

Antimony - Silent Threat... or Just Bad Press?

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T+T

Why antimony?

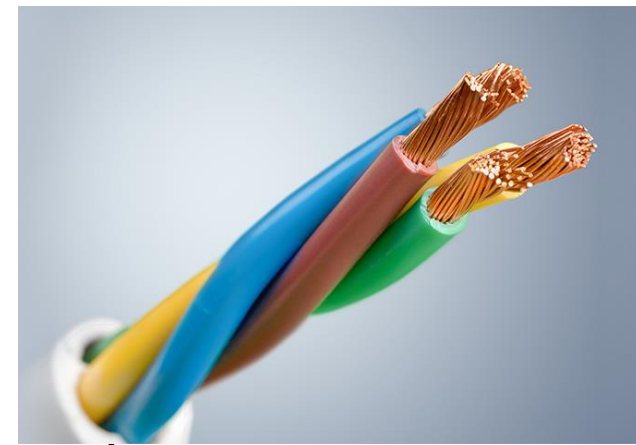
As: 200mg/kg;
Hg: 200 mg/kg
Sb: 31 mg/kg



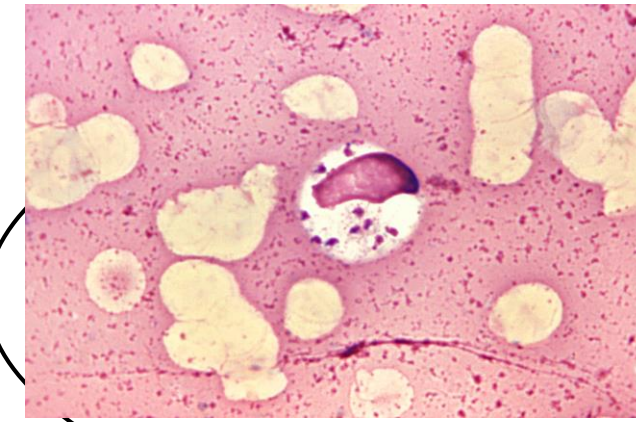
As: 9 mg/kg;
Hg: 38 mg/kg
Sb: 1,140 mg/kg



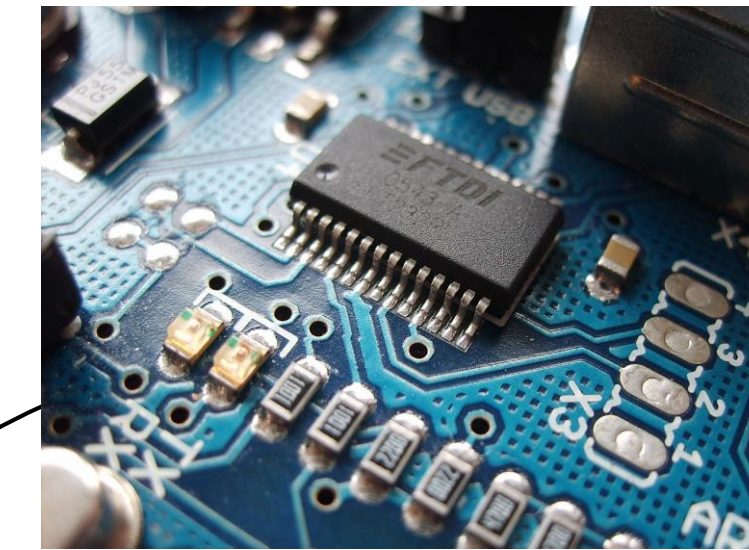
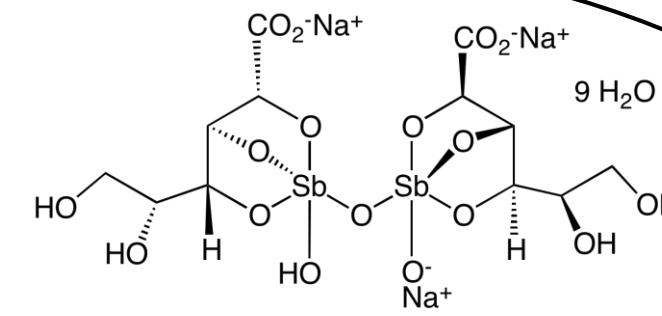
Antimony - industrial/societal uses



