

ANTIMONY

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The antimony market finally reacted in 2002 to the various mining disasters that have been occurring in China, the world's largest producer. Initially there had been doubts over the severity of the situation and market participants outside China were hesitant to react, believing the reports to be exaggerated. It now appears that stocks of antimony concentrates, metal and trioxide in China, along with continuing depressed world demand, cushioned the immediate effects.

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 industrialised Western countries.

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, an atomic weight of 121.75 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 the sulphide mineral *stibnium* in Latin, hence the chemical symbol is Sb. Antimony is also found in minor amounts in ores of various metals such as copper, lead, silver and mercury.

In modern industry, antimony 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 metal or 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.

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 as a flame retardant in an organic solvent applied to textiles, plastics, building materials, adhesives, rubber, pigments, paper etc.

The uses of antimony in non-metal products include: in enamels for plastics, metal, and ceramics; as a decolourising and refining agent in glass; in

stabilisers and plastics; in 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* (MB) on an 'in warehouse' Rotterdam basis, was US\$1,140-1,250/t at the beginning of the year which was still close to its all-time low of US\$1,080-1,130/t seen at the end of April 2000. For the third year running the price did not experience its usual seasonal improvement early in the year when the Chinese Lunar New Year is celebrated at the end of January. Consumers and traders appear to have learnt over the years to build up sufficient stocks to cover any disruption to shipments during this period.

From this time on, however, the market price steadily increased amid reports that many Chinese smelters were relying upon stockpiled concentrates as mining in the Nandan area of Guangxi Province was still suspended after the fatal accident at the Longquan Mining Co.'s mine in July 2001. By the end of July, the MB quotation stood at US\$1,780-1,860/t.

It was about this time that news broke of flooding at the southern operations of Hsikuangshan Mining Administration (HMA), which is the world's largest antimony trioxide producer. Sources of antimony concentrates had been rendered inaccessible, some indefinitely, and a considerable shortage of concentrates available to the Chinese smelters seemed inevitable. The market assumed that the amount of antimony metal and trioxide produced would decrease, with a knock-on effect on exports. As a result, world market prices broke through the US\$2,000/t barrier by the end of August, and continued dramatically upwards to more than US\$3,000/t by mid-September. On October 2, the MB quotation reached a level of US\$3,250-3,350/t, encouraged by speculative traders and, of course, Chinese producers who were not unhappy with higher world prices for their product after years at lower levels.

These high quotations proved to be somewhat unrealistic and the market slipped back, with prices ending the year in the US\$2,750-3,050/t range. Although this quotation remained unchanged well into 2003 the reality was that, although production of concentrates was being affected, sufficient stocks were available and actual prices slipped back during the first quarter of 2003 to close to US\$2,000/t. From this it can be seen that although the situation in

China is crucial to the world antimony market, it is mostly unknown, even to the Chinese, with much of the information and statistics being inaccurate and leaving the market as vulnerable as ever to inaccurate quotations and reporting by trade publications, allowing speculative movements.

Antimony was mined as a principal product or was a by-product of smelting base metal ores in at least 15 countries. Despite its reduced output, China remained dominant, producing around 75-80% of world primary output. The next largest contribution came from South Africa, with only about 5%, about the same as the combined production of the Commonwealth of Independent States (CIS). World antimony reserves are estimated by the US Geological Surveys (USGS) at between 2 Mt and 3 Mt, China's share having fallen to less than 40%.

Chinese production is split between state-run plants and the private sector. HMA is state-owned and based in Hunan Province with a production capacity of 30,000 t/y of combined metal and trioxide. In November 2002, a partial restart of the southern antimony mine was begun although production of the mine in Lengshuijiang was only expected to be at 40-50% of its capacity of 37,000 t/y.

The largest concentration of Chinese antimony production, however, is in Guangxi Province where major producers include the Huan Dong Metal Materials plant (10,000 t/y of trioxide capacity) and Liuzhou China Tin Group. This group operates several smelters, the two most important for antimony being Jing Chengjiang and Hechi Metallurgy and Chemistry Factory sourcing concentrates from their own mines. Of these, only the Dachang mine was believed to be mining as usual after an accident at the main Gaofeng mine at the end of April that killed at least three people. More important, however, is the proliferation of small privately-owned mines in Guangxi Province, which contribute to China's huge capacity to produce around 140,000 t/y of antimony concentrates. In 2002, the Hunan, Guangxi and Yunnan mines accounted for 64%, 27% and 4% respectively of China's total antimony concentrate output.

China's output of antimony concentrates has decreased by 34% since 2000 (see Table) and is not expected to increase in the foreseeable future. Despite this, production of refined antimony units (which increased by 22% in 2001), dipped during 2002 but output was still in excess of the 2000 figure. With Chinese domestic consumption estimated at only about 10% of production it is clear that stocks have been accumulating as a result of the imbalance between concentrate production and exports, a situation that has existed for many years, certainly since the last antimony boom in the mid-1990s.

