

# Mineral Commodity Report 2 — Antimony

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## Discovery and Origin of Names

Antimony was used as early as 4000 BC in containers, mirrors and bells. Stibnite, the major ore of antimony, was known and used in Biblical times as medicine and as a cosmetic for eyebrow painting. Antimony is from the Latin *antimonium* and stibnite is from the Latin *stibium*.

## Major Ores and Minerals

Antimony is rarely found naturally as native metal. It is chalcophile and usually occurs in combination with sulphur and the heavy metals copper, lead and silver. There are more than 100 antimony minerals, but stibnite  $Sb_2S_3$  is the main ore mineral. Other common antimony minerals are the sulphosalts tetrahedrite  $Cu_8Sb_2S_7$  and jamesonite  $Pb_2Sb_2S_3$ , and the oxides formed predominantly from the oxidation of stibnite, mainly stibiconite  $Sb_2O_4 \cdot H_2O$ , kermesite  $2Sb_2S_3 \cdot Sb_2O_3$  and senarmonite  $Sb_2O_3$ .

Most of the important antimony deposits are mineralogically simple. They consist principally of stibnite or, rarely, native antimony in a siliceous gangue, commonly with some pyrite, and, in places, a little gold and small amounts of silver and mercury sulphides.

In complex deposits, antimony is a subordinate component of ores mined primarily for gold, lead, silver, tungsten or zinc. Generally, these consist of stibnite associated with pyrite, arsenopyrite, cinnabar or scheelite; still others have sulphosalts with varying amounts of copper, lead and silver, as well as the common sulphides of these metals and zinc.

## Properties

Antimony is a member of Group VA of the periodic table and although predominantly metallic in chemical character, it exhibits some degree of nonmetallic behaviour and is a poor conductor of heat and electricity. It is a bright silvery-white coloured metal, brittle, with a crystalline rhombohedral structure, flaky appearance, hardness of 3 to 3.5 and specific gravity of 6.7.

Stibnite is orthorhombic and may occur in prismatic crystals, often in radiating groups (Figure 1), as well as in granular aggregates. It is lead-grey to black in colour, with a metallic lustre, hardness of 2 and specific gravity of 4.6.

## Formation

The major antimony deposits were formed from hydrothermal solutions at relatively low temperature and shallow depth. They occur as filled fissures and joints and irregular replacement bodies.

Symbol	Sb
Atomic No.	51
Atomic wt	121.75
Specific gravity	6.69
Valence	3,5
Melting point	630°C
Boiling point	1380°C
Crustal abundance	0.2 ppm
Preferred analysis method	atomic absorption spectroscopy
Routine detection limit	0.2 ppm

## Uses

Antimony is used in alloys because it hardens soft metal such as tin and lead. For example, up to 15% Sb is used in the white metals: Britannia metal (Pb-Sb-Cu), pewter (Pb-Sn-Sb), Queen's metal (Sn-Sb-Cu-Zn) and Sterline (Cu-Sb-Zn-Fe). Its major use is in the alloy used for the plates in lead acid storage batteries, although antimony alloys are also used in semiconductors, chemical pumps, tank linings, plumbing fixtures and pipes, foil and bullets. Antimony has the unusual characteristic of expanding on solidifying, making it a valuable ingredient of alloys used in type metal (commonly 58% Pb, 26% Sn, 15% Sb, 1% Cu) and casting. The expansion of the alloy forces the metal to fill the small crevices of casting moulds. Combined with tin, lead and copper, antimony forms anti-friction alloys called babbitt metals that are used as components of machine bearings. Antimony oxides are used in paints and plastics as a pigment and fire-retarding agent, and in white ceramic enamels as an opacifying agent. Antimony sulphides are used in the manufacture of ammunition primers, friction matches, smoke generators, tracer bullets, fireworks and as a vulcanising agent in the rubber industry. Organic compounds of antimony are used in the textile industry to aid in binding certain dyes to fabrics and in medicine as remedies for certain tropical diseases.

## Price

The average price for antimony metal quoted by the London Metals Exchange during 1992, was about US\$1690 per tonne, whereas antimony ore (60%) averaged US\$15.75.

## World Occurrence and Production

World mine production of antimony metal is about 60 000 tonnes (t) a year (63,800 t Sb contained in ores and concentrates in 1992; Masters, 1993). Most of the production is from China, Bolivia, South Africa and countries of the former USSR, with significant production also from USA, Mexico, Australia, Thailand, Turkey and Guatemala.

