ANTIMONY

By Howard Masters
Lambert Metals International

Around 65% of antimony consumed in 2000 went into flame retardants, the balance was used by the transportation, chemical, ceramics and glass industries along with other applications. Secondary antimony, which is derived almost entirely from recycled lead-acid batteries, was used in the manufacture of new batteries although the amount of antimony used by battery manufacturers was substantially lower than it was 5-10 years ago because of changing material requirements for batteries. The price of antimony fluctuated substantially throughout the year eventually ending the pattern of steadily lower prices in each of the past four years. As in 1999 world production remained at a much lower level, compared with recent prior years, reflecting a concerted effort by major producers particularly in China, to cut back output in light of the lower prices.

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, boiling point of 1,380°C, atomic weight of 121.75g/mol and relative density of 6.691. The 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 which is mined mostly as raw ore and Pliny the Elder named it "STIBIUM" in Latin and wrote about seven medicinal remedies with Stibium or Antimony sulphide. Since then the chemical symbol has been Sb. It is also found in minor amounts in ores of various metals such as copper, lead, silver and mercury.

Although the name was intended to describe the metal's mineralogical association in ores it also properly describes the use of antimony in modern industry because the metal is too easily broken to be used by itself. To make it stronger it is usually mixed with other metals such as lead and zinc to form various alloys. 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 either processed into antimony metal or combined with oxygen to form antimony oxide, a white powder.

Chemical grade ore is that which is sufficiently pure to be used directly in producing 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 2000 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 in an organic solvent to make textiles, plastics, building materials, adhesives, rubber, pigments, paper and other combustible materials, flame retardant.

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; vulcanising agents; ammunition primers; and fireworks.

Most commercial grades of antimony trioxide contain between 99.20% and 99.50% antimony trioxide 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$1,200–US$1,250/t at the beginning of the year, being almost the same level that it had started 1999. Unusually the price did not experience a seasonal improvement early in the year as a result of the Chinese New Year celebrations at the end of January as consumers and traders appeared to have built up sufficient stocks to offset any disruptions to supply. As a result, the price dropped dramatically after the Chinese returned from their holidays to an all time low of US$1,080–US$1,130/t at the end of April.

During the June quarter reports from China indicated that the government would be making new attempts to limit further the export of antimony products to 60,000 t in 2000 compared with the official quota of 80,000 t as in the previous two years. Officials stated that, despite the failure of previous efforts to limit exports this latest move had serious support. The Ministry of Foreign Trade and Economic Co-operation (Moftec) was fully supportive of the move. No new export licences would be granted until 2001. Officials believed that smuggling of antimony, which in previous years has accounted for a significant tonnage of antimony shipped abroad, had been virtually eliminated due to greater efforts against illegal shipments. Officials projected Chinese production of antimony products at 70,000 t in 2000, with 10,000 t going for domestic consumption. Moftec indicated that reduced exports would also help to keep global supply and demand reasonably well balanced.

As a result prices moved steadily back up again to reach a high for the year of US$1,820-US$1,900/t in the middle of September by which time it became apparent that supplies from China both legal and illegal were continuing unabated and, indeed, the higher prices were if anything encouraging increased exports. This caused the price to hesitate and by the end of the year it had slipped back to US$1,400–US$1,500 t and its decline continued with the price dropping back to around US$1,200 during the first quarter of 2001. The quotations for both clean sulphide concentrates and lumpy sulphide ores similarly decreased from US$8.50–US$9/Mt at the beginning of the year to US$8–US$8.50/Mt in March, only to recover to US$9–US$9.50/Mt at the end of August where they stayed for the rest of the year.

Antimony was mined as a principal product or was a by-product of the smelting of base-metal ores in 15 countries. Some 82% of world primary antimony was mined in China, 54% in South Africa and 3% in Russia (Table 1) meaning that these three countries accounted for a total of 90% of world mining of which China was totally dominant. World antimony reserves were estimated at 2.1 Mt (Table 2) 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. Based in Hunan Province it has a capacity for antimony products, including metal and trioxide, of 30,000 t/y. The biggest concentration of antimony production in China, however, is in Guangxi Province where large producers include the Huan Dong Metal Materials Plant, which

announced plans to produce 10,000 t of antimony trioxide in 2000, up 25% from 1999.

