

MOLYBDENUM

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In the past two years, fluctuating demand from the steel sector, the main consumer of molybdenum, rejuvenated molybdenum supply from Russia and South America, and an abundance of low-cost material from China, particularly ferromolybdenum, has contributed to a high level of oversupply that has sent molybdenum prices down to record low levels. The situation is further complicated by co-production of molybdenum at a large number of porphyry copper operations (76% of the world total supply in 1999), which is largely insensitive to price, and the concomitant reduction in ability of primary mines to act as 'swing' producers.

Consolidation within the industry at the end of 1999, driven by interests in copper rather than molybdenum, led to the merger of Asarco Inc. with Grupo Mexico and Phelps Dodge Mining Corp. (PDMC) with Cyprus Amax Inc., making Phelps Dodge the largest molybdenum producer in the world at that time. In 2000, both Codelco and Phelps Dodge are estimated to have produced around twice the amount of molybdenum supplied by Grupo Mexico, the third largest producer. Such trends within the industry have put further pressure on molybdenum operations to remain profitable and could lead to closures, particularly when molybdenum mining does not form part of a company's core business.

Supply

Since 1995, the molybdenum market has been severely affected by oversupply, primarily the result of an influx of low-cost material from China, mainly in the form of ferromolybdenum, combined with a rejuvenated supply from Russia and South America. Output from the primary producers has been steadily cut back since 1998 but new by-production from copper operations, such as Los Pelambres in Chile, which

started producing molybdenum in February 2000, has partly compensated for this. This is evident in the table below which shows that since 1995, Canada and the US have cut production by 33% and 47% respectively, while output from Latin America has increased by 33%.

Since 1997, world production has fallen from a peak of 138,820 t (305 Mlb) to 111,600 t (246 Mlb) in 2000. Further cuts in production are planned in 2001 so a further draw down in inventory is possible.

Historically, the US is the world's dominant producer of molybdenum, although with the recent cuts in output, there is currently relatively little difference between production rates in the US, China and Chile. These three countries accounted for around 78% of world production in 2000.

A large proportion of output in the US, and most of that in China, comes from primary molybdenum mines and, therefore, fluctuates

Molybdenum Production ('000t)			
	1998	1999	2000^e
Canada	8	5.9	6
Chile	25.3	27.3	27
China	30	27.9	28
CIS ¹	5.3	5.5	5.6
Mexico	5.9	6	6
Peru	4.3	4.4	4.5
US	53.3	43	32.1
Others ²	2.6	2.4	2.4
Total	134.7	122.4	111.6

Source: USGS *Mining Annual Review*.

Notes: Production from North Korea, Romania, Turkey and Yugoslavia is not included.

¹ Armenia, Kazakhstan, Kyrgyzstan, Russia and Uzbekistan.

² Chiefly Mongolia and Iran.

^e estimate.

according to price and perceived demand. In the past year, the primary mines at Henderson, Thompson Creek and Questa in the US, and Endako in Canada, have reduced output by up to a third in an attempt to constrain the build up of inventory. Although some of the smaller copper-molybdenum operations have closed down, US supply remains firmly underpinned by production at the giant porphyries of Bingham Canyon and Butte (Continental mine). In China, molybdenum mining was initially not affected by normal economic pressures, and enjoyed a competitive cost base and strong domestic demand from a fast-growing steel industry. However, the prolonged period of low prices has forced China also to reduce production rates in 2000.

In Chile and the rest of Latin America, molybdenum is produced solely as a by-product of copper mining and is dependent on the economic state of the copper market. For copper miners, such as Codelco, the added value of molybdenum credits has been an important bonus to the economics of their core operations. For this reason, molybdenum output in Chile, the world leader in copper production, has actually risen by 8.5%/y since 1995, despite the declining state of the molybdenum market. This has had two inter-related effects. The increased output has not only added to the inventory overhang but also cancelled out the effect of reduced output from the 'swing' producers.

Exports of low-cost material from China continue to contribute towards world oversupply and this is unlikely to change in the short-term. However, domestic molybdenum output is falling and demand from the Chinese steel industry is growing. Together, these factors will combine to reduce Chinese exports of molybdenum. In addition, anti-dumping duties, which may be enforced by the US and Europe by the end of

2001, could also lead to a cut in China's export volumes and potentially could remove a highly uncertain variable on the supply side of the molybdenum market.