World resources of antimony are estimated at about 4.2 million tonnes (Mt), with more than 50% located in China.

Other countries with major antimony resources are Bolivia, some countries of the former USSR, South Africa and Mexico.

Antimony is obtained from low grade sulphide ores (5–25% Sb) by roasting the ore to form the oxide  $Sb_2O_4$ , which is then reduced to the element by heating with carbon. Higher grade ores (25–40% Sb) are melted with scrap iron in a furnace. The iron combines with the sulphur to form a liquid layer of molten iron sulphide, and the heavier liquid antimony settles to the bottom and is drawn off. High grade ores (40–60% Sb) are “liquated” by melting in a reverberatory furnace in a reducing atmosphere. The solidified product is called liquated or needle antimony, and may be used as sulphide or converted to antimony by iron precipitation. Some complex ores can be treated by leaching and electrowinning to recover the antimony.

## New Zealand Occurrence, Past Production and Imports

Stibnite has been recorded from many localities in New Zealand (Figure 1), principally in association with mesothermal gold-bearing quartz lodes in Paleozoic to Mesozoic greywacke and schist, although it also occurs in epithermal quartz veins and sinters associated with late Cenozoic volcanism. Tetrahedrite, precious and base metal sulphosalt minerals, livingstonite ( $HgSb_4S_7$ ), and the secondary minerals kermesite, senarmonite and stibiconite have been recorded from a few localities and these are listed by Railton and Watters (1990).

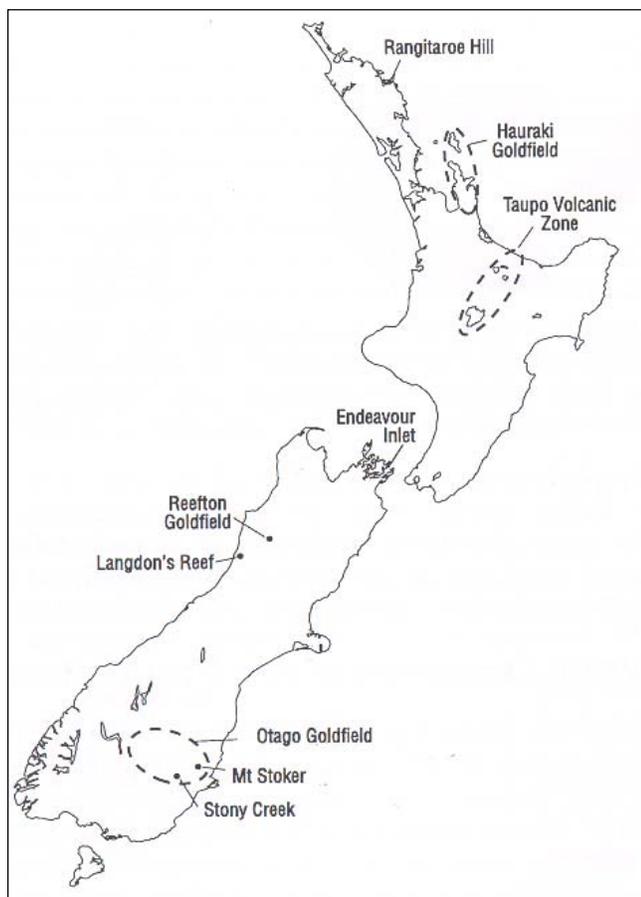


Figure 1: Location of antimony (stibnite) deposits in New Zealand.

Past mining of a few of the stibnite deposits produced a total of about 3900 t of antimony ore. No antimony is currently mined and all our requirements are being met by imported antimony.

### Rangitaroe Hill, Waikare Inlet

At Rangitaroe Hill (Lanigan's Mine), 10 km southeast of Russell, Bay of Islands, stibnite is found within a 3 m wide silicified crush zone, dipping 80°SW, in Waipapa Group greywacke (Ferrar, 1925). The deposit was first mined in 1907 and 115 t of ore, at an average grade of 50–60% Sb, was extracted and exported.

### Endeavour Inlet, Marlborough

Antimony was first discovered at the head of Endeavour Inlet in about 1872 and approximately 3000 t of ore were mined between 1880 and the mid 1890s (Park, 1890). Initially the ore was sorted and exported without further treatment, but a smelter was later constructed on site (Gregg *et al.*, 1970; Williams, 1974). Maclaurin (1901) recorded samples of the ore containing between 60.12 and 96.84% stibnite.