Flame retardant



Antimonial drugs



Semiconductors

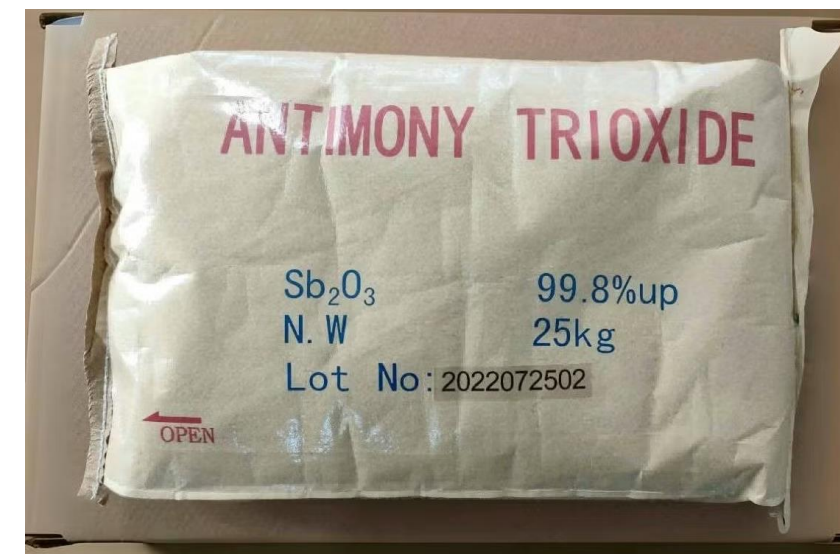


Primer

STANFORD
ADVANCED MATERIALS



InSb



Catalyst



Lead-antimony alloys



Brake pads

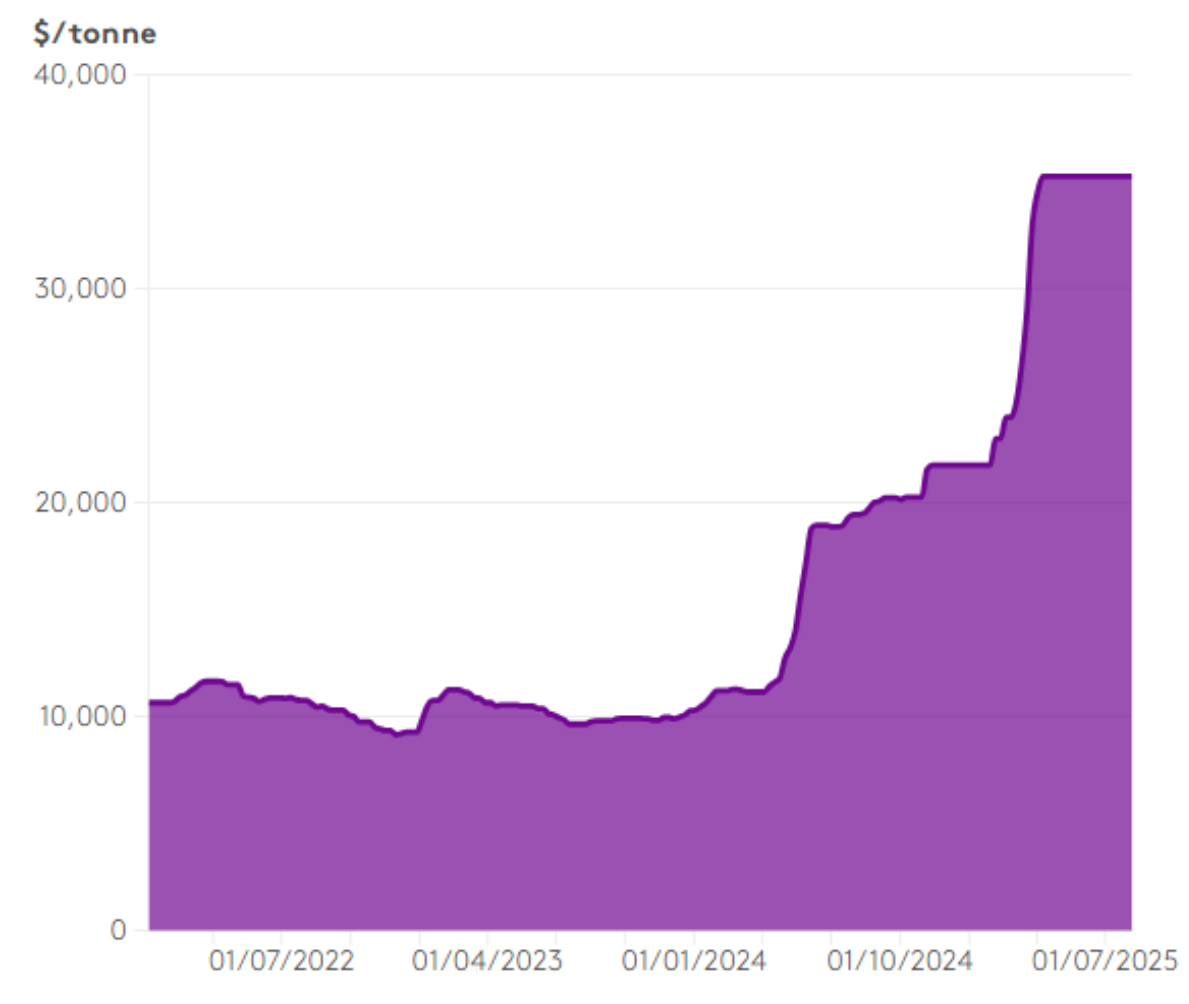


Image credits: USGS Mineral Resources Program, 2015.



Strategic element

Antimony has gone from niche to indispensable in short order. Driven by China’s export ban, recent structural supply constraints, and rising critical minerals policy urgency in the US, antimony is now a red-hot commodity. Mining.com.au – Oct 2025.



SbO₃ Chinese market price- reproduced from Fastmarket.com

Mineral	New Zealand import dependence	New Zealand net import dependence	2029 Market balance	Global supply availability	Market supply concentration	Supply country risk rating	Overall supply risk score
Gallium	10	10	8	5	10	10	8.9
Fluorspar	10	10	8	5	10	5	8.3
Chromium	10	10	6	8	10	5	7.6
Germanium	10	10	4	5	10	10	7.2
Silicon	10	10	6	0	10	5	7.2
Platinum Group Metals	10	10	6	0	10	5	7.2
Tungsten	10	10	4	0	10	10	7.0
Rare Earth Elements	10	10	4	0	10	10	7.0
Molybdenum	10	10	5	0	10	5	6.8
Antimony	10	10	4	6	10	5	6.6

Sb supply risk assessment for NZ critical minerals list - Wood Mackenzie Limited, 2024



Natural occurrence and forms



Antimony (III) Sulphide

Antimony (III) Trioxide

Antimony (III,V) Tetroxide
 $Ca_{4x} Sb(III)_{3-8x} Sb(V)_{1+4x} (O, OH, H_2O)_y$