Production from the large number of small private companies throughout China (the world's second largest molybdenum producer) is highly variable and some could close in the mid-term. Many Chinese oxide and ferromolybdenum producers may also be forced to close under tightening pollution-related legislation. This is likely to have a major impact on China's molybdenum industry over the next 3-5 years.

Supply from the CIS has also fallen steadily as producers in Armenia, Kazakhstan and Russia have lost both their major customer, the Soviet defence industry, and the state subsidies, which kept them in business. Although production was estimated to have increased slightly in the latter half of the 1990s, this came about as Western producers were looking to reduce output due to market oversupply.

In 2000, the five largest producers, Codelco, Phelps Dodge, Grupo Mexico, JDC and Thompson Creek, accounted for 70% of world production, of which all but the JDC operations in China are located in North or South America. The merger with Cyprus Amax in 1999 made Phelps Dodge the world's largest molybdenum producer, but cutbacks at Henderson in 2000 has since returned Codelco to the position of world leader. Although proposed cuts at Sierrita

Major Producers of Molybdenum ('000 t contained)			
Company	Country	1999	2000
Codelco	Chile	23,787	24,000 ^e
Phelps Dodge Mining Corp.	US	25,424	23,154
Grupo Mexico	Mexico & Peru	12,732	11,974
JDC	China	10,710	9,690
Thompson Creek Metals	US & Canada	9,556	9,448
Total Listed		72,653	78,266
% World Total		59	70

Source: *The Economics of Molybdenum 7, 2001* (Roskill)
e-estimate

and Chino (driven more by energy costs than molybdenum price) will reduce Phelps Dodge's molybdenum output further, this will not affect its position as one of the two world leaders in this sector.

In terms of new production, the giant copper-molybdenum operation at Los Pelambres started producing by-product molybdenum in the first quarter of 2000 and, once operating at full capacity could place Anaconda Chile in the top ten producers in the world. Another major producer, the Antamina polymetallic mine in Peru, is due to start production by the end of 2001. The potential combined output from these two operations alone will be equivalent to 6.5% of the total world production in 2000. Evidently, the proportion of co-produced molybdenum is set to grow in the future.

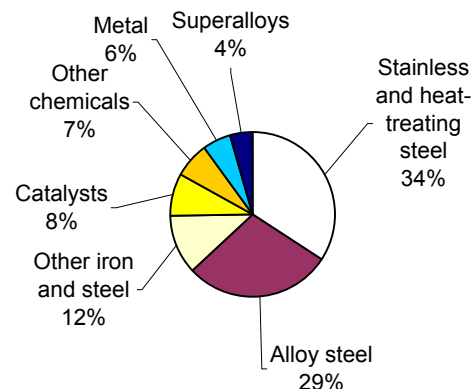
Demand

Since 1995, molybdenum consumption has grown annually by around 2%, and although global consumption is a matter of some debate in the industry, estimates for 1999-2000 generally fall in the range 122,000-130,000 t. The iron and steel industry account for 75% of molybdenum consumption, of which 30-35% goes to the stainless steel sector, which has had an annual growth rate of around 4% over the same period. The market for high strength-low alloy (HSLA) steels containing molybdenum has also been growing and there have been moves to promote the further use of duplex steels, which contain relatively high levels of molybdenum.

Molybdenum Consumption			
	1997	1998	1999
US	34.5	34	31.8
Western Europe	44.5	45.9	48.1
Japan	21.3	21.8	18.6
China	8.2	8.6	8.6
CIS	2.3
Other	16.8	17.3	19.5
Total	125.3	127.6	128.9

Source: International Molybdenum Association (IMO)

Molybdenum Consumption by End-Use, 2000



Source: Industry estimates.

Notes: Other iron and steel includes tool steel, high speed steel, cast iron and welding rods.