The quartz veins occur in a 300 to 350 m wide NNW-trending shear zone in schist at the head of the inlet (Pirajno, 1979). Individually the veins are 0.2 to 1 m wide and up to 65 m long. They are locally arranged in an en echelon pattern and generally parallel the shear zones with a dip between 60 and 70° to the east. Mineral zoning is well developed over the exposed vertical range of 400 m and is seen as an upper stibnite zone passing into an arsenopyrite-pyrite-marcasite-gold assemblage. The stibnite is considered to be late in the paragenetic sequence and was deposited at a shallower depth and at lower temperatures than the gold-bearing mineral assemblage. Pirajno (1979) considered that the mineralisation was derived from a hydrothermal system developed during the metamorphism of Pelorus Group rocks.

Recent investigations show the area still has potential. Samples collected from tailings beneath the Endeavour Inlet mine by Gregg *et al.* (1970) had rich concentrations of stibnite. In addition, stream sediment samples indicate the possible presence of mineralisation in the hills behind Furneaux Lodge and above Tawa Bay (Gregg *et al.*, 1970). Richards (1977) showed that with correct treatment low grade ore and tailings from the Endeavour Inlet mine operations could be converted into high grade stibnite concentrate (>60% Sb) with better than 90% recovery of antimony.

Galvin (1887) recorded stibnite lodes, containing between 51.12 and 69.4% antimony, located at Jacksons Head near the entrance to Queen Charlotte Sound. Other stibnite bearing lodes are known in the schist hills above Resolution Bay and Anakakata Bay.

### Langdon's Reef, Westland

Langdon's Reef (also known as Langdon's Antimony Lode), in the Langdons Creek area at the southern end of the Paparoa Range, was discovered in 1879, and 17 claims were taken up by 1882. Ten tonnes of ore were shipped to England, but results were “disappointing”. The lode was described by Hector (1879), McKay (1883a) and Morgan (1911) as a bedded quartz lode 0.6–2.7 m thick including 0.6 m “compact

stibnite”, enclosed in Greenland Group greywacke and argillite. Pyrite, arsenical pyrite, calcite and free gold are also present in the quartz lode. Picked samples assayed up to 14.7%  $\text{Sb}_2\text{S}_3$  (10.05% Sb), 7.8 grams/tonne (g/t) Au and 1.5 g/t Ag. Initial values reported by Hector were 2610 g/t Au and 1120 g/t Ag and 45.28 kg of gold were produced between 1884 and 1888. The area was recently investigated by Mineral Resources Ltd (Aliprantis, 1988; Cotton and Stewart, 1989).

### **Croesus Knob Reefs, Westland**

Stibnite is present in quartz lodes at several localities in the Croesus Knob Reefs, 14 km north of Langdon’s Reef, in the southern part of the Paparoa Range. The Croesus Knob reef system was worked primarily for gold in the period 1891–1905, principally on the Minerva, Croesus, Taffy and Garden Gully claims. Quartz vein stockworks, with veins ranging from 1 mm to 3 m width, occur along bedding planes or faults within Greenland Group metasedimentary rocks. Visible gold mineralisation and associated sulphides are confined to small pockets within or on the margins of the typically lenticular quartz veins. Sulphides include pyrite, sphalerite, chalcopyrite, galena, arsenopyrite, stibnite and bournonite ( $\text{CuPbSbS}_3$ ). AMOCO explored the area in the early 1980s (Erceg and Barnes, 1982) and reported maximum base metal values from picked material as: 7400 ppm Sb, 5700 ppm Cu, 1.72% Pb, 2400 ppm Zn and 8490 ppm As. A peak gold value of 12 ppm was supported by weakly anomalous gold in soil samples over 500 m.