Official Chinese export figures show that, apart from the emphasis switching to the higher-value trioxide, there has been an overall decrease in the export of antimony units. Guangxi is adjacent to Vietnam and considerable quantities of antimony cross this border to avoid export controls so that it is difficult to quantify total exports. In the past, smuggling increased when the price moved up as it did in the second half of 2001, perhaps explaining the

reduction in official exports in that year. The increase again in 2002 is probably as a result of reforms announced by China's State Economic and Trade Commission (SETC) which included paying specific attention to the border trade and smuggling that causes damage to the country's non-ferrous metals industry. Evidence of this came in November in Guangxi when an estimated 2,500 t were seized by the police from three warehouses in Nanning as suspected of being smuggled. A few hundred tonnes were auctioned off to China Tin when the owners failed to come forward.

As a result of the mine disasters in Nandan, the main mine in Guangxi Province, No. 100, remained closed, possibly permanently. Efforts were being made to get the government to re-open a small mine close by but by early 2003 no progress had been made. Many other smaller mines also remained closed, and with the now strict government directives on the running of mines, are unlikely to re-open.

China's total exports, both official and unofficial, are estimated at around 70,000 t/y and are unlikely to increase whilst the world economy remains subdued. Moreover, if mining in China continues to be curtailed there is always the possibility of a supply shortage developing. It would seem that Chinese stocks of concentrates have been turned into refined antimony units creating a surplus of the latter, but the fact that concentrates are in short supply is borne out by figures from China National Bureau of Statistics showing that in 2002 China imported 13,000 of antimony ores from various countries including Russia (31%), Kazakhstan (21%), Australia (11%) and Tajikistan (11%). In January 2003, China produced only 7,807 t of refined antimony, a drop of 20% compared with the same period in 2002, but concentrate output halved to just 1,500 t, and imports of ore exceeded 3,000 t, equivalent to nearly a quarter of the total imports in the previous year by volume and about half by value. Around 97% of the imports were from Russia, and mainly went to Guangdong and Guangxi Provinces.

In Kyrgyzstan, production of antimony at the Kadamjay Antimony Combine's smelter fell dramatically during 2002. In the first 11 months, output was 1,300 t of antimony, a decline of 40% from the comparable period of 2001 and significantly below the target of 3,000 t set at the start of 2002. Reportedly, Kadamjay has been unable to source antimony feedstock and is relying on low-grade and recycled material. Kadamjay is the only antimony smelter in the CIS and has traditionally relied on feed from antimony mines in the Sakha Republic (Yakutia), Anzobsky GOK in Tajikistan and the Ust-Kamenogorsk Titanium-Magnesium Combine in Kazakhstan.

Mines in the Sakha Republic produce a gold-Antimony concentrate but they are believed to have closed during 2002. Anzobsky GOK in Tajikistan has been the main source of antimony concentrates for Kadamjay in recent years, producing a concentrate containing both antimony and mercury. This material is difficult to treat and is first processed by the Khaydarken Mercury Combine in Kyrgyzstan for removal of the mercury before being delivered to Kadamjay for processing the antimony. The Kazakh producer Ust-Kamenogorsk produces an antimony-containing bullion as a by-product of its other metals

production but the combine began exporting its material to China for processing in 2002.

It appears unlikely that Kadamjay's plans for production of around 8,000 t/y (close to its capacity of 10,000 t/y), during 2003 will be achieved. However, it did manage to increase production to 130 t during the first two months of 2003, compared with only 10.1 t in the same period of 2002, after having received considerable state funding.

In July 2003, the Metorex Mining Group announced it was increasing production at its Consolidated Murchison antimony mine in South Africa, the country's only producer of antimony concentrates and crude trioxide, by commissioning its third shaft. The mine is located in the Murchison greenstone belt near Gravelotte in Northern Province. The new shaft will see concentrates output increase from 7,067 t of 58% Sb to 8,400 t/y during 2003 to take advantage of improved prices.

With this increase in concentrate output, the company was planning to upgrade its crude trioxide facilities which will see production rise to 6,400-6,500 t/y from 5,600 t/y. Consolidated Murchison had already boosted trioxide production from around 4,700-4,800 t/y through improved efficiencies at the two existing shafts. Production is mostly exported to the US and Mexico. One of its traditional customers, Amspec Chemical Co. in Gloucester City, New Jersey, which was one of only three antimony refiners in the US, ceased operations in February 2002. However, one of its other major customers, Great Lakes Chemicals, which has concentrated its world production of antimony compounds in Mexico in recent years, was more than willing to take the extra material. Metorex now plans to increase output at Consolidated Murchison's operations by a further 15-20% in 2003.

In the US, Rathborne Energy Co. in New Orleans, Louisiana, announced during the second quarter that it might buy the historic Sunshine Mine, near Kellog, Idaho. Rathborne planned to conduct a due diligence study of the defunct silver-lead-copper-antimony mine. The study required powering up the main mine hoist in the Jewell Shaft and restarting the mine's ventilation system. Rathborne officials indicated that the firm sought to obtain an option on Sunshine, which historically produced significant quantities of antimony as a by-product of silver mining, but the efforts to re-open the mine reached an impasse and in September, Sunshine reportedly reached an agreement to sell the mine to Nevada-based American Reclamation Co. Under the agreement, American Reclamation would purchase Sunshine for US\$100,000 and assume all of Sunshine's liabilities, including about US\$5 million in outstanding pension-fund debt and undisclosed amounts for taxes and other debts. Sunshine's majority bondholder, however, reportedly rejected the offer. The mine, a high-cost silver producer, had been the only producer of antimony in the US in recent years, until its closure in early 2001.

