 51** and **Exhibit 52**, which show how the investment case for doubling capacity and halving life changes depending on original mine life. The critical point for Chile is that the country has passed this threshold – the rate of growth in its resource base has slowed, the rate of growth in production has increased and Chile's current life of reserves suggest that it will struggle to keep track with depletion, let alone grow through the easy expedient of the more efficient exploitation of existing reserves. It is this mechanism that stands

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behind the stagnation of Chilean mined output at ~5,500ktpa. This mechanism also provides the fundamental explanation why a country's output of a commodity should be given by its underlying geological endowment. Past this critical point in a country's development, all subsequent increases in mined growth must come from one of two sources.

- The exploitation of resources that did not originally pass the economic filter to be included in reserves (and consequently require much higher prices to render them economically viable sources of production).
- New discoveries that enable the resource base to increase proportionate to the increased in mined production.

Having understood the financial mechanism that generates the coupling between production and reserves through an analysis of the copper mining history of Chile, we are in a position to extend it globally. **Exhibit 53** shows the current reserve life of the ten largest copper producers (who collectively account for more than 80% of supply). As can be seen, there are some locations – notably China – where known reserves are woefully short of current production, and others – such as Peru – where there is significant upside. This enables us to calculate the increase in mined production that the politically unimpeded development of any country's geology should allow (and so predict the ultimate trajectories for peak production for those countries whose history we have shown in **Exhibit 24** to **Exhibit 33**). We look at this for every country with known copper deposits. The outcome of our analysis for the top ten most significant new supply locations is shown in **Exhibit 54**. This analysis indicates that current copper reserves have the ability to supply less than 1/3rd of the world's incremental copper demand by 2030.

The conclusions of this are clear – either more production will have to come from material currently defined as resources rather than reserves, which will necessitate a price higher than today's one; or new supply will have to come from fresh discoveries. However, if we look at the recent history of new copper porphyry discoveries, two things become clear. Firstly, the rate of discovery of massive new ore bodies has declined sharply. Secondly, the lead time to development of the deposits that are actually capable of making a difference to the supply-demand dynamic has increased dramatically. It took ten years to bring Escondida on line. It will have taken seventeen to develop Oyu Tolgoi (and probably more like twenty to twenty five years for it to realise its full potential). Finally, Pebble is at twenty five years and counting. Consequently, new discoveries are incapable of meeting the world's copper demand and that leaves one alternative – namely, higher prices and the ability to supply the world from deposits that do not meet investment thresholds at today's prices.

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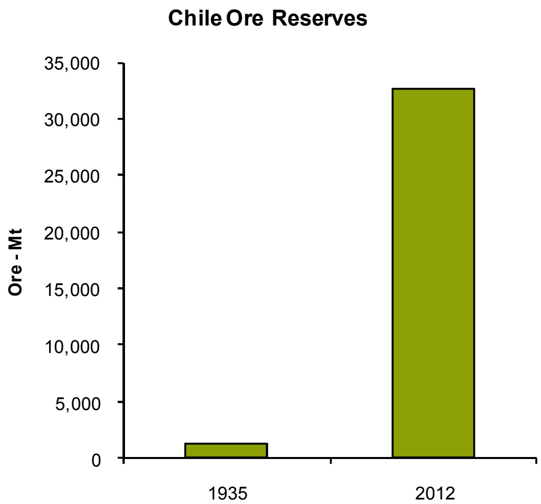
Exhibit 45

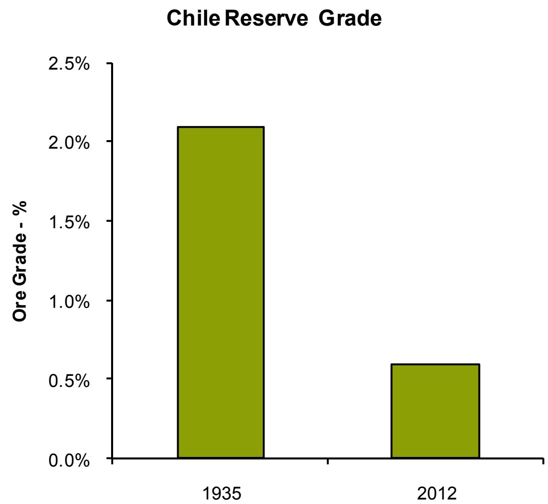
The history of Chilean copper development is one of massive increases in resources...



Source: Wood Mackenzie, ABMS, Bernstein analysis & estimates

Exhibit 46

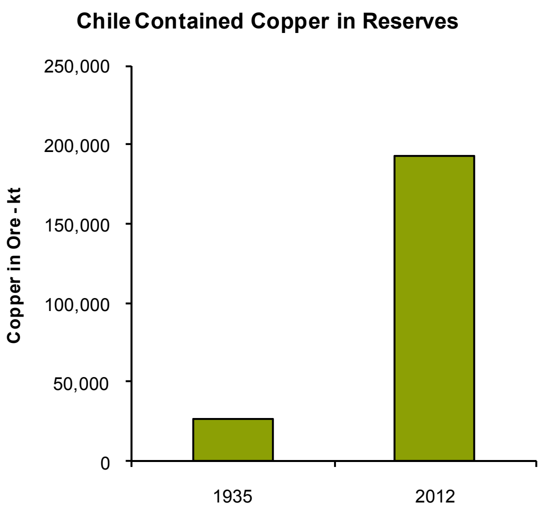
...occasioned by the ability to exploit ever lower grade material.



Source: Wood Mackenzie, ABMS, Bernstein analysis & estimates

Exhibit 47

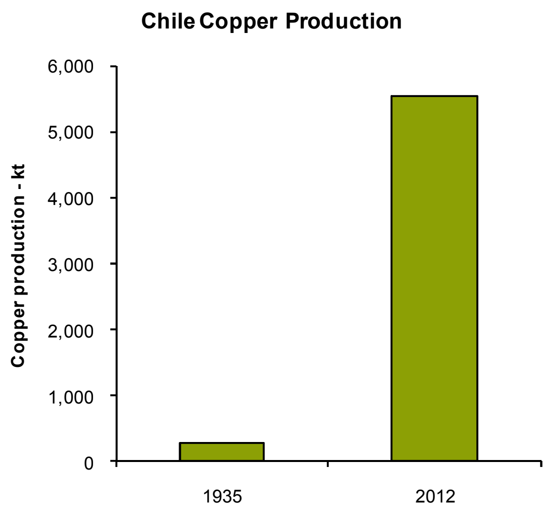
However, the net result is a massive increase in available metal...



Source: Wood Mackenzie, ABMS, Bernstein analysis & estimates

Exhibit 48

...and an even greater rise in metal output. So there has to be more to Chile than increasing discovery rates.



Source: Wood Mackenzie, ABMS, Bernstein analysis & estimates

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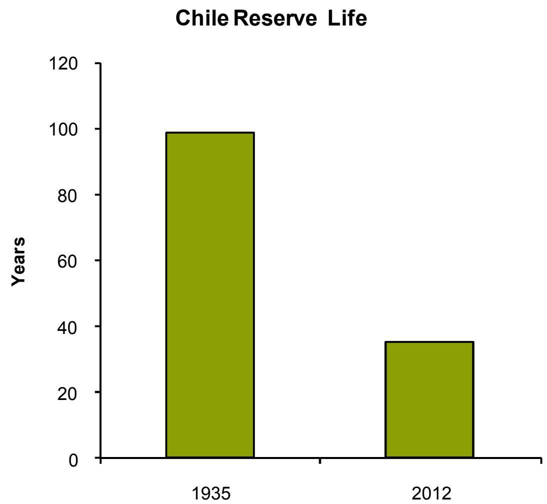
Exhibit 49

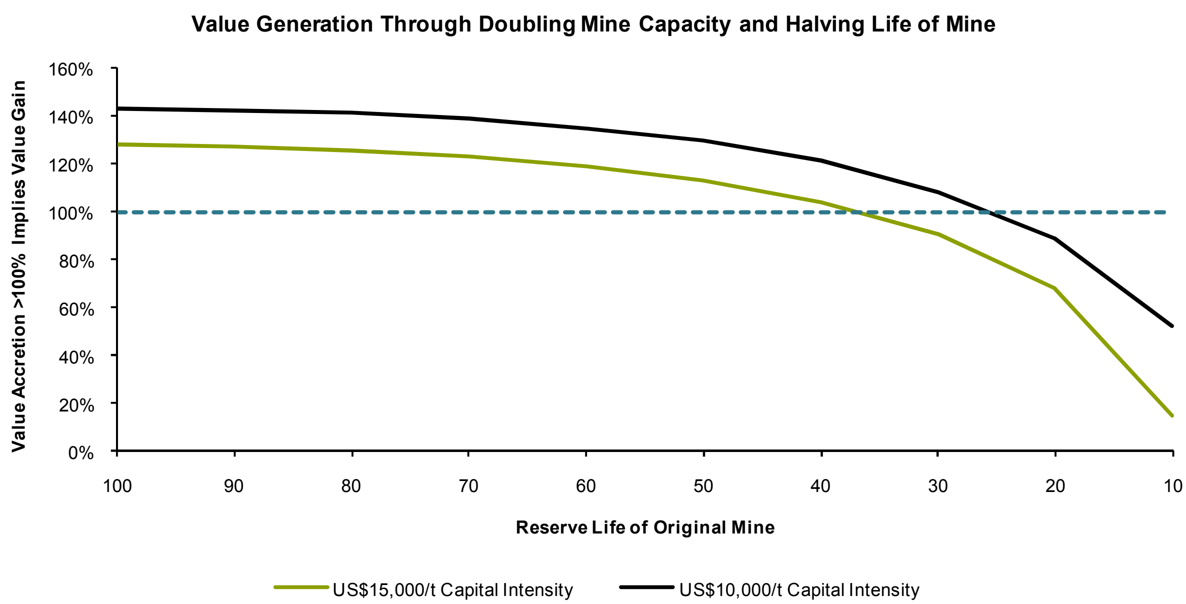
And there is – it is the increased efficiency in exploiting existing material as seen in mine life reductions.



Source: Wood Mackenzie, ABMS, Bernstein analysis & estimates

Exhibit 50

But there is a highly non linear relationship in the value proposition represented by mine life reductions. They represent efficiency gains only down to about 30 years LOM. Afterwards, they become value destructive.



Source: Bernstein analysis & estimates

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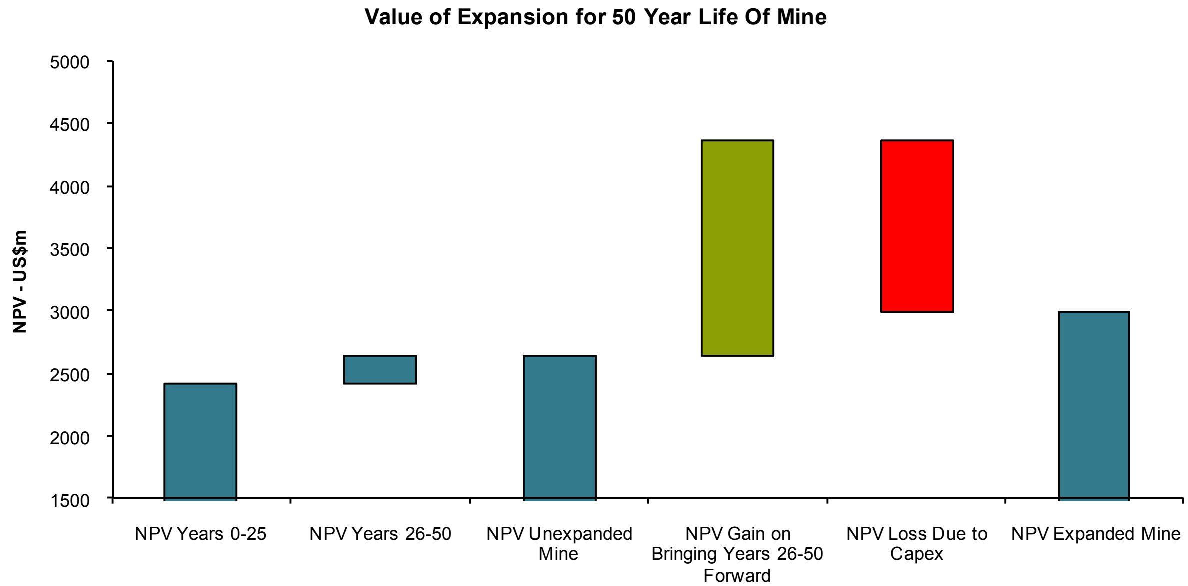
Exhibit 51

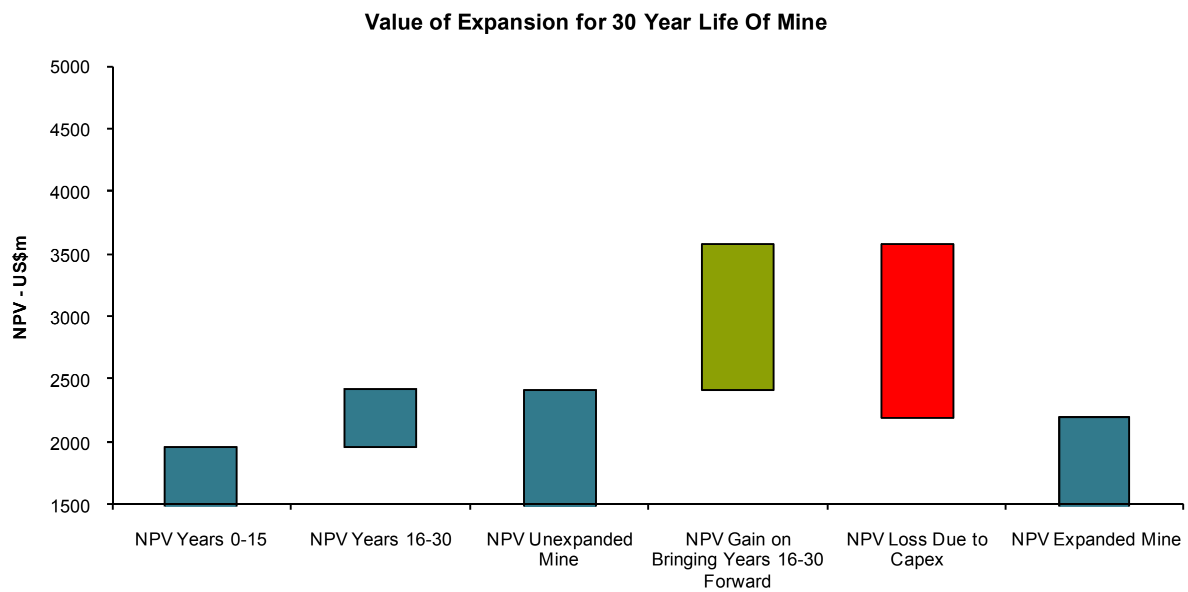
Halving a mine life from 50 years to 25 years (from the same geology) is a highly profitable exercise.



Source: Bernstein analysis & estimates

Exhibit 52

Halving a mine life from 30 years to 15 years (from the same geology) is a value destructive exercise.



Source: Bernstein analysis & estimates

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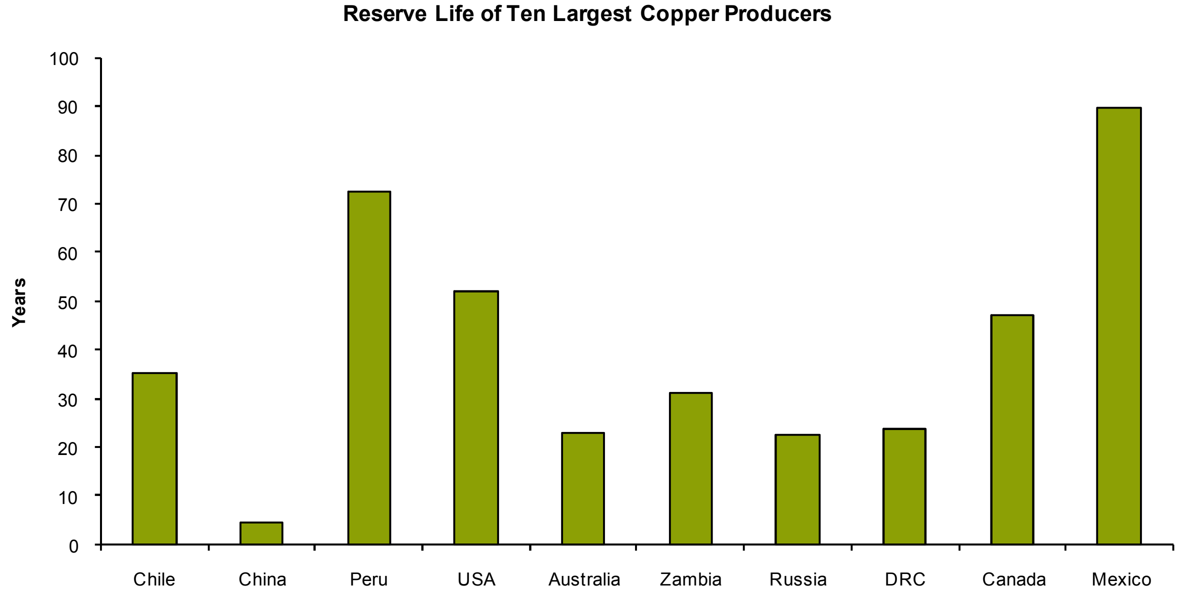
Exhibit 53

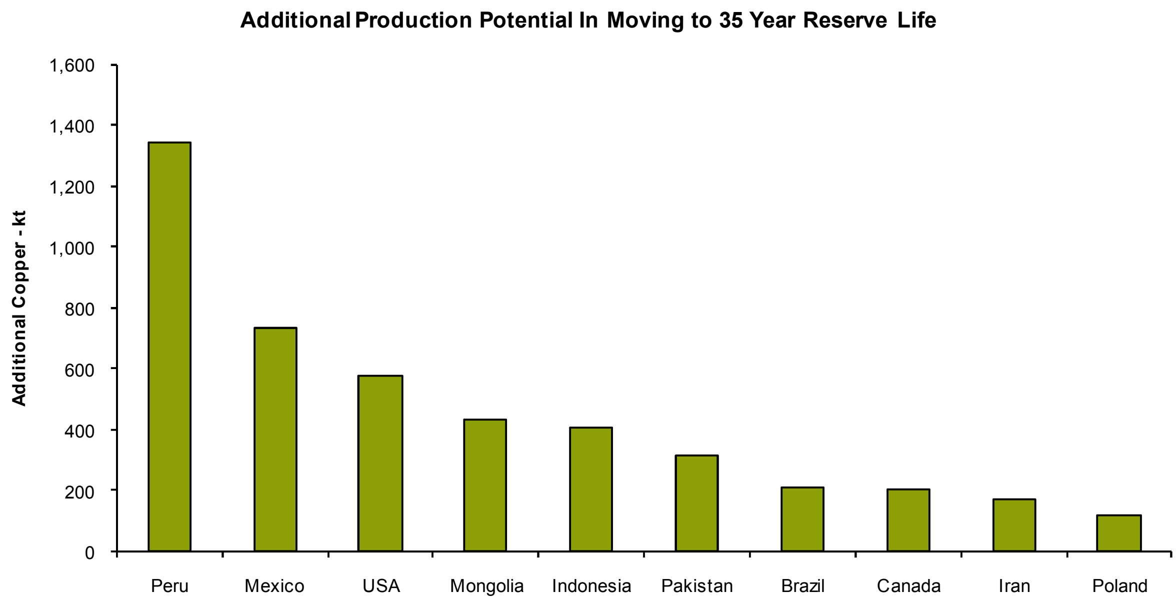
This goes some way to explaining why Chilean metal output stalled after hitting 5.5Mtpa and a 35 year average LOM. It also highlights why Chinese production looks challenged and where the "low(ish)" hanging fruit lies.



Source: Wood Mackenzie, ABMS, Bernstein analysis & estimates

Exhibit 54

Mine life expansions from existing reserves have the potential to deliver less than 1/3rd of the required copper demand by 2030. Projects exploiting new resources will be required and this requires new finds of copper...