### **Reefton Goldfield**

Stibnite was found in many of the quartz lodes in the Reefton Goldfield, locally making up 10–30% of some veins (Finlayson, 1909b) and causing some metallurgical difficulties during the gold recovery process (eg Murray Creek mines). The Reefton lodes are developed in shear zones within Greenland Group metasedimentary rocks and most are located in a northerly trending belt of intense folding and shearing, 5 km in width. In addition to quartz, stibnite and gold, other minerals found in the goldfield included: carbonate, pyrite, arsenopyrite, chalcopyrite, galena and molybdenite. Stibnite was reported from mines at Blackwater, Globe Hill, Crushington, Capleston–Specimen Hill, Big River, Ajax, Murray Creek, Blacks Point–Painkiller, Merrijigs and Alexander River. The mineralisation in the Murray Creek area was particularly antimony rich with up to 7% reported in ore concentrates by Henderson (1917) and abundant stibnite reported from the Golden Treasure lodes by Downey (1928) and Suggate (1957). A discrete antimony-bearing lode, the Bonanza lode, was described from Aulds Creek by McKay (1883b), and Williams (1974, p. 31) noted that at the Blackwater mine a discrete stibnite lode was believed to have been found in the country rock not far from the main lode. Recent reconnaissance geochemical exploration for antimony in the Reefton Goldfield (Riley and Ball, 1971, 1972a, 1972b; Viljoen, 1972) highlighted a few potential targets where small resources might be found.

### **Otago**

Several of the quartz lodes in schist (Haast Schist Group) of the Otago region carry significant quantities of stibnite, particularly at Mt Stoker and Stoney Creek.

**Mt Stoker** deposit, also known as the Hindon Antimony Mine, near Hindon (Rowe, 1881a) consists of an auriferous quartz lode with pyrite and some stibnite. The lode is 5.5 m wide and dips 45° to the northeast. The deposit was worked intermittently up to 1948, when 9 t of ore were produced.

**Stony Creek** deposit, 15 km NNE of Lawrence, consists of a 75 cm wide quartz lode, dipping 20°, that contains fibrous and compact stibnite, pyrite and some scheelite (Rowe, 1881b). A 4 t sample contained 47% Sb and 60 t of ore were shipped in 1875.

Stibnite has also been won from the Carrick goldfield (10 t from the Buchans lode), Nenthorn goldfield (Home Rule lode, Consolidated lode) and lodes near Patearoa (Williamson, 1939) and Alexandra (Park, 1906). Trace amounts of stibnite have also been reported from Macraes Flat and Barewood (McKay, 1892; Finlayson, 1909a; McKeag and Craw, 1989), Mt Difficulty (Park, 1908), near Macetown and in the Shotover (Williams, 1974).

### **Epithermal Deposits**

Stibnite is found in epithermal mineralisations associated with Cenozoic volcanic activity in Northland, the Hauraki Goldfield (Coromandel Peninsula region) and the Taupo Volcanic Zone.

At Puhipuhi, Northland, stibnite occurs as radiating aggregates in the Mt Mitchell sinter and in silicified greywacke associated with epithermal mercury deposits formed in a geothermal system during the Pliocene.

At Ngawha, Northland, minor stibnite is associated with mercury in Pleistocene lake sediments and is related to the active Ngawha geothermal system.

In the Hauraki Goldfield, stibnite is found in some epithermal quartz veins, particularly at Te Ahumata (Great Barrier Island; Ramsey and Kobe, 1974), Mahakirau (Fraser and Adams, 1907; Robson, 1979) and Thames (Fraser, 1910; Merchant, 1978, 1986).

Sinter deposits surrounding hot springs in many of the geothermal fields of the Taupo Volcanic Zone (eg Waiotapu, Ohaaki) contain antimony along with arsenic, mercury and thallium, present as amorphous minerals (eg metastibnite; Weissberg, 1969).

### **Potential and Prospectivity**

Small resources of stibnite are present in some of the known deposits (eg Endeavour Inlet) and although they are too small to consider mining under current conditions, they could be extracted if required for strategic purposes. Antimony could be produced as a byproduct of goldmining. For example, the resources outlined at the proposed Globe–Progress goldmine at Reefton (5.3 Mt grading 3.12 g/t Au at a 1.5 g/t Au cut off) include 0.4% Sb (Macraes Mining, 1992).

### **Future Trends**

There has been a general decline in the use of antimony, particularly in batteries, and for almost all its end-uses, antimony can be substituted by other elements. In

low-maintenance batteries, the antimony content has been reduced from the 5 to 10% range to about 1.75 to 2.75% while maintenance-free batteries with lead-calcium grids contain antimony only in the straps. A large proportion of the material for use in batteries, type metal and babbitt is obtained from recycling.

Possible future uses of antimony include stabilisers in specialised plastics, high-antimony batteries for deep-cycling characteristics in electrical vehicles, and uses in aircraft sight-vision systems and in space astronomy (Crowson, 1988).

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