Other chemicals includes lubricants, pigments, water treatment, polymers and airbags

Although superalloys and molybdenum metal have also shown significant growth, the second largest consumer of molybdenum after iron and steel is the catalyst industry, where continued growth in the petroleum refining and automotive catalysts sector has pushed up demand by 5.5% annually since 1990. Annual growth is set to continue at around 3-4% through to 2005. It is, therefore, the stainless steel and catalyst sectors that are largely responsible for overall growth in world molybdenum demand since 1993. Future demand is very much dependent on the world economy.

Western Europe is the world's largest molybdenum-consuming region by virtue of the size of its steel industry, accounting for around 37% of total demand in 1999. In comparison, the US accounts for 25% and Japan for 14%. China could eventually emerge as a net importer as its steel industry continues to expand, but in 1999 molybdenum consumption stood at about one-third of its production. Although 11-12 Mlb (5,000-5,400 t) of concentrates were imported in 1999, most was used to produce

high quality ferro-molybdenum that was subsequently re-exported to the West. The former Eastern bloc is now a net exporter with about 4 Mlb (1,800 t) of molybdenum shipped to the West in 1999.

Demand from the iron and steel industry has grown by an annual average of 3% since 1990, and continues to be the largest consumer of molybdenum, accounting for 75% of demand in 1999. In recent years, stainless steel has taken market share from alloy steel and is now the predominant sector, having grown by 55% since 1990.

Prior to 1997, molybdenum consumption by stainless steel in the US had been growing by 2.5% annually although consumption by all steels was marginal at 0.1%. However, between 1997 and 1999 there was a 20% fall in molybdenum use in the steel industry. Demand from stainless fell by 9%, despite a 6% rise in stainless output, and a further decrease was expected in 2000. Evidently, there has been a decrease in production of molybdenum-bearing grades of stainless and other steels. The downturn in the US economy forecast for 2001 could lead to further decreases in molybdenum consumption which, because of the time lag between capital spending and normal economic activity, may not become apparent until 2002-2003.

Price

Molybdenum has a 'natural' price range of US\$2.00-5.00/lb for oxide and US\$6.00-12.00/kg (\$2.70-5.40/lb) for ferromolybdenum, which it has exceeded only once since 1982, during the short-lived boom in 1994-1995. This was caused by a sharp rise in demand from growing world steel production which molybdenum producers were unable to meet, coupled with delays and cancellations of exports from China.

The main reason behind the low molybdenum prices in the second half of the 1990s is the large excess of stocks. This oversupply is largely determined by two factors, which are

expected to continue as the main drivers of the molybdenum market in the future:

- the demand from steel producers, the primary end-users of molybdenum;
- the pattern of imports from China, arguably the main cause of oversupply since 1995.

The growing proportion of supply as a by-product of copper mining and the concomitant reduction in the ability of primary mines to act as 'swing' producers, is also important but remains more predictable than the two factors listed above.

In the first quarter of 1998, oversupply drove prices to a five-year low (US\$2.20-2.30/lb oxide) thereby enforcing cutbacks by the world's primary molybdenum producers. The prices have subsequently remained flat, at around US\$2.50-3.00/lb for molybdenum oxide and US\$3.00-4.00/lb or ferromolybdenum.

Although prices increased gradually during the first half of 2000 they subsequently declined, mostly remaining below US\$3.00/lb for oxide. During the first six months, an increase in demand from the stainless-steel sector coupled with a tight supply of stainless-steel scrap helped to raise molybdenum prices. Further cuts in production by Thompson Creek, Climax Molybdenum (PDMC), and JDC and Huladao in China contributed to this trend. Restricted delivery from Chile in June resulted in a peak of US\$2.85-3.05/lb for oxide and US\$7.35-7.50/kg for ferromolybdenum in Europe.

In the second half of the year, demand from the stainless steel sector peaked and started to fall in response to an excess of stainless scrap, which had become available owing to falling nickel prices, as consumers unloaded stockpiled material that had been expected to retain a higher market value. Cutbacks and closures, such as at Montana Resources's Continental mine in July and JDC in October, made no impression on price falls as they

were compensated for by new Russian exports and the continued surplus of ferromolybdenum from China.

