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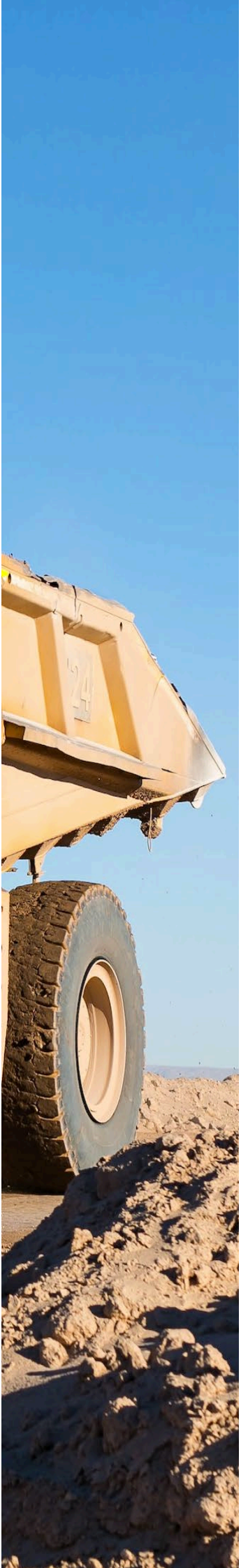
51
Sb
Antimony
121.76

Antimony

A Market Under Severe Stress

Critical Minerals Commodity Report

February 2025



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Front picture: Olimpiada mine, Russia – Polyus

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Executive Summary

Introduction

This report on antimony is the first of six reports on niche critical minerals, which we will publish in 2025. Due to their use in clean energy technologies and semiconductors, critical minerals have gained prominence in government policy agendas and in the public interest. Many of these commodities are experiencing increased demand, supply chain bottlenecks, volatile price movements, and geopolitical concerns. China is now leveraging its strong position as a supplier of many critical minerals through export restrictions. In the case of antimony, it is pushing the price to record highs.

While many valuable reports are available about critical minerals in general, few concentrate on the actual market dynamics of individual commodities. This lack of coverage partly reflects the relatively small size of these commodity markets (many are principally produced as a by-product), the small number of mining and processing companies, and the limited opportunities for equity investment. Access to data is difficult, and industry facts are hard to find, and this leads to a general opaqueness in the supply and demand picture. Our reports will attempt to explore what information is available and analyse some of the key risks to these commodity supply chains.

Antimony as a Critical Mineral

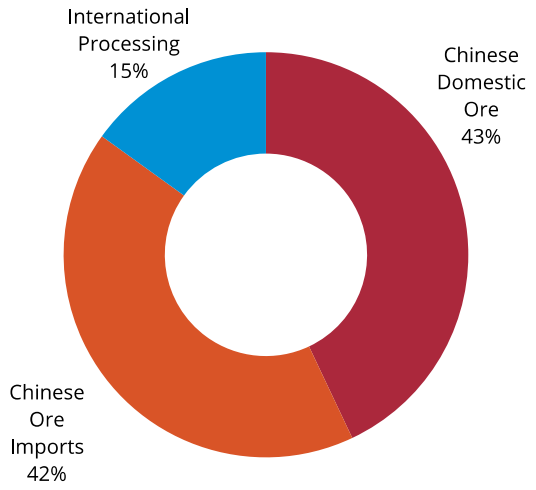
Critical minerals lack a universally accepted definition and are classified based on current technological requirements and the respective supply and demand dynamics applicable to different countries and markets. For example, the United States identifies 50 minerals as critical, the European Union 34, Japan 34, and Australia 31. Seventeen commodities are common to all these countries, including antimony.

Antimony is prominently featured on the critical minerals lists of most countries because of their reliance on imports, the limited substitution options, and the essential role it plays in producing goods vital to economies and national security.

An Industry Dominated by China

The leading global producer of antimony in 2023 was China. It produced 36% of the world's mined antimony, followed by Russia, accounting for 28%, and Tajikistan, producing 19%. The midstream production of antimony products is also dominated by China, and RFC Ambrian estimates that China currently processes 85% of global mined antimony production from domestic and imported concentrates. Figure 1 shows the breakdown of global antimony ore processing.

Figure 1. Processing of Antimony Ore 2023



Source: Jiefu Corp., RFC Ambrian estimates

In 2023, the global production of mined antimony was approximately 110 kt. However, production has consistently declined since 2011, when output was about 187 kt. The supply of antimony ore and concentrate has decreased worldwide during the past decade. In China, it has fallen due to stricter environmental and safety regulations, the closure of small mines, and declining grades of existing antimony operations. In the rest of the world, mines and smelters have closed due to weaker demand and low antimony prices. Closures of mines and smelters include operations in South Africa, Australia, Serbia, Mexico, and Oman.

As a result of the fall in domestic mine capacity, China's midstream antimony industry has attempted to increase its imports of antimony ore and concentrate to try and maintain output. In 2023, Russia, Tajikistan, Australia, and Myanmar were the main sources of imported materials.

Olimpiada Mine in Russia is a Wild Card

The Olimpiada gold-antimony mine in Russia, operated by Polyus, has been the most significant source of new antimony production in recent years. In its first year, in 2018, it produced 23.6 kt of antimony in concentrate, equivalent to about 15% of the annual global mine antimony supply. However, Polyus' antimony production sharply declined in subsequent years and has been variable (to a low of 2.5 kt in 2021) due to its focus on primary gold output. Then, in 2023, antimony output surged to 27.1 kt, equivalent to 25% of global antimony production.

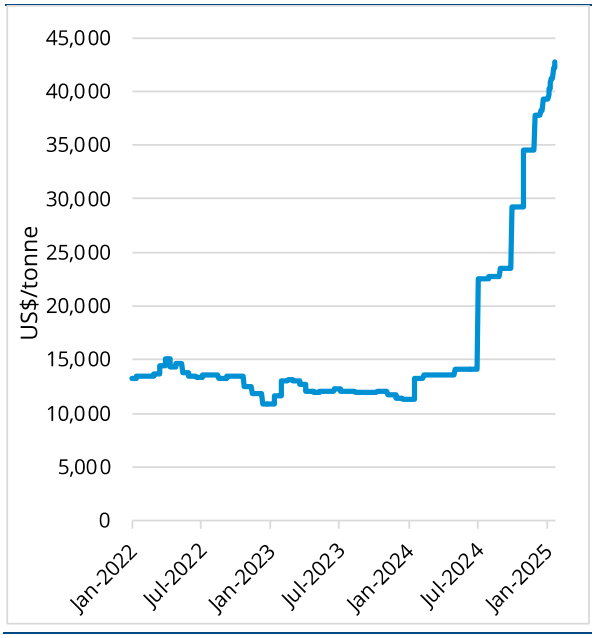
Polyus has not forecast future antimony production from the mine, but its reports suggest that the mine has depleted its antimony ore reserves and is now processing stockpiled high-grade antimony ore. The exact amount of high-grade antimony stockpiled at Olimpiada is unknown, but it is likely limited to a few years, depending on the processing rate.

Compounding this issue, Polyus has been under Western sanctions since Russia invaded Ukraine in February 2022, and the quantity of antimony concentrate being exported from Russia remains unknown. This uncertainty surrounding antimony production levels, reserves, and the capacity to export the concentrates makes it impossible to forecast future antimony production. Considering the potentially significant impact of the mine on the market balance, this uncertainty poses a considerable risk to the industry supply chain.

Antimony Concentrate Shortage

There is a shortage of antimony concentrate in the world due to supply issues in China, mine closures in other parts of the world, and fluctuations in antimony concentrate imports from Olimpiada and other mines. Consequently, most antimony smelters in China have been operating at only 45 to 55% of their capacity in recent years. The antimony market is presently in deficit, which is evident in the recent dramatic rise in prices and low stock levels. Prices have almost quadrupled since the beginning of 2024, reaching nearly $43,000/t in January 2025. Figure 2 shows the antimony price over the past three years.

Figure 2. Antimony Price 2022-2025



Source: Bloomberg

Recycling of Antimony is Declining

Unlike most other commodities, the recycling of antimony is declining. Most secondary antimony is recovered from lead-acid batteries at lead smelters. Extracting antimony from other applications rarely happens because antimony is very dispersed within the compounds in which it is used.

Since the 1970s, the amount of old antimony scrap generated from recycled batteries has significantly decreased, largely due to the introduction of calcium-lead-acid batteries and the thrifting of antimony in batteries. The new threat to antimony recovery from recycling lead batteries emerges from increased electric vehicle (EV) production, which does not use lead batteries.

The Cupboard is Bare of New Projects

There appears to be a global shortage of new development and exploration projects for future antimony production. RFC Ambrian has identified only nine potentially viable projects at the development and exploration stage that could

produce antimony. However, these are still several years away from producing ore or concentrate. The lack of viable mining operations might change if the antimony price remains high for an extended period, as this could stimulate renewed interest in antimony exploration and the potential restart of closed operations.

