

ANTIMONY

By Howard Masters, Lambert Metals, UK

Availability from China remained the main factor determining trends in the antimony market during 2001. China accounts for about 83% of world mine production and a similar percentage of recorded exports although this figure is much higher if unrecorded or illegal exports are included. Various mining disasters through the year, particularly in the main antimony mining province of Guangxi, resulted in the closure (or at least suspension) of production at many mines and, indeed, exports of unwrought antimony fell by 51% to 22,007 t according to Chinese customs figures. Despite this, prices had fallen by the end of the year reflecting general low demand as a result of depressed world economies and the extent to which antimony continued to be exported by means not showing up on 'official' statistics.

International trade is in the form of ores, concentrates, trioxide and metal in various grades from pure to high and antimonial Lead. Trading is on a large scale as resources are concentrated in developing countries such as China while consumption of refined products is mostly in the more developed Western countries. During the 1980s China expanded its smelting capacity and this increased the availability of low-cost metal replacing the more traditional exports of ores and concentrates as crude antimony metal became more commonly used by Western consumers as raw material for refined antimony metal and trioxide production.

Antimony has several forms, the most common of which is a hard, silver-white crystalline solid. Lustrous and extremely brittle, antimony has a melting point of 630.5°C, a boiling point of 1,380°C, an atomic weight of 121.75 g/mol and a relative density of 6.691. Its name derives from the Greek 'Anti-Monas' meaning a metal seldom found alone.

Antimony, like arsenic and bismuth, normally occurs in nature in the form of sulphide minerals and is obtained from sulphide ore. Pliny the Elder named it 'stibium' in Latin and wrote about seven medicinal remedies using stibium or antimony sulphide. Hence the chemical symbol has been Sb. Antimony is also found in minor amounts in ores of various metals such as copper, lead, silver and mercury.

Antimony in modern industry is rarely used alone and is usually alloyed with other metals such as lead and zinc. These alloys are used in lead storage batteries, solder, sheet and pipe metal, bearings, castings, type-metal, ammunition and pewter.

Antimony ores are mined and then beneficiated and processed into antimony oxide, a white powder. Chemical-grade ore is that which is sufficiently pure to be used directly in producing the trioxide, chloride or other industrial chemical compounds. For chemical-grade sulphide ore, total impurities including arsenic and lead must not exceed 0.25% and no single metallic impurity can exceed 0.1%.

More than 2,000 years ago the natural sulphide of antimony, stibnite, was used as both a medicine and a facial cosmetic. Today the most significant of the antimony compounds, antimony trioxide, is employed as a flame retardant in an organic solvent applied to textiles, plastics, building materials, adhesives, rubber, pigments, paper etc.

Antimony is used in non-metal products, including enamels for plastics, metal, and ceramics, as a decolourising and refining agent in special optical glass and other glasses; stabilisers and plastics; pigments in paints and ceramics; in vulcanising agents; in ammunition primers; and in fireworks.

Most commercial grades of antimony trioxide contain between 99.20% and 99.50% Sb with varying amounts of impurities such as arsenic, iron and lead. Commercial suppliers offer various grades of antimony trioxide based on the relative tinting strength of their product which is related to average particle size. In general the tinting strength increases as the particle size decreases.

The commercial metallic products are generally semi-circular shaped ingots (regulus), plates, broken pieces, granules and cast cake. Other forms are powder, shot and single crystals.

The most common form of metal produced by smelting is minimum 99.65% Sb regulus material on which most world prices for metal are based. The price for this standard regulus as quoted by Metal Bulletin on an in-warehouse Rotterdam basis, was US\$1,400-US\$1,500/t at the beginning of the year having recovered from an all-time low of US\$1,080-US\$1,130/t at the end of April 2000. For the second year running, however, the price did not experience its usual seasonal improvement early in the year as a result of the Chinese Lunar New Year celebrations at the end of January. As in 2000, consumers and traders appeared to have built up sufficient stocks to offset any possible disruption to shipments. Also worsening world economies were slowing demand. As a result the price dropped steadily back down again to reach a new low in August of US\$1,000-US\$1,050/t.