Source: Bernstein analysis & estimates

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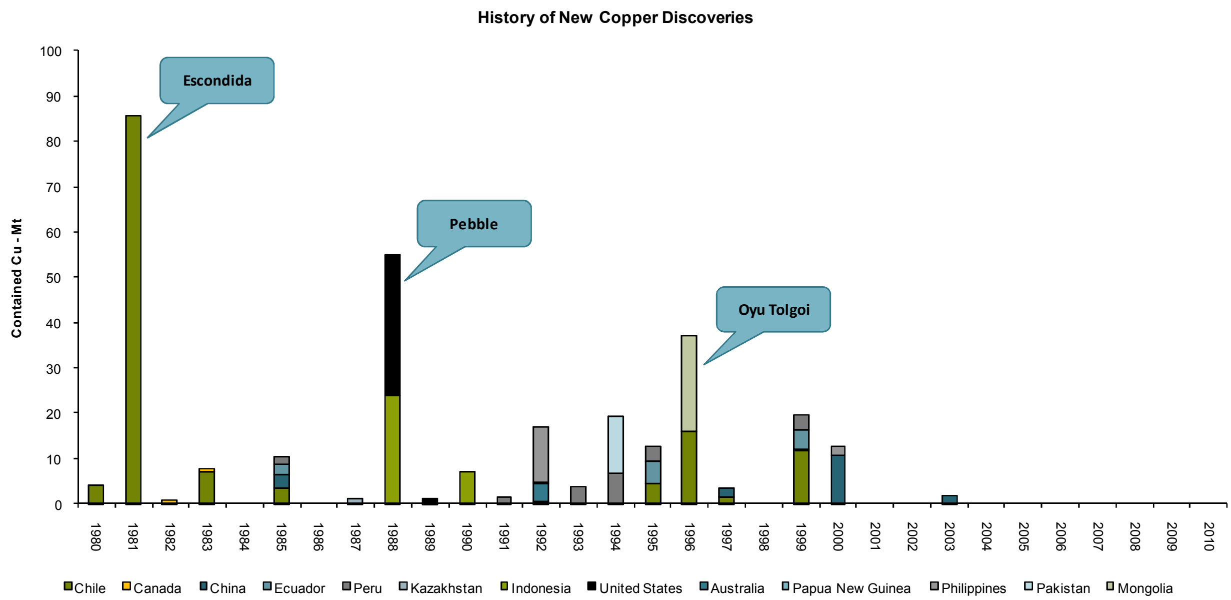
Exhibit 55

...but this activity is looking ever less likely to yield results. Even if massive new finds are encountered, the history of Pebble and Oyu Tolgoi tells us that it will take between 20 and 30 years for these finds to deliver commercially meaningful metal (compared to 10 years for Escondida).



Source: USGS Bernstein analysis & estimates

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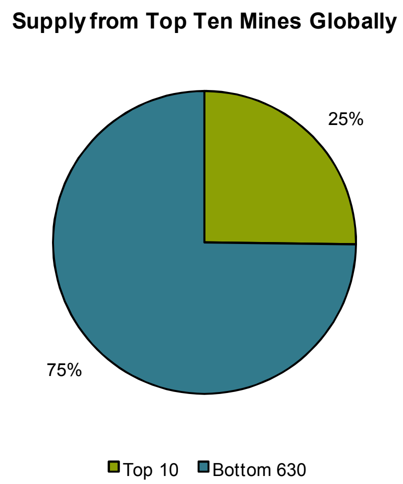
Just 10 mines account for 25% of global supply.

Of the 10 most important copper mines in the world, 8 are in Chile, 1 is in Peru and 1 in Indonesia. The development of these mines has been instrumental in securing cheap copper over the last few decades.

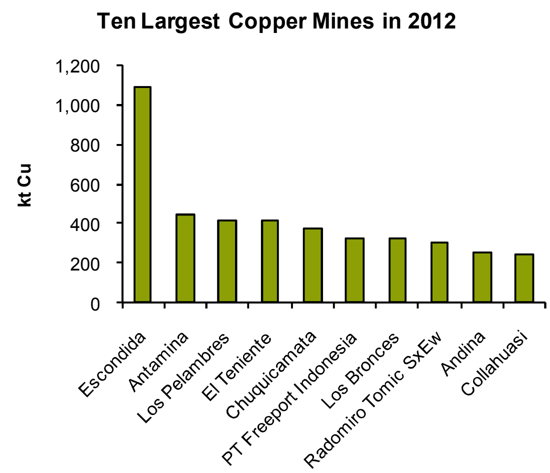
The call so far has looked at the development of the world's copper supply on a country by country basis. However, there is significant granularity within any country's mine supply with a finite number of assets contributing to overall output. Moreover, there is a very significant difference between the average copper asset and the handful of truly "Tier 1" operations that have stood behind the increases in mined production over the last few decades. The top ten mines (or top 1.5% mines out of ~640 known copper operations) account for 25% of mined supply (**Exhibit 56**). These mines are hugely influential in determining the future copper price – not because they set the supply of the marginal tonne themselves, but because of the influence they have in the determination of the requirement for marginal units of supply. Consequently, a familiarity with these operations (**Exhibit 57**) is essential for any view on the future of the copper price. In the following appendix we present an overview of the ten largest copper mines globally.

Exhibit 56
1.5% of mines account for 25% of copper.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 57
Understanding the development of these ten mines is critical to understanding the forward looking copper balance.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Escondida

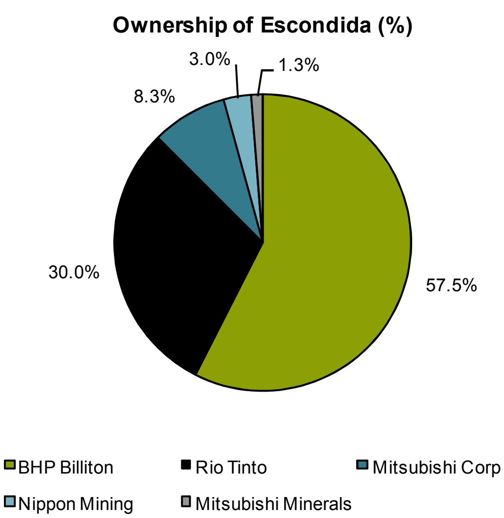
Exhibit 58
Escondida overview

General Information	Details/Facts
Country	Chile
Location	170km SE of Antofagasta
State/Province	Antofagasta
Locale	Atacama Desert In N. Chile
Start Up	1990 (Q4)
Commodity	Copper/Gold/Silver
Development Stage	Production
Mine type	Open Pit
Latitude/Longtitude	24°16'0" S, 69°4'0" W

Geology	Details/Facts
Zone Name	Escondida
Ore Genesis	Supergene (Secondary) Enrichment Hydrothermal processes
Orebody type	Porphyry Deposit
Ore Mineral	Chalcocite, Covellite, Chalcopyrite, Pyrite, Bornite
Class of Ore	Oxide, Sulfide
Ore Controls	Faulting
Width	2.5 km
Length	4.5 km
Thickness	600 m
Host Rock	Andesite (Paleocene)
Country Rock	Sedimentary (Mesozoic), Volcanics (Paleozoic)
Strike	N/A

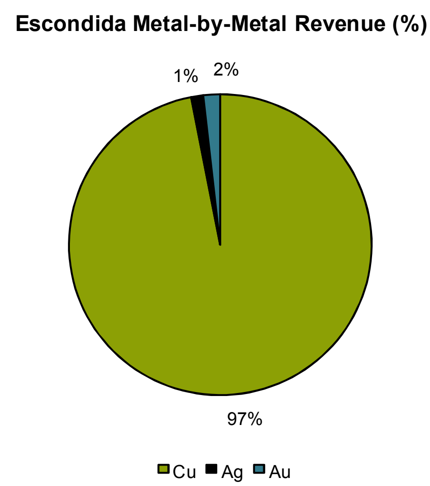
Source: MEG, Bernstein analysis & estimates

Exhibit 59
Escondida ownership



Source: MEG, Bernstein analysis & estimates

Exhibit 60
Escondida metal exposure



Source: MEG, Bernstein analysis & estimates

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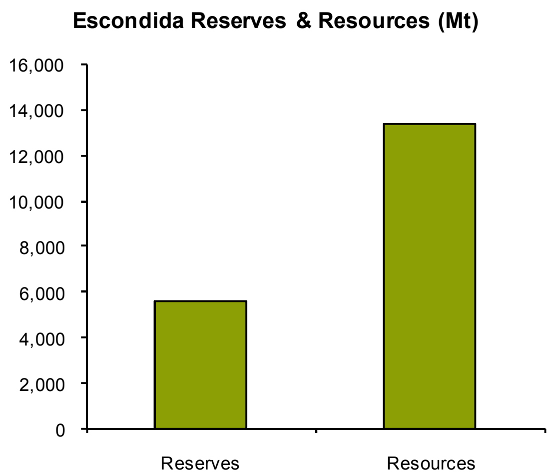
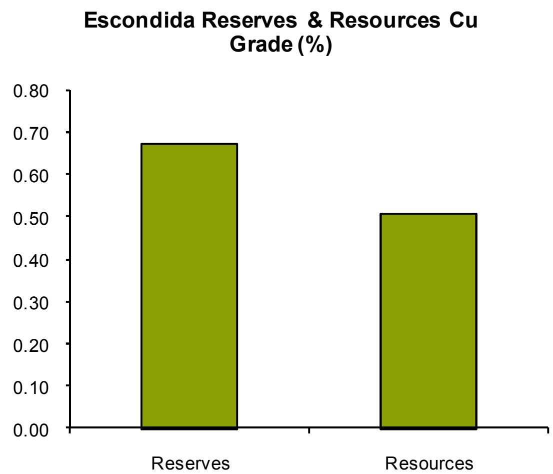
Exhibit 61
Escondida geological endowment.



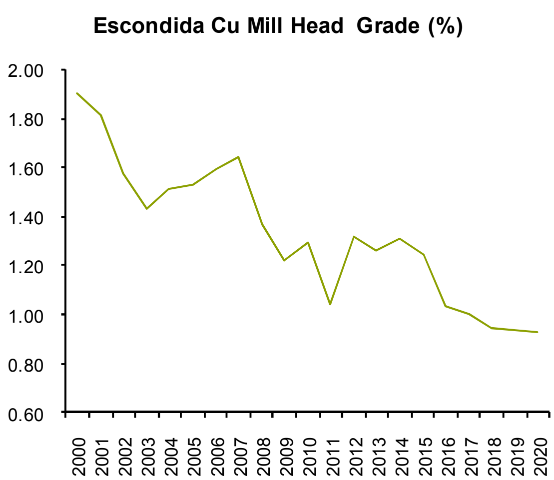
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 62
Escondida ore grade.



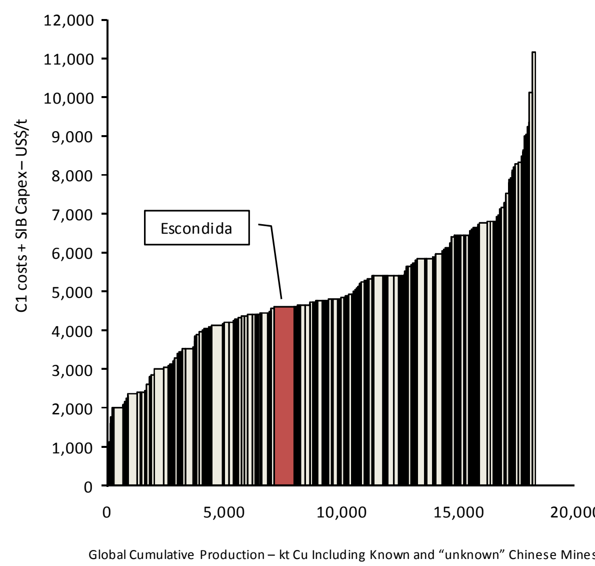
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 63
Escondida head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 64
Escondida cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Antamina

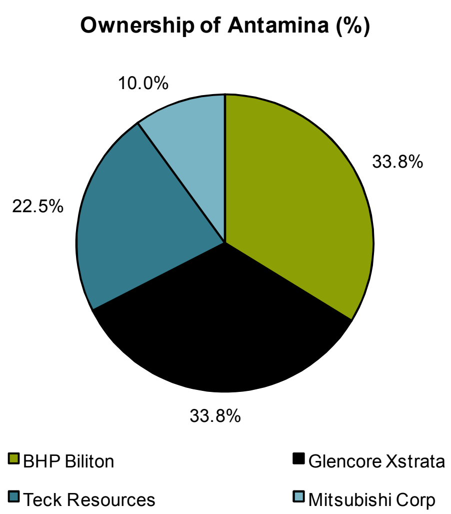
Exhibit 65
Antamina overview.

General Information	Details/Facts
Country	Peru
Location	280 km N of Lima; 135 km NE of Huarmey
State/Province	Ancash (District/Town is San Marcos)
Locale	Andes Mountains
Start Up	2001 (Q4)
Commodity	Copper/Zinc/Molybdenum/Lead/Silver/Bismuth
Development Stage	Production
Mine type	Open Pit
Latitude/Longtitude	9°32'21" S, 77°3'0" W

Geology	Details/Facts
Zone Name	Antamina
Ore Genesis	N/A
Orebody type	N/A
Ore Mineral	Chalcopyrite, Sphalerite, Bornite, Pyrite, Magnetite
Class of Ore	N/A
Ore Controls	N/A
Width	1 km
Length	2.5 km
Thickness	N/A
Host Rock	Skarn (Tacite)
Country Rock	N/A
Strike	SW-NE

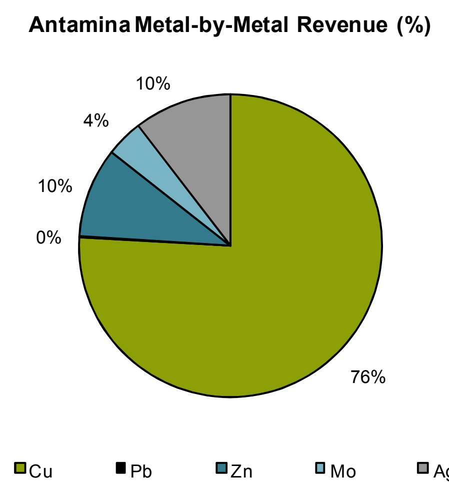
Source: MEG, Bernstein analysis & estimates

Exhibit 66
Antamina ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 67
Antamina metal exposure.



Source: MEG, Bernstein analysis & estimates

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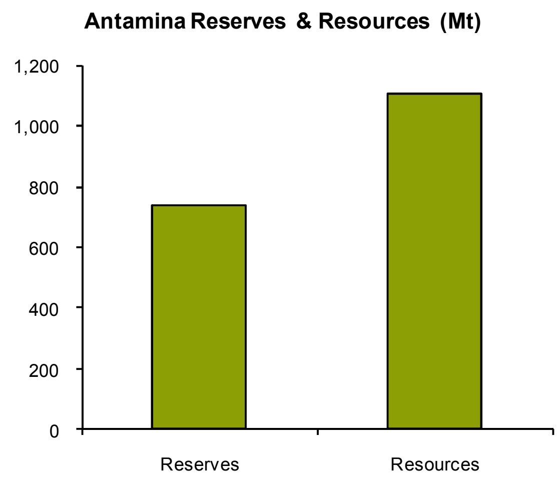
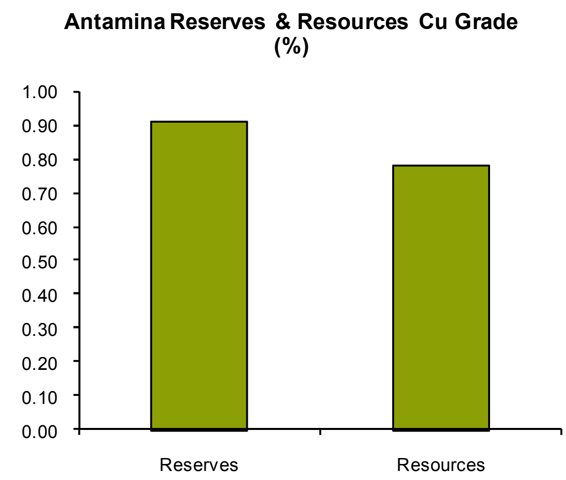
Exhibit 68
Antamina geological endowment.



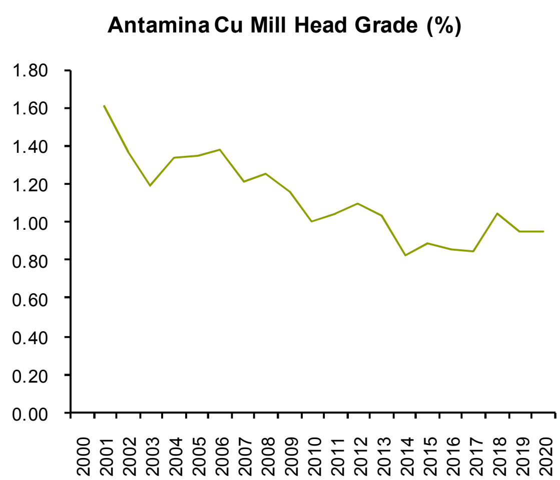
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 69
Antamina ore grade.



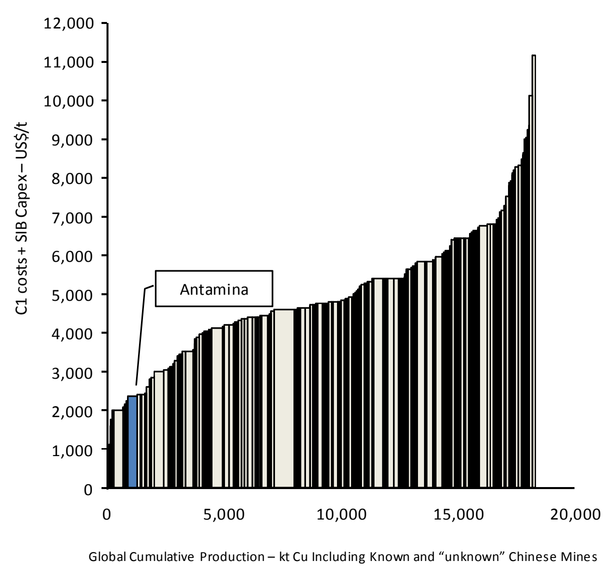
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 70
Antamina head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 71
Antamina cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Los Pelambres

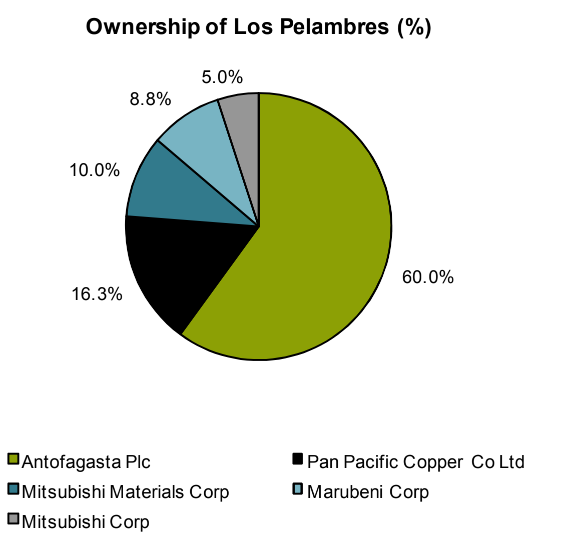
Exhibit 72
Los Pelambres overview.

General Information	Details/Facts
Country	Chile
Location	46 km E of Salamanca; 200 km N of Santiago
State/Province	Coquimbo
Locale	Andes Mountains
Start Up	1999 (Q4)
Commodity	Copper/Molybdenum/Gold/Silver
Development Stage	Production
Mine type	Open Pit
Latitude/Longtitude	31°43'4" S, 70°29'22" W

Geology	Details/Facts
Zone Name	Los Pelambres
Ore Genesis	N/A
Orebody type	Porphyry Deposit
Ore Mineral	Chalcocite, Chalcopyrite, Bornite
Class of Ore	N/A
Ore Controls	N/A
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	Andesite, Diorite
Country Rock	N/A
Strike	N/A

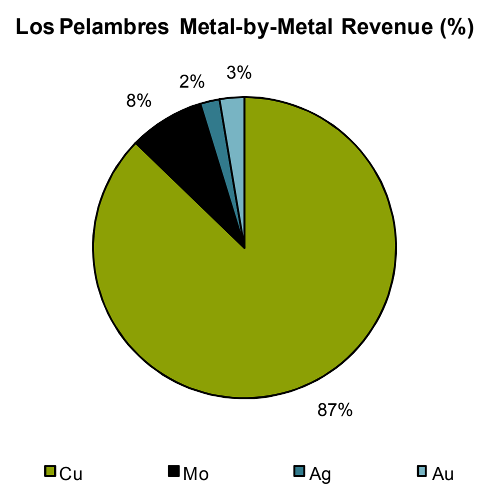
Source: MEG, Bernstein analysis & estimates

Exhibit 73
Los Pelambres ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 74
Los Pelambres metal exposure.