The Guangxi Nandan Longquan Mining and Smelting Works completed an expansion that began about a year before, doubling ore-handling capacity from 2,400 t/d to 4,800 t/d. Longquan previously had the capacity to produce 6,000 t/y of antimony ingot, but now has a capacity of 15,000 t/y. Cost of the expansion project is estimated to be US$12 million. Longquan has accumulated 100,000 t of antimony concentrates, which will be processed in the smelter. Its antimony ingot output in 1999 was 3,500 t. An output of 7,000 t was expected in 2000.

Guangxi accounts for about 80% of Chinese antimony output and the country's proliferation of small privately-owned mines contributes to the country's huge capacity of around 150,000 t/y.

According to statistics from Chinese customs, the country exported 35,600 t of antimony in the period January-August 2000, a 41.1% leap on the corresponding period in 1999. However, producers in China maintained that the export rate was slowing now that the government had reduced export licences for 2000 to 20,000 t below the level of Chinese exports in 1999 and that, as a result, they were running out of licences.

Little is usually known of production in the Russian Federation but the publication of Russian Mining 2000 for once gives information on antimony resources in the Republic of Sakha (Yakutia) which is the only producing area for antimony in the Federation. Gold-antimony quartz deposits are the main sources of the antimony in Yakutia. The deposits, which account for about 50% of total reserves in the Russian Federation, are associated with the Adyche-Tarynskaya metallogenic zone, which is located in the central part of Yakutia and is over 450 km long in the north-western direction and up to 10 km wide. No other region in the Federation has such a high level of antimony mineralisation.

Two deposits currently exploited in Yakutia – Sarylakh and Sentachan – have anomalous high metal contents reported to be as high as 30% and 58% antimony content, respectively. For comparison, the main antimony ore deposits being exploited at present in the rest of the world are of jasperoid and vein type with grades of only 3–6% antimony content. The Sarylakh and Sentchan deposits account for over 80%–200,000 t – of the proven reserves in the Russian Federation. The reserves of four other gold-antimony and antimony deposits discovered in the Federation are of secondary importance; of these, only the Udereiskoye deposit may have commercial potential with its 38,000 t of antimony reserves at an ore grade of 9.9%.

The Sarylakh deposit is located about 65 km southwest of the town of Ust-Nera, the administration centre of the Oymyakon Ulus district. The deposit is a mineralised zone with a distinct quartz-stibnite vein up to 10 m thick. The deposit is located within a permafrost area about 250-300 m thick and has been explored to a depth of 660 m. The Sarylakh deposit was exploited from 1976 until 1997 by the Indigirzoloto Mining Co. and currently it is mined by the Sarylakh-Surma company. Two-thirds of the reserves have already been extracted. The bulk of the remaining reserves are located at depth and their extraction will require a deepening of the existing shaft and the sinking of a new shaft. The antimony reserves at the mine are estimated to contain 92,000 t of proven reserves and 20,000 t (Sb content) of resources. The annual capacity of the mine is at least 60,000 t. Available ore reserves ensure a mine life of more than 10 years at the current production level. About 250,000 t of antimony have been produced thus far.

The Sentachan deposit is located in northeast Yakutia, about 170 km from the town of Batagai. Mining of the deposit began in 1978; the deposit has been exploited to a depth of

650 m and has an area of 2 km^2. It consists of four orebodies, of which only two are of commercial interest. The deposit is located in a permafrost area, 250 to 400 m deep. The average antimony content of the deposit is 28%. Reserves total more than 100,000 t and indicate a mine life of about 30 years.

Flotation concentrates and lump ore from the Yakutia deposits can be processed at several metallurgical plants in the Commonwealth of Independent States. A plant also was constructed in 1999 at the Sarylakh mine for the processing of concentrates.

In Kyrgyzstan the 20,000 t/y capacity Kadamjaisk Antimony combine remained on care and maintenance having stopped production in 1998.