There may also be above-ground stocks of antimony metal in China, including those accumulated by the former Fanya Metal Exchange. The US Defense Logistics Agency also stockpiles antimony.

Three Uses Dominate Consumption

There is no complete set of data available on antimony consumption. Based on available data, RFC Ambrian estimates antimony consumption of about 105 kt in the three main markets of China, the United States, and Europe. Other significant consumers include Japan and South Korea. The forecasts of commodity consultant Project Blue indicate global consumption of about 130 kt for 2023, while the chairman of Twinkling Star in China (the world's largest antimony producer) estimated global consumption of 160 kt in 2023.

The largest use of antimony is in flame retardant materials, representing 45% of the estimated global consumption. Its use in alloys, including lead alloys for lead-acid batteries, contributes an additional 23%. Glass and ceramics account for an estimated 16%, polymer catalysts for about 6%, and semiconductors for around 5%.

However, both the flame retardant and alloy industries have experienced substitution and thrifting of antimony over the past decade and before. The impact has been a fall in demand in the use of antimony in alloys, but there is insufficient data on flame retardants to ascertain whether its use has declined or if its growth rate has merely slowed. New flame-retardant formulations have led to some substitution and thrifting, but at the same time, increasingly stringent fire regulations continue to drive the growth in antimony usage.

More recently, a positive area of demand has been the use of antimony in solar photovoltaic (PV) glass. Antimony consumption has markedly increased in this industry, particularly in China (the principal producer of solar PV glass). This growth is anticipated to persist because sodium antimonate constitutes only a small proportion of the total production cost.

China Announces Controls on Antimony

In September 2024, previously announced Chinese export controls came into force on various forms of antimony, including ore, metal, oxides, and smelting and separation technologies. Both the US and Europe are particularly vulnerable to these export restrictions. Subsequently, in December 2024, an export ban on antimony shipments to the US was announced, and other critical minerals were included. China declared this move after the US government expanded the list of Chinese companies subject to export controls on computer chip-making equipment, software, and high-bandwidth memory chips.

Conclusion

The antimony market is currently under severe stress, primarily due to a lack of global supply of ore and concentrate, along with recent export controls by China that limit the global availability of refined products. The bleak outlook is further exacerbated by the limited prospect of new mine capacity coming onstream due to the lack of projects capable of recovering antimony. This weak supply outlook, combined with the growing consumption in the PV market, suggests that the antimony market could remain in deficit for an extended period.

The price has surged dramatically over the past six months, but it appears that these high antimony prices will be necessary in the short- to medium-term to attract new supply to come onstream and/or cause some demand destruction through substitution and thrifting. The new supply could emerge from unidentified stocks coming into the market, and/or closed mining and smelting operations could be prompted to restart production. In the longer term, sustained higher prices could encourage increased exploration for antimony and the development of new mining and processing capacity.

1. The Industry Basics

This section provides a general background on global antimony resources, mining, processing and consumption.

Antimony is represented by the chemical symbol Sb (from the Latin stibium). It is a hard, brittle, steel-grey metal with poor heat and electrical conductivity and a relatively low melting temperature. Compared with many other metals, the antimony industry is relatively small. Total global production of refined antimony was only about 110 kt in 2023. This is equivalent to about US$1.36bn at an average 2023 price of $12.44/kg [(1)] for antimony metal (compared with about US$232bn for the copper market).

1.1 Antimony Geology

Antimony is rarely found in its pure state and most commonly occurs as the sulphide mineral stibnite (Sb_2S_3), as shown in Figure 3. It also occurs in over 100 other minerals, usually as an oxide but also as antimonies of heavy metal sulphides. However, ore-grade antimony concentrations are uncommon, and economically exploitable stibnite deposits are generally small and discontinuous. It is commonly associated with gold mineralisation but also with some silver-lead-zinc deposits. Most current and recently mined production comes from simple quartz-stibnite veins and replacement deposits. Antimony is produced from mining operations as the primary product and as a by-product.

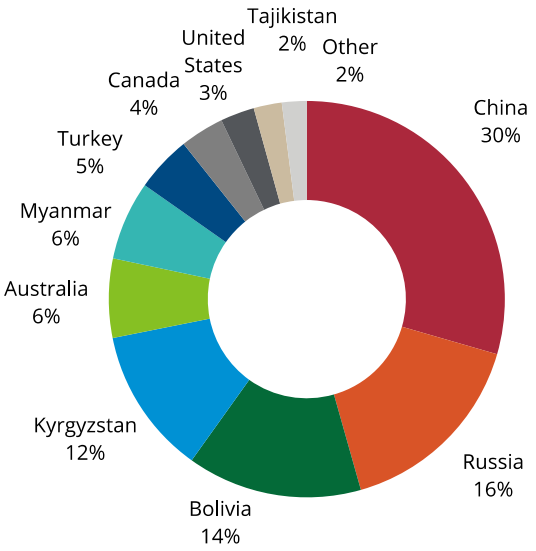
Figure 3. Sample of Stibnite Ore

Source: Arkansas Geological Survey

1.2 Antimony Reserves

The USGS reported global antimony reserves of about 2.17 Mt in 2023. Based on the 2023 mine production of 110 kt, this is sufficient for about 20 years of output. China has the largest reported reserves (30%), followed by Russia (16%), Bolivia (14%), and Kyrgyzstan (12%). However, reserves are unavailable for some regions, such as Iran and Kazakhstan, where some production occurs. Figure 4 shows the global reserves of antimony by country.

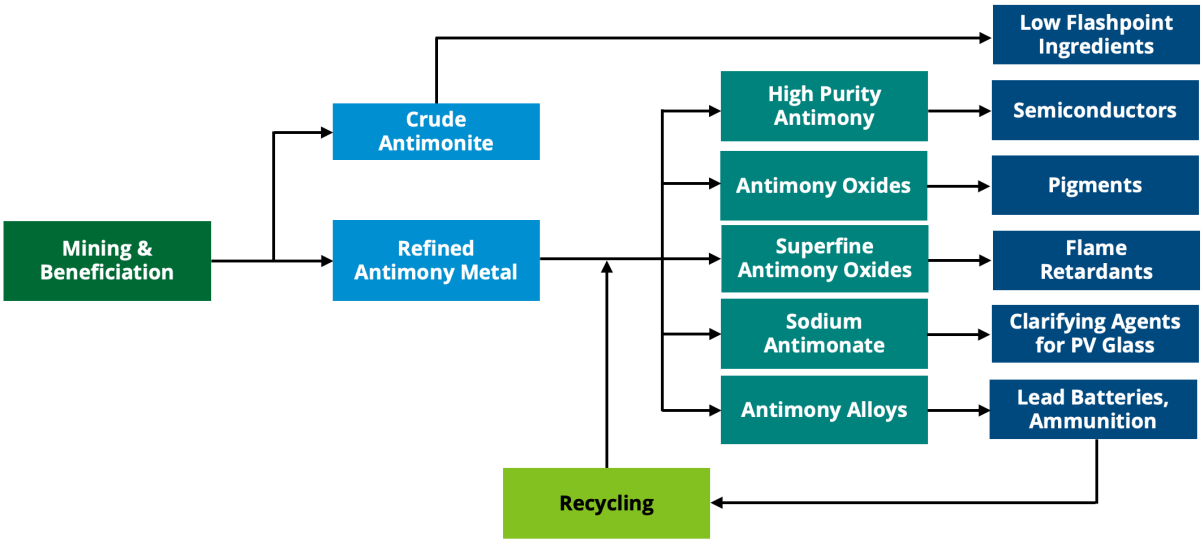
Figure 4. Global Antimony Reserves 2023



Source: USGS 2023

China has reported antimony reserves of 640 kt, primarily located in the Hunan, Guangxi, Guizhou, and Yunnan provinces. The Southeast China Orogenic Belt is the world's leading source of antimony, containing over 500 known deposits. In China, pure stibnite deposits comprise approximately 67% of reserves, gold-antimony-wolfram deposits account for around 21%, and base metal deposits represent about 12% of reserves. Major types of antimony ore deposits are discussed in Appendix 1.