Metastibnite

Senarmotinite

Stibconite

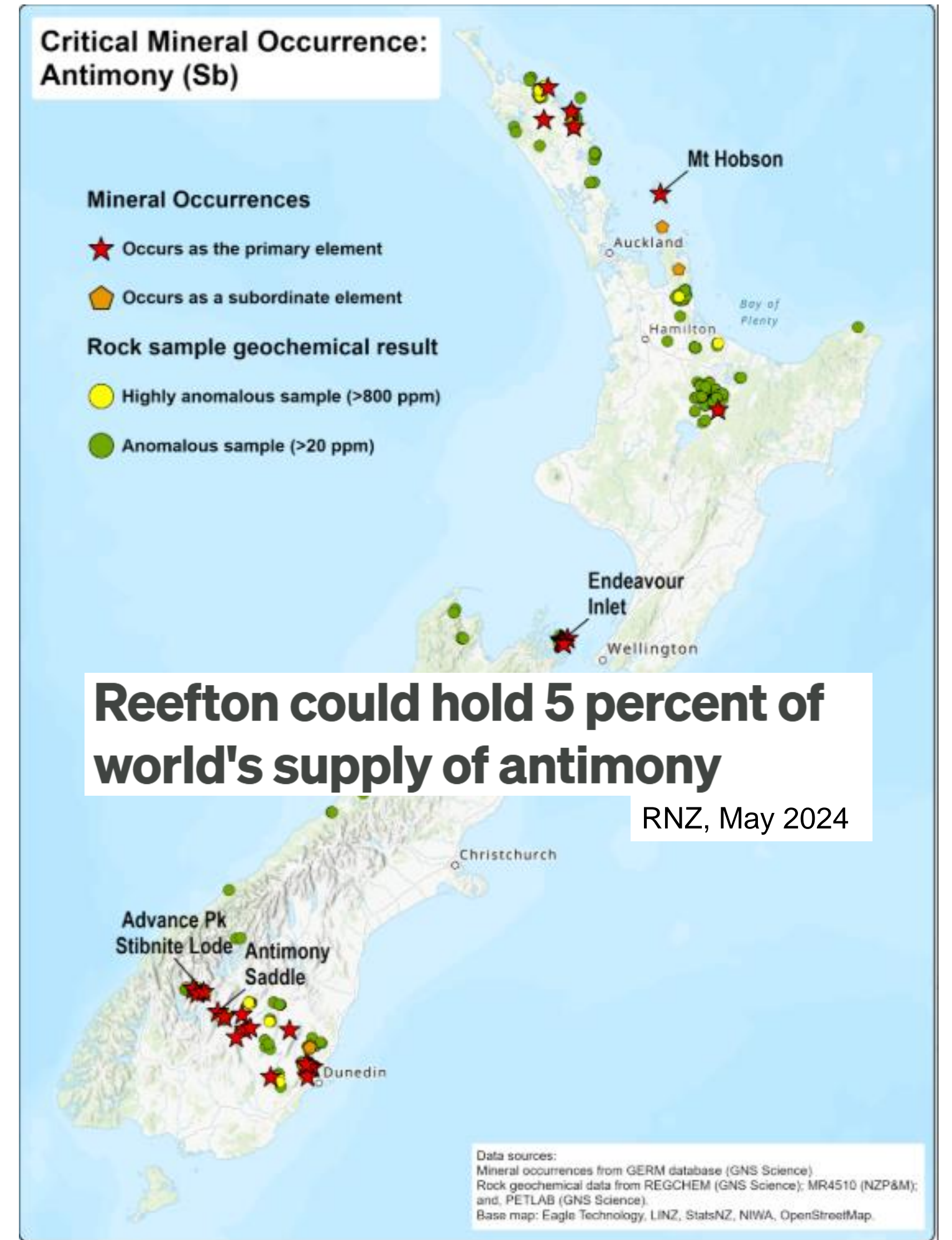


Image credits: Rob Lavinsky, iRocks.com – CC-BY-SA-3.0; Luca Oddone - Museo Geopaleontologico GAMPS – CC-BY-SA-3.0; Rémi Bornet www.le-comptoir-geologique.com