Source: MEG, Bernstein analysis & estimates

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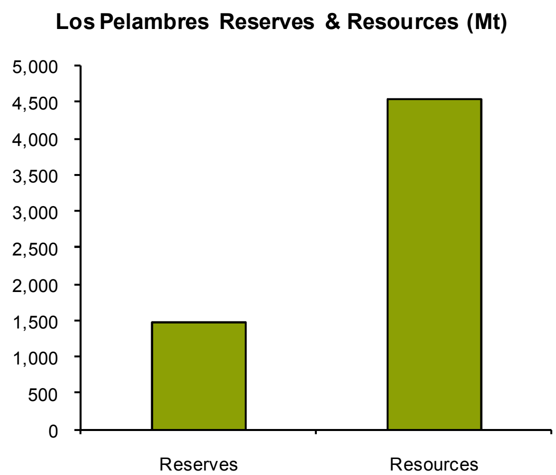
Exhibit 75

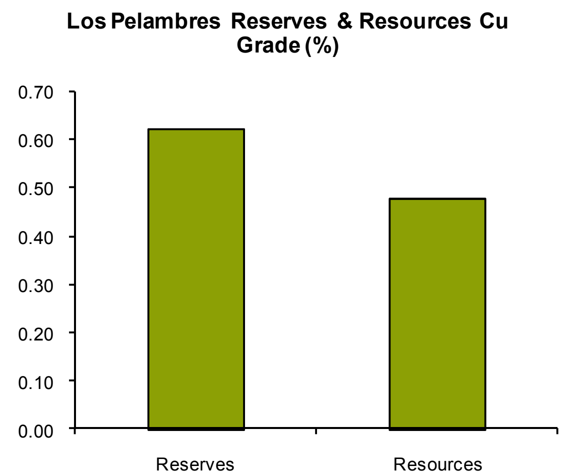
Los Pelambres geological endowment.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 76

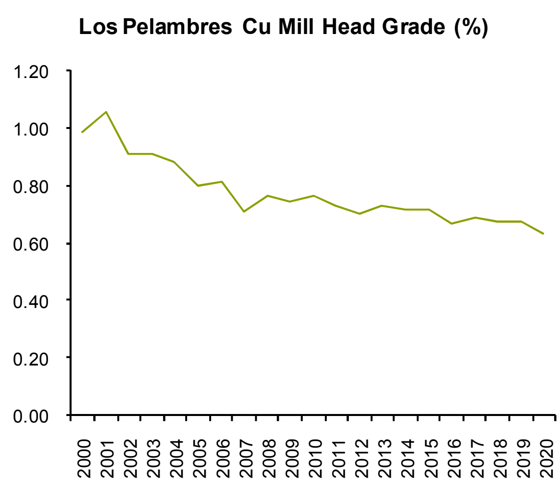
Lost Pelambres ore grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 77

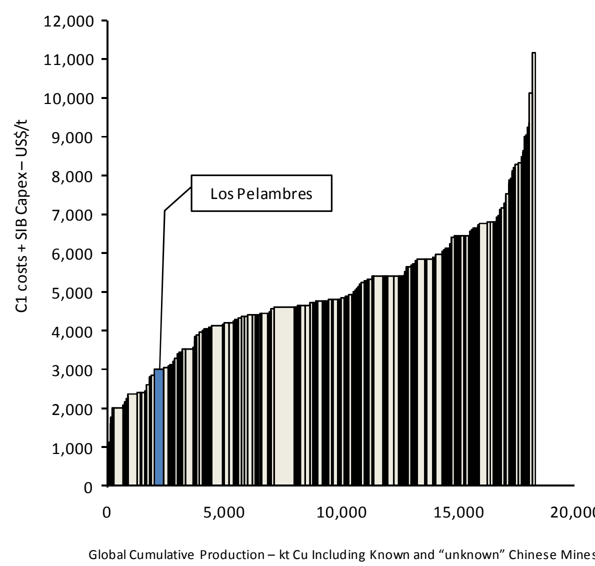
Los Pelambres head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 78

Los Pelambres cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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El Teniente

Exhibit 79

El Teniente overview.

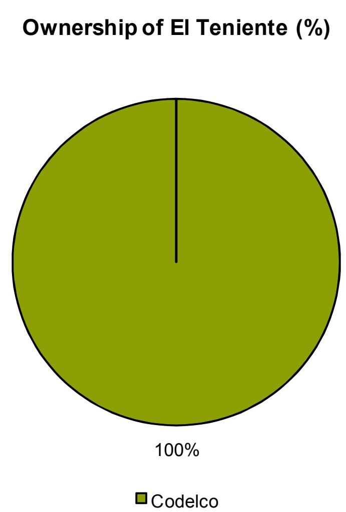
General Information	Details/Facts
Country	Chile
Location	44 km NE of Rancagua, 80 Km SE of Santiago
State/Province	Region Iv (District/Town O'Higgins (Region VI)/Rancagua
Locale	N/A
Start Up	1904
Commodity	Copper/Molybdeum/Gold/Silver
Development Stage	Production
Mine type	Underground
Latitude/Longtitude	34°4'59" S, 70°22'0" W

Geology	Details/Facts
Zone Name	N/A
Ore Genesis	N/A
Orebody type	Porphyry Deposit
Ore Mineral	N/A
Class of Ore	N/A
Ore Controls	Brecciation
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	Intrusive (plutonic)
Country Rock	N/A
Strike	N/A

Source: MEG, Bernstein analysis & estimates

Exhibit 80

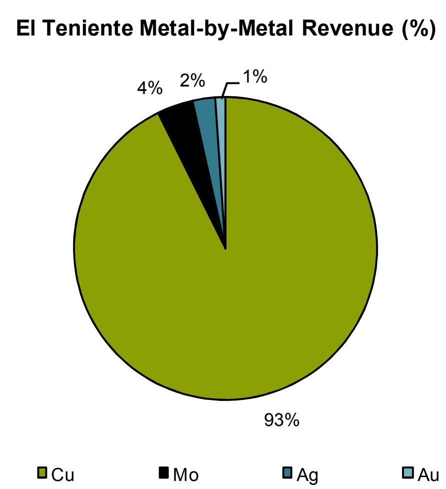
El Teniente ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 81

El Teniente metal exposure.



Source: MEG, Bernstein analysis & estimates

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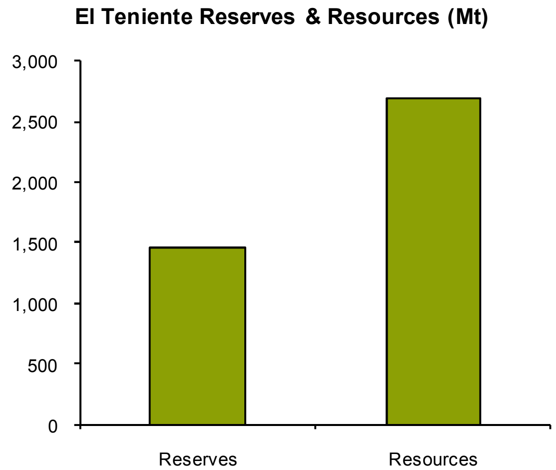
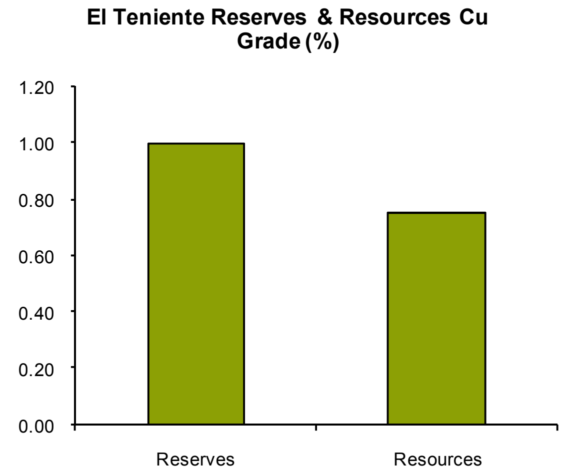
Exhibit 82
El Teniente geological endowment.



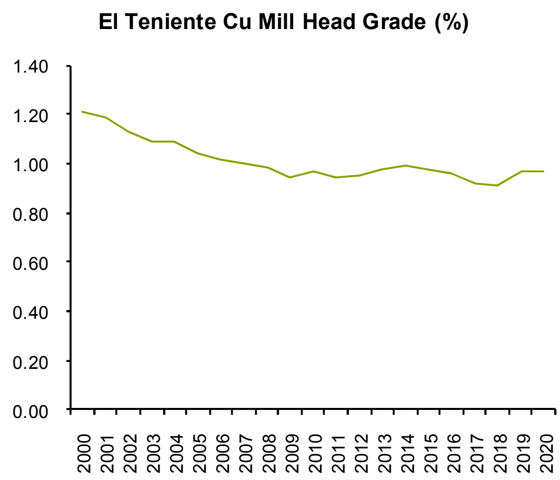
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 83
El Teniente ore grade.



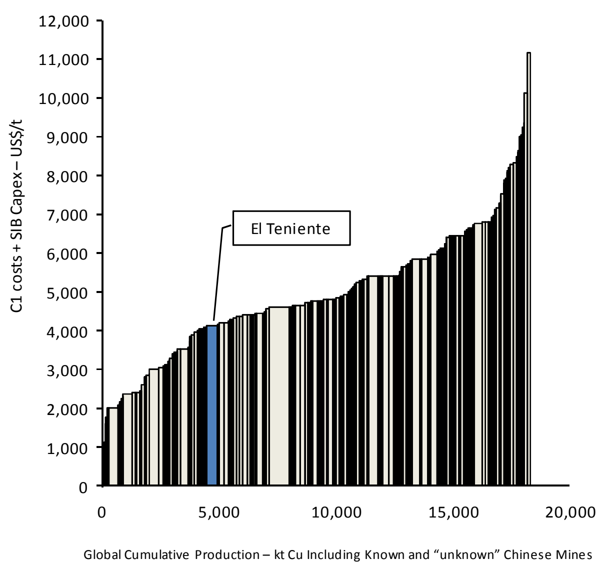
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 84
El Teniente head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 85
El Teniente cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Chuquicamata

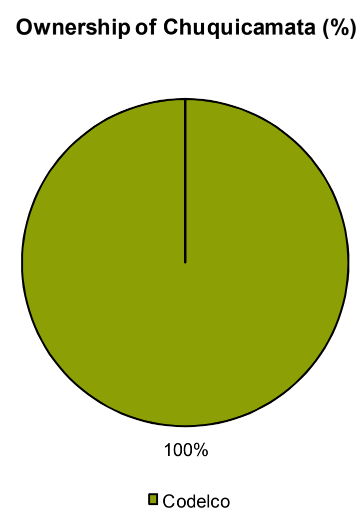
Exhibit 86
Chuquicamata overview.

General Information	Details/Facts
Country	Chile
Location	16 km N of Calama; 1,592 km N of Santiago
State/Province	Antofagasta
Locale	Atacama Desert; northern Chile
Start Up	1910
Commodity	Copper/Molybdenum/Gold/Silver/Rhenium
Development Stage	Production
Mine type	Open Pit/Tailings/Underground
Latitude/Longtitude	22°17'30" S, 68°54'30" W

Geology	Details/Facts
Zone Name	N/A
Ore Genesis	N/A
Orebody type	N/A
Ore Mineral	N/A
Class of Ore	N/A
Ore Controls	N/A
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	N/A
Country Rock	N/A
Strike	N/A

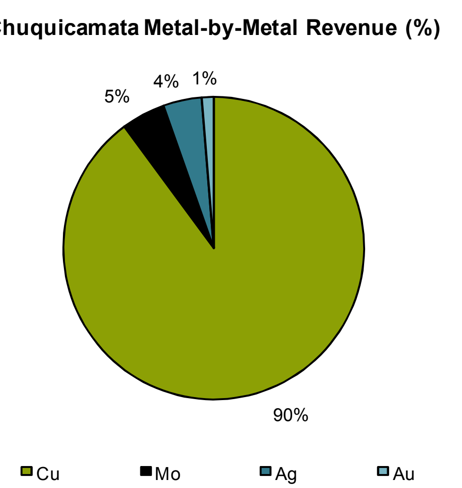
Source: MEG, Bernstein analysis & estimates

Exhibit 87
Chuquicamata ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 88
Chuquicamata metal exposure.



Source: MEG, Bernstein analysis & estimates

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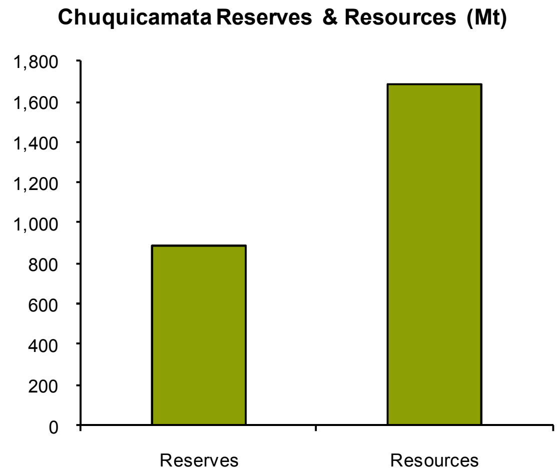
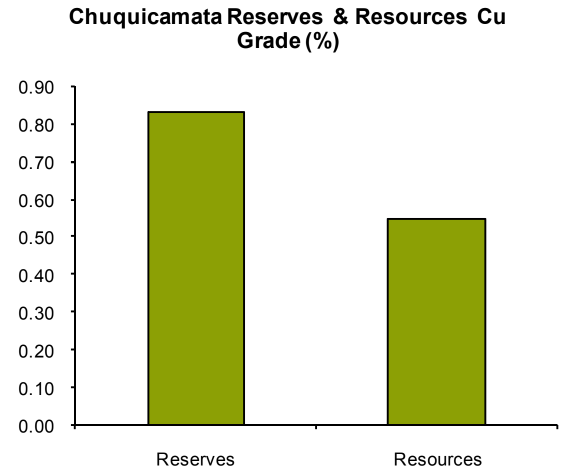
Exhibit 89
Chuquicamata geological endowment.



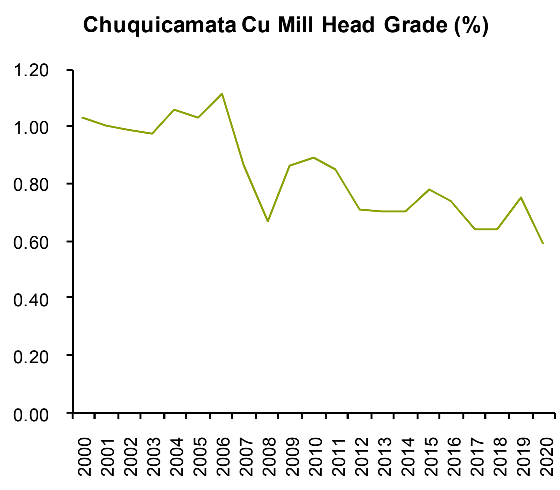
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 90
Chuquicamata ore grade.



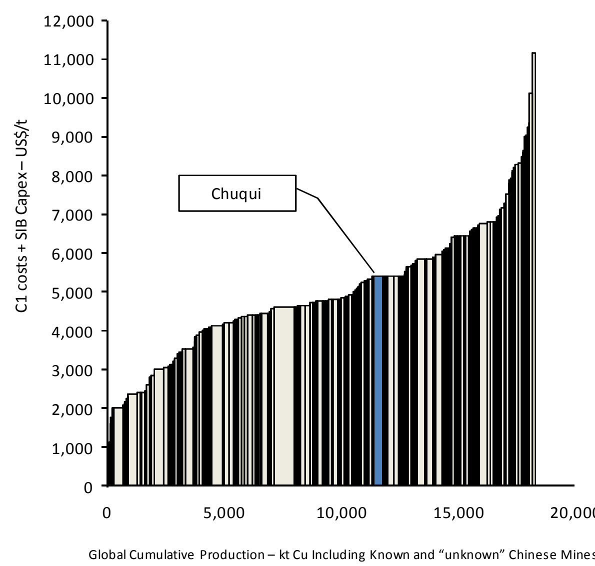
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 91
Chuquicamata head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 92
Chuquicamata cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Grasberg

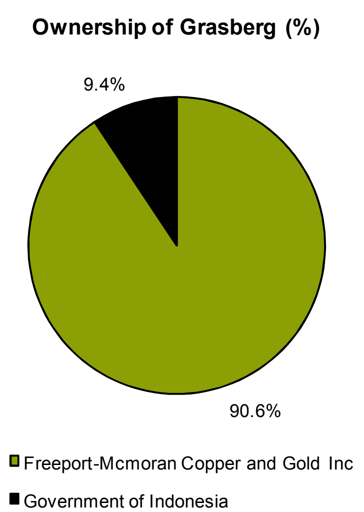
Exhibit 93
Grasberg overview.

General Information	Details/Facts
Country	Indonesia
Location	N/A
State/Province	Papua (Town/District Timika/Jaya Wijaya Mountains)
Locale	N/A
Start Up	1972
Commodity	Copper/Gold/Silver
Development Stage	Production
Mine type	Open Pit and Underground
Latitude/Longtitude	4°7'59" S, 137°40'0" E

Geology	Details/Facts
Zone Name	Grasberg
Ore Genesis	N/A
Orebody type	Porphyry Deposit, Skarn
Ore Mineral	N/A
Class of Ore	N/A
Ore Controls	N/A
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	Limestone, Monzonite, Granodiorite
Country Rock	N/A
Strike	N/A

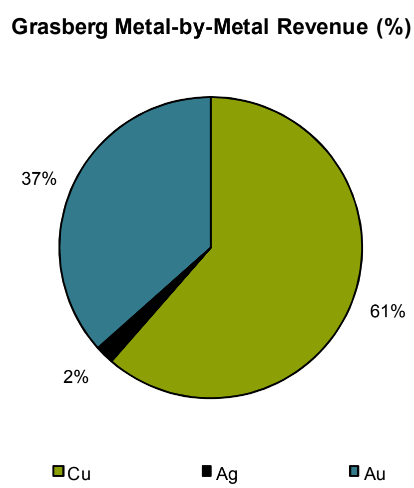
Source: MEG, Bernstein analysis & estimates

Exhibit 94
Grasberg ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 95
Grasberg metal exposure.



Source: MEG, Bernstein analysis & estimates

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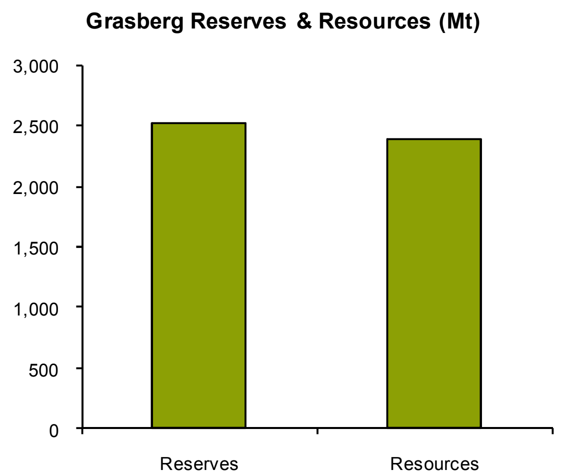
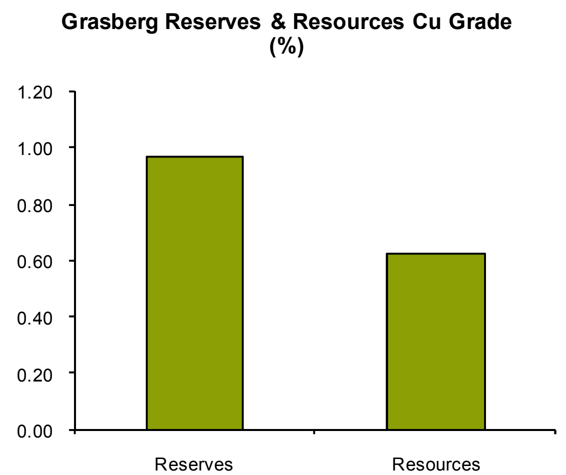
Exhibit 96
Grasberg geological endowment.



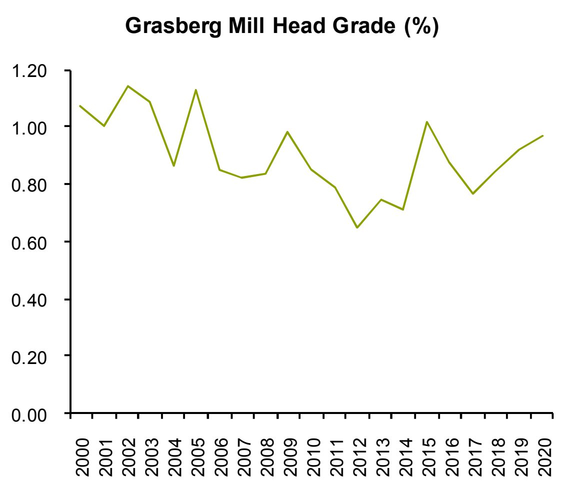
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 97
Grasberg ore grade.