Figure 5. Antimony Supply Chain



Source: RFC Ambrian

1.3 Antimony Supply Chain

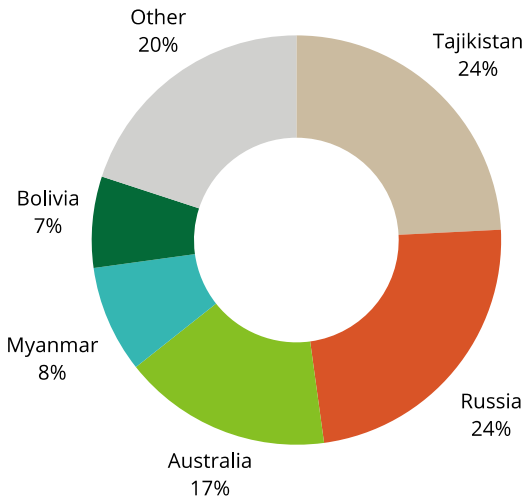
The supply chain for antimony includes mining and beneficiation, followed by refining the antimony metal for direct use in antimony alloys or conversion into chemicals such as antimony oxides and sodium antimonate. These products are then consumed in the primary applications depicted in Figure 5. Antimony from lead alloys is recovered and recycled back into the industry, mainly for alloys in the lead-acid battery market. Estimates vary regarding the contribution of recycling to the supply of antimony, partly due to the decline in recycling volumes associated with the reduced use of antimony in alloys. However, recycling is estimated to account for around 20% of the total supply.

Three major producers dominate the mining of antimony ore, accounting for 84% of output in 2023: China (36%), Russia (28%), and Tajikistan (19%) (Figure 9).

China is also a significant midstream processor of antimony ores, smelting both domestic and imported ores and concentrates. It accounts for an estimated 85% of global antimony ore processing, making the industry highly concentrated in China. As demonstrated in Figure 1, nearly 50% of the ores and concentrates processed in China in 2023 were sourced offshore, with Russia, Tajikistan, Australia, and Myanmar as the main contributors [2]. The breakdown of imports is illustrated in Figure 6.

Antimony is usually produced in metallic form for consumption but then can be combined with oxygen to form antimony trioxide (Sb_2O_3). Sodium antimonate can also be produced directly from processing antimony concentrates.

Figure 6. Chinese Antimony Ore Imports 2023



Source: USGS 2023

2. Demand Fundamentals

There is no complete set of data available on antimony consumption. However, based on available data, RFC Ambrian estimates that the combined antimony consumption of China, the US, and Europe, the three largest markets, amounted to about 105 kt in 2023. This calculation is based on consumption of 65 kt in China[1], 22 kt in the US[2], and 18 kt in the European Union[3]. Other significant consumers include Japan and South Korea.

Forecasts from commodity consultant Project Blue indicate global antimony consumption of about 130 kt in 2023 (2), while Mr Kang, chairman of Twinkling Star in China, estimates consumption at 160 kt (3).

Antimony has three major uses:

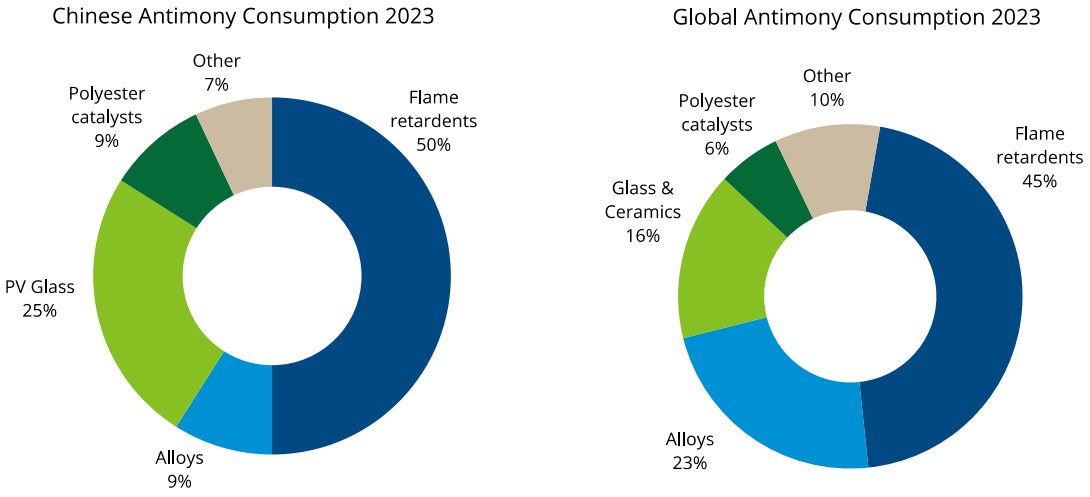
- Antimony trioxide is utilised as a fire retardant in industrial and consumer products.
- Metallic antimony is used as a hardening agent for lead, especially in lead storage batteries.
- Sodium antimonate enhances the quality of glass products, including improving the efficiency of solar PV panels.

Flame retardants have a significant use in each of the three major markets. However, lead alloy use is more significant in both the US and European markets, while the use in PV glass is more significant in China. The consumption of antimony for use in PV glass is reported to have increased from 11% in 2020 to 25% in 2023 in China (4). Figure 7 shows Chinese and global antimony demand estimates by main uses for 2023.

2.1 Antimony in Fire Retardants

Antimony trioxide (ATO) is a fire retardant that makes fabrics, plastics, paints, and other materials fireproof. Antimony compounds function as co-synergists with halogenated flame retardants to boost their effectiveness. These halogenated antimony compounds act as dehydrating agents, preventing ignition and pyrolysis in solid, liquid, and gas phases. They also encourage char formation on the substrate, creating a barrier that reduces oxygen availability and the formation of volatile gases. Their properties allow plastics to be utilised in applications where they would typically melt, such as computer casings and televisions.

Figure 7. Global and Chinese Antimony Demand by End Use



Source: Fastmarkets antimony conference, RFC Ambrian estimates.

[1] Based on Fastmarkets' antimony conference data.
[2] USGS 2023.
[3] Based on the average annual EU consumption of processed antimony from 2016 to 2020

Commercial suppliers provide various grades of ATO based on the relative tinting strength of their product, which depends on particle size. New flame-retardant formulas have led to some substitution and reduction of ATO use in flame retardants; however, increasingly stringent fire regulations are driving the ongoing growth in the use of ATO in these applications.

2.2 Antimony in Alloys

Metallic antimony is utilised as a hardening agent for lead, particularly in the electrodes (grids) of lead-acid storage batteries.

Lead batteries are used in a wide range of industries and applications, from transportation to communication networks. They are used in most road vehicles worldwide, accounting for 49% of global consumption [5]. Stationary lead batteries account for an additional 35% of the demand. They supply electrical power to critical systems, such as hospitals, telecommunications, and emergency lighting during power outages. Motive lead batteries, which power the motors of industrial electric vehicles such as forklift trucks, account for an additional 5%.

In 2022, the battery industry is estimated to have accounted for 92% of refined lead metal usage in China, 92% in the US, and 84% in Europe [6]. Figure 8 shows the composition of the lead battery market by sector and the lead battery manufacturers by region. Asia accounts for around 73% of lead battery manufacturing.

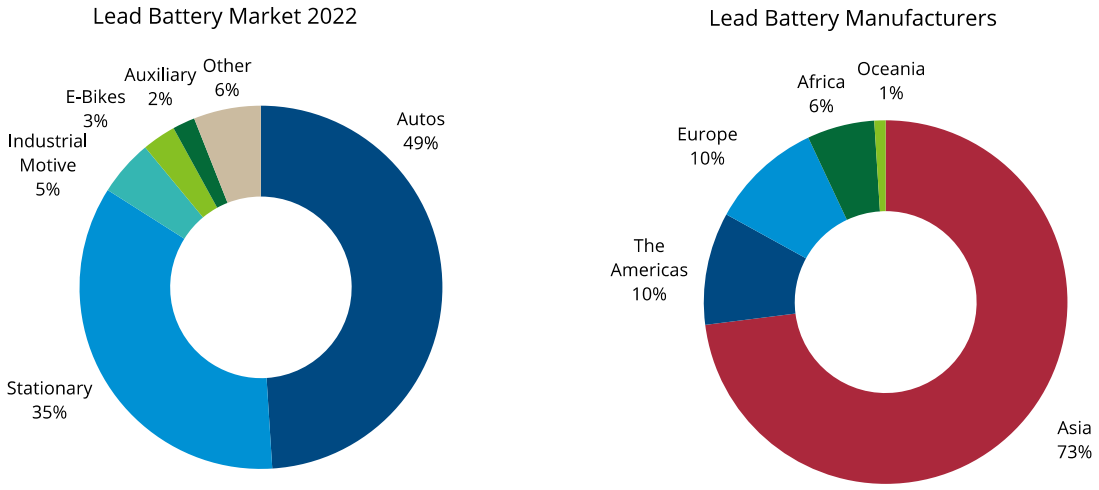
However, there has been a continuous trend away from antimony alloys towards lead-calcium products for lead-acid batteries [7]. Higher engine temperatures and the demand for maintenance-free products mainly drive this shift. Current antimony-containing battery alloys typically contain 1.6 to 2.5% antimony, with higher values used in hotter climates like Asia. All motive applications in China now use lead-calcium-tin batteries, as do many auto and industrial batteries [8].

Antimony alloys are also used to manufacture solder, sheet and pipe metal, ammunition, bearings, castings, and pewter. They are also present in certain lead–tin–antimony anti-friction metals used to make large compressor and propeller shaft bearings.

2.3 Antimony in Glass and PV Cells

Sodium antimonate ($NaSb(OH)_6$) is primarily used as a fining and degassing agent in producing high-quality clear glass, including solar PV glass. The antimonate decomposes in the molten glass, generating large bubbles that rise to the surface and scavenge much slower-moving fine bubbles, which leads to the purification and homogenisation of the glass batch.

Figure 8. The Lead Battery Market



Source: Consortium for Battery Innovation.

Sodium antimonate also acts as a decolourant for glass, effectively eliminating traces of iron that can produce a greenish tint. Additionally, it possesses anti-solarant properties, protecting against discolouration caused by sunlight or fluorescent lights throughout the glass's lifespan. China is the leading producer of solar PV cells, controlling 80 to 90% of certain segments of the global solar supply chain [9]. Antimony consumption in the solar PV sector has significantly increased in recent years and was expected to reach about 50 kt in 2023 [10].

The outlook for using sodium antimonate in solar PV cells suggests continued growth, driven by the ongoing expansion of the PV sector, particularly in China. The 2024 tariff increases by the United States on imported PV cells from China (rising from 25% to 50%) may slightly hinder this growth. However, the supply of PV cells in China is more influenced by government policy than market forces. Moreover, solar PV glass manufacturers have a relatively high tolerance for price increases in antimony, as sodium antimonate constitutes only a small proportion of their total production cost [11].

2.4 Antimony in Polyester Catalysts

Antimony use in polyester catalysts accounts for an estimated 6% of the antimony market. ATO is the most widely used polymerisation catalyst in global markets for polyethylene terephthalate (PET) manufacturing. PET is used to produce synthetic textiles (polyester) and plastic containers, including drinking bottles and polyester film, which is primarily used for packaging. The most commonly used catalysts are ATO, antimony acetate ($Sb(CH_3COO)_3$), and antimony glycol oxime ($Sb_2(OCH_2CH_2CO)_3$). The use of ATO in catalysts for PET production and as a heat stabiliser is reported to be increasing.

2.5 Antimony in Semiconductors

Antimony is commonly used in semiconductor manufacturing to dope silicon, creating n-type semiconductors. We estimate that this accounts for about 4 to 6% of the demand for antimony. In n-type doping, antimony enhances the semiconductor's conductivity and, therefore, its performance. Antimony is also employed to produce indium antimonide, a compound semiconductor material. Indium antimonide is renowned for its high electron mobility and sensitivity to infrared light, making it valuable for infrared detectors, thermal imaging cameras, infrared LEDs, and optoelectronic devices.

2.6 Other Antimony Uses

Other antimony compounds, such as antimony trisulfide, are essential for manufacturing ammunition and detonators. Antimony oxide is also used as a colour fastener in paint and as a phosphorescent agent in fluorescent light bulbs. Additionally, antimony is being tested in trials of molten-salt batteries in combination with lithium and lead.

2.7 Substitution of Antimony

The use of ATO in flame retardants increases smoke and toxic gas production during combustion, raising concerns about its toxicity. Manufacturers occasionally employ other compounds alongside or replacing antimony oxide in certain formulations. Examples include phosphorus compounds (TCP), magnesium hydroxide, alumina trihydrate, azoxymethane, zinc stannate, and zinc borate. These alternatives can lower costs, enhance char formation, and diminish smoke. However, using these alternative retardants considerably reduces flame retardancy compared with ATO.

There has been a consistent shift from antimony alloys to other alloys in lead-acid batteries. Calcium, copper, selenium, sulphur, and tin have replaced antimony in these battery alloys, particularly in China. The long-term threat to antimony in lead-acid batteries arises from the increase in the production of EVs (which do not use lead batteries) and the decline of internal combustion engines in autos.

Chromium, tin, titanium, zinc, and zirconium compounds substitute for antimony chemicals in enamels, paint, and pigments.

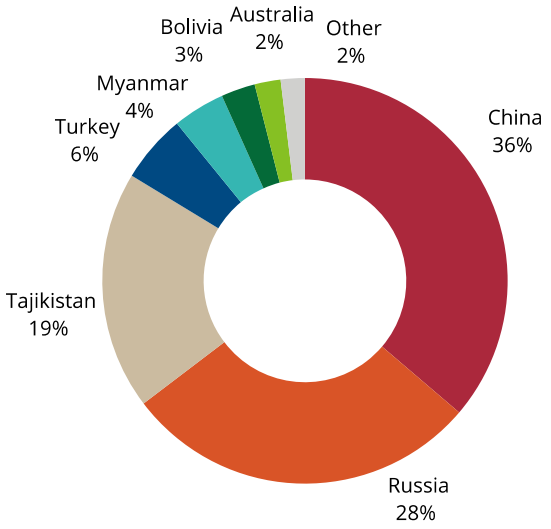
Record high commodity prices, driven by supply restrictions such as those seen in current antimony markets, often result in temporary thrifting and occasionally lead to substitution and demand destruction.

3. Supply Fundamentals

Mined antimony production sharply increased in 2023, from 83.1 kt in 2022 to 110.5 kt, although some of this output from Russia may not have reached the end market. The historical picture is less positive because production has continuously declined since 2011, when it was at 186.6 kt [12]. This was initially caused by weaker demand due to substitution and thrifting in the two largest markets, alloys and flame retardants. This led to price declines and caused mines and smelters to close, reducing supply.

In 2023, China produced 36% of the world's mined antimony, making it the leading global antimony producer. Russia was the second largest producer, accounting for 28%, followed by Tajikistan (19%), Turkey (6%), Myanmar (4%), Bolivia (3%), and Australia (2%). The 2023 data from USGS have been adjusted to reflect a large increase in production from Polyus in Russia (27.3 kt), which was reported after the publication of the USGS data. This also accounts for the large year-on-year increase in production in 2023. Figure 9 shows mined antimony production by country for 2023.

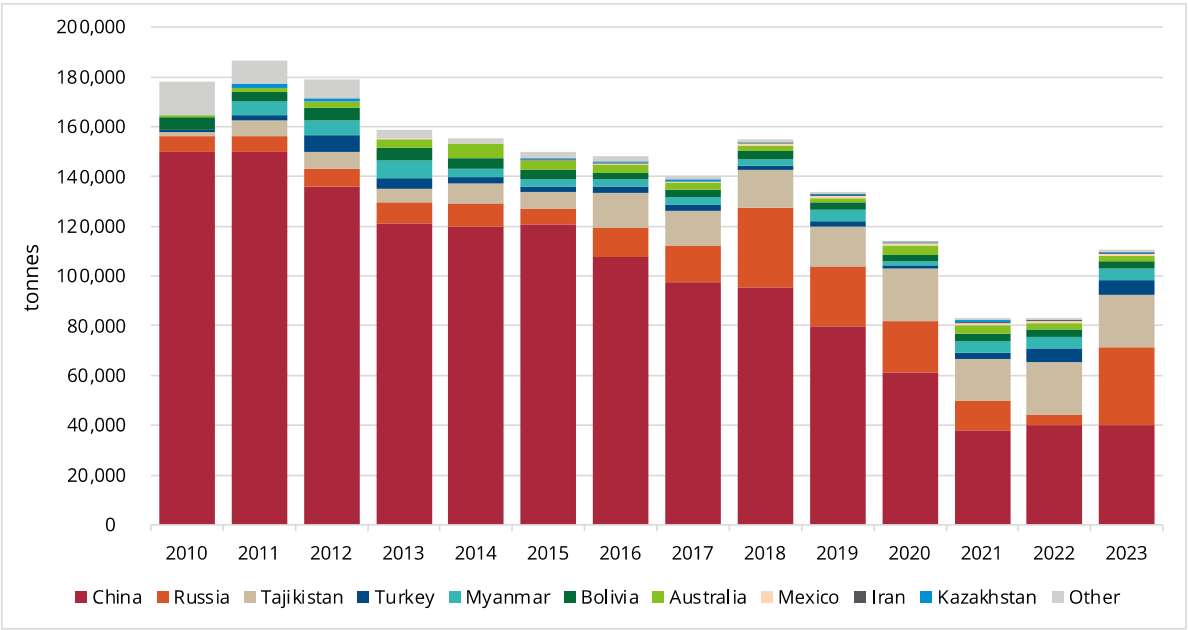
Figure 9. Antimony Mine Production 2023



Source: USGS 2023, RFC Ambrian estimates.

Several other smaller sources of mined antimony exist, mostly small-scale mines and artisanal mining (ASM). Figure 10 shows global antimony mine production by country from 2010 to 2023.

Figure 10. Global Antimony Mine Production by Country 2010-2023

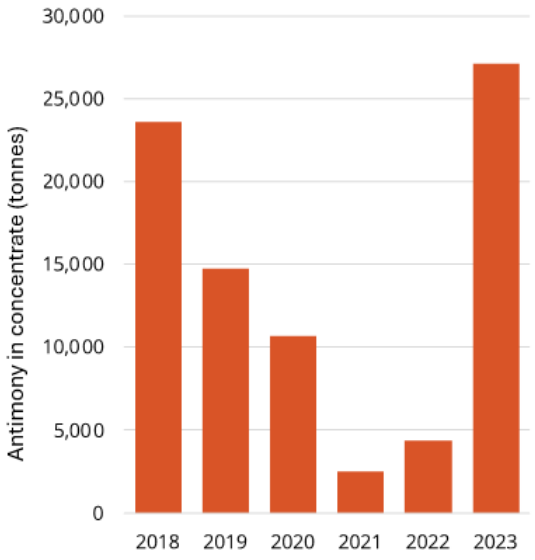


Source: USGS, RFC Ambrian estimates.

In 2023, Polyus' antimony production represented 25% of the overall antimony market. The market for antimony concentrates started to tighten in 2023, and the supply-side situation was not alleviated by Polyus' increase in output in 2023 as much of the gold-antimony concentrate was not exported to China for smelting and remains stockpiled in Russia [13]. The delay in exporting the concentrate was partly due to Polyus' plans to wait until 1 June 2024, when the Russian government removed export duties on gold concentrates and introduced extraction taxes [14]. However, ongoing sanctions imposed by the West on Russia have prompted Chinese banks to suspend payments to Russia, further delaying the feedstock delivery to China.

Polyus produced 23.6 kt of antimony in 2018, but production declined in the following years (see Figure 11) as the company processed lower-grade gold-antimony ore to maximise gold production and stockpiled the high-grade antimony ore [15], until the sharp increase in 2023. There may now be limited antimony resources remaining. Olimpiada's output is significant to the antimony market.

Figure 11. Olimpiada's Antimony Production



Source: Company reports.

The quantity of antimony concentrate that Polyus produces in the coming years, along with the timing of its current stockpile sale, is likely to be a critical factor in determining the market balance and price of antimony in the near to medium term.

Figure 12. Location of Antimony Mines, Smelters, and Projects

Source: RFC Ambrian. Positions are indicative only.

3.1 Antimony Mining

China is the largest producer of mined antimony in the world. However, its output has significantly decreased since 2008 due to declining domestic ore grades, depletion of reserves in several major mines, industry rationalisation due to stricter environmental and safety regulations, and the closure of small-scale mines. This decline can be seen clearly in Figure 10. Figure 12 illustrates the location of known antimony mines, smelters, and projects.

The world's largest antimony producer is **Twinkling Star**, which operates the Xikuangshan mine in China and has been in operation for over 125 years. The second largest is **Hunan Gold**, which manages the Chenzhou gold-antimony mine in China. The state-mining company **China Minmetals** ultimately controls both assets as well as **Yunnan Muli Antimony**.

Other large operations in China include **Yunnan Muli Antimony**, **Guangxi China Tin Group**, **Guangxi Youngsun Chemicals**, **Guizhou Dongfeng Antimony Industry**, **Taojiang Jiutong Antimony Industry**, and **Tibet Huayu Mining**.

Russia is a significant player in antimony production, primarily derived from **Polyus**' Olimpiada gold-antimony mine in Siberia's Krasnoyarsk region. Nevertheless, the annual antimony output has exhibited considerable variability (as previously mentioned). The **Gorevsky Group** manages the Udereyskoe gold-antimony deposit in Siberia and processes the antimony ore at the Novoangarsky plant. **GeoProMining** operates several gold-antimony mines in Yakutia, situated in the Russian Far East.

In Tajikistan, **Talco Gold** commenced a significant new gold-antimony operation in 2020 in the northeastern Sughd Province. It is a joint venture between the state-owned **Tajik Aluminium Co.** (Talco) and **Tibet Huayu Mining** from China. The operation produces gold and antimony concentrates. The Anzob mine, located in the Sughd region of central Tajikistan, is managed by US-based **Comsup Commodities**, producing an antimony-mercury concentrate from the Jizhikrut deposit.

Turkey extracts antimony from several small-scale mines, with most concentrates exported to China and Belgium. **ODAŞ** produces 2.5 t/y of antimony in ingot and ATO, along with gold and silver from the Karaağaç mine located in southern Turkey. **Eti Bakir**, a subsidiary of **Cengiz Holding**, operates the Halikoy mine in southeast Izmir, which produces approximately 830 t/y antimony in concentrate. **Lepoteknik** manages multiple mines in the provinces of Kütahya and Balıkesir and produces antimony metal ingot and ATO. **Anadolu Mining** runs two antimony mines and produces ATO. **Özdemir Antimuan Madenleri**, part of the **Koza Group**, operates the Turhal antimony mine.

Myanmar has four small mines located in the State of Kayah within the Eastern Highland Belt. These are Thabyu, Lebyin, Natsan, and Painchit. In recent years, significant investment has been made in exploration and development through partnerships between state-owned Chinese companies and the Myanmar government. Production from these mines has been steadily increasing, with concentrates reportedly shipped to Chinese roasters and refiners. However, political unrest in Myanmar since the end of 2023 has hindered cross-border trade due to ongoing conflict, preventing shipments of antimony raw materials from reaching smelters in Southeast Asia.

Bolivia possesses significant resources; however, most of the larger known deposits have not been exploited since the mid to late 1980s. Current production primarily stems from numerous small mines and artisanal operations [16]. The **St. Louis Group**, based in Indianapolis, United States, is a supplier of flame-retardant products and operates the Caracota antimony mine and antimony trioxide manufacturing facilities in Bolivia through its partnership with **Empresa Minera Unificada** (EMUSA).

Australia has one small producer of antimony: **Mandalay Resources**. The company operates the Costerfield mine in Victoria, which extracts gold, silver, and antimony from an underground narrow-vein deposit. The concentrate is sold to Chinese smelters and **US Antimony Corp**.

Table 1. Significant Antimony Mines Currently in Operation

Mine	Country	Operator	Commodities	Metal Capacity kt/y	ATO Capacity kt/y
Xikuangshan	China	Twinkling Star	Sb	30.0	40.0
Olimpiada	Russia	Polyus	Au, Sb	27.1	na
Chenzou	China	Hunan Gold	Au, Sb	25.0	30.0
Shah-Kon	Tajikistan	Talco Gold	Au, Sb	16.0	na
Banpo	China	Guizhou Dongfeng Antimony	Sb	10.0	25.0
Muli	China	Yunnan Muli Antimony	Sb	10.0	4.0
Udereyskoe	Russia	Gorevsky Group	Au, Sb	10.0	na
Tonkeng-Changpo	China	Guangxi China Tin Group	Sn, Pb, Zn, Sb	9.3	na
Anzob	Tajikistan	Comsup Commodities	Hg, Sb	7.5	na
Sentachan	Russia	GeoProMining	Au,Sb	7.0	na
Banxi	China	Taojiang Jiutong Antimony	Sb	4.0	na
Costerfield	Australia	Mandalay Resources	Au, Sb	3.4	na
Karaağaç	Turkey	ODAŞ	Sb	2.5	na
Zhaxikang	China	Tibet Huayu Mining	Pb, Zn Sb, Au	2.0	na
Caracota	Bolivia	St. Louis Group	Sb	na	na
Turhal	Turkey	Özdemir Ant. Madenleri	Sb	na	na

Source: Company data, RFC Ambrian estimates.

Small-scale antimony production also occurs in Serbia, Slovakia, Iran, Vietnam, Laos, Pakistan, Guatemala, and Honduras.

In the past decade, several Western antimony operations have closed, including the Consmurch mine (Consolidated Murchison) in South Africa in 2014, the mines and smelter at Zajaca in Serbia (Koncern Farmakom) in 2020, the Hillgrove mine (Larvotto Resources) in Australia in 2022, the Beaver Brook mine (Chinese Hunan Nonferrous Metals) in Canada in 2023, and the Los Juarez and Queretaro mining operations (US Antimony Corp.) in Mexico in 2024.

Table 1 presents the largest antimony mining operations currently believed to be in production, ranked by capacity.

3.2 Midstream Antimony Processing

The primary production of antimony metal from antimony concentrates is generally carried out in a blast furnace using pyrometallurgical methods, such as volatilisation-roasting-reduction smelting or direct reduction smelting. These methods account for over 90% of antimony production. The remaining production relies on hydrometallurgical routes via leaching, while bio-hydrometallurgy is currently under investigation.

The details of the treatment process for antimony concentrates depend significantly on the grade of the concentrate. The lowest grades, containing 5 to 25% antimony, are volatilised to antimony trioxide. Grades between 25 to 40% are smelted in a blast furnace, while those with 45 to 60% antimony concentrate are treated through liquation or iron precipitation. The resulting products are refined with NaOH to produce pure antimony metal by removing undesirable elements such as arsenic. This pure antimony metal can also be oxidised to yield pure antimony trioxide (Sb_2O_3) [17].

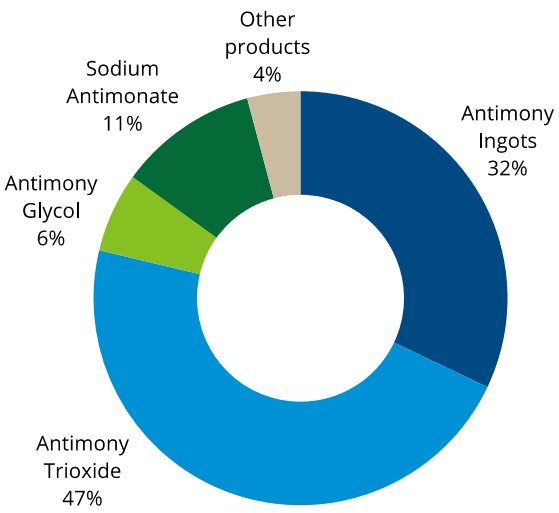
Antimony metal is also recovered from slags and residues produced during the processing of other metals, such as lead and gold. The typical recovery rate of antimony from smelting is reported to be between 90 and 94% [18]. This implies that the new supply of antimony metal to the market in 2023 was

equivalent to 76.6 kt, based on the 83.3 kt of antimony ore supplied for smelting (excluding Polyus' production).

Antimony metal is subsequently converted into antimony chemicals either at the smelter site or at a separate location. ATO is the most significant antimony compound. The commercial grade is typically a fine, white powder containing between 99.2 and 99.5% Sb_2O_3, along with varying levels of other impurities (such as arsenic, lead, and iron), depending on the intended application. Other chemicals produced include antimony pentoxide (Sb_2O_5), sodium antimonate ($NaSb(OH)_6$), and sodium antimonite (Na_3O_4Sb).

Figure 13 shows the main intermediary antimony products produced in China in 2023.

Figure 13. Antimony Production in China 2023



Source: Jeifu Corp.

3.3 Midstream Antimony Producers

China is the dominant midstream producer of antimony products. Traditionally, antimony concentrates in China were mainly obtained from domestic mining operations. However, in recent years, domestic supply has decreased due to industry restructuring. The Chinese antimony industry has endeavoured to address these challenges by increasing imports of antimony ore and concentrate.

The main sources of imported ore in 2023 were Russia (24%), Tajikistan (24%), Australia (17%), and Myanmar (8%) (Figure 6). In 2022, RFC Ambrian estimates that around 74% of international antimony production (excluding Polyus) was imported to China, equivalent to China processing 85% of global mined antimony production. Despite this dominance, ongoing domestic supply issues with concentrate and fluctuating levels of antimony ore imports have resulted in most antimony ingot smelters in China operating at only 45 to 55% of capacity in recent years [(4)]. This has also contributed to an increase in per-unit operating costs.

Several antimony mining operations also have integrated smelters. These include **Twinkling Star**, **Hunan Gold**, **Guizhou Dongfeng Antimony**, and **Yunnan Muli Antimony**. Other smelters in China include those operated by **Yiyang Huachang Antimony Industry**, **Nandan Zhenghua Nonferrous Metals**, and **Guangxi Huayuan Metal Chemical Hechi City**. Nine small antimony smelters (apart from Twinkling Star's operation) have also been reported to exist in Lengshujiang.

In Europe, antimony smelting is carried out by **Umicore** and **Campine** in Belgium and **AMG SICA** in France. **ODAŞ** operates a small smelter in Turkey.

In the United States, **US Antimony Corp.** operates an antimony smelter in Thompson Falls, Montana. The company previously imported antimony concentrates from its Mexican mining operations and other global suppliers but closed its Mexican operations in March 2024. The smelting facility at Thompson Falls is currently only running at 50% of its capacity due to a lack of ore supply.

In Trail, British Columbia, Canada, **Teck Resources** processes metal concentrates containing antimony and recycled lead-acid batteries. The antimony is present in lead and zinc concentrates supplied to three secondary smelters in the United States. Additionally, small smelters produce antimony in India, Bolivia, Kazakhstan, Thailand, and Vietnam.

In the past decade, new antimony smelters have been built outside China, including in Tajikistan, Vietnam, Burma, Thailand, Kyrgyzstan, and Oman. However, four of these smelters have been

relatively small, and two have closed due to technical and financial issues and the lack of availability of antimony ore for processing.

Antimony production at the Kadamzhay complex in Kyrgyzstan was stopped in 2017 due to a shortage of raw materials and financial problems. The operation initially received raw materials from the Novoangarsky processing plant in Russia and from Tajikistan. In Oman, **SPMP** constructed a large antimony smelter that commenced operations in mid-2019 but was permanently closed around 2022 due to the plant's inability to secure sufficient feedstock. The smelter was entirely dependent on imported feedstock from other locations.

The only other large new smelter is **Talco Gold**'s gold-antimony smelter in Tajikistan, which started production in 2022.

3.4 Recycling of Antimony

Most secondary antimony is recovered from lead batteries at lead smelters. Recovering antimony from other applications rarely occurs because antimony is highly dispersed in the compounds in which it is used, such as flame-retardant materials and PV cells. Old antimony scrap generated from recycled batteries has significantly declined since the 1970s due to the introduction of the calcium-lead-acid battery and the thrifting of antimony in the batteries [7]. In recent years, particularly in China, the capacity for recycling antimonial lead has been increasing, partly to compensate for the decrease in mined antimony supply. In the long term, as the production of EVs increases, the demand for lead batteries is expected to decline [19]. However, hybrid vehicles still require a small lead battery to start the engine.

Obsolete lead batteries have high collection and recycling rates. The lead from these spent batteries is typically recycled through pyrometallurgical processes, primarily returning to the lead-acid battery industry. Lead recycling companies, known as secondary lead smelters, produce pure lead from lead-acid batteries, other lead-containing waste materials, and small quantities of antimony-containing residues from copper, lead, and gold production. The USGS has estimated the recycling efficiency of antimony old scrap to be 89%.

At Umicore's precious metals refinery in Hoboken, Belgium, antimony is recovered from complex lead-bearing concentrates and various complex residues from the lead, copper, and zinc industries. During the lead refining process, Umicore extracts sodium antimonate [20]. Campine produces ATO at its battery recycling plant in Beerse, Belgium.

The recycling rate for antimony is unclear but is estimated to be up to 28% in the European Union [21], approximately 18% of antimony supply in the United States, and overall accounts for about 20 [22] to 25% [23] of total antimony production. This suggests a secondary antimony production of around 16.7 to 20.8 kt in 2023. However, due to the anticipated ongoing reduction in the use of antimony in batteries, owing to material substitution (which could be accelerated by the current high prices), the amount of antimony recovered from recycling will also likely decline.

3.5 Chinese Controls on exports

In September 2024, China's Ministry of Commerce introduced export controls on various forms of antimony, including ore, metal, oxides, and smelting and separation technologies. In December 2024, an export ban on antimony exports to the US was declared. The antimony export controls will establish licensing procedures for exporters and require an export contract with the Ministry of Commerce, a technical product description, and end-user details.

In recent years, many industrial users in Europe and North America have diversified their sourcing of antimony products to include suppliers outside of China [24]. Data from Eurostat indicates a significant decrease in China's antimony metal imports into the European Union, falling from 18% in 2023 to just 6% in 1H 2024. Similarly, the market share of China's antimony oxide suppliers in the US has declined from 72% in 2023 to 63% in 1H 2024. However, both regions remain considerably exposed to China's export restrictions [25].

3.6 Antimony Stockpiles

There may be above-ground stocks of antimony metal in China, including stocks accumulated by the Fanya Metal Exchange (FME) between 2011 and 2015. FME was a state-backed exchange based in Kunming, Yunnan Province, focused on metals employed in technologies highlighted in China's official strategic plan. The exchange raised US$6.4 billion from investors across China in three years. However, in 2015, the exchange was revealed to be a Ponzi scheme and collapsed. The exchange reportedly held 18.7 kt of antimony, which a subsidiary of **China Minmetals**, a state-owned company, subsequently purchased [26].

The Defense Logistics Agency (DLA) oversees the US national defence stockpile, which contains materials critical to national security to reduce its dependence on foreign sources. The exact level of the antimony stockpile is unknown, but the DLA continues to acquire antimony.

Figure 14. Stibnite Gold-Antimony Project in Idaho, United States

Source: Perpetua Resources

4. Antimony Mining Projects

Currently, there is a shortage of mined antimony concentrate available to supply the world's smelters that recover antimony. Similarly, there is a lack of potential new projects to produce mined antimony concentrate. Table 2 illustrates just three active antimony development projects and six exploration projects. If the three development projects come on-stream, they would contribute about 13.4 kt/y (approximately 12% of the 110.4 kt produced in 2023) to existing production. This is a very weak pipeline of potential new projects.

Antimony's close mineralogical association with silver and its affinity for gold make it a useful exploration indicator of precious metal potential in certain types of ore deposits. Consequently, exploration companies sometimes report the presence of antimony alongside other primary metals; however, this does not necessarily imply that antimony can be recovered economically, and these should not be regarded as antimony projects.

Occasionally, the antimony in the mixed concentrate produced in these instances can be recovered when sold to a smelter where antimony recovery occurs. However, the volumes are extremely small and seldom reported. For example, **Calidus Resources** [ASX: CAI] is developing the Nullagine gold project in Australia, which includes the Blue Spec deposit containing traces of antimony. It has reported the sale of a high-grade gold concentrate with some antimony credits.

4.1 Development and Exploration Projects

Larvotto Resources [ASX: LRV] intends to restart the Hillgrove gold-antimony mine in New South Wales, Australia. A PFS was completed in August 2024 for a mine expected to produce an average of 41.1 koz/y of gold and 5.4 kt/y of antimony over a 7-year mine life, with a capital cost of US$50m. The mine already has equipment in place and has an operational processing plant. A DFS is currently in progress, and the company aims to achieve its first production in early 2026. The project has an antimony resource of 93.0 kt, with a grade of 1.3% antimony.

Antilles Gold [ASX: AAU] is developing the La Demajagua gold-silver-antimony project in Cuba through an equal joint venture with **GeoMinera**. A scoping study was completed in July 2023 for a mine anticipated to produce 50 kt/y of gold-arsenopyrite concentrate over nine years at an initial capital cost of US$100m. The project was subsequently expanded to include a 50 kt/y two-stage fluidised-bed roaster, a CIL circuit, and an antimony recovery circuit for processing the gold arsenopyrite concentrate.

Table 2. Active Antimony Development and Exploration Projects

Project	Country	Owner	Resources Sb kt	Production Sb t/y	Development Stage
Hillgrove	Australia	Larvotto Resources	93.0	5,400	Feasibility
Demajagua	Cuba	Antilles Gold/GeoMinera	32.4	4,500	Scoping study
Stibnite	USA	Perpetua Resources	118.4	3,478	Feasibility
Nagambie	Australia	Nagambie Resources	17.8	na	Exploration
Mt Clement	Australia	Black Cat Syndicate	13.9	na	Exploration
Estelle	USA	Nova Minerals	na	na	Pre-feasibility
Sunday Creek	Australia	Southern Cross Gold	na	na	Exploration
Montezuma	Australia	Lode Resources	na	na	Exploration
Scraffold	USA	Felix Gold	na	na	Exploration
Golden Range	Australia	Warriedar Resources	na	na	Exploration
Total			**275.5**	**13,378**	

Source: Company data.

This will yield about 47 koz/y of gold and approximately 10 kt/y of antimony concentrate, with a grade of about 45% antimony. A DFS for the expanded La Demajagua project is scheduled to be completed in mid-2026, with construction in 2026-27. The project has an antimony resource of 32.4 kt, grading 0.34% antimony.

Perpetua Resources [TSE: PPTA] is developing the Stibnite gold-antimony project in northern Idaho, United States. A feasibility study completed in 2020 outlines an open pit mine and conventional processing methods designed to produce gold and silver doré, as well as an antimony concentrate. The project is anticipated to require an initial capital investment of US$1.26bn and aims to produce an average of 297 koz/y of gold and 3.5 kt/y of antimony over a mine life of 15 years. There is an antimony resource of 118.4 kt, with a grade of 0.06% antimony.

Perpetua has received a letter of interest from the US Export-Import Bank (EXIM) for a loan of up to US$1.8bn to develop the project. This follows an award of US$24.8m from the Department of Defense under the Defense Production Act Investments Program to complete an environmental study and US$60m to fund the permitting process. Perpetua plans to commence construction in 2025 and production in 2028. The company has recently announced plans to conduct metallurgical testing of its antimony concentrate with US Antimony Corp. Figure 14 shows a picture of the former workings at Stibnite.

Nagambie Resources [ASX: NAG] operates the Nagambie antimony-gold exploration project in Victoria, Australia. In May 2024, the company announced its maiden inferred resource, which graded 3.3 g/t gold and 3.9% antimony and comprised 47.8 koz gold plus 17.8 kt antimony. A follow-up drill programme is currently underway to explore along strike and at depth.

Black Cat Syndicate [ASX: BC8] owns the Mt Clement antimony-gold exploration project in the Pilbara region of Western Australia. The deposit is located 30 km from its recently recommissioned Paulsens gold mine and hosts an inferred resource of 13.9 kt antimony and 1.46 Moz silver. The company plans to conduct extensional and infill drilling on the property to prove a large exploration target estimated to contain up to 100 kt antimony potentially. High-level historical metallurgical test work indicates the ore could be processed at Paulsens by adding a flotation circuit to produce an antimony concentrate.

Nova Minerals [ASX: NVA, Nasdaq: NVA] is exploring the early-stage Estelle gold-antimony project located in Alaska. It currently comprises seven antimony-gold prospects, including Stibium, a high-grade antimony-gold resource. The company is considering a low-capital, quick start-up for this asset to secure funding for developing the other deposits. The company reports that the University of Alaska Fairbanks, a grantee under the Department of Energy (DoE) CORE critical minerals programme, is responsible for commercialising critical minerals in Alaska, with the Estelle project now participating as a partner in the programme.

Other exploration projects with the potential to produce antimony in future include the Sunday Creek gold project in Victoria, Australia, operated by **Southern Cross Gold** [ASX: SX2], the Montezuma project in Tasmania, Australia, operated by **Lode Resources** [ASX: LDR], the Scraffold project in Alaska, United States, operated by **Felix Gold** [ASX: FXG] and the Golden Range project in Western Australia, operated by **Warriedar Resources** [ASX: WA8].

5. Antimony Markets & Prices

Antimony is not traded on a metal exchange, and there are no official prices. The price is determined solely through negotiations between buyers and sellers. Most contracts between antimony producers and processors are long-term and confidential. Spot prices are sourced from specialist data providers such as Argus Media, Asian Metal, Bloomberg, and Fastmarkets.

The main antimony products in international trade are stibnite ores and concentrates, antimony metal, antimony trioxide, and antimonial lead. Antimony ore concentrates contain 5 to 60% antimony. Antimony metal is typically traded in ingots and slabs and occasionally in the form of granules, cast cakes, powder, shot, and single crystals [27].

The price of antimony has more than quadrupled since the beginning of 2024, reaching nearly $43,000/t in January 2025. The current price increase is due to the ongoing declines in production in China due to domestic industry rationalisation and the fluctuating import levels of antimony ore and concentrates. Meanwhile, there has been a rising demand for antimony for use in solar PV glass. Antimony stock levels in China are reported to be at historically low levels [4].

Figure 15 illustrates the price of antimony since 2006. The last notable peak was observed in 2011 when prices reached around $17,100/t. This was attributed to the closure of several small and illegal mines in China, which constrained the supply of antimony [28]. The higher prices prompted some substitution in its primary application areas, such as flame retardants and lead-acid batteries, ultimately resulting in lower prices.

Antimony trioxide trades largely in line with the antimony metal and is available in standard and high-purity grades, but there are many sub-grades within these categories.

Figure 15. Antimony Price 2006 to 2025 (US$/tonne)

Source: Bloomberg

6. The Antimony Market Outlook

This section summarises outlook for the antimony market.

The analysis and forecasting of the antimony market are particularly difficult due to China's sector dominance, the market's opaqueness, the industry's small size, and the lack of reported data. However, the available information suggests that the outlook for antimony is extremely uncertain following several important changes in supply and demand over the past few years.

The supply-side developments have been largely negative for the market, resulting in a fall in global antimony supply. Mine ore and concentrate have become scarce, and capacity closures in the West have allowed China to become the dominant player in antimony concentrate processing and metal production.

The weakness in supply is probably linked to a weaker demand picture caused by a long-term decline in the consumption of antimony used in alloys and weak demand growth in flame retardants. However, demand has increased more recently as a result of a sharp increase in the demand for antimony for use in PV glass in China.

The overall impact has been that the antimony market has moved into deficit. This is reflected in the recent dramatic rise in the price of antimony and reported low stock levels. Moreover, China's recent decision to restrict exports of antimony products has compounded this situation for Western markets.

As a result, the antimony market is under severe stress and is arguably one of the most critical of the Critical Mineral commodities.

6.1 Supply Side Issues

On the supply side, the antimony industry has experienced continued mine closures over the past decade in both the West and China, as well as declining grades and reserve depletion at operating mines. Closures include mines in South Africa, Serbia, Canada, Australia, and Mexico and smelters in Serbia, Kyrgyzstan, and Oman. At the same time, only a few new antimony producers have emerged, producing antimony as a by-product of gold production. There is now a shortage of antimony concentrates worldwide, and Chinese smelters are operating at significantly reduced operating levels.

The most significant new production has come from Polyus' Olimpiada gold-antimony mine in Russia, which produced 24 kt of antimony in concentrate in 2018, equivalent to about 15% of the global mine antimony supply. However, Polyus' antimony production declined sharply in subsequent years and has been variable (a low of 2.5 kt in 2021) due to its focus on primary gold output. Then, in 2023, antimony output jumped to 27.1 kt, equivalent to about 25% of global antimony production. However, it is believed that much of this concentrate did not reach the market because Polyus has been subjected to Western sanctions since Russia invaded Ukraine in February 2022.

There are no forecasts of future antimony production from Polyus, but company reports suggest that the mine has depleted its antimony ore reserves and is now processing stockpiled high-grade antimony ore. However, the high-grade antimony stockpile level is unknown and likely limited.

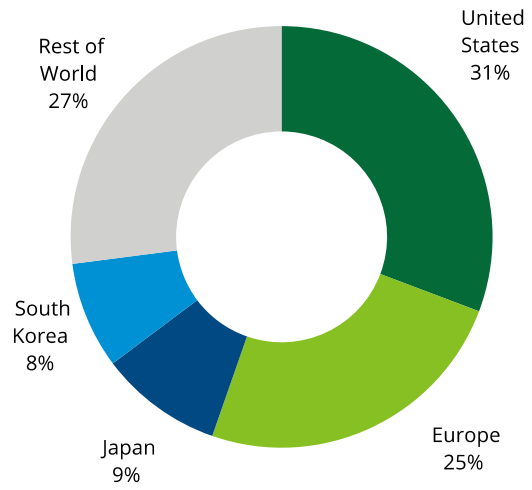
This uncertainty in the level of antimony production, the level of antimony reserves, and the ability to export the concentrates from Olimpiada makes forecasting future antimony production impossible. Given the mine's potentially significant impact on the market balance, Olimpiada poses a massive risk to the antimony industry's supply chain.

Meanwhile, the pipeline of new development and exploration projects that could produce antimony in the medium term appears very small and limited, again posing a risk to the future market. However, if the antimony price remains at its current high levels for a prolonged period, this may change, as it could stimulate renewed interest in exploration.

There may be above-ground stocks of antimony metal in China, including those accumulated by the Fanya Metal Exchange between 2011 and 2015. The United States government has also been stockpiling antimony for national defence purposes for many years to reduce its reliance on foreign sources.

Finally, in September 2024, China's Ministry of Commerce introduced export controls on various forms of antimony, including ore, metal, oxides, and smelting and separation technologies. In December 2024, an export ban on antimony exports to the US, including other critical minerals, was declared. Both the US and Europe have considerable exposure to these export restrictions. Figure 16 shows the antimony export destinations in recent years.

Figure 16. China's Antimony Exports 2020-2024



Source: S&P Global Markets, RFC Ambrian estimates.

6.2 Demand Side Issues

On the demand side, substitution and thrifting have negatively impacted antimony's two largest markets: alloys (mainly in lead batteries) and flame retardants. This has resulted in a decline in demand for antimony in alloys, although there is insufficient data to determine whether its use in flame retardants has declined or its growth rate has slowed. These substitution and thrifting trends will likely continue. The decline in the demand for antimony in lead batteries is also causing a decline in antimony supply as recycled alloys are the only source for recycling, as antimony is not recovered from other uses. The rise in the production of EVs, which do not require lead batteries, threatens the long-term demand for antimony.

However, antimony consumption in solar PV glass has increased significantly in recent years and is now the third-largest consumption area. The outlook is for further growth based on the continued growth of the PV sector, particularly in China, which dominates the PV glass industry. Growth in this sector is expected to continue despite recent US tariff increases on imported PV cells from China.

6.3 Antimony Market Outlook

With only a patchwork of industry data, it is very difficult to determine the overall direction of the antimony market balance and prices with any certainty.

In the short and medium term, antimony production from the Olimpiada mine will be critical to supply levels and the price direction, and the uncertainty of output poses a massive risk to the industry supply chain.

In the medium to longer term, the weak supply outlook, offset by the softer demand for antimony in alloys and fire retardants but growing consumption in the PV market, suggests that the antimony market could remain in deficit for an extended period.

The price has surged dramatically over the past six months, but it appears that these high antimony prices will be necessary in the short- to medium-term to attract new supply to come onstream and/or cause some demand destruction through substitution and thrifting. The new supply could appear from unidentified stocks coming into the market, and/or closed mining and smelting operations could be prompted to restart production. In the longer term, sustained higher prices could encourage increased exploration for antimony and the development of new mining and processing capacity.

Appendix 1 – Antimony Resources

Due to increased magmatic activity, antimony deposits are often found near active continental plate margins and orogenic belts with steep geothermal gradients. Most antimony-bearing ore deposits are associated with the subduction-related western Pacific plate boundaries, particularly in East and Southeast Asia. Another significant antimony region can be identified at the Nazca-South American plate boundary in Bolivia and Peru, extending along the western plate margins of North America. Additional regions are associated with different metallogenic periods in central Europe, encompassing the Hercynian and Alpine belts.

Although the abundance of antimony in the Earth's crust is estimated at only 0.2 parts per million, a wide variety of antimony minerals exist. Antimony substitutes for bismuth, lead, arsenic, and sulphur in various ore minerals and tends to concentrate in sulphide ores alongside copper, lead, gold and silver.

Antimony seldom occurs in its native form, with the most significant antimony mineral in economic deposits being stibnite (Sb_2S_3). Stibnite may appear as a primary deposit or be associated with other types of ore deposits. However, standalone concentrations of stibnite are rare, and economically exploitable stibnite deposits are typically small and discontinuous.

Antimony occurs in a variety of deposits of various ages, and the most important types of exploitable antimony deposits include:

- Greenstone carbonate replacement deposits (1.5 to 25% stibnite).
- Epithermal gold-antimony vein-type deposits (0.1 to 3.5% stibnite).
- Reduced-magmatic gold deposits (0.1 to 1.5% stibnite).

Antimony, arsenic and bismuth are significant pathfinder elements in geochemical prospecting surveys because they are associated with many mineral deposits.

Greenstone Deposits

Greenstone-hosted carbonate replacement deposits hold significant economic value. These deposits typically contain tens of millions of tonnes of mineralisation and notable stibnite grades. They generally consist of a stockwork of gold-antimony-quartz-carbonate veins hosted by metavolcanic and/or metasedimentary rocks. Notable carbonate replacement antimony deposits include Hwikuangshan in Hunan, China; Muli in Yunnan, China; Olimpiada and Kadamdzhay in Russia; and the Murchison greenstone belt in South Africa.

Epithermal Deposits

Epithermal gold-antimony deposits are typically smaller than greenstone-hosted deposits. They are typically up to 1 Mt in size, have lower ore grades and are often associated with gold and silver. The formation of these epithermal deposits is connected to the emplacement of magmatic porphyry copper systems within the shallow crust (the upper 1.5 km) and associated with hydrothermal solutions. Mineralisation generally takes the form of stibnite veins or disseminated stibnite, which is found in volcanic, sedimentary, and metamorphic rocks. Examples of epithermal gold-antimony deposits are the Banpo antimony deposit in Guizhou, China [29] and the gold-bearing sulphide reefs of the Bendigo Zone in Australia.

Reduced Magmatic Deposits

Reduced magmatic gold systems are linked to the intrusion of metaluminous granite plutons, with mineralisation manifesting as quartz-carbonate sheeted veins, replacement bodies, and/or skarns. This mineralisation may be enriched in several metals, including gold, tellurium, tungsten, arsenic, and antimony. Antimony-rich deposits typically occur as fault-filled veins. Although mostly small to medium-sized, these deposits can occasionally be large and generally exhibit low antimony grades. Notable deposits include Woxi, Gongguan, and Yawan in China and deposits in the Bolivian polymetallic belt [27].

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