It was at about this time that news broke of a disaster at Longquan Mining Co. in Guangxi Province in July in which over 200 people were killed. There could be severe repercussions in the medium to long term for the antimony market. The Chinese government called a halt to all mining in Guangxi pending an investigation into the incident. Arrests were made and industry sources feared that a stringent crackdown on illegal mining activity and a subsequent restructuring of mining practices in the province would prolong the shutdown.

World Mine Production (Antimony content of ores and concentrates produced, in tonnes)

	1997	1998	1999	2000	2001 ^e
Australia	1,900	1,800	1,800	1,000	1,800
Bolivia	5,999	4,735	2,790	2,800	3,000
Canada	529	428	566	300	800
China	131,000	97,400	100,000	100,000	95,000
CIS: Russia	6,000	4,000	4,000	5,000	3,000
Kyrgyzstan	1,200	150	100	200	200
Tajikistan	1,200	1,500	1,800	2,000	2,000
Guatemala	880	440	440	200	500
Mexico	1,909	1,301	1,500	1,000	1,800
Morocco	160	160	150	100	250
Namibia	-	-	-	-	-
Pakistan	-	-	-	-	-
Peru	242	364	255	200	350
South Africa	3,415	4,243	6,000	5,000	5,000
Thailand	60	200	190	100	300
Turkey	31	30	30	100	200
US.	356	498	449	N/A	300
Zimbabwe	-	-	-	-	-
TOTAL	154,881	117,249	120,070	118,000	114,500

^e Estimated

Source:- US Geological Survey Mineral Commodity Summaries on Antimony January 2002 much of which contains estimated figures. Accordingly adjustments have been made where more accurate information has been obtained.

The area of Guangxi in which the Longquan mines are located, Nandan county, is responsible for an estimated two thirds of China's output of antimony concentrates. A privately-owned company, Longquan was believed to employ in the region of 20,000 people and production of non-ferrous concentrates during the first half of the year

topped 12,000 t, according to the China Nonferrous Metals Industry Association with around 3,800 t of contained antimony, 3,500 t of tin and 5,000 t of lead. Although the company's closure alone could have an effect on the market, the government's extension of the mining ban across the entire province would have a much more marked effect once inventory levels had been run down. The ramifications were expected to be felt more in the antimony market than either the tin or the lead sectors.

Initially there was little reaction, July and August being traditional holiday months particularly in the northern hemisphere. The trade was generally long of material and remained cautious with demand still weak. However, as consumers returned to the market in September demand improved and, aided by some speculative and panic buying, the price rose dramatically to US\$1,400-US\$1,480/t by the middle of the month, almost back to the levels at which the year started. This improvement in price was not to last, as it became clear that most Chinese smelters had built up considerable stocks owing to the previously poor demand and these higher prices tempted many to release these stocks. In addition, smuggled material continued to appear on the market and after the initial flurry demand returned back to being poor. As such the price drifted back down for the rest of the year to end at US\$1,140-US\$1,250/t. The quotations for both clean sulphide concentrates and lumpy sulphide ore decreased regularly from US\$9.00-US\$9.50/mtu at the beginning of the year to US\$7.00-US\$8.00/mtu during August at which time the *Metal Bulletin* suspended its quotations reflecting the ever decreasing lack of business in these forms of antimony.

Antimony was mined as a principal product or was a by-product of smelting base-metal ores in 15 countries. Some 83% of world primary antimony output was mined in China, and just over 4% in each of South Africa and the combined CIS. World antimony reserves were estimated at 2.075 Mt sufficient at current mining levels for a further 20-30 years.

Chinese production is split between state-run plants and the private sector. Of the former, Hsikuangshan Mining Administration is the largest antimony trioxide producer worldwide. Based in Hunan Province, it has a capacity for antimony products including metal and trioxide of 30,000 t/y and plans to increase trioxide production from 15,171 t in 1998 to 24,200 t in 2005. The Guangdong smelter in Guangdong Province, with a capacity of 10,000 t/y was expecting only to maintain metal output at the same level of 2,000 t as produced in 2000. Prior to this, production had been running at nearly 6000 t/y.