Antimony as a contaminant

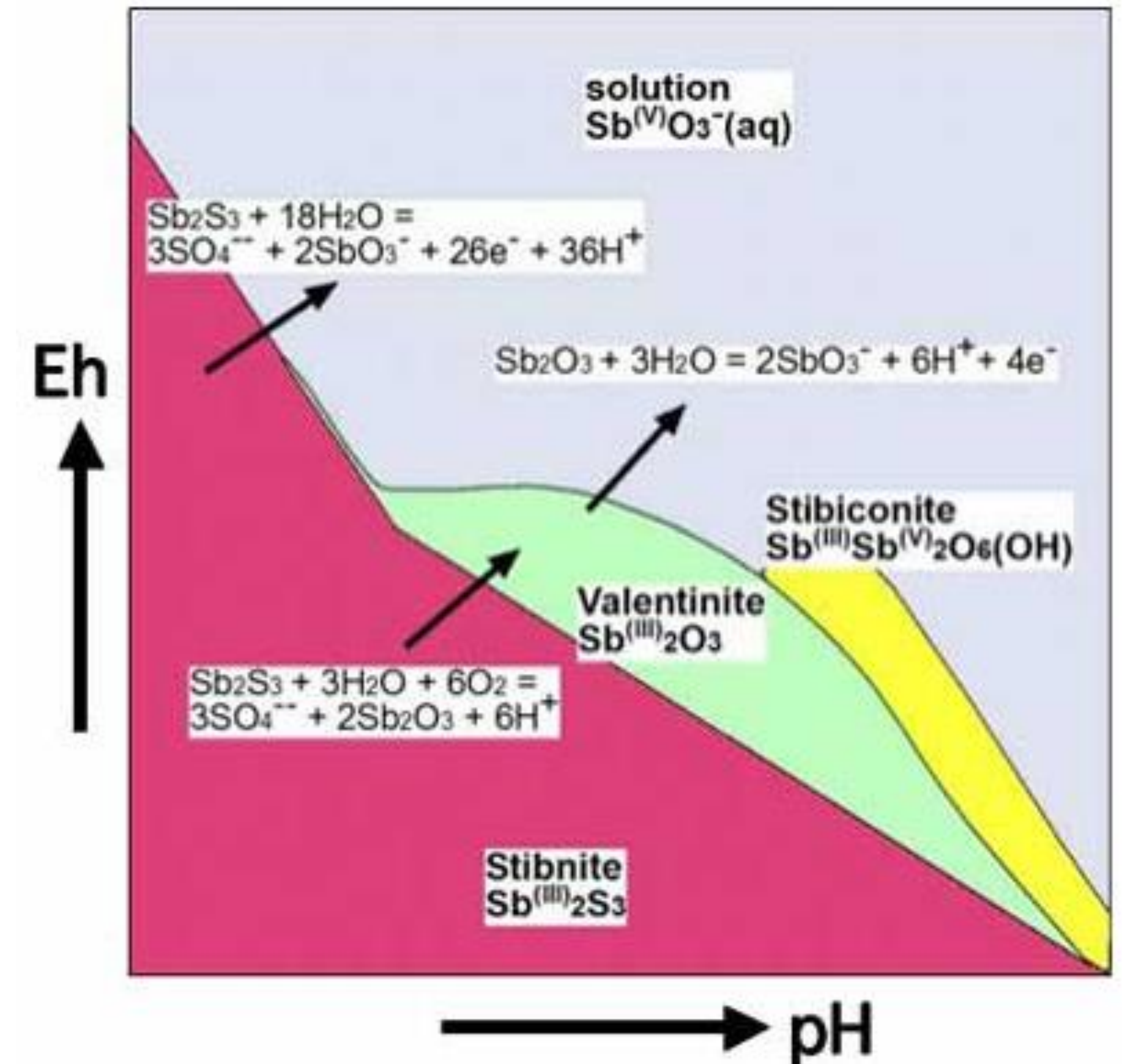
Media	Background/ambient	Industry related	Extraction related
Soil	Surface soils (2-20cm): 0.01-3.22 mg/kg – Median 0.13mg/kg	Gun Club, New Plymouth: 3.8-3,200 mg/kg	Endeavour inlet antimony mine: mining debris 500-5000 mg/kg; Sand tailings: 10-20% w/v stibnite
Sediment	Wellington stream : 0.28 mg/kg Waikato River: 0.8-8.3 mg/kg Port Waikato : 1.9 mg/kg	Te Mome stream: upto 21 mg/kg; 419 mg/kg in kerb drain sediment.	-
Water	West Coast groundwater: <1 µg/L Waikato River: 0.3-0.9 µg/L Wellington general stormwater : 0.7 µg/L	Te Mome stream:<2-21 µg/L	Endeavour inlet: Adits: 200 µg/L. Globe-Progress gold mine drainage: upto 3000 µg/L:

Sources: BTW, 2024; GNS, 2023 and 2025; GWRC, 2005; Wilson & Webster-Brown, 2009; Wilson, Craw & Hunter, 2004. Druzicka & Craw 2013 .