By November, slowing economic growth in Europe was more than made up for by improved demand from tool/speed steels and automotives (for ferromolybdenum) in the US. Although Chinese shipments to Rotterdam had fallen by 30% since June, an anti-dumping investigation of Chinese ferromolybdenum exports to Europe and the US was being called for. While this could lead to a reduction of material from China, the threat of action may encourage China to increase exports before any duty is imposed, thereby keeping prices low, or driving them even lower. However, the situation remained unresolved with prices finishing the year at around US\$2.35/lb oxide and US\$6.30/kg ferromolybdenum in Europe.

Outlook

Swing producers, such as the Henderson, Thompson Creek and Endako mines, have been forced to cut back production incrementally since 1998 due to the general state of oversupply in the market and the consequent low molybdenum price. The cutbacks have yet to make a significant impact on prices, however, and further cuts have been proposed. This should have a positive impact on the widely contested supply-demand balance for molybdenum.

There is no uniform agreement on the size of inventory overhang that has driven molybdenum prices to their current low levels. Although some reports estimated that the surplus at the end of 2000 was around 40-45 Mlb (18,000-20,500 t), stocks could actually be considerably higher. An excess of demand over supply of around 6,000 t (13 Mlb) in 1999 represented the first drop in surplus during the 1990s. A further drop took place in 2000 following the reductions in output in North America. If demand continues to exceed supply, as seems likely in 2001, then the inventory will decrease further.

Primary output in China has been forced to cut back as the output from the world's copper-molybdenum producers has increased. The growing steel sector in China is expected to consume a progressively greater amount of domestic production in future years so it is possible that China may eventually become a net importer. This would have a major effect on supply patterns as China has supported Western demand for molybdenum since 1991. However, such a situation is not likely to occur in the short- to mid-term.

The percentage of molybdenum production coming from copper mining operations has grown by an annual average of around 2.5% since 1980 and was estimated at about 76% in 2000. Clearly, if this rising trend continues and prices remain in the range that has typified the past 20 years, irrespective of whether they move away from the recent record lows, the future of primary mines looks uncertain, particularly in the light of the continuing development of new copper operations, such as Los Pelambres and Antamina.

A growing proportion of molybdenum is likely to be derived from recycling or regeneration of spent catalysts because of environmental legislation preventing the disposal of such catalysts. Recycling also has an economic benefit as a company can expect to recover 75-95% of catalytic activity at around 20% of the cost of a new catalyst.

The International Molybdenum Association (IMOA) estimated that, in the US alone, 2,250 t molybdenum was recovered from spent catalysts in 1993, whereas in 1995, the worldwide total of molybdenum derived from recycled catalysts amounted to 3,175 t. This decreased to 2,270 t in 1996 and although more recent figures are not available, catalyst recycling in general, in 1998, was estimated to be growing at 5% in Europe and North America, and 10% in Asia/Pacific. This is equivalent to 2,760-3,320 t (or about 3% of world supply) in 2000.

In the five years following 2000, world molybdenum demand is predicted to grow by 2-3% each year. The highest growth rate is expected to come from non-metallurgical applications where demand is predicted to increase annually by about 3-4% on the back of the continued growth in the petroleum refining and automotive catalysts sector. However, some plateau in consumption will become evident as the conversion to low-sulphur, lead-free gasoline is completed worldwide.

Growth will also continue to be heavily influenced by activity in the iron and steel industry, particularly in relation to stainless steel, which will continue to be a major driving force behind worldwide molybdenum consumption patterns. Growth in other steel sectors may be quite flat, although current preferences for HSLA steels will contribute towards moderate growth (1% annually) in the alloy steel sector.

Superalloys are dependent on aerospace applications, which account for around 75% of this market. However, land-based turbines could become more important as this industry was predicted to grow by 35% between 1997 and 1999.

Overall, the molybdenum price will probably be maintained within its 'natural' range of US\$2.00-5.00/lb for oxide and US\$6.00-12.00/kg (US\$2.70-5.40/lb) for ferromolybdenum. The recent cuts in supply could help to improve prices by reducing inventory but additional by-product molybdenum from new copper operations would tend to counter this effect. The quantity of imports from China will continue to be important but the ruling on Chinese dumping of ferromolybdenum expected towards the end of 2001, could be the main factor in pushing the prices away from the recent 'lows'.