The biggest concentration of antimony production in China is in Guangxi Province where large producers include the Huan Dong Metal Materials Plant, which has a capacity of 10,000 t/y of trioxide. The province's proliferation of small privately-owned mines contribute to the country's huge capacity of around 140,000 t/y.

Guangxi is adjacent to Vietnam and considerable quantities of antimony cross this border to avoid official export controls. Prior to the accidents and suspension of mining in the province, Nandan Longquan Mining planned to hold back production to 6,600 t in 2001, the same as in the previous year, rather than its previous target of 7,000-8,000 t. However, the company also expected to complete a lead-antimony expansion during the year which would boost capacity to 15,000 t/y. The Guangdong Quijiang refinery also intended to maintain production of metal ingots at 2,000 t. Antimony and lead producer Nanfang Non-Ferrous Metals continued with plans to produce antimony trioxide and was expected to start production at the end of September. Production by the year end was targeted at 5,000-6,000 t of oxide with an eventual capacity of 15,000 t/y. In addition production of antimony ingot was to be increased to 10,000 t, up from previous capacity of 7,000 t/y as a result of a series of improvements at the company's operations. Planned diversification into aluminium production was put on hold following the tightening of supplies of raw

material as a result of mine closures in the Nandan region which were also threatening to undermine the improvements in antimony production capacity.

The closure of a large number of important sources of ore and the destruction of mining pits, haphazardly dug by private companies in the search for ore which were, despite being dreadfully unsafe, a major contributor to the supply of ore from the region, left Nanfang with an uncertain future despite having a reserve feed of 8,000 t in the middle of September. This was because traditionally 90% of its feed came from the Nandan mines. Indeed production which was then only running at 20% of capacity ceased at the end of March 2002 as the ore shortage, which had bitten progressively harder as the government crackdown on illegal mining in the Guangxi Province, began to take a stranglehold. Nanfang did admit, however, to holding back a stock of 1,000 t in the expectation of an improved market. This left China Tin and Non-Ferrous Industry Group as the only producers in Guangxi able to operate normally. Both are state-owned enterprises with their own mines but, despite their newly developed monopoly situation in the province, neither was operating anywhere near capacity as world demand remained depressed.

China Tin has two smelters - Jinchengjiang and Hechi Metallurgical & Chemical - both with a capacity in excess of 10,000 t/y although throughout the year they were only running at about 50% of capacity. Furthermore, the concentrates shortage was not affecting these smelters as the company's own Gaofang mines were still operating and producing some 3,000 t/mth of antimony content in ores of which China Tin takes two thirds and as a result was believed to have large stocks of concentrates. Nanxing, which has a 30% stake in the mines, accounts for the remaining third of the concentrates. Also, the state-owned company stopped production at one of its old 10,000 t/y smelters during the year due to a shortage of concentrates but was still operating its old 20,000 t/y plant and

planned to start up a new 20,000 t/y plant in early 2002. Throughout 2001 Nanxing was producing 1,500-2,000 t/mth of ingots of which most was sold domestically and part exported by trading companies.

Hechi Non-Ferrous was producing at its capacity of 3,000 t/y ingots and 2,000 t/y trioxide as it uses ore not mined in Nandan county. Towards the end of the year China Tin announced plans for increased production of lead and antimony in 2002 at both the Jinchengjiang and Hechi plants.

Statistics from China Non-Ferrous Metal Industry Association showed that China produced 119,103 t of antimony in January-November 2001, up 21.9% year-on-year despite an export quota aimed at capping this total. Antimony concentrates production in the same period fell by 20.1% to 73,445 t of contained metal, almost certainly a reflection of mining restrictions seen in the previous year. However, the same figures show metal production for the period actually rose in Guangxi by 41.5% to 61,553 t.

Intriguingly, figures from Chinese customs show that exports of unwrought antimony in January-November 2001 fell by 52.2% to 20,447 t. According to the same source, antimony oxide exports also fell by nearly 10% to 31,948 t. However, no official indication is given for the likely total of antimony smuggled out of China in 2001.