Depressed world prices for antimony due to surplus Chinese supply have seen Bolivian antimony output sharply decline by 57% over the past three years. Closure of the antimony operations of Empresa Minera Unificada (Emusa), and in particular its Chilcobija Mine, in mid 1999, means that antimony output was expected to dwindle to less than 1,000 t in 2000. The closure meant that Bolivian state mining group Comibol was unable to source sufficient material to keep its antimony plant viable and operations ceased. Attempts to interest bidders in the operation failed during the previous year's auction of Comibol's assets but finally in November the privatisation sale of the shuttered 5,500 t/y capacity Vinto antimony smelting plant was concluded to Colquiri SA, a subsidiary of Bolivia's biggest mining concern Comsur SA. Colquiri's bid was backed by the Commonwealth Development Corp Ltd (UK) and exceeded by eleven times the US$100,000 base price set by Banque Paribas, the government's advisor for the sale. Another unsuccessful bidder was the local Empresa Minera Poromas, which began

World Mine Production
(Mt Antimony content of ores and concentrates produced)

	1996	1997	1998	1999	2000 (e)
Australia	1,800	1,900	1,800	1,800	1,500
Bolivia	6,426	5,999	4,735	2,790	1,000
Canada	1,716	529	428	566	500
China	129,000	131,000	97,400	100,000	95,000
CIS: Russia	6,000	6,000	4,000	4,000	4,000
Kyrgyzstan	1,200	1,200	150	100	-
Tajikistan	1,000	1,200	1,500	1,800	1,500
Guatamala	880	880	440	440	500
Mexico	983	1,909	1,301	1,500	1,500
Morocco	152	160	160	150	150
Namibia	8	-	-	-	-
Peru	305	242	364	255	250
South Africa	5,137	3,415	4,243	6,000	5,500
Thailand	70	60	200	190	200
Turkey	285	31	30	30	50
US	242	356	498	449	450
Zimbabwe	5	-	-	-	-
Total	**155,209**	**154,881**	**117,249**	**120,070**	**116,600**

(e) Estimated
Source:- US Geological Survey on Antimony 1999 *Mining Annual Review* much of which contains estimated figures. Accordingly adjustments have been made where more accurate information has been obtained.

producing 100 t/d of antimony ore from its mine 7 km outside the city of Sucre in 1999. Poromas is currently selling its concentrate production to Oxy Chemie and other Brazilian buyers but hopes to increase output to produce 200 t/mth of regulus antimony once the smelter is recommissioned.

South Africa's sole antimony concentrates producer, Consolidated Murchison Ltd, which is part of the South African diversified miner Metorex, maintained limited production as in recent years. The re-opening of the Beta shaft at Consolidated Murchison's antimony gold operations was completed in May 2001 with a small quantity of ore being mined in April. However, full production of 10,000–15,000 t/mth of ore from the shaft will not be achieved until the September quarter of 2002. Consolidated Murchison was milling 40,000 t/mth of ore by the end of the year producing 886 Mt of antimony contained in the December quarter, which increased to 1,126 Mt during the March quarter of 2001.

Australia's main source of antimony remained the New England antimony mine producing around 2,000 t/y of concentrates containing 63-65% Sb.

In Guatemala one of the most important antimony producers in Central America has long been Minas de Guatemala SA, a privately-held company formed in 1969. The company is a producer of antimony products as well as a mine owner and operator. Facilities include six mines located in northwest Guatemala, a 250 t/d gravity and flotation mill; and a smelting refining oxidising plant. The mines are operated by sinking vertical shafts down to 100–150 m and driving tunnels to the ore zones. The mill produces antimony flotation concentrates. These concentrates are processed in the company's metallurgical facility to produce antimony metal and antimony trioxide. Over the firm's 30-year history, employment has averaged 600 workers, with the peak being 800 plus people, but due to depressed antimony prices employment was only 120 people in early 2000.

In Canada, Amspec's mine at Lake George, New Brunswick, and Roycefield Resources' Beaver Brook mine near Gander remained closed throughout the year.