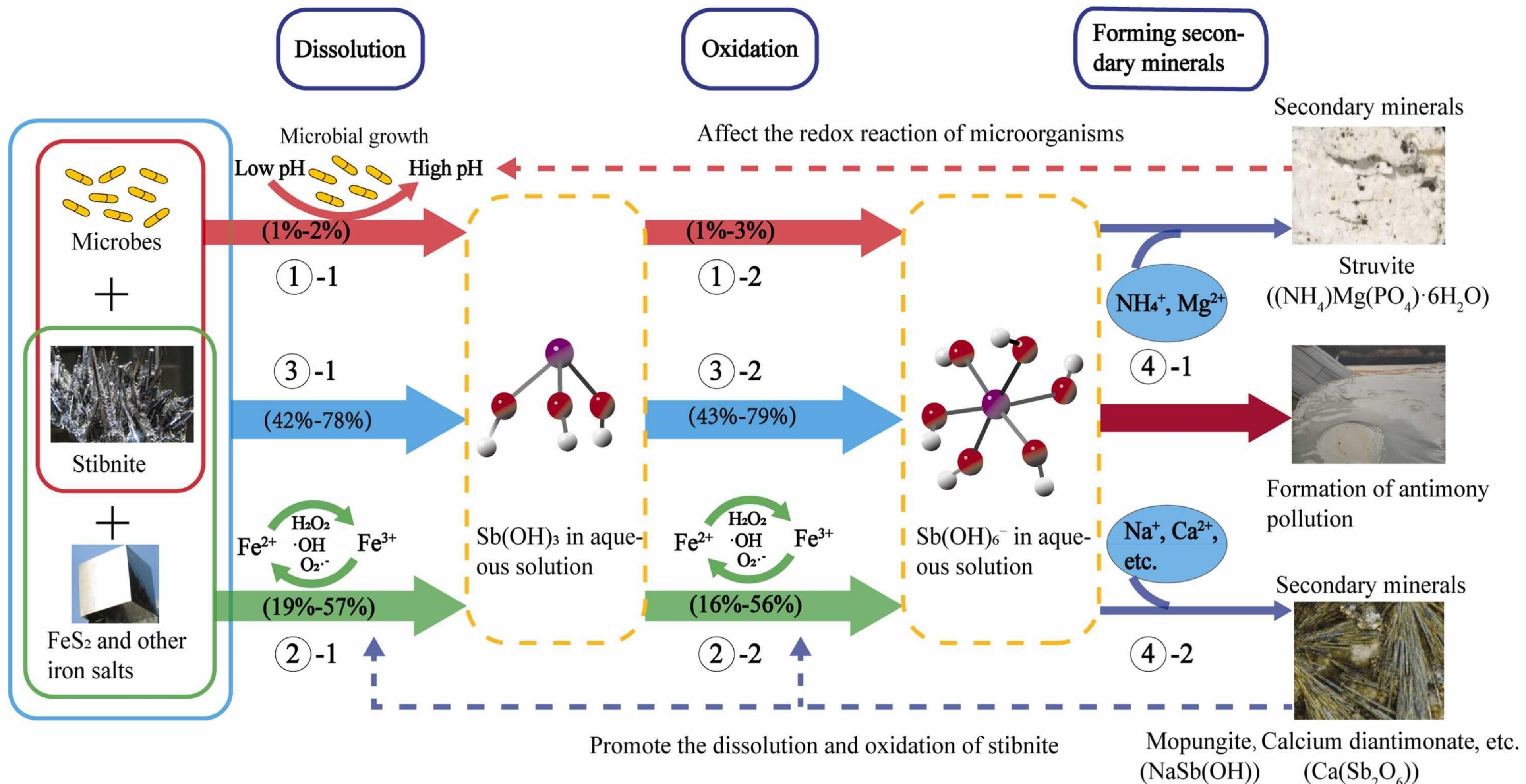


Environmental Fate

- In anoxic systems Sb(III) effectively insoluble
- Mineral sources of Sb(III) oxidise in surface conditions, this can increase acidity due to H⁺ release
- In soil Sb(III) rapidly oxidised by soil Fe/Mn hydrous oxides to Sb(V). Humic acid may also catalyse this. (EURAR, 2008)
- Pb/Sb alloy contamination in firing range soil initially present as Sb(III/V) but after 9 months weathering only Sb(V) (Barker et al., 2019)
- Sb(V) absorbed on to Fe/Mn/Al hydrous oxides but desorbed in alkaline conditions. Lowest mobility ~pH 4.3
- Dissolved Sb(V) limited at low to neutral pH through precipitation with Ca



Reproduced from <https://www.otago.ac.nz/geology/research/environmental-geology/metals-in-the-new-zealand-environment/antimony-in-australasia>



- ① -1 : AO-1 alone promotes the dissolution of stibnite ① -2 : AO-1 alone promotes Sb³⁺ oxidation ② -1 : Ferric salt alone promotes the dissolution of stibnite
- ② -2 : Ferric salt alone promotes Sb³⁺ oxidation ③ -1 : Coupling promotes the dissolution of stibnite ③ -2 : Coupling promotes Sb³⁺ oxidation
- ④ -1 : Forming struvite ④ -2 : Forming secondary minerals containing Sb

Reproduced from Xu et al., 2024



Human toxicity – Conventional view

Antimony is a metalloid of group 5a in the Mendeleef classification. From a chemical point of view, it resembles bismuth more than arsenic, while biochemically and toxicologically it behaves more like arsenic. It is considered to be more toxic (1–3). As far as is known,

Quoted from Lauwers et al., 1990

The toxicity of antimony is regarded to be on par with, or even higher than, that of arsenic, and the inorganic form of antimony, Sb(III), is far more toxic, than the organic one, Sb(V). In

Quoted from Periferakis et al., 2022

Antimony (Sb) and its compounds are highly toxic and potentially carcinogenic (Boreiko and Rossman, 2020, Zhang et al., 2021). Long-term exposure to high concentrations of antimony can potentially result in cardiovascular diseases, respiratory disorders, and even cancer (Lai et al., 2022). Due to the wide application of antimony in industry and