The US Defense Logistics Agency (DLA), which manages the National Defense Stockpile continued as a major source of antimony supply during 2002, particularly for US consumers. DLA Antimony is considered to be of

lower quality than Chinese metal, which accounts for most US imports, but is acceptable to most consumers. The Annual Materials Plan to the end of the fiscal year (September 30), allowed for the disposal of 4,535 t, and sales throughout the year meant that only 2630 t remained in the stockpile, which is now expected to be finally exhausted during fiscal 2003.

In Australia, AGD Mining was awaiting results from trial mining at its Costerfield antimony project in central Victoria before it launched plans to develop the mine. The results were expected by April 2003. The company is banking on strong metal prices to see its project get off the ground. It also hopes to capture market share in view of the reduced supplies of antimony from Chinese smelters. AGD is using an equivalent antimony metal price of US\$1,350/t in its feasibility studies for its high-grade ore reserves. It is studying three scenarios that would see it produce between 3,400 t/y and 6,500 t/y of antimony from the processing of 50,000-75,000 t/y of ore. On present schedules, mine construction could start in May 2003 and take four months to complete but the timetable is dependent on the successful and timely financing of the project, with the first stage to be accomplished via a share issue.

Antimony production in New South Wales is derived solely from operations at Hillgrove, east of Arridale, which produce antimony and gold concentrates. At the beginning of 2002, the mine was closed and placed in the hands of the receivers as its owner, Malaysian Mining Corp., had severe financial problems. The administrators have been seeking a buyer for the mine and in March 2003 New England Gold Pty took over the mine and started to prepare it for a resumption of production. In 2001 only 1,251 t contained antimony was produced at Hillgrove, all of which was exported to China.

In Peru, the only producer is Doe Run, which usually smelts about 300 t/y of low-quality metal as a by-product but even this output was reduced in 2002, to only about 100 t as a result of the lower antimony content in the concentrates treated.

The supply of antimony from China is the principle driver of the antimony price, and poor world demand is the main factor keeping prices from spiralling upwards. This could, however, be a short-term trend as consumers' inventories are believed to be limited. Future growth in demand for antimony will depend upon the flame-retardants sector where antimony trioxide is used as a synergist normally with bromine or chlorine. The demand for brominated flame-retardants (BFR) in the North American electrical and electronics markets continues to grow and, despite restrictions on specific classes of BFR, demand is expected to reach a level of 147,000 t by 2005 a growth rate of 4.2%. Antimony trioxide consumption is showing annual growth of 5.4% and is expected to reach 43,000 t by 2005. Due to environmental concerns the use of chlorinated products has declined, and future demand is estimated at 29,000 t by 2005, a growth rate of only 1.6%/y.

The expected growth of the antimony-based flame-retardant market comes as good news to antimony trioxide producers who are under scrutiny because of the potential environmental impact of halogenated flame retardants. This

growth highlights the problems of substitution as the current alternatives are both more expensive and have a detrimental effect on the mechanical properties of the plastic in which they are used. However, in early 2003 the Japanese company, Toyobo, announced that it had developed an aluminium-based PET catalyst that overcomes the problems of the antimony catalyst currently used in the bulk of PET production, and which are under regulatory pressure.

World antimony supply has tightened as a result of the mine closures in China but because of a general economic slowdown in the industrialised countries during 2002, there was evidence of a drop in global demand for antimony. In the US, for example, which along with Japan and Korea is a major market, imports in 2002 dropped to a total of 25,070 t for combined ore and concentrate, metal and oxide, against 37,900 t in the preceding year.

It is clear that China has converted much of its substantial stocks of ores and concentrates into refined metal but since official exports are not even approaching the 67,000 t export licence quota set by the government, demand would have to pick up substantially in order to create a situation where China might not be able to source sufficient raw material to replace these units quickly enough. The mining industry, however, is so vital to the Chinese economy that it is most likely that many mines will re-open, albeit under stricter regulations in the near future. Then, the strength of the market will again depend upon the ability of the Chinese authorities to restrict exports, both legal and illegal.

Chinese Production and Exports 2000 - 2002

Production (t)	2000	2001	Annual % change	2002	Annual % change	% change 2000-02
Concs. (antimony units)	94,000	82,000	-13%	62,400	-24%	-34%
Refined antimony units	110,00	134,000	+22%	118,000	-12.1%	+ 7%
Exports						
Antimony metal 99.65%	44,959	22,007	-51%	20,276	- 8%	-55%
Antimony trioxide (material)	36,086	36,067	0%	49,539	+37%	+37%
Antimony trioxide (Sb units)	30,132	30,116		41,365		
Total Antimony units	75,091	52,123	-31%	61,641	-18%	-18%
Balance: (conc. production less exports)	18,909	29,877		759		

Source:- National Bureau of Statistics, China