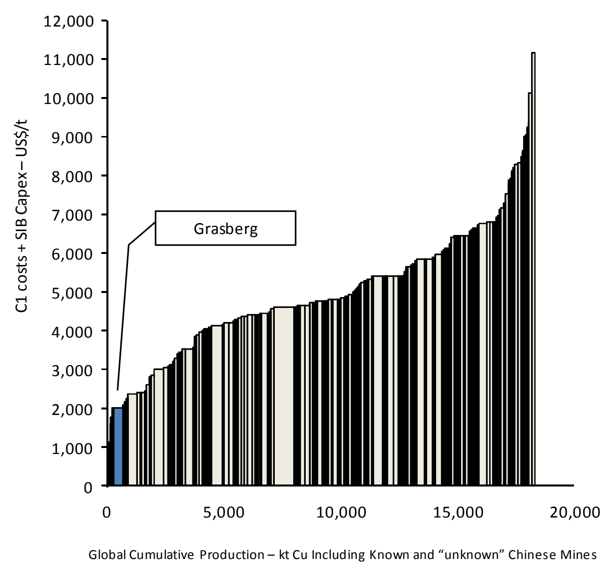
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 98
Grasberg head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 99
Grasberg cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Los Bronces

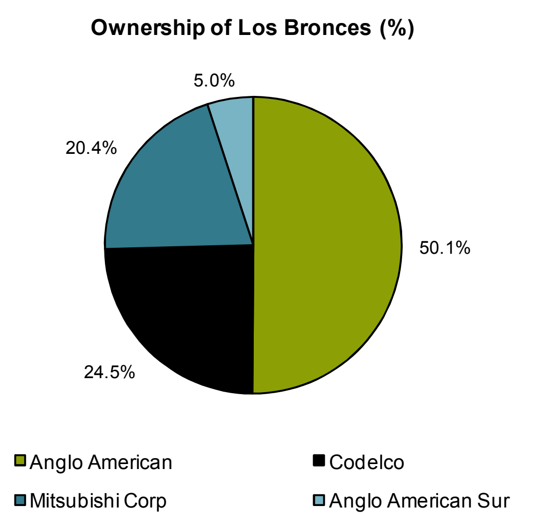
Exhibit 100
Los Bronces overview.

General Information	Details/Facts
Country	Chile
Location	45 km NE of Santiago
State/Province	Valparaiso (Town Santiago)
Locale	N/A
Start Up	1925
Commodity	Copper/Molybdenum
Development Stage	Production
Mine type	Open Pit
Latitude/Longtitude	33°8'56" S, 70°16'54" W

Geology	Details/Facts
Zone Name	Los Bronces
Ore Genesis	Hydrothermal processes
Orebody type	Breccia Fill, Stockwork
Ore Mineral	Chalcopyrite, Specularite, Molybdenite
Class of Ore	N/A
Ore Controls	N/A
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	Intrusive (plutonic), Volcanics
Country Rock	N/A
Strike	N/A

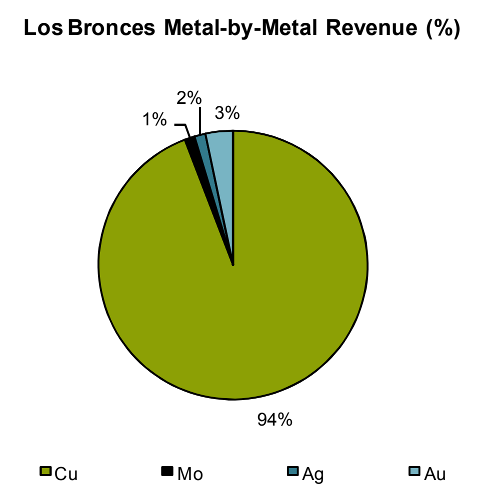
Source: MEG, Bernstein analysis & estimates

Exhibit 101
Los Bronces ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 102
Los Bronces metal exposure.



Source: MEG, Bernstein analysis & estimates

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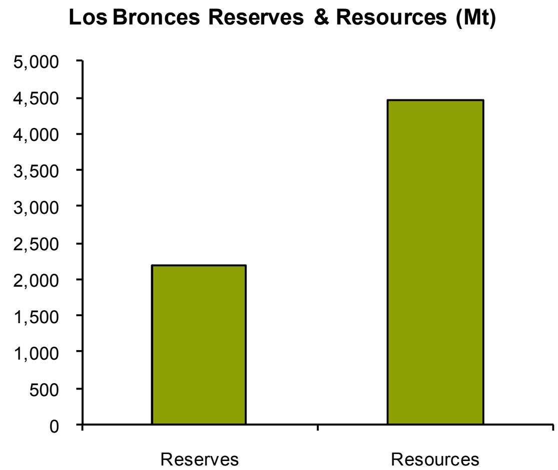
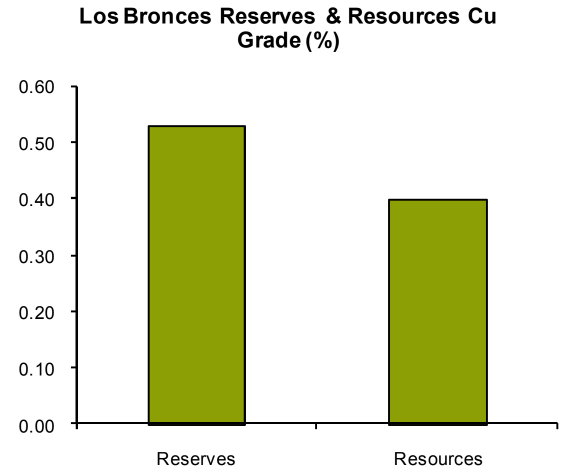
Exhibit 103
Los Bronces geological endowment.



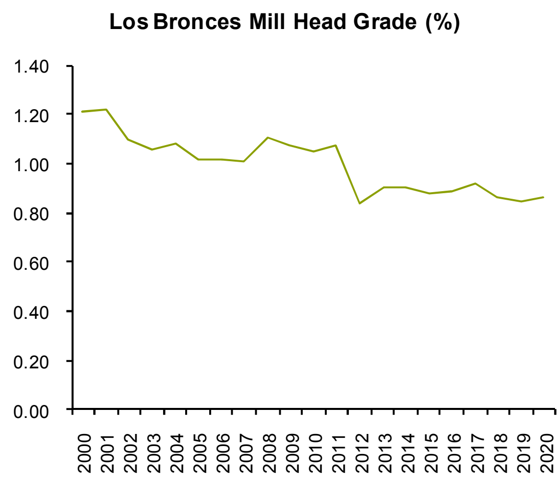
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 104
Los Bronces ore grade.



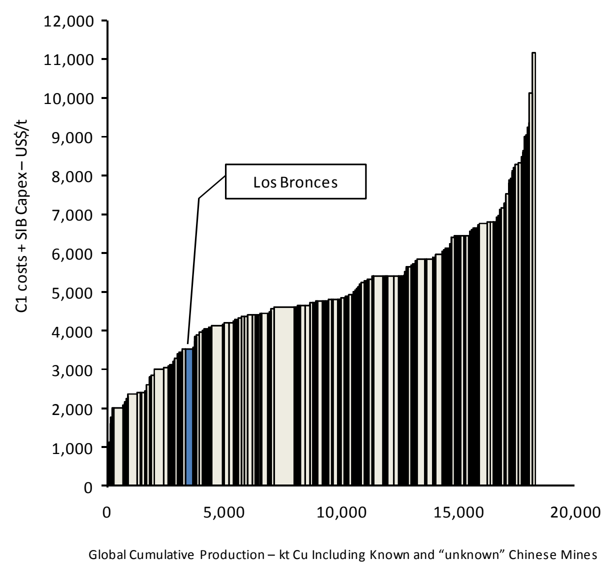
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 105
Los Bronces head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 106
Los Bronces cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Radomiro Tomic SxEw

Exhibit 107
Radomiro Tomic overview.

General Information	Details/Facts
Country	Chile
Location	35 km N of Calama; 6 km N of the Chuquicamata mine
State/Province	Atacama
Locale	Atacama Desert; northern Chile
Start Up	1998 (Q1)
Commodity	Copper/Molybdenum
Development Stage	Production
Mine type	Open Pit
Latitude/Longtitude	22°13'59" S, 68°55'0" W

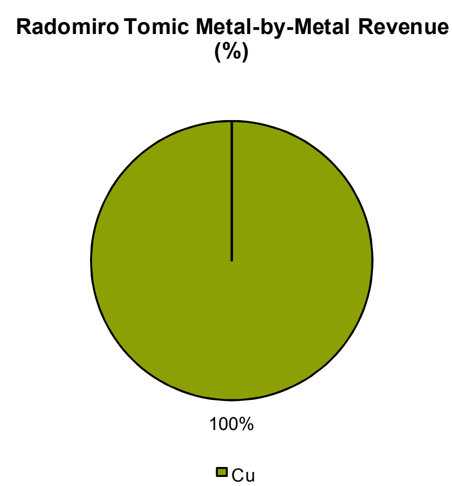
Geology	Details/Facts
Zone Name	Radomiro Tomic
Ore Genesis	N/A
Orebody type	N/A
Ore Mineral	Atacamite
Class of Ore	Oxide, Sulfide
Ore Controls	N/A
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	N/A
Country Rock	N/A
Strike	N/A

Source: MEG, Bernstein analysis & estimates

Exhibit 108
Radomiro Tomic ownership.

Source: MEG, Bernstein analysis & estimates

Exhibit 109
Radomiro Tomic metal exposure.



Source: MEG, Bernstein analysis & estimates

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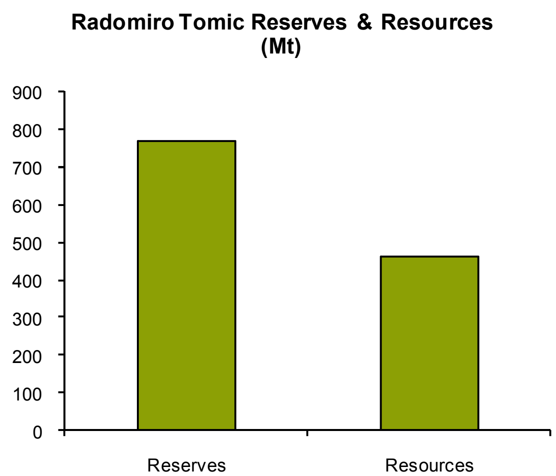
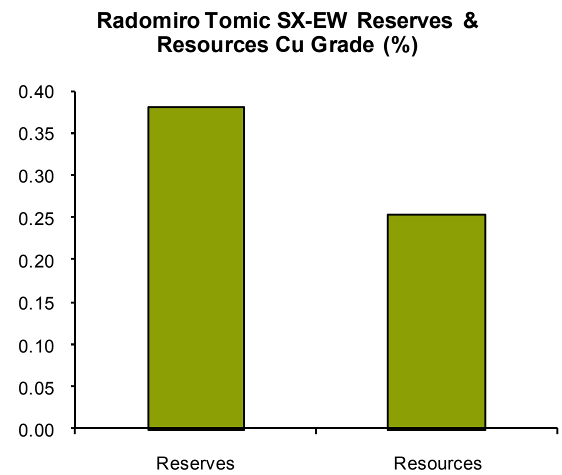
Exhibit 110
Radomiro Tomic geological endowment.



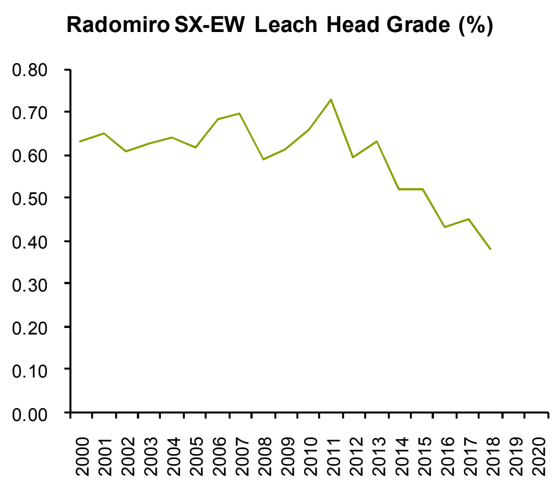
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 111
Radomiro Tomic ore grade.



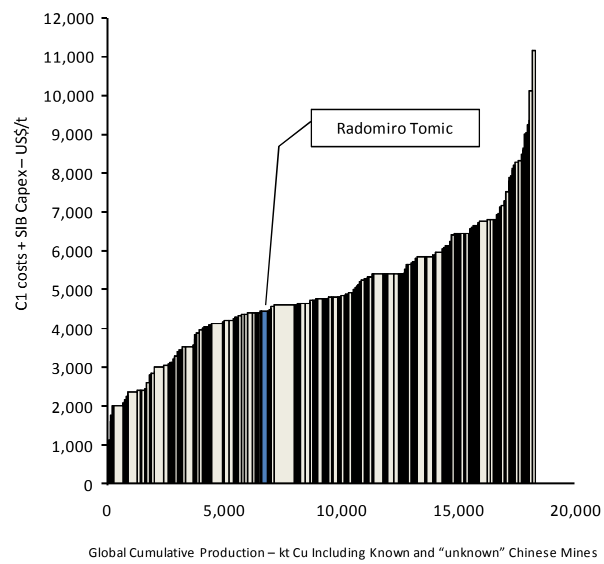
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 112
Radomiro Tomic leach grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 113
Radomiro Tomic cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

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Andina

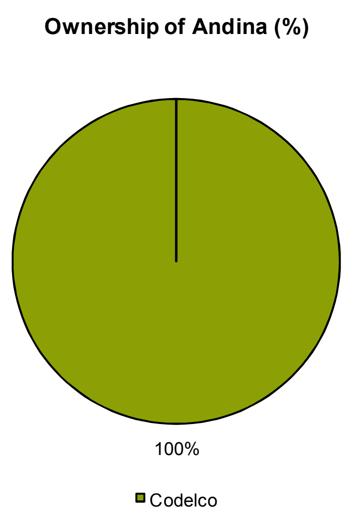
Exhibit 114
Andina overview.

General Information	Details/Facts
Country	Chile
Location	40 km NE of Santiago
State/Province	Valparaiso (Town Santiago)
Locale	Mt Aconcagua; Fifth Region
Start Up	1970
Commodity	Copper/Molybdenum/Gold/Silver
Development Stage	Production
Mine type	Underground and Open Pit
Latitude/Longtitude	33°9'5" S, 70°15'21" W

Geology	Details/Facts
Zone Name	Andina Division
Ore Genesis	N/A
Orebody type	Porphyry Deposit
Ore Mineral	Chalcopyrite, Molybdenite
Class of Ore	N/A
Ore Controls	Brecciation
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	Intrusive (plutonic), Volcanics
Country Rock	N/A
Strike	N/A

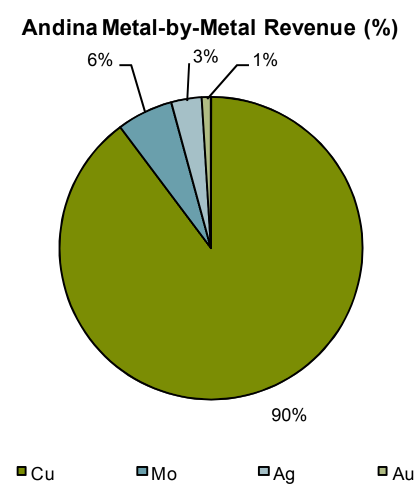
Source: MEG, Bernstein analysis & estimates

Exhibit 115
Andina ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 116
Andina metal exposure.



Source: MEG, Bernstein analysis & estimates

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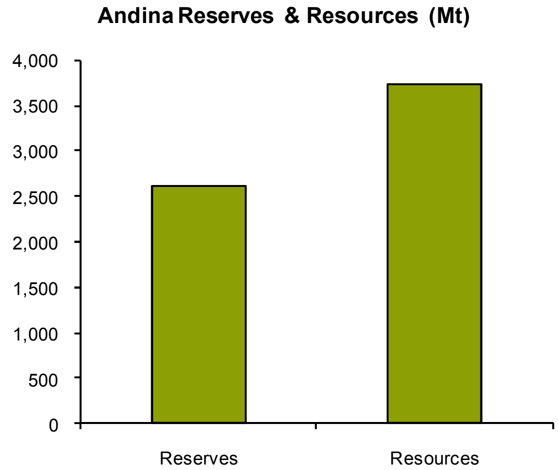
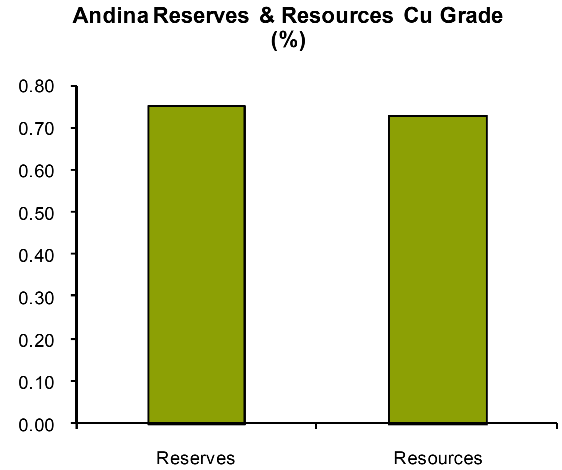
Exhibit 117
Andina geological endowment.



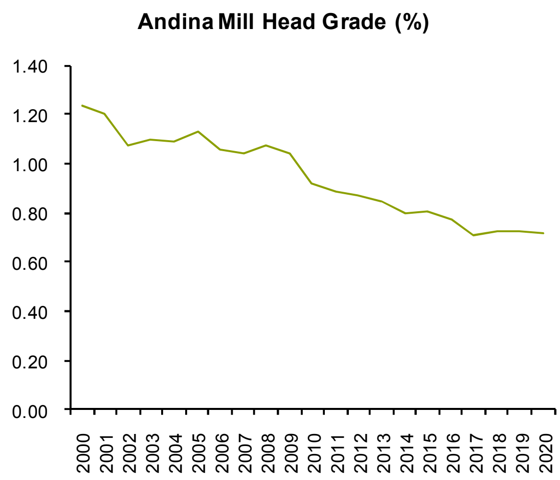
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 118
Andina ore grade.



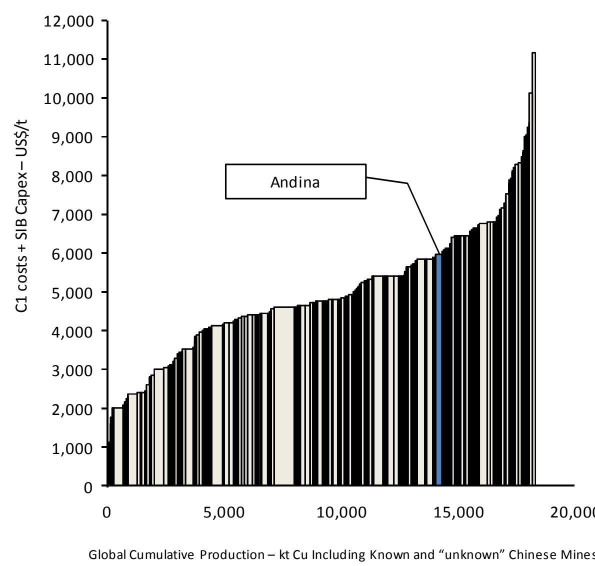
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 119
Andina head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 120
Andina cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

European Metals & Mining

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Collahuasi

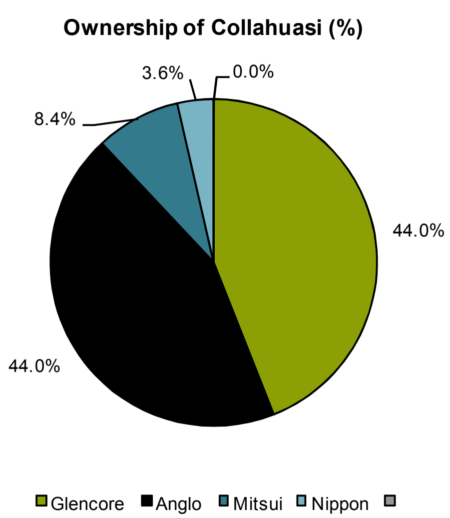
Exhibit 121
Collahuasi overview.