Outside China, Kyrgyzstan has traditionally been the largest supplier of antimony metal to world markets and until 1995 the Kadamjaisk plant was the sole producer of refined antimony in the CIS, processing raw materials produced in Russia, Tadjikistan and domestically.

The plant was built in 1932 on the site of a large antimony ore resource and has a capacity of 10,000 t/y, but antimony prices are now so low that production of the metal cannot support the facility. Kadamjay enjoys a number of advantages over its Chinese competitors. The grade of the ore is higher

and the product is thus purer but, more importantly, the ore contains gold, and it is this added value that is keeping Kadamjay in existence and antimony production in 2001 was negligible.

This reduced antimony production reflects also higher energy costs and transport charges (government no longer subsidises the transport of concentrates from Russia) and a raw material shortage following the start of refined antimony production in Russia since the break up of the former Soviet Union. Russia's only producer of antimony concentrates is the Sarylakh - Surria mine in Yakutz. In 2001, the company produced 4,152 t of antimony concentrates but only sold 29%. The remaining 33% of reserves are deeper than 520 m and recovery would require abundant expenditure. In view of mounting losses, the Yakutia Government's Economic Council advised that the mine and beneficiation plant should be mothballed in 2002.

In September 2001, approval was given for a Tajik-Austrian Joint Venture (JV) at the Anzobsky Mining & Metallurgical Complex, a producer of antimony and mercury ore. The JV would produce antimony metal in Tajikistan. Previously, Tajikistan's production of antimony-mercury ore was processed in Kyrgyzstan; the mercury was first removed at the Khaidarkensky Mercury Works and then sent to Kadamjay.

Consolidated Murchison Ltd, South Africa's sole producer of antimony, continued to expand its output despite the low prices that have caused other Western producers to curtail operations. With gold as a by-product of its antimony mining, Murchison has been able to withstand the low prices. The reopening of its Beta shaft was completed with a small quantity of ore being mined in April although full production of 10-15,000 t/mth of ore from the shaft will not be achieved until the third quarter of 2002.

Murchison is developing the Beta shaft to replace depleted reserves. It is committed to

maintaining reserves equivalent to six years' output. That goal is likely to remain intact even though reserves at the mine's Athens shaft are falling. Athens has a four-year life expectancy at its current ore production rate of 10,000 t/mth. The Athens shortfall will be made up with ore from the Beta shaft and Murchison believes Athens could also be extended. By the middle of 2002, the Athens and Beta shafts are expected to be producing ore at a rate of 10,000 t/mth each, while output from the Monarch shaft will match the other two combined. However, if underground exploration, particularly at the deeper levels, results in new reserves, the company could find itself with three producing shafts, each with a capacity of 20,000 t/mth. Processing this potential mine output would call for an expansion of the treatment plant, which at present can only process 50,000 t/mth of ore even if it operates seven days a week. Murchison delivers all of its production of Antimony Sulfide concentrate to an on-site oxide plant, which converts sulphide concentrate into crude Antimony oxide for export to refineries in Mexico and the US.

World Reserves and Reserve Base (tonnes antimony content)

	Reserves	Reserve Base
US	80,000	90,000
Bolivia	310,000	320,000
China	900,000	1,900,000
Kyrgyzstan	120,000	150,000
Russia	350,000	370,000
South Africa	240,000	250,000
Tadjikistan	50,000	60,000
Other Countries	25,000	75,000
World Total	2,075,000	3,215,000

Source:- US Geological Survey Mineral Commodity

Summaries January 2002.

Murchison contributes 4-5% of world supply. This is in sharp contrast to 30 years ago when South Africa provided more than one-third of the world's supply, closely followed by Bolivia with its host of small mines. Bolivian output dropped sharply in 1997 and has steadily dwindled. In recent years, as Chinese material flooded the market and prices dropped mounting losses by the poorly capitalised Bolivian industry made further significant production impossible there.