In the US, Sunshine Mining Co. in the Coeur d'Alene District of Idaho continued as the sole domestic mine producer, recovering antimony in concentrate as a by-product of the treatment of complex silver-copper-antimony sulphide ore. However, sales of antimony from the National Defense Stockpile continued for the eighth consecutive year. Sales were conducted on a negotiated bid basis and were held by the Defense National Stockpile centre every month. There was no maximum limit to the quantity for which a company could submit a bid but the minimum quantity was 40,000 lbs. The materials available were grade A & B ingots, cake and broken pieces. At the beginning of the year the inventory stood at 11,641 t and sales were authorised for up to 5,000 st/y, sufficient to last only until 2002.

The year 2000 saw the exit of Great Lakes Chemical Corp. the world's leading producer of various speciality chemicals for such applications as flame retardants, polymer stabilisers, fire extinguishers, water treatment, as well as a growing line of performance and fine chemicals for the life science industries in the UK and US, to focus its antimony trioxide production at its Reynosa operation in Mexico. This leaves the Belgian producer Campine as the only major Western European producer apart from Minas de la Lucette, based in France, which was purchased by Belgian-based Sudamin Holdings in early 2001. Sudamin Holdings already owned Belgian trioxide producer Sica. The formation of this new company Produits Chemique de la Lucette marked a further move towards consolidation in the antimony trioxide industry.

The move by Great Lakes Chemical Corp. did not help the market during 2000 as the trioxide producer was only at the incremental stage of production in Mexico. When it cranks up production to full capacity, increased consumption will naturally follow.

The largest of the minor metals in terms of tonnage, antimony has failed to get off its knees. Most people in the trade place the blame at the door of the Chinese. This initially appears slightly unfair: indeed, Chinese producers of antimony are struggling to survive with production costs for metal generally estimated at around US$1,500–US$1,600/t for most of the largest plants.

Two things can be drawn from this sad state of affairs:

- First, problems with over supply from China ideally need to be resolved at the earliest opportunity. There appears to be at least a little room for optimism in this instance. China's enormous capacity has helped to drive most antimony production in the rest of the world out of business. Bolivian output is unlikely to recover, while South African production has become almost insignificant. Kyrgyzstan's huge Kadamzhaisk combine is not operating and probably cannot survive in this market.

- Second, the market is increasingly desperate for a new application. Mined production is mostly used after transformation into Antimony trioxide in fire retardants. Other uses include batteries and catalysts but none of these are big growth sectors instead they are mature end-uses. Antimony has yet to find a new application of its own that can excite the market.

In such a limited market something else will have to give. Many Western traders have consistently reported their frustration at the pattern of Chinese exports. They say they usually receive the same explanation when offers suddenly spill from East Asia after the price nudges upwards: the desperation for cash. Many producers are still working to monthly targets, which prevent them holding back from the market. Perhaps, crucially, it is the western trioxide producers that are currently crying the loudest. Chinese trioxide production is hurting them in addition to the low metal prices, which have depressed revenue from their own production.

Clearly output needs to be cut. Forcible cutbacks in tungsten production in China have brought alarming tales of shutting, and in some cases demolition, of operations. But this would not just have to be applied to the small private miners even though China has too many of these. A solution probably lies in the continued modernisation of the state-owned enterprises.

At the rate that Chinese producers are reckoned to be losing money it is only subsidy that is keeping some of them alive. Neither export licences nor increases in duties have proved to be successful. Smuggling despite an official clamp-down continues to be as much a symptom as a cause of over-production. China's huge and complex metals industry has undergone some major restructuring in recent times but there is more pain to come.

World Reserves and Reserve Base: (Mt Antimony Content)

	Reserves	Reserve Base
US	80,000	90,000
Bolivia	310,000	320,000
China	900,000	2,035,000
Kyrghyzstan	120,000	150,000
Russia	250,000	370,000
South Africa	240,000	250,000
Australia	125,000	150,000
Tadjikistan	50,000	60,000
Other Countries	25,000	75,000
World Total	**2,100,000**	**3,500,000**

Source:- US Geological Survey, 1999 *Mining Annual Review*