General Information	Details/Facts
Country	Chile
Location	160 km SE of the port of Iquique
State/Province	Tarapaca (Town Iquique)
Locale	Andes Mountains; Northern Chile
Start Up	1999 (Q1)
Commodity	Copper/Molybdenum/Silver
Development Stage	Production
Mine type	Open Pit
Latitude/Longtitude	20°59'21" S, 68°38'9" W

Geology	Details/Facts
Zone Name	Collahuasi
Ore Genesis	Hydrothermal processes; Replacement
Orebody type	Porphyry Deposit
Ore Mineral	Chalcocite, Chalcopyrite, Bornite, Covellite
Class of Ore	Sulfide, Oxide
Ore Controls	Fracturing, Vein (Lode)
Width	N/A
Length	N/A
Thickness	N/A
Host Rock	Intrusive (plutonic)
Country Rock	N/A
Strike	N/A

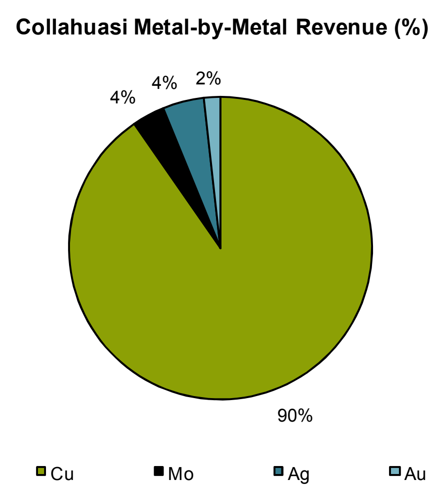
Source: MEG, Bernstein analysis & estimates

Exhibit 122
Collahuasi ownership.



Source: MEG, Bernstein analysis & estimates

Exhibit 123
Collahuasi metal exposure.



Source: MEG, Bernstein analysis & estimates

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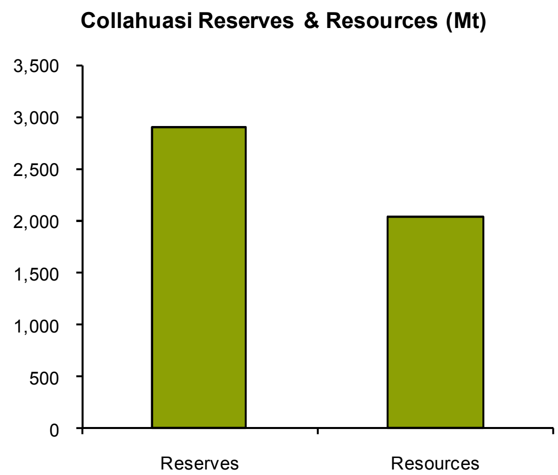
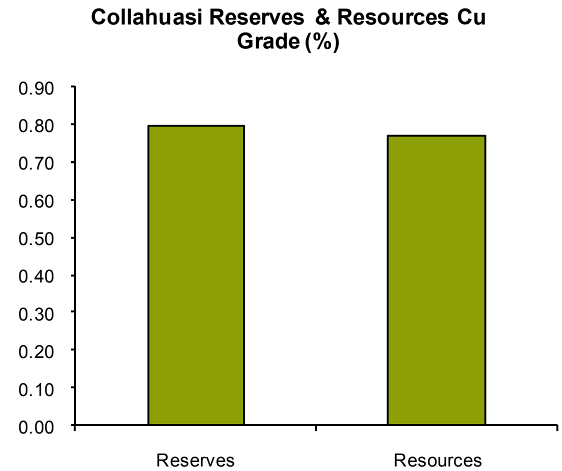
Exhibit 124
Collahuasi geological endowment.



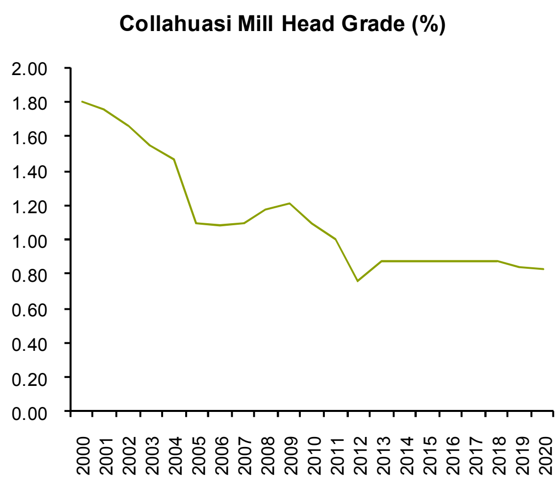
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 125
Collahuasi ore grade.



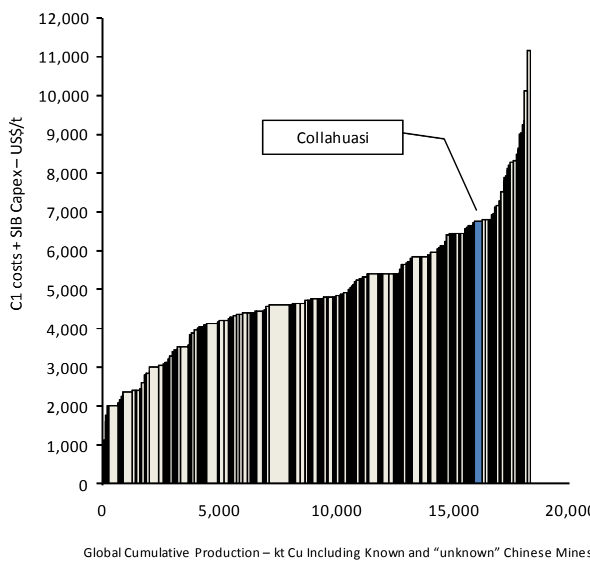
Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 126
Collahuasi head grade.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 127
Collahuasi cost position.



Source: Wood Mackenzie, Bernstein analysis & estimates

Exhibit 128

Summary of our coverage valuation.

09/08/2013					Capitalisation (US$)					EPS (US$)				EBITDA (US$)				PE				EV/EBITDA						
Company	Year End	**Sh. Price (LCU)**	**Sh. Price ($)**	MCAP	Net Debt	Minorities	EV	Net Debt / EBITDA	2012A	2013E	2014E	2015E	2012A	2013E	2014E	2015E	2012	2013	2014	2015	2012A	2013E	2014E	2015E	2012A	2013E	2014E	2015E
Anglo American	31-Dec	**15.43**	**23.55**	30,096	8,828	17,642	56,566	1.00	2.22	2.10	2.64	3.10	8,815	10,002	11,494	14,005	10.6	11.2	8.9	7.6	6.4	5.7	4.9	4.0	-0.6	2.0	1.0	5.3
BHP Billiton	30-Jun	**19.64**	**29.93**	159,253	23,549	1,349	184,151	0.78	2.93	2.70	3.73	4.73	30,324	25,614	38,119	45,903	10.2	11.1	8.0	6.3	6.1	7.2	4.8	4.0	1.3	-0.5	2.9	4.0
Rio Tinto	31-Dec	**31.68**	**48.28**	89,152	19,412	490	109,053	0.95	5.03	5.27	7.19	9.33	20,381	24,183	31,348	38,698	9.6	9.2	6.7	5.2	5.4	4.5	3.5	2.8	-3.6	1.7	6.4	8.7
Vale	31-Dec	**34.75**	**17.25**	88,289	26,088	(4,702)	109,675	1.44	1.07	2.28	2.55	3.58	18,133	22,523	26,230	32,415	16.2	7.6	6.8	4.8	6.0	4.9	4.2	3.4	0.4	-0.1	0.6	2.1
Mean							114,861	1.04	2.81	3.09	4.03	5.19	19,413	20,581	26,798	32,755	11.65	9.75	7.61	5.98	5.97	5.56	4.35	3.56	-0.64	0.78	2.71	5.02
Max							184,151	1.44	5.03	5.27	7.19	9.33	30,324	25,614	38,119	45,903	16.18	11.19	8.90	7.60	6.42	7.19	4.92	4.04	1.26	2.04	6.39	8.68
Min							56,566	0.78	1.07	2.10	2.55	3.10	8,815	10,002	11,494	14,005	9.60	7.57	6.71	4.82	5.35	4.51	3.48	2.82	-3.64	-0.49	0.58	2.11
Glencore Xstrata	31-Dec	**2.98**	**4.53**	60,429	35,492	5,032	100,953	2.57	0.46	0.43	0.63	0.97	13,784	15,902	20,203	26,252	9.9	10.6	7.2	4.7	7.3	6.3	4.6	3.6	0.2	0.4	0.7	1.1

All Companies report in US$, SCB's EPS estimates are used for 2013 & 2014 PEs

Vale's local currency share price is quoted in BRL, all others in GBP

Source: Company reports, Bloomberg, Bernstein analysis and estimates.

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Exhibit 129

Rio Tinto Income Statement

Income Statement Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
Production											
Iron Ore	Mt	133	145	153	172	185	192	199	210	254	296
Copper	kt	804	738	699	805	678	520	549	527	799	907
Gold	koz	1,007	1,231	459	1,111	772	670	294	176	401	467
Coking Coal	Mt	5.9	6.2	7.4	7.5	9.0	8.8	7.9	8.4	8.8	9.2
Thermal Coal	Mt	29.1	22.2	19.3	20.2	18.4	17.4	19.7	24.2	24.2	22.9
Uranium	klbs	12.6	12.6	14.2	14.1	11.4	7.1	9.8	9.5	9.5	10.6
Diamonds	k carats	35,163	26,023	20,816	14,026	13,843	11,733	13,122	15,758	24,458	29,802
Aluminium	kt	845	1,473	3,981	3,804	3,790	3,824	3,456	3,552	3,608	3,622
Prices											
Iron Ore Fines	US$/t	42	46	76	65	108	152	120	131	138	142
Copper	US$/t	6,725	7,124	6,969	5,142	7,531	8,822	7,952	7,830	9,049	10,352
Gold	US$/oz	604	695	872	972	1,225	1,571	1,669	1,541	1,572	1,604
Hard Coking Coal	US$/t	117	103	328	145	220	296	210	179	203	222
Thermal Coal	US$/t	49	66	129	72	99	121	94	92	104	116
Uranium	US$/lb	47	99	64	47	46	56	49	43	49	54
Diamonds	US$/carat	62	60	64	70	80	80	80	94	108	103
Aluminium	US$/t	2,567	2,640	2,575	1,663	2,172	2,398	2,019	2,012	2,260	2,483
Revenue											
Iron Ore	US$m	6,938	9,193	16,150	12,598	24,024	29,909	24,695	27,958	34,937	41,194
Aluminium	US$m	3,493	7,359	18,297	12,038	15,206	12,159	10,105	12,104	13,681	14,899
Copper	US$m	7,079	8,501	5,829	6,206	7,782	7,555	6,520	5,788	9,786	12,481
Energy	US$m	4,240	4,765	8,018	4,869	5,652	7,327	5,783	6,039	7,077	7,890
Diamonds & Minerals	US$m	3,461	3,658	4,116	2,618	3,035	3,220	3,640	4,083	4,770	4,995
Other	US$m	229	42	5,655	5,707	4,624	5,508	4,823	4,524	4,524	4,524
Group revenue	**US$m**	**25,440**	**33,518**	**58,065**	**44,036**	**60,323**	**65,678**	**55,566**	**60,496**	**74,775**	**85,984**
Associate revenue	US$m	(2,975)	(3,818)	(3,801)	(2,211)	(3,747)	(5,141)	(4,599)	(4,801)	(5,534)	(6,317)
Consolidated revenue	**US$m**	**22,465**	**29,700**	**54,264**	**41,825**	**56,576**	**60,537**	**50,967**	**55,695**	**69,242**	**79,667**
Operating costs	US$m	(13,892)	(20,752)	(37,641)	(33,818)	(36,667)	(36,260)	(37,536)	(38,769)	(46,388)	(50,135)
Exploration & evaluation costs	US$m	-	(321)	(1,134)	(514)	(594)	(1,437)	(1,970)	(2,050)	(2,533)	(2,913)
Special items & other	US$m	401	(56)	(5,295)	13	379	(9,492)	(15,071)	-	-	-
Associate income	US$m	1,378	1,584	1,039	786	1,101	704	1,034	943	1,131	1,392
Operating profit	**US$m**	**10,352**	**10,155**	**11,233**	**8,292**	**20,795**	**14,052**	**(2,576)**	**15,818**	**21,451**	**28,011**
Net interest	US$m	(54)	(404)	(1,414)	(809)	(615)	(382)	(160)	(1,232)	(1,171)	(947)
Other financing charges	US$m	(58)	85	(641)	377	397	(456)	168	(390)	(390)	(390)
PBT	**US$m**	**10,240**	**9,836**	**9,178**	**7,860**	**20,577**	**13,214**	**(2,568)**	**14,197**	**19,890**	**26,674**
Income tax expense	US$m	(2,373)	(2,090)	(3,742)	(2,076)	(5,296)	(6,439)	(429)	(3,857)	(5,721)	(7,940)
Loss from discontinued operations	US$m	-	-	(827)	(449)	(97)	(10)	(7)	-	-	-
Tax rate, %	%	23.2%	21.2%	40.8%	26.4%	25.7%	48.7%	-16.7%	27.2%	28.8%	29.8%
PAT	US$m	**7,867**	**7,746**	**4,609**	**5,335**	**15,184**	**6,765**	**(3,004)**	**10,339**	**14,168**	**18,734**
Minority interests	US$m	(429)	(434)	(933)	(463)	(860)	(939)	14	(614)	(884)	(1,506)
Reported Earnings	**US$m**	**7,438**	**7,312**	**3,676**	**4,872**	**14,324**	**5,826**	**(2,990)**	**9,726**	**13,284**	**17,229**
Reported EPS, USD/sh	**USD/share**	**5.58**	**5.69**	**2.86**	**2.76**	**7.30**	**3.03**	**(1.62)**	**5.27**	**7.19**	**9.33**
Underlying Earnings	**US$m**	**7,338**	**7,443**	**10,303**	**6,298**	**13,987**	**15,549**	**9,303**	**9,726**	**13,284**	**17,229**
Underlying EPS, USD/sh	**USD/share**	**5.50**	**5.79**	**8.03**	**3.57**	**7.13**	**8.09**	**5.03**	**5.27**	**7.19**	**9.33**
DPS	USD/share	1.92	1.16	1.52	.68	.90	1.17	1.64	1.66	1.70	2.15
W. average shares outstanding	m	1,333	1,286	1,284	1,764	1,961	1,923	1,849	1,847	1,847	1,847

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 130

Rio Tinto Balance Sheet

Balance Sheet Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
Non-current assets											
Intangible assets	US$m	1,225	23,407	20,581	19,998	21,016	16,142	9,402	9,402	9,402	9,402
PP&E	US$m	22,207	45,647	41,753	45,803	56,024	64,967	75,131	81,673	83,936	86,348
Investments in associates	US$m	2,235	7,038	5,053	6,735	6,855	9,833	5,312	5,312	5,312	5,312
Other	US$m	1,952	3,456	3,794	4,986	5,713	6,617	7,535	7,731	8,259	8,707
Total non-current assets	**US$m**	**27,619**	**79,548**	**71,181**	**77,522**	**89,608**	**97,559**	**97,380**	**104,118**	**106,909**	**109,769**
Current assets											
Inventories	US$m	2,540	5,382	5,607	4,889	4,756	5,307	6,136	5,906	7,013	7,432
Receivables	US$m	2,938	6,479	5,401	4,447	5,582	6,058	5,319	5,720	6,798	7,714
Cash and equivalents	US$m	736	1,645	1,181	4,233	9,948	9,670	7,082	6,659	12,166	20,734
Other	US$m	661	8,337	6,246	6,145	2,879	951	1,656	686	686	686
Total current assets	**US$m**	**6,875**	**21,843**	**18,435**	**19,714**	**23,165**	**21,986**	**20,193**	**18,971**	**26,664**	**36,566**
Total assets	**US$m**	**34,494**	**101,391**	**89,616**	**97,236**	**112,773**	**119,545**	**117,573**	**123,089**	**133,573**	**146,335**
Current liabilities											
Payables	US$m	(2,693)	(6,667)	(7,197)	(5,759)	(6,570)	(9,381)	(9,244)	(7,643)	(9,076)	(9,618)
Short-term debt	US$m	(1,504)	(8,213)	(10,034)	(847)	(2,151)	(1,447)	(2,228)	(2,299)	(1,381)	(391)
Other	US$m	(1,583)	(2,155)	(2,748)	(2,923)	(4,155)	(4,138)	(2,349)	(2,349)	(2,349)	(2,349)
Total current liabilities	**US$m**	**(5,780)**	**(17,035)**	**(19,979)**	**(9,529)**	**(12,876)**	**(14,966)**	**(13,821)**	**(12,291)**	**(12,806)**	**(12,358)**
Non current liabilities											
Long-term debt	US$m	(2,007)	(38,614)	(29,724)	(22,155)	(13,277)	(20,357)	(24,591)	(24,662)	(23,744)	(22,754)
Deferred tax liabilities	US$m	(2,425)	(6,486)	(4,054)	(4,304)	(5,222)	(6,592)	(5,119)	(5,119)	(5,119)	(5,119)
Other	US$m	(4,897)	(12,932)	(13,398)	(15,323)	(16,886)	(18,422)	(16,021)	(15,608)	(15,608)	(15,608)
Total non current liabilities	**US$m**	**(9,329)**	**(58,032)**	**(47,176)**	**(41,782)**	**(35,385)**	**(45,371)**	**(45,731)**	**(45,389)**	**(44,471)**	**(43,481)**
Total liabilities	**US$m**	**(15,109)**	**(75,067)**	**(67,155)**	**(51,311)**	**(48,261)**	**(60,337)**	**(59,552)**	**(57,679)**	**(57,277)**	**(55,839)**
Net assets	**US$m**	**19,385**	**26,324**	**22,461**	**45,925**	**64,512**	**59,208**	**58,021**	**65,410**	**76,296**	**90,496**
Equity											
Shareholders equity	US$m	18,232	24,772	20,638	43,831	58,247	52,539	46,865	54,254	65,140	79,340
Minority interests	US$m	1,153	1,552	1,823	2,094	6,265	6,669	11,156	11,156	11,156	11,156
Total equity	**US$m**	**19,385**	**26,324**	**22,461**	**45,925**	**64,512**	**59,208**	**58,021**	**65,410**	**76,296**	**90,496**
Net debt/(Net Cash)	**US$m**	**2,775**	**45,182**	**38,577**	**18,861**	**4,071**	**8,807**	**19,412**	**19,976**	**12,633**	**2,086**

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 131

Rio Tinto Cash Flow Statement

Cash Flow Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
EBITDA		**12,566**	**13,611**	**23,870**	**14,471**	**26,639**	**29,586**	**20,381**	**24,183**	**31,348**	**38,698**
Change in working capital	US$m	(696)	129	431	991	(825)	347	401	(1,968)	(1,281)	(1,240)
Other	US$m	(674)	(1,171)	(3,633)	(1,628)	(2,284)	(2,543)	(4,234)	(3,025)	(3,624)	(4,170)
Operating cash flow	**US$m**	**11,196**	**12,569**	**20,668**	**13,834**	**23,530**	**27,390**	**16,548**	**19,190**	**26,443**	**33,288**
Income tax paid	US$m	(2,799)	(3,421)	(3,899)	(3,076)	(4,100)	(6,197)	(5,823)	(3,857)	(5,721)	(7,940)
Dividends paid to minorities	US$m	(193)	(168)	(348)	(410)	(457)	(548)	(422)	(614)	(884)	(1,506)
Net Interest paid	US$m	(128)	(489)	(1,538)	(1,136)	(696)	(613)	(837)	(1,232)	(1,171)	(947)
Net cash flow from operations	**US$m**	**8,076**	**8,491**	**14,883**	**9,212**	**18,277**	**20,032**	**9,466**	**13,488**	**18,666**	**22,896**
Capital expenditure	US$m	(3,920)	(5,000)	(8,574)	(5,388)	(4,591)	(12,335)	(17,458)	(12,272)	(8,926)	(9,319)
Acquisitions & investments	US$m	-	(37,509)	-	(661)	(1,061)	(4,901)	(1,647)	-	-	-
Disposals	US$m	14	32	2,734	2,677	4,027	491	944	557	-	-
Other	US$m	(456)	(265)	(341)	15	(86)	(93)	(13)	-	-	-
Net cash flow from investing	**US$m**	**(4,362)**	**(42,742)**	**(6,181)**	**(3,357)**	**(1,711)**	**(16,838)**	**(18,174)**	**(11,715)**	**(8,926)**	**(9,319)**
(Repayment)/receipt of debt	US$m	(619)	38,161	(7,970)	(16,445)	(9,360)	5,891	7,888	141	(1,836)	(1,979)
Dividends paid to shareholders	US$m	(2,573)	(1,507)	(1,933)	(876)	(1,754)	(2,236)	(3,038)	(2,337)	(2,397)	(3,029)
Shares issued	US$m	31	37	23	14,877	342	424	2,945	-	-	-
Shares bought back	US$m	(2,370)	(1,648)	-	-	-	(5,504)	(1,471)	-	-	-
Other financing activities	US$m	142	54	772	(19)	162	(2,001)	1	-	-	-
Net cash flow from financing	**US$m**	**(5,389)**	**35,097**	**(9,108)**	**(2,463)**	**(10,610)**	**(3,426)**	**6,325**	**(2,196)**	**(4,233)**	**(5,009)**
Effects of exchange rate on cash	US$m	30	(27)	(101)	(284)	(139)	(71)	(49)	-	-	-
Change in cash and equivalents	**US$m**	**(1,645)**	**819**	**(507)**	**3,108**	**5,817**	**(303)**	**(2,432)**	**(423)**	**5,507**	**8,568**
Closing cash & equivalents	**US$m**	**736**	**1,645**	**1,181**	**4,233**	**9,948**	**9,670**	**7,082**	**6,659**	**12,166**	**20,734**
FCF to Firm	US$m	4,477	4,148	8,195	5,370	14,839	8,858	(6,733)	3,061	11,796	16,029
FCF Per Share	**US$/share**	**3.36**	**3.23**	**6.38**	**3.04**	**7.57**	**4.61**	**(3.64)**	**1.66**	**6.39**	**8.68**

(FCF = Operating cash flow less tax paid, less Capex)

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 132

BHP Income Statement

Income Statement June year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
Production											
Crude oil, Condensate & NGL	mmbbl	55	57	68	76	97	92	85	93	98	106
Natural Gas	bcf	360	357	368	365	369	405	822	952	1,186	1,524
Alumina	kt	4,187	4,460	4,554	4,396	3,841	4,010	4,152	5,114	5,735	5,838
Aluminium	kt	1,362	1,340	1,298	1,233	1,241	1,246	1,153	1,209	1,284	1,284
Copper	kt	1,268	1,250	1,376	1,207	1,075	1,139	1,095	1,175	1,258	1,315
Uranium	t	3,936	3,486	4,144	4,007	2,279	4,045	3,885	4,112	4,112	4,112
Nickel	kt	175	186	168	173	176	153	158	143	143	143
Iron Ore	Mt	97	99	112	114	125	134	159	170	188	203
Manganese Ore	kt	5,280	6,009	6,575	4,162	6,765	7,011	7,879	8,337	9,001	9,001
Manganese Alloy	kt	652	662	775	467	602	774	688	490	413	413
Metallurgical Coal	Mt	35	38	35	36	37	33	33	37	38	39
Energy Coal	Mt	86	87	80	68	66	70	71	79	85	87
Prices											
Oil - WTI	US$/bbl	66	72	100	62	79	95	94	98	112	125
Natural Gas - Henry Hub	US$/mmbtu	6.73	6.96	8.89	3.94	4.37	4.00	2.75	4.07	4.83	5.44
Aluminium	US$/t	2,567	2,640	2,575	1,663	2,172	2,398	2,019	2,012	2,260	2,483
Copper	US$/t	6,725	7,124	6,969	5,142	7,531	8,822	7,952	7,830	9,049	10,352
Uranium	US$/lb	47	99	64	47	46	56	49	43	49	54
Nickel	US$/t	24,102	37,147	21,155	14,655	21,799	22,896	17,544	16,507	17,890	19,412
Iron Ore Fines	US$/t	42	46	76	65	108	152	120	131	138	142
Ferromanganese	US$/t	853	1,379	2,957	1,316	1,395	1,323	1,223	1,128	1,264	1,398
Hard Coking Coal	US$/t	117	103	328	145	220	296	210	179	203	222
Thermal Coal	US$/t	49	66	129	72	99	121	94	92	104	116
Revenue											
Petroleum	US$m	5,230	5,885	8,382	7,211	8,782	10,737	12,937	14,198	18,935	24,417
Aluminium	US$m	5,084	5,879	5,746	4,151	4,353	5,221	4,766	4,753	5,707	6,259
Base Metals	US$m	10,294	12,635	14,774	7,105	10,409	14,152	11,596	12,317	13,958	16,351
Diamonds & Specialty Products	US$m	1,263	893	969	896	1,272	1,517	1,326	681	499	499
Stainless Steel Materials	US$m	2,955	6,901	5,088	2,355	3,617	3,861	2,993	2,454	2,504	2,714
Iron Ore	US$m	4,782	5,524	9,455	10,048	11,139	20,412	22,601	20,125	24,177	27,314
Manganese	US$m	1,037	1,244	2,912	2,536	2,150	2,423	2,152	2,050	2,311	2,498
Metallurgical Coal	US$m	3,941	3,769	3,941	8,087	6,059	7,573	7,576	5,736	6,681	7,660
Energy Coal	US$m	3,965	4,576	6,560	6,524	4,265	5,507	6,022	5,182	5,911	6,781
Other Group & Inter Segment	US$m	548	167	1,646	1,298	752	336	257	100	100	100
Group revenue	**US$m**	**39,099**	**47,473**	**59,473**	**50,211**	**52,798**	**71,739**	**72,226**	**67,596**	**80,782**	**94,592**
Other Income	US$m	1,227	588	648	589	528	531	906	4,429	5,293	6,198
Operating costs	US$m	(25,655)	(29,660)	(35,976)	(38,640)	(33,296)	(40,454)	(49,216)	(50,507)	(55,003)	(62,079)
Operating profit	**US$m**	**14,671**	**18,401**	**24,145**	**12,160**	**20,030**	**31,816**	**23,916**	**21,518**	**31,073**	**38,710**
Financial Income	US$m	226	260	293	309	215	245	225	128	100	253
Financial Expense	US$m	(731)	(650)	(955)	(852)	(674)	(806)	(955)	(1,508)	(1,775)	(1,644)
PBT	**US$m**	**14,166**	**18,011**	**23,483**	**11,617**	**19,571**	**31,255**	**23,186**	**20,138**	**29,397**	**37,318**
Income tax expense	US$m	(3,207)	(4,174)	(6,798)	(4,784)	(6,112)	(6,481)	(7,238)	(4,257)	(7,088)	(8,998)
Royalty related taxation	US$m	(425)	(341)	(723)	(495)	(451)	(828)	(252)	(1,393)	(2,319)	(2,944)
Tax rate, %	%	25.6%	25.1%	32.0%	45.4%	33.5%	23.4%	32.3%	28.1%	32.0%	32.0%
PAT	US$m	**10,534**	**13,496**	**15,962**	**6,338**	**13,008**	**23,946**	**15,696**	**14,488**	**19,990**	**25,377**
Minority interests	US$m	(84)	(80)	(572)	(461)	(287)	(298)	(115)	(103)	(158)	(183)
Reported Earnings	**US$m**	**10,450**	**13,416**	**15,390**	**5,877**	**12,721**	**23,648**	**15,581**	**14,384**	**19,832**	**25,193**
Reported EPS, USD/sh	**USD/share**	**1.76**	**2.39**	**2.77**	**1.06**	**2.29**	**4.44**	**2.93**	**2.70**	**3.73**	**4.73**
DPS	USD/share	.32	.39	.56	.82	.83	.91	1.10	1.14	.96	.99
Shares outstanding, millions	m	5,934	5,615	5,565	5,564	5,563	5,323	5,321	5,321	5,321	5,321

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 133
BHP Balance Sheet

Balance Sheet June year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
Non-current assets											
Intangible assets	US$m	683	615	625	661	687	904	5,112	5,207	5,207	5,207
PP&E	US$m	30,985	36,705	47,332	49,032	55,576	68,468	95,247	100,513	104,539	107,721
Other	US$m	8,072	9,761	6,371	6,591	7,455	8,239	8,463	9,693	10,001	10,297
Total non-current assets	**US$m**	**39,740**	**47,081**	**54,328**	**56,284**	**63,718**	**77,611**	**108,822**	**115,412**	**119,746**	**123,224**
Current assets											
Inventories	US$m	2,732	3,296	4,971	4,821	5,334	6,154	6,233	6,850	7,544	8,360
Receivables	US$m	3,831	4,689	9,801	5,153	6,543	8,197	7,704	8,299	9,888	11,412
Cash and equivalents	US$m	776	1,937	4,237	10,833	12,456	10,084	4,781	3,748	10,028	20,943
Other	US$m	1,437	1,165	2,671	1,679	801	845	1,733	1,982	1,982	1,982
Total current assets	**US$m**	**8,776**	**11,087**	**21,680**	**22,486**	**25,134**	**25,280**	**20,451**	**20,880**	**29,441**	**42,697**
Total assets	**US$m**	**48,516**	**58,168**	**76,008**	**78,770**	**88,852**	**102,891**	**129,273**	**136,292**	**149,188**	**165,922**
Current liabilities											
Payables	US$m	(4,053)	(4,724)	(6,774)	(5,619)	(6,467)	(9,718)	(12,024)	(8,865)	(9,763)	(10,819)
Short-term debt	US$m	(1,368)	(1,352)	(3,461)	(1,094)	(2,191)	(3,519)	(3,531)	(3,866)	(2,793)	(953)
Other	US$m	(3,248)	(4,173)	(6,243)	(4,774)	(4,384)	(6,496)	(6,046)	(4,480)	(4,480)	(4,480)
Total current liabilities	**US$m**	**(8,669)**	**(10,249)**	**(16,478)**	**(11,487)**	**(13,042)**	**(19,733)**	**(21,601)**	**(17,211)**	**(17,036)**	**(16,253)**
Non current liabilities											
Long-term debt	US$m	(7,648)	(9,291)	(9,234)	(15,325)	(13,573)	(12,388)	(24,799)	(32,051)	(30,978)	(29,138)
Deferred tax liabilities	US$m	(1,592)	(1,822)	(3,116)	(3,038)	(4,320)	(2,683)	(5,287)	(5,177)	(5,177)	(5,177)
Other	US$m	(6,152)	(6,888)	(8,137)	(8,209)	(8,588)	(10,332)	(10,501)	(9,339)	(8,766)	(8,186)
Total non current liabilities	**US$m**	**(15,392)**	**(18,001)**	**(20,487)**	**(26,572)**	**(26,481)**	**(25,403)**	**(40,587)**	**(46,567)**	**(44,921)**	**(42,502)**
Total liabilities	**US$m**	**(24,061)**	**(28,250)**	**(36,965)**	**(38,059)**	**(39,523)**	**(45,136)**	**(62,188)**	**(63,778)**	**(61,957)**	**(58,754)**
Net assets	**US$m**	**24,455**	**29,918**	**39,043**	**40,711**	**49,329**	**57,755**	**67,085**	**72,513**	**87,231**	**107,167**
Equity											
Shareholders equity	US$m	24,218	29,667	38,335	39,954	48,525	56,762	65,870	71,270	85,988	105,924
Minority interests	US$m	237	251	708	757	804	993	1,215	1,243	1,243	1,243
Total equity	**US$m**	**24,455**	**29,918**	**39,043**	**40,711**	**49,329**	**57,755**	**67,085**	**72,513**	**87,231**	**107,167**
Net debt/(Net cash)	**US$m**	**8,240**	**8,706**	**8,458**	**5,586**	**3,308**	**5,823**	**23,549**	**32,169**	**23,743**	**9,149**

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 134
BHP Cash Flow Statement

Cash Flow June year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
EBITDA		**17,447**	**21,284**	**27,757**	**16,031**	**24,790**	**36,855**	**30,324**	**25,614**	**38,119**	**45,903**
Change in working capital	US$m	-	-	(3,744)	3,931	(1,719)	28	968	(4,058)	(1,693)	(1,580)
Other	US$m	(5,432)	(5,329)	1,135	5,220	(825)	198	2,146	1,984	(662)	(662)
Operating cash flow	**US$m**	**12,015**	**15,955**	**25,148**	**25,182**	**22,246**	**37,081**	**33,438**	**23,540**	**35,764**	**43,661**
Income tax paid	US$m	(3,152)	(3,682)	(5,867)	(5,129)	(4,379)	(5,951)	(7,312)	(6,946)	(7,088)	(8,998)
Royalty related tax paid	US$m	(659)	(554)	(885)	(906)	(576)	(607)	(1,015)	(1,224)	(2,319)	(2,944)
Net Interest paid	US$m	(378)	(380)	(630)	(314)	(421)	(455)	(588)	(1,192)	(1,586)	(1,309)
Other	US$m	2,671	4,257	51	30	20	12	25	10	-	-
Net cash flow from operations	**US$m**	**10,497**	**15,596**	**17,817**	**18,863**	**16,890**	**30,080**	**24,548**	**14,188**	**24,770**	**30,410**
Capital expenditure	US$m	(5,239)	(6,365)	(7,558)	(9,492)	(9,323)	(11,147)	(18,385)	(18,003)	(11,072)	(10,376)
Acquisitions & investments	US$m	(1,362)	(1,667)	(1,686)	(1,710)	(1,048)	(5,515)	(13,967)	(567)	-	-
Disposals	US$m	1,089	408	180	277	386	198	310	2,413	-	-
Other	US$m	-	-	-	(126)	-	-	6	-	-	-
Net cash flow from investing	**US$m**	**(5,512)**	**(7,624)**	**(9,064)**	**(11,051)**	**(9,985)**	**(16,464)**	**(32,036)**	**(16,157)**	**(11,072)**	**(10,376)**
(Repayment)/receipt of debt	US$m	(1,101)	1,382	(750)	3,575	(485)	(577)	8,827	7,257	(2,146)	(3,679)
Dividends paid to company shareholders	US$m	(1,936)	(2,271)	(3,135)	(4,563)	(4,618)	(5,054)	(5,877)	(6,098)	(5,114)	(5,257)
Dividends paid to minority shareholders	US$m	(190)	(68)	(115)	(406)	(277)	(90)	(56)	(53)	(158)	(183)
Shares issued	US$m	34	22	-	-	-	-	-	-	-	-
Shares bought back	US$m	(2,215)	(5,906)	(3,365)	(169)	(274)	(10,329)	(507)	(348)	-	-
Other financing activities	US$m	(4)	(2)	366	383	347	32	122	61	-	-
Net cash flow from financing	**US$m**	**(5,412)**	**(6,843)**	**(6,999)**	**(1,180)**	**(5,307)**	**(16,018)**	**2,509**	**819**	**(7,418)**	**(9,120)**
Effects of exchange rate on cash	US$m	1	11	21	26	26	27	(56)	(1)	-	-
Change in cash and equivalents	**US$m**	**(426)**	**1,140**	**1,775**	**6,658**	**1,624**	**(2,375)**	**(5,035)**	**(1,151)**	**6,279**	**10,915**
Closing cash & equivalents	**US$m**	**776**	**1,937**	**4,237**	**10,833**	**12,456**	**10,084**	**4,781**	**3,748**	**10,028**	**20,943**
FCF to Firm	US$m	2,965	5,354	10,838	9,655	7,968	19,376	6,726	(2,633)	15,284	21,344
FCF Per Share	**US$/share**	**.50**	**.95**	**1.95**	**1.74**	**1.43**	**3.64**	**1.26**	**(.49)**	**2.87**	**4.01**

(FCF = Operating cash flow less tax paid, less Capex)

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 135

Vale Income Statement

Income Statement											
Dec year-end		**2006 A**	**2007 A**	**2008 A**	**2009 A**	**2010 A**	**2011 A**	**2012 A**	**2013 E**	**2014 E**	**2015 E**
Production											
Iron Ore	kt	264,153	303,161	301,698	237,953	307,793	322,597	319,961	272,398	297,995	329,993
Manganese Ore	kt	2,243	1,333	2,384	1,656	1,842	2,557	2,363	2,008	2,008	2,008
Ferroalloys	kt	534	543	473	224	451	436	392	128	128	128
Metallurgical Coal	kt	-	1,764	2,810	2,528	3,059	2,767	5,083	7,992	11,695	12,465
Thermal Coal	kt	-	440	1,286	2,894	3,832	4,505	3,419	2,616	4,213	4,543
Nickel	kt	232	249	275	187	178	238	235	285	310	314
Copper	kt	265	284	312	197	208	300	290	405	469	558
Potash	kt	733	671	607	716	662	625	549	480	480	480
Prices											
Iron Ore	US$/t	37	42	64	55	100	139	108	122	129	132
Manganese Ore	US$/t	117	155	639	246	347	271	222	241	267	287
Ferro Manganese	US$/t	828	1,357	2,892	1,291	1,374	1,302	1,205	1,130	1,264	1,398
Hard Coking Coal	US$/t	117	103	328	145	220	296	210	179	203	222
Thermal Coal	US$/t	51	61	123	60	77	111	84	77	90	104
Nickel	US$/t	24,141	37,183	21,145	14,665	21,813	22,866	17,533	16,517	17,890	19,412
Copper	US$/t	6,738	7,133	6,961	5,148	7,533	8,813	7,948	7,825	9,049	10,352
Phosphates	US$/t	258	423	967	318	499	628	635	667	742	799
Revenue											
Bulk Materials	US$m	12,569	15,434	23,553	15,071	34,478	46,904	35,662	33,222	39,305	44,892
Base Metals	US$m	5,962	15,313	11,764	6,679	8,200	9,627	7,133	8,720	11,087	13,267
Fertilizers	US$m	143	178	295	413	1,846	3,547	3,777	4,790	5,629	6,060
Logistics	US$m	1,376	1,525	1,607	1,104	1,465	1,727	1,644	889	906	924
Other	US$m	313	665	1,290	672	492	541	537	738	753	767
Group revenue	**US$m**	**20,363**	**33,115**	**38,509**	**23,939**	**46,481**	**62,346**	**48,753**	**48,359**	**57,679**	**65,909**
VAT	US$m	(716)	(873)	(1,083)	(628)	(1,188)	(1,399)	(1,059)	(3,940)	(4,514)	(5,095)
Net Operating Revenue	**US$m**	**19,647**	**32,242**	**37,426**	**23,311**	**45,293**	**60,947**	**47,694**	**44,419**	**53,165**	**60,815**
Operating costs	US$m	(11,017)	(16,862)	(18,921)	(14,532)	(20,338)	(28,225)	(29,561)	(22,297)	(26,935)	(28,400)
Depreciation, depletion and amortization	US$m	(998)	(2,190)	(2,807)	(2,722)	(3,260)	(4,122)	(4,396)	(4,753)	(5,427)	(5,797)
Operating profit	**US$m**	**7,632**	**13,190**	**15,698**	**6,057**	**21,695**	**28,600**	**13,737**	**17,369**	**20,803**	**26,618**
Financial income	US$m	327	295	602	381	290	718	401	2,281	1,653	2,642
Interest expense	US$m	(1,338)	(2,482)	(1,765)	(1,558)	(2,646)	(2,465)	(2,414)	(3,919)	(3,981)	(3,884)
Other financing charges	US$m	883	3,449	(448)	2,203	975	(1,566)	(1,788)	-	-	-
Gain on sale of investments	US$m	-	320	777	(870)	40	-	1,513	(491)	-	-
PBT	**US$m**	**7,504**	**14,772**	**14,864**	**6,213**	**20,354**	**25,287**	**11,449**	**15,240**	**18,476**	**25,376**
Income tax expense	US$m	(1,432)	(3,201)	(535)	(2,100)	(3,705)	(5,282)	833	(4,940)	(6,188)	(7,985)
Equity results in affiliates	US$m	710	595	794	433	987	1,135	(1,001)	726	861	1,102
Loss from discontinued operations	US$m	-	-	-	-	(143)	-	-	-	-	-
Tax rate, %	%	19.1%	21.7%	3.6%	33.8%	18.2%	20.9%	-7.3%	32.4%	33.5%	31.5%
PAT	US$m	**6,782**	**12,166**	**15,123**	**4,546**	**17,493**	**21,140**	**11,281**	**11,026**	**13,149**	**18,492**
Minority interests	US$m	(579)	(802)	(258)	(107)	(189)	233	257	39	(30)	(39)
Reported Earnings	**US$m**	**6,203**	**11,364**	**14,865**	**4,439**	**17,304**	**21,373**	**11,538**	**11,065**	**13,119**	**18,453**
Reported EPS - preferred, US$/sh	US$/share	2.14	2.42	2.53	0.97	3.23	4.37	1.06	2.28	2.55	3.58
Reported EPS - common, US$/sh	US$/share	2.18	2.42	2.53	0.97	3.22	4.34	1.07	2.28	2.55	3.58
Reported EPS - pref linked to convertibles, US$/sh	US$/share	0.00	2.20	4.13	1.73	4.95	6.37	0.00	0.00	0.00	0.00
Reported EPS - common linked to convertibles, US$/sh	US$/share	0.00	2.36	4.31	2.26	7.44	8.15	0.00	0.00	0.00	0.00
DPS	US$/share	.80	.56	.56	.53	.57	1.73	1.17	.33	.51	.72
Preferred Shares Outstanding	m	1,181	1,889	1,985	2,031	2,025	1,964	1,944	1,968	1,968	1,968
Common Shares Outstanding	m	1,840	2,943	3,094	3,182	3,209	3,187	3,176	3,186	3,186	3,186
Treasury Prefs Shares Linked to Mandatory Convertible N	m	-	23	30	66	47	47	-	-	-	-
Treasury Common Shares Linked to Mandatory Convertib	m	-	42	57	70	18	18	-	-	-	-

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 136

Vale Balance Sheet

Balance Sheet											
Dec year-end		**2006 A**	**2007 A**	**2008 A**	**2009 A**	**2010 A**	**2011 A**	**2012 A**	**2013 E**	**2014 E**	**2015 E**
Non-current assets											
Intangible assets	US$m	4,484	3,791	2,773	3,486	4,591	4,161	3,969	9,308	9,308	9,308
PP&E	US$m	38,007	54,625	48,454	67,637	83,096	88,895	90,744	95,975	105,882	112,684
Investments in associates	US$m	2,353	2,922	2,408	4,585	4,497	8,093	6,492	6,956	7,817	8,919
Other	US$m	3,142	3,999	3,119	5,277	5,164	5,843	7,376	7,948	7,948	7,948
Total non-current assets	**US$m**	**47,986**	**65,337**	**56,754**	**80,985**	**97,348**	**106,992**	**108,581**	**120,188**	**130,955**	**138,859**
Current assets											
Inventories	US$m	3,493	3,859	3,896	3,196	4,298	5,251	5,052	6,117	7,488	7,568
Receivables	US$m	3,604	3,952	3,204	3,120	8,211	8,505	6,795	7,121	8,522	9,465
Cash and equivalents	US$m	4,448	1,046	10,331	7,293	7,584	3,531	5,832	4,162	4,338	10,404
Other	US$m	1,395	2,523	5,807	7,685	11,698	4,449	5,218	5,299	5,299	5,299
Total current assets	**US$m**	**12,940**	**11,380**	**23,238**	**21,294**	**31,791**	**21,736**	**22,897**	**22,699**	**25,646**	**32,736**
Total assets	**US$m**	**60,926**	**76,717**	**79,992**	**102,279**	**129,139**	**128,728**	**131,478**	**142,887**	**156,601**	**171,595**
Current liabilities											
Payables	US$m	(2,382)	(2,430)	(2,261)	(2,309)	(3,558)	(4,814)	(4,529)	(4,646)	(5,687)	(5,748)
Short-term debt	US$m	(1,434)	(1,416)	(633)	(2,963)	(2,962)	(1,517)	(3,468)	(3,563)	(3,534)	(2,523)
Other	US$m	(3,496)	(6,237)	(4,343)	(3,909)	(8,240)	(4,712)	(4,407)	(3,871)	(3,871)	(3,871)
Total current liabilities	**US$m**	**(7,312)**	**(10,083)**	**(7,237)**	**(9,181)**	**(14,760)**	**(11,043)**	**(12,404)**	**(12,080)**	**(13,092)**	**(12,142)**
Non current liabilities											
Long-term debt	US$m	(21,122)	(17,608)	(17,914)	(20,650)	(22,875)	(22,874)	(28,452)	(28,842)	(28,813)	(27,802)
Deferred tax liabilities	US$m	(4,527)	(5,725)	(4,005)	(5,755)	(8,085)	(5,654)	(3,538)	(3,504)	(3,504)	(3,504)
Other	US$m	(5,481)	(7,470)	(5,789)	(6,196)	(10,978)	(9,043)	(10,721)	(14,002)	(16,209)	(18,362)
Total non current liabilities	**US$m**	**(31,130)**	**(30,803)**	**(27,708)**	**(32,601)**	**(41,938)**	**(37,571)**	**(42,711)**	**(46,348)**	**(48,526)**	**(49,668)**
Total liabilities	**US$m**	**(38,442)**	**(40,886)**	**(34,945)**	**(41,782)**	**(56,698)**	**(48,614)**	**(55,115)**	**(58,428)**	**(61,617)**	**(61,809)**
Net assets	**US$m**	**22,484**	**35,831**	**45,047**	**60,497**	**72,441**	**80,114**	**76,363**	**84,459**	**94,984**	**109,786**
Equity											
Shareholders equity	US$m	19,673	33,276	42,556	56,935	68,899	77,715	74,241	82,907	93,402	108,164
Minority interests	US$m	2,811	2,555	2,491	3,562	3,542	2,399	2,122	1,552	1,582	1,621
Total equity	**US$m**	**22,484**	**35,831**	**45,047**	**60,497**	**72,441**	**80,114**	**76,363**	**84,459**	**94,984**	**109,786**
Net debt/(Net Cash)	**US$m**	**18,108**	**17,978**	**8,216**	**16,320**	**18,253**	**20,860**	**26,088**	**28,244**	**28,009**	**19,921**

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 137
Vale Cash Flow Statement

Cash Flow Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
EBITDA		**8,620**	**15,380**	**18,505**	**8,779**	**24,955**	**32,722**	**18,133**	**22,523**	**26,230**	**32,415**
Change in working capital	US$m	288	1,060	(229)	1,426	(3,083)	(803)	1,621	(2,137)	(1,730)	(963)
Other	US$m	(636)	(604)	2,021	(624)	871	1,317	(3,081)	691	-	-
Operating cash flow	**US$m**	**8,272**	**15,836**	**20,297**	**9,581**	**22,743**	**33,236**	**16,673**	**21,077**	**24,499**	**31,452**
Income tax paid	US$m	(541)	(3,284)	(2,867)	(1,331)	(1,972)	(7,293)	1,238	(4,833)	(6,188)	(7,985)
Net Interest paid	US$m	(498)	(1,338)	(1,266)	(1,114)	(1,102)	(1,146)	(1,316)	(94)	(121)	911
Net cash flow from operations	**US$m**	**7,233**	**11,214**	**16,164**	**7,136**	**19,669**	**24,797**	**16,595**	**16,150**	**18,191**	**24,378**
Capital expenditure	US$m	(4,431)	(6,853)	(8,972)	(8,096)	(12,647)	(16,075)	(15,777)	(16,609)	(15,333)	(12,599)
Acquisitions & investments	US$m	(13,201)	(2,926)	-	(1,952)	(6,252)	-	-	(182)	-	-
Disposals	US$m	886	1,042	134	448	-	1,081	974	700	-	-
Other	US$m	(208)	(471)	(2,563)	(3,559)	1,715	625	(544)	(345)	-	-
Net cash flow from investing	**US$m**	**(16,954)**	**(9,208)**	**(11,401)**	**(13,159)**	**(17,184)**	**(14,369)**	**(15,347)**	**(16,436)**	**(15,333)**	**(12,599)**
(Repayment)/receipt of debt	US$m	15,011	(2,620)	559	2,471	1,907	(1,135)	7,621	332	(59)	(2,022)
Dividends paid to shareholders	US$m	(1,319)	(1,875)	(2,850)	(2,724)	(3,000)	(9,000)	(6,000)	(1,726)	(2,624)	(3,691)
Dividends paid to minority interests	US$m	(46)	(714)	(143)	(47)	(140)	(100)	(45)	-	-	-
Shares issued	US$m	-	-	-	-	-	(1,134)	(411)	-	-	-
Shares bought back	US$m	(301)	-	(752)	925	(1,996)	(3,002)	-	-	-	-
Other financing activities	US$m	-	-	12,190	-	660	-	-	-	-	-
Net cash flow from financing	**US$m**	**13,345**	**(5,209)**	**9,004**	**625**	**(2,569)**	**(14,371)**	**1,165**	**(1,395)**	**(2,682)**	**(5,713)**
Effects of exchange rate on cash	US$m	(217)	(199)	(5,432)	2,360	375	(109)	(112)	11	-	-
Change in cash and equivalents	**US$m**	**3,407**	**(3,402)**	**8,335**	**(3,038)**	**291**	**(4,052)**	**2,301**	**(1,670)**	**176**	**6,066**
Closing cash & equivalents	**US$m**	**4,448**	**1,046**	**10,331**	**7,293**	**7,584**	**3,531**	**5,832**	**4,162**	**4,338**	**10,404**
FCF to Firm	US$m	3,300	5,699	8,458	154	8,124	9,868	2,134	(365)	2,979	10,868
FCF Per Share	**US$/share**	**1.09**	**1.16**	**1.64**	**.03**	**1.53**	**1.89**	**.42**	**(.07)**	**.58**	**2.11**

(FCF = Operating cash flow less tax paid, less Capex)

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 138

Glencore Xstrata Pro-forma Income Statement – including Synergies

Income Statement December year-end		2008 E	2009 E	2010 E	2011 E	2012 E	2013 E	2014 E	2015 E
Sales Volume									
Zinc Own Feed	kt	1,795	1,814	1,761	1,668	1,569	1,601	1,955	2,028
Copper Own Feed	kt	1,198	1,206	1,199	1,241	1,161	1,446	1,578	1,801
Nickel & Ferronickel Own Feed	kt	91	80	85	100	104	123	145	167
Coal	Mt	107	104	100	105	137	153	162	176
Ferrochrome	kt	1,126	786	1,165	1,021	918	990	1,204	1,204
Platinum	koz	138	133	118	92	76	76	148	244
Oil Own Feed	Mstb	17	9	-	1	5	5	6	6
Oil - Share of RussNeft Investment	Mstb	-	-	3	5	6	6	6	6
Prices									
Zinc	US$/t	1,886	1,656	2,158	2,195	1,949	2,036	2,237	2,387
Copper	US$/t	6,969	5,142	7,531	8,822	7,952	7,830	9,049	10,352
Nickel	US$/t	21,155	14,655	21,799	22,896	17,544	16,507	17,890	19,412
Thermal Coal	US$/t	129	72	99	121	94	92	104	116
Platinum	US$/oz	1,576	1,200	1,611	1,722	1,552	1,598	1,733	1,859
Brent	US$/bbl	99	62	80	111	110	121	135	145
Revenue									
Zinc	US$m	5,671	5,445	6,678	7,047	7,117	6,913	8,221	8,878
Copper	US$m	14,203	11,554	17,435	19,213	16,191	18,209	21,742	26,687
Nickel	US$m	3,754	2,500	3,451	3,872	3,306	3,346	4,134	5,010
Alumina & Aluminium	US$m	263	235	422	520	410	454	475	532
Coal	US$m	9,175	7,816	9,035	11,648	12,205	12,576	15,216	18,183
Oil & Oil Products	US$m	1,672	534	253	642	1,640	1,828	2,206	2,457
Agricultural Products	US$m	1,337	1,789	2,180	3,359	2,935	3,100	3,153	3,211
Alloys	US$m	2,002	1,305	1,894	1,689	1,413	1,434	1,997	2,380
Marketing - Metals & Mining	US$m	34,940	30,971	38,639	44,067	50,834	48,703	52,789	57,291
Marketing - Energy Products	US$m	87,310	54,041	80,061	104,775	118,192	129,598	145,034	155,637
Marketing - Agricultural Products	US$m	12,057	6,793	8,238	13,744	14,155	12,284	12,356	12,434
Other	US$m	235	114	153	222	358	358	358	358
Group revenue	**US$m**	**173,369**	**123,847**	**169,189**	**211,548**	**229,505**	**239,552**	**268,430**	**293,806**
Operating costs	US$m	(161,545)	(116,778)	(157,970)	(199,700)	(220,589)	(230,466)	(255,535)	(274,731)
Operating profit	**US$m**	**11,824**	**7,069**	**11,219**	**11,848**	**8,916**	**9,086**	**12,895**	**19,075**
Financial Income	US$m	490	674	433	476	579	437	532	809
Financial Expense	US$m	(1,987)	(1,608)	(1,837)	(1,638)	(1,808)	(1,688)	(1,628)	(1,452)
PBT	**US$m**	**10,327**	**6,135**	**9,815**	**10,686**	**7,688**	**7,835**	**11,799**	**18,432**
Income tax expense	US$m	(2,051)	(1,402)	(2,194)	(2,033)	(1,065)	(1,485)	(2,499)	(4,209)
Tax rate, %	%	19.9%	22.8%	22.4%	19.0%	13.8%	19.0%	21.2%	22.8%
PAT	US$m	**8,276**	**4,733**	**7,621**	**8,653**	**6,623**	**6,350**	**9,299**	**14,223**
Minority interests	US$m	(339)	(296)	(475)	(456)	(497)	(672)	(951)	(1,286)
Reported Earnings	**US$m**	**7,937**	**4,437**	**7,146**	**8,197**	**6,126**	**5,678**	**8,348**	**12,937**
Reported EPS, USD/sh	**US$/share**	**.59**	**.33**	**.54**	**.61**	**.46**	**.43**	**.63**	**.97**
DPS	US$/share	.06	.06	.06	.09	.14	.14	.19	.23
Post Acquisition Shares Out	m	13,326	13,326	13,326	13,326	13,326	13,326	13,326	13,326

Source: Company reports, Bernstein analysis and estimates.

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Exhibit 139

Glencore Xstrata Pro-forma Balance Sheet – including Synergies

Balance Sheet December year-end		2008 A	2009 A	2010 A	2011 A	2012 E	2013 E	2014 E	2015 E
Non-current assets									
Intangible assets	US$m	6,714	6,238	6,216	6,254	6,850	6,850	6,850	6,850
PP&E	US$m	43,000	46,242	57,972	66,093	78,146	78,191	76,858	74,355
Other	US$m	9,887	11,027	11,677	11,836	10,930	10,941	11,101	11,562
Total non-current assets	**US$m**	**59,601**	**63,507**	**75,865**	**84,183**	**95,926**	**95,983**	**94,810**	**92,767**
Current assets									
Inventories	US$m	11,378	19,643	22,156	22,371	20,435	22,515	24,824	26,744
Receivables	US$m	15,897	18,495	23,457	25,637	25,110	28,230	31,015	34,143
Cash and equivalents	US$m	1,982	2,037	3,185	3,253	2,130	2,702	4,736	9,903
Other	US$m	14,238	10,967	7,135	5,845	6,024	6,024	6,024	6,024
Total current assets	**US$m**	**43,495**	**51,142**	**55,933**	**57,106**	**53,699**	**59,471**	**66,600**	**76,814**
Total assets	**US$m**	**103,096**	**114,649**	**131,798**	**141,289**	**149,625**	**155,454**	**161,409**	**169,581**
Current liabilities									
Payables	US$m	(14,847)	(15,179)	(20,775)	(23,262)	(21,878)	(24,217)	(26,574)	(28,601)
Short-term debt	US$m	(6,039)	(10,172)	(14,683)	(9,790)	(8,808)	(8,215)	(6,505)	(3,800)
Other	US$m	(14,880)	(10,137)	(10,233)	(6,886)	(6,935)	(6,941)	(6,952)	(6,972)
Total current liabilities	**US$m**	**(35,766)**	**(35,488)**	**(45,691)**	**(39,938)**	**(37,621)**	**(39,373)**	**(40,031)**	**(39,374)**
Non current liabilities									
Long-term debt	US$m	(29,408)	(29,655)	(25,405)	(28,648)	(28,766)	(28,173)	(26,463)	(23,758)
Other	US$m	(10,741)	(11,798)	(13,651)	(14,375)	(17,194)	(17,594)	(18,062)	(18,665)
Total non current liabilities	**US$m**	**(40,149)**	**(41,453)**	**(39,056)**	**(43,023)**	**(45,960)**	**(45,767)**	**(44,525)**	**(42,423)**
Total liabilities	**US$m**	**(75,915)**	**(77,237)**	**(84,948)**	**(82,961)**	**(83,581)**	**(85,140)**	**(84,556)**	**(81,797)**
Net assets	**US$m**	**27,181**	**37,412**	**46,850**	**58,328**	**66,044**	**70,314**	**76,853**	**87,785**
Equity									
Shareholders equity	US$m	24,639	34,517	42,194	53,221	59,753	63,585	69,397	79,288
Minority interests	US$m	2,542	2,895	4,656	5,107	6,290	6,729	7,457	8,496
Total equity	**US$m**	**27,181**	**37,412**	**46,850**	**58,328**	**66,044**	**70,314**	**76,853**	**87,785**
Net debt/(Net cash)	**US$m**	**33,979**	**34,813**	**36,895**	**35,384**	**35,492**	**32,889**	**26,019**	**14,077**

Source: Company reports, Bernstein analysis and estimates.

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Exhibit 140

Glencore Xstrata Pro-forma Cash Flow Statement – including Synergies

Cash Flow December year-end		2008 A	2009 A	2010 A	2011 A	2012 E	2013 E	2014 E	2015 E
EBITDA		**14,638**	**9,949**	**14,708**	**15,878**	**13,784**	**15,902**	**20,203**	**26,252**
Change in working capital	US$m	2,682	(6,970)	(3,523)	(2,691)	1,754	(2,891)	(2,812)	(3,114)
Other	US$m	2	891	750	(175)	(75)	187	384	776
Operating cash flow	**US$m**	**17,322**	**3,870**	**11,935**	**13,012**	**15,464**	**13,198**	**17,775**	**23,914**
Income tax paid	US$m	(2,170)	(1,158)	(1,854)	(1,557)	(1,965)	(1,483)	(2,585)	(4,515)
Net Interest paid	US$m	(1,449)	(1,085)	(1,268)	(1,226)	(1,315)	(1,048)	(1,002)	(844)
Other	US$m	850	585	345	403	431	427	413	382
Net cash flow from operations	**US$m**	**14,553**	**2,212**	**9,158**	**10,632**	**12,615**	**11,093**	**14,601**	**18,936**
Capital expenditure	US$m	(6,645)	(4,665)	(7,709)	(10,844)	(11,224)	(7,006)	(6,119)	(4,817)
Acquisitions & investments	US$m	(6,909)	(390)	(1,238)	(1,478)	2,143	-	-	-
Disposals	US$m	352	1,161	652	379	378	1,206	144	10
Other	US$m	74	(2,948)	382	(301)	(168)	(895)	415	1,052
Net cash flow from investing	**US$m**	**(13,128)**	**(6,842)**	**(7,913)**	**(12,244)**	**(8,872)**	**(6,695)**	**(5,560)**	**(3,755)**
(Repayment)/receipt of debt	US$m	2,380	(769)	2,101	(1,466)	(2,383)	(1,186)	(3,420)	(5,409)
Dividends paid to company shareholders	US$m	(826)	(782)	(817)	(1,149)	(1,887)	(1,872)	(2,584)	(3,061)
Dividends paid to minority shareholders	US$m	(522)	-	(407)	(1,002)	(1,209)	(365)	(613)	(1,188)
Shares issued	US$m	-	5,667	-	7,616	-	-	-	-
Shares bought back	US$m	-	-	-	-	-	-	-	-
Other financing activities	US$m	(1,874)	615	(1,055)	(1,586)	385	(403)	(389)	(358)
Net cash flow from financing	**US$m**	**(842)**	**4,731**	**(178)**	**2,413**	**(5,093)**	**(3,826)**	**(7,006)**	**(10,015)**
Effects of exchange rate on cash	US$m	-	-	-	-	-	-	-	-
Change in cash and equivalents	**US$m**	**583**	**101**	**1,067**	**801**	**(1,350)**	**572**	**2,034**	**5,167**
Closing cash & equivalents 31 Dec	**US$m**	**1,982**	**2,037**	**3,185**	**3,253**	**2,130**	**2,702**	**4,736**	**9,903**
FCF to Firm	US$m	8,507	(1,953)	2,372	611	2,275	4,709	9,071	14,582
FCF Per Share	**US$/share**	**.64**	**(.15)**	**.18**	**.05**	**.17**	**.35**	**.68**	**1.09**

(FCF = Operating cash flow less tax paid, less Capex)

Source: Company reports, Bernstein analysis and estimates.

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Exhibit 141
Anglo American Income Statement

Income Statement Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
Production											
Platinum	koz	2,817	2,474	2,387	2,452	2,570	2,530	2,379	2,301	2,386	2,378
Palladium	koz	1,539	1,390	1,319	1,361	1,449	1,431	1,396	1,324	1,393	1,404
Diamonds	k carats	23,011	23,001	21,659	11,070	14,849	14,098	18,314	24,302	24,302	24,302
Copper	kt	680	663	679	677	633	610	670	693	703	735
Nickel	kt	26	26	20	20	20	29	39	29	23	23
Iron Ore	kt	31,109	32,400	37,411	44,596	47,482	46,089	49,137	44,800	46,008	59,234
Thermal Coal - Domestic	kt	43,390	42,521	44,412	51,080	49,923	47,592	46,939	51,422	50,622	48,798
Thermal Coal - Export	kt	33,762	35,212	33,771	25,960	26,808	27,217	28,076	25,789	28,387	30,816
Metallurgical Coal	kt	10,964	11,289	14,889	12,934	17,034	15,243	18,864	19,531	19,331	21,201
Prices											
Platinum	US$/oz	1,142	1,301	1,576	1,200	1,611	1,722	1,552	1,594	1,733	1,859
Palladium	US$/oz	320	355	358	267	526	716	605	737	766	785
Copper	US$/t	6,725	7,124	6,969	5,142	7,531	8,822	7,952	7,320	7,400	7,700
Nickel	US$/t	24,102	37,147	21,155	14,655	21,799	22,896	17,544	16,443	17,890	19,412
Iron Ore Lump	US$/t	54	60	105	80	125	173	127	139	147	151
Iron Ore Fines	US$/t	42	46	76	65	108	152	120	131	138	142
Thermal Coal	US$/t	49	66	129	72	99	121	94	92	104	116
Hard Coking Coal	US$/t	117	103	328	145	220	296	210	179	202	220
Revenue											
Platinum	US$m	5,861	6,789	6,327	4,535	6,602	7,359	5,489	5,959	6,306	6,694
Diamonds	US$m	3,148	3,076	3,096	1,728	2,644	3,320	4,028	6,727	7,113	6,430
Copper	US$m	4,537	4,507	3,907	3,967	4,877	5,144	5,122	4,466	4,756	5,179
Nickel	US$m	553	878	408	348	426	488	336	212	235	255
Iron Ore and Manganese	US$m	2,684	2,300	4,099	3,419	6,612	8,124	6,730	6,999	7,947	10,456
Metallurgical Coal	US$m	1,398	1,389	3,119	2,239	3,377	4,347	3,889	3,591	4,081	4,796
Thermal Coal	US$m	1,935	2,165	3,157	2,490	2,866	3,722	3,447	2,997	3,725	4,488
Other Mining & Industrial	US$m	18,521	9,455	8,851	5,908	5,520	4,039	3,739	2,372	2,372	2,372
Other	US$m	-	-	-	3	5	5	5	6	6	6
Group revenue	**US$m**	**38,637**	**30,559**	**32,964**	**24,637**	**32,929**	**36,548**	**32,785**	**33,331**	**36,540**	**40,678**
Less associates' revenue	US$m	(5,565)	(5,089)	(6,653)	(3,779)	(4,969)	(5,968)	(4,024)	(3,638)	(4,075)	(4,628)
Consolidated revenue	**US$m**	**33,072**	**25,470**	**26,311**	**20,858**	**27,960**	**30,580**	**28,761**	**29,693**	**32,466**	**36,049**
Operating costs	US$m	(24,330)	(16,952)	(18,330)	(16,481)	(19,452)	(20,912)	(23,356)	(23,543)	(25,462)	(28,148)
Associate income	US$m	582	640	1,303	318	845	978	493	164	253	406
Operating profit (underlying)	**US$m**	**9,324**	**9,158**	**9,284**	**4,695**	**9,353**	**10,646**	**5,898**	**6,314**	**7,257**	**8,307**
Net interest	US$m	(165)	(137)	(452)	(273)	(244)	(20)	(288)	(486)	(462)	(395)
PBT (underlying)	**US$m**	**9,159**	**9,021**	**8,832**	**4,422**	**9,109**	**10,626**	**5,610**	**5,828**	**6,794**	**7,912**
Income tax expense	US$m	(2,763)	(2,676)	(2,545)	(1,305)	(2,699)	(2,741)	(1,488)	(1,661)	(1,876)	(2,185)
Tax rate, %	%	30.2%	29.7%	28.8%	29.5%	29.6%	25.8%	26.5%	28.5%	27.6%	27.6%
PAT (underlying)	US$m	**6,396**	**6,345**	**6,287**	**3,117**	**6,410**	**7,885**	**4,122**	**4,167**	**4,919**	**5,728**
Minority interests	US$m	(925)	(902)	(1,050)	(548)	(1,434)	(1,765)	(1,283)	(1,470)	(1,531)	(1,757)
Underlying Earnings	**US$m**	**5,471**	**5,443**	**5,237**	**2,569**	**4,976**	**6,120**	**2,839**	**2,696**	**3,388**	**3,970**
Underlying EPS, USD/sh	**USD/share**	**3.74**	**4.47**	**4.36**	**2.14**	**4.13**	**5.05**	**2.22**	**2.10**	**2.64**	**3.10**
EPS incl Special Items	USD/share	4.23	6.00	4.34	2.02	5.43	5.09	(1.17)	1.44	2.64	3.10
Diluted EPS incl Special Items	USD/share	-	-	-	1.98	5.18	4.89	(1.14)	1.44	2.64	3.09
DPS	USD/share	.67	.80	.92	-	.25	.68	.78	.85	.67	.73
Shares outstanding, millions	m	1,461	1,218	1,201	1,202	1,206	1,211	1,278	1,281	1,281	1,281

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 142

Anglo American Balance Sheet

Balance Sheet Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
Non-current assets											
Intangible assets	US$m	2,134	1,556	3,006	2,776	2,316	2,322	4,571	4,190	4,190	4,190
PP&E	US$m	23,498	23,534	29,545	35,198	39,810	40,549	45,089	44,650	48,418	47,181
Investments in associates	US$m	4,780	3,341	3,612	3,312	4,900	5,240	3,063	4,696	4,823	5,026
Other	US$m	3,039	5,611	3,995	3,991	4,952	5,029	5,449	4,741	4,970	5,283
Total non-current assets	**US$m**	**33,451**	**34,042**	**40,158**	**45,277**	**51,978**	**53,140**	**58,172**	**58,277**	**62,400**	**61,680**
Current assets											
Inventories	US$m	2,974	2,344	2,702	3,212	3,604	3,517	5,005	4,326	4,672	4,964
Receivables	US$m	5,312	3,731	2,929	3,351	3,731	3,674	3,275	3,682	4,012	4,523
Cash and equivalents	US$m	3,004	3,129	2,771	3,269	6,401	11,732	9,094	7,894	6,815	8,378
Other	US$m	1,742	1,516	1,178	1,199	942	379	3,823	862	862	862
Total current assets	**US$m**	**13,032**	**10,720**	**9,580**	**11,031**	**14,678**	**19,302**	**21,197**	**16,764**	**16,360**	**18,727**
Total assets	**US$m**	**46,483**	**44,762**	**49,738**	**56,308**	**66,656**	**72,442**	**79,369**	**75,040**	**78,761**	**80,407**
Current liabilities											
Payables	US$m	(5,040)	(3,950)	(4,770)	(4,395)	(4,950)	(5,098)	(4,536)	(5,534)	(5,975)	(6,349)
Short-term debt	US$m	(2,028)	(5,895)	(6,784)	(1,499)	(1,535)	(1,018)	(2,604)	(3,994)	(4,138)	(2,709)
Other	US$m	(1,731)	(1,635)	(1,570)	(851)	(1,397)	(2,062)	(1,663)	(1,474)	(1,493)	(1,516)
Total current liabilities	**US$m**	**(8,799)**	**(11,480)**	**(13,124)**	**(6,745)**	**(7,882)**	**(8,178)**	**(8,803)**	**(11,002)**	**(11,607)**	**(10,574)**
Non current liabilities											
Long-term debt	US$m	(4,220)	(2,404)	(7,211)	(12,816)	(11,904)	(11,855)	(15,150)	(12,870)	(12,965)	(12,013)
Deferred tax liabilities	US$m	(3,687)	(4,650)	(4,555)	(5,192)	(5,641)	(5,730)	(6,069)	(5,285)	(5,453)	(5,648)
Other	US$m	(2,650)	(1,898)	(3,092)	(3,486)	(3,258)	(3,490)	(5,560)	(4,679)	(4,575)	(4,471)
Total non current liabilities	**US$m**	**(10,557)**	**(8,952)**	**(14,858)**	**(21,494)**	**(20,803)**	**(21,075)**	**(26,779)**	**(22,834)**	**(22,993)**	**(22,132)**
Total liabilities	**US$m**	**(19,356)**	**(20,432)**	**(27,982)**	**(28,239)**	**(28,685)**	**(29,253)**	**(35,582)**	**(33,836)**	**(34,600)**	**(32,706)**
Net assets	**US$m**	**27,127**	**24,330**	**21,756**	**28,069**	**37,971**	**43,189**	**43,787**	**41,205**	**44,161**	**47,700**
Equity											
Shareholders equity	US$m	24,271	22,461	20,221	26,121	34,239	39,092	37,657	35,171	37,592	40,516
Minority interests	US$m	2,856	1,869	1,535	1,948	3,732	4,097	6,130	6,033	6,569	7,184
Total equity	**US$m**	**27,127**	**24,330**	**21,756**	**28,069**	**37,971**	**43,189**	**43,787**	**41,205**	**44,161**	**47,700**
Net debt/(Net Cash)	**US$m**	**3,051**	**4,782**	**11,348**	**11,328**	**7,443**	**1,374**	**8,828**	**9,716**	**11,033**	**7,089**

Source: Corporate reports, Bernstein analysis and estimates

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Exhibit 143

Anglo American Cash Flow Statement

Cash Flow Dec year-end		2006 A	2007 A	2008 A	2009 A	2010 A	2011 A	2012 A	2013 E	2014 E	2015 E
EBITDA		**12,197**	**11,171**	**11,790**	**6,930**	**11,983**	**13,463**	**8,815**	**10,002**	**11,494**	**14,005**
Share of associates operating profit	US$m	(1,090)	(1,072)	(2,104)	(580)	(1,255)	(1,427)	(759)	(483)	(720)	(1,191)
Share of associates D&A	US$m	(329)	(183)	(253)	(248)	(301)	(286)	(233)	(228)	(197)	(206)
Change in working capital	US$m	(532)	(688)	(23)	(910)	(380)	(159)	(527)	400	(303)	(537)
Other	US$m	(189)	611	112	(288)	(123)	(93)	(275)	(195)	(104)	(104)
Operating cash flow	**US$m**	**10,057**	**9,839**	**9,522**	**4,904**	**9,924**	**11,498**	**7,021**	**9,496**	**10,170**	**11,967**
Dividends received	US$m	288	311	659	639	285	403	340	140	154	230
Income tax paid	US$m	(2,035)	(2,886)	(2,173)	(1,456)	(2,482)	(2,539)	(2,539)	(161)	(1,688)	(1,966)
Other	US$m	-	-	-	-	-	-	-	-	-	-
Net cash flow from operations	**US$m**	**8,310**	**7,264**	**8,008**	**4,087**	**7,727**	**9,362**	**4,822**	**9,474**	**8,635**	**10,231**
Capital expenditure	US$m	(3,686)	(3,931)	(5,146)	(4,607)	(5,280)	(6,203)	(5,607)	(6,859)	(7,341)	(3,471)
Acquisitions & investments	US$m	(344)	(1,933)	(7,246)	(384)	(653)	(63)	(4,946)	(145)	-	-
Disposals	US$m	1,766	822	1,554	2,818	2,863	610	166	270	-	-
Other	US$m	459	2,781	(912)	(50)	600	803	566	294	191	191
Net cash flow from investing	**US$m**	**(1,805)**	**(2,261)**	**(11,750)**	**(2,223)**	**(2,470)**	**(4,853)**	**(9,821)**	**(6,440)**	**(7,150)**	**(3,280)**
(Repayment)/receipt of debt	US$m	583	3,121	6,613	(371)	(1,144)	(297)	4,886	109	239	(2,381)
Dividends paid to minorities	US$m	(383)	(728)	(796)	(472)	(617)	(1,404)	(1,267)	(1,058)	(995)	(1,142)
Dividends paid to shareholders	US$m	(2,888)	(1,538)	(1,550)	-	(302)	(818)	(970)	(1,082)	(858)	(937)
Interest paid	US$m	(426)	(483)	(741)	(741)	(837)	(807)	(775)	(934)	(840)	(818)
Shares issued	US$m	-	-	-	-	-	-	-	-	-	-
Shares bought back	US$m	-	-	-	-	-	-	-	-	-	-
Other financing activities	US$m	(3,561)	(5,341)	16	(35)	500	4,800	76	(256)	(110)	(109)
Net cash flow from financing	**US$m**	**(6,675)**	**(4,969)**	**3,542**	**(1,619)**	**(2,400)**	**1,474**	**1,950**	**(3,220)**	**(2,564)**	**(5,388)**
Change in cash and equivalents	**US$m**	**(170)**	**34**	**(200)**	**245**	**2,857**	**5,983**	**(3,049)**	**(186)**	**(1,079)**	**1,563**
Closing cash & equivalents	**US$m**	**3,004**	**3,129**	**2,771**	**3,269**	**6,401**	**11,732**	**9,094**	**7,894**	**6,815**	**8,378**
FCF to Firm	US$m	4,624	3,333	2,862	(520)	2,447	3,159	(785)	2,615	1,294	6,760
FCF Per Share	**US$/share**	**3.16**	**2.74**	**2.38**	**(.43)**	**2.03**	**2.61**	**(.61)**	**2.04**	**1.01**	**5.28**

(FCF = Operating cash flow less tax paid, less Capex)

Source: Corporate reports, Bernstein analysis and estimates

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Disclosure Appendix

Valuation Methodology

European Metals & Mining

Mining companies are operationally and financially geared to their underlying commodity exposure, so we provide two valuation metrics:

- ~80% of weekly mining equity price moves can be explained by underlying commodity price moves, so we use a regression-based trading model and our commodity price forecasts to help determine our 12-month price targets. If the regression remains stable or deviations appear temporary, the model determines the target price. If we believe a deviation is signalling a fundamental change, we will adjust our target price for this fundamental shift and disclose the manner and magnitude of the adjustment made. At present, no adjustments have been made. Target prices are rounded in values in 25p/cent increments.
- We additionally provide a supplementary DCF-based valuation constructed in nominal local currency terms out to 2030 over which explicit commodity price and exchange rate forecasts apply. The nominal local currency cash flows are de-escalated into real U.S. dollar cash flows and discounted at the company-specific WACC. A country risk premium reflecting the geographic origin of the cash flows is added to the underlying WACC to reflect cash flow items (i.e., expropriation) that cannot be explicitly modelled in the cash flow. All reserves are considered exploited by the model. In addition, 50% of the incremental resources (i.e., 50% of the residual resources, excluding those that have already been converted to reserves) of the company are modelled. Where residual life of mine (LOM) may be inferred for operations beyond the 2030 time horizon, a terminal value is applied for the remaining years of potentially exploitable material. We forecast our models in reporting currency (USD), convert to listing currency (GBP or Real), and round final DCF values in 25p/cent increments.

Risks

European Metals & Mining

The four most significant risks facing the major mining houses are lack of capital discipline, operating cost inflation, a sustained downturn in the Chinese economy and resource nationalism.

- Capital discipline. We believe that mined commodity prices will stay high and will continue to trend higher until such point that the massive amounts of labour currently employed in the Chinese mining industry are displaced by capital. This can happen either through a reform of the domestic mining industry in China or through the displacement of that industry by supply increases in other geographies. We do not believe that the natural resource endowment of China will allow for a rapid (if any) domestic reform, as this requires the existence of massive high grade long life deposits (such as copper in Chile or iron ore in Brazil and Australia). Consequently, the duration of the current pricing environment comes down to the extent to which the Western capital deployed by the major mining houses to increase low cost commodity production will displace the requirement for Chinese domestic production.
- Operating cost inflation. US dollar denominated unit costs in all the major mining houses have seen double digit growth rates over the last ten years. Part of this can be explained by movements in exchange rates and part by the prevailing inflationary environment in producer geographies. However, there has still been a very significant increase in underlying real costs. Should this persist or accelerate then it has the capacity to erode value.

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- Chinese economic risks. China is important in commodities as both the major source of demand growth and as the location of the marginal units of supply. We believe that the current slowdown in the Chinese economy has been largely self-induced in an effort to contain food inflation and, as a consequence, of a political stasis ahead of the handover of power at the end of the year. However, a more long lived slowdown has the capacity to move the commodity markets into oversupply on a sustained basis – particularly, if new supply is not curtailed.
- Resource nationalism. Finally, we note with concern the trend towards global fragmentation and the ever greater desire to extract value from the mining sector. We believe that this is ultimately a self-defeating strategy by host governments but it is one with an impressively long pedigree. Persistent macroeconomic headwinds will make this an ever more attractive option.

Glencore Xstrata PLC

- In the case of Xstrata, company specific risks include continued weakness in the price of thermal coal and copper. In the immediate short term, if the Glencore offer were to lapse we see this as possibly creating some temporary downside pressure to Xstrata's share price. Operationally, the biggest challenge is the transition required to replace some older assets towards the end of their LOM with newer assets (e.g. in copper Tintaya and Antappacay).
- Additionally, in the case of Glencore, we see downside risk should the proposed merger with Xstrata not go through. Looking beyond the regulatory approval, the greatest unknown, in our minds, for Glencore relates to the marketing activities. We believe there is insufficient transparency to assess both embedded risk in the trading book and persistence of edge. We also note that Glencore requires high levels of working capital and remains vulnerable to large swings in cash-flow generation as a result. We note as a result of its operations in frontier jurisdictions, as well as the unknown nature of embedded risk and persistence of edge in the marketing book, headline risk remains a significant concern for Glencore
  - Post merger (assuming it clears the final regulatory hurdles), we see challenges facing the combined Glencore-Xstrata entity, specifically integration of Xstrata's significantly larger operating business into Glencore's management structures whilst avoiding disruption to a number of critical projects. Furthermore the choice for a new Chairman will be critical to ensuring that the corporate governance and minority shareholder interests are well protected as Glencore enters a new stage in its life as one of the largest publicly listed mining companies in the world.

Anglo American PLC

- For Anglo American in particular, inability to improve the efficiency of its platinum operations and continued margin pressure arising from South African labour inflation poses downside risk, as does the potential for increased union militancy in South Africa (and again in platinum in particular). A continued deterioration in labor unrest along with the attendant physical hazards, delays and expenses could weigh on results. Further delays at the Minas Rio iron ore project in Brazil would also be a significant negative catalyst. Failure to properly integrate De Beers into the Anglo American portfolio could again risk value loss.

BHP Billiton PLC

- In the case of BHP Billiton, company specific risks include continued weakness in the price of natural gas in the US and iron ore. Repeats of the weather induced volume losses in BHP's metallurgical coal operations as well as continued labour related disruptions in these assets could also prove an impediment to our price target.

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Vale SA

- In the case of Vale, company specific risks include any sustained down-turn in the price of iron ore as the company derives nearly the entirety of its value from exposure to iron ore. The continuation of disruptions to the output of nickel and attendant cost pressures are also a risk. The commissioning of Goro (VNC) is an issue that needs to be addressed, as is the performance at Onca Puma.

Rio Tinto PLC

- In the case of Rio Tinto, company specific risks include any sustained down turn in the price of iron ore will negatively impact Rio as the company is the second most exposed of our coverage group to iron ore (after Vale). Any relaxation of capital discipline particularly around the Simandou project in Guinea would also be, in our view, a negative catalyst. Execution delays in the commissioning of the Oyu Tolgoi copper project in Mongolia or significant revenue grabs from the Mongolians could also be a risk.

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  Outperform: Stock will outpace the market index by more than 15 pp in the year ahead.

  Market-Perform: Stock will perform in line with the market index to within +/-15 pp in the year ahead.

  Underperform: Stock will trail the performance of the market index by more than 15 pp in the year ahead.

  Not Rated: The stock Rating, Target Price and estimates (if any) have been suspended temporarily.
- As of 08/09/2013, Bernstein's ratings were distributed as follows: Outperform - 39.2% (0.9% banking clients) ; Market-Perform - 48.2% (0.4% banking clients); Underperform - 12.6% (0.0% banking clients); Not Rated - 0.0% (0.0% banking clients). The numbers in parentheses represent the percentage of companies in each category to whom Bernstein provided investment banking services within the last twelve (12) months.
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12-Month Rating History as of 08/11/2013

Ticker	Rating Changes	
AAL.LN	O (IC) 09/05/12	O (DC) 07/29/11
BBL	O (IC) 09/26/12	O (DC) 07/29/11
BHP	O (IC) 09/05/12	
BHP.AU	O (IC) 09/26/12	
BLT.LN	O (IC) 09/05/12	O (DC) 07/29/11
GLEN.LN	O (RC) 02/13/13	M (IC) 09/05/12
RIO	O (IC) 09/05/12	O (DC) 07/29/11
RIO.LN	O (IC) 09/05/12	O (DC) 07/29/11
VALE	O (RC) 06/07/13	U (IC) 09/05/12
VALE3.BZ	O (RC) 06/07/13	U (IC) 09/05/12

Rating Guide: O - Outperform, M - Market-Perform, U - Underperform, N - Not Rated
Rating Actions: IC - Initiated Coverage, DC - Dropped Coverage, RC - Rating Change

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