Other potential growth areas are Myanmar (Burma), where Myanmar Mayflower Mining has a capacity of 4,500 t/y of antimony, and Australia where Hillgrove Gold Ltd, plans to become an integrated producer of antimony trioxide. Australia was once a leading producer of antimony, mostly as a by-product of gold recovered from a number of mines in the Costerfield region. Production of antimony from the region was terminated due to environmental and health issues. Until 1999, AGD Mining and sister company, Deep Green Minerals, ran the small Brunswick treatment plant at Costerfield, producing modest amounts of antimony in concentrate but the high arsenic content of the Brunswick ore rendered the concentrate unsaleable and as a result the plant was closed. In October it announced it had managed to consolidate the entire field for the first time since its discovery in 1861. Since then, after extensive perusal of previous mining exploration results, AGC has discovered the MH zone, 3 km southwest of Brunswick, where significant grades up to 6.8% Sb were recorded in 1968. Results from latest studies revealed intersections of 0.2 m at 24% Sb and 29.6 g/t Au, 0.9 m of 20.5% Sb and 43 g/t Au, and 0.8 m of 20.7% Sb and 37 g/t Au. AGD strongly believes that it will soon define sufficient ore to support a 50,000 t/y underground mine with a minimum life of five years. At an estimated production cost of about US\$120/t, AGD expects to generate a cost margin of about US\$180/t of ore produced.

In the US, the sole domestic mine producer, Sunshine Mining Co., in Idaho, which recovered antimony as a by-product of the

treatment of complex silver-copper antimony sulphide ores, shut down in March leaving only a very small amount of antimony being recovered in the US as a by-product of the smelting of lead and silver-copper ores. The US, however, remained influential as a supplier of metal to the market with its continued monthly sales from the National Defense Stockpile by the Defense Logistics Agency (DLA). Although authorised to dispose of up to 5,000 t, only 2,691 t had been sold by the end of the fiscal year of September 30, at which time the DLA announced that its Annual Materials Plan for fiscal year 2002 would permit the sale of up to a further 5,000 t. Remaining stocks were around 9,000 t so that at present sales levels metal would continue to be available from this source for another three to four years.

About 2,000 to 2,500 t of antimony metal were also released from old Russian stockpiles during the year, most of which was exported. This material from State Reserve stocks dated back to the 1980s and of the reported 1,200 t imported into Russia during 2001 about 40% was to replenish the State Reserves. The balance was mostly consumed by battery-producing plants and a very small amount of some 100 t was used by solder and babbitt producers.

The dominant role held by China in the world supply of antimony ensures that the availability of Chinese material remains the main factor that determines price trends. The potential for a recovery in prices depends primarily on the level of Chinese export quotas and on the ability of the Chinese Government to enforce these quotas.

Future growth in demand for antimony, will remain highly dependent on the level of demand from the flame retardants sector, which accounts for 60-65% of primary antimony consumption worldwide and for some 90% of global antimony trioxide consumption. The introduction of more stringent flammability standards and safety legislation, together with increased demand

for plastics and IT related products, will result in higher demand for flame retardants. Roskill Information Services' report, *The Economics of Antimony*, forecasts that world demand for antimony trioxide in this market will rise by some 4% annually from an estimated 83,500 t in 1998 to around 95,000 t in 2003, although the downturn in the US economy may slow growth in demand for plastics raw materials in the US and in Asian countries exporting to the US.

Polyethylene Terephthalate (PET) catalysts provide a further area of growth, concentrated in industrialising countries where markets for PET in carbonated soft drinks, beer and mineral water are less mature. The South-East Asian market for bottle-grade PET was estimated at 800,000 t in 2000 and is forecast

to rise by 14-15% annually. In contrast, little or no growth is forecast for antimony metal in metallurgical markets. Expanding markets for lead-acid batteries will increasingly use valve-regulated lead acid batteries containing grids of lead-calcium rather than lead-antimony alloys.

Low metal prices have caused world output of antimony to fall by over 25% from peak levels seen in the mid-1990s but current installed and planned capacity should meet the predicted 4% annual rise in demand for antimony trioxide through 2003. Therefore, demand-led factors are unlikely to exert upward pressure on prices and prospects for higher, and less volatile prices will therefore continue to depend primarily on the success achieved by the Chinese Government in controlling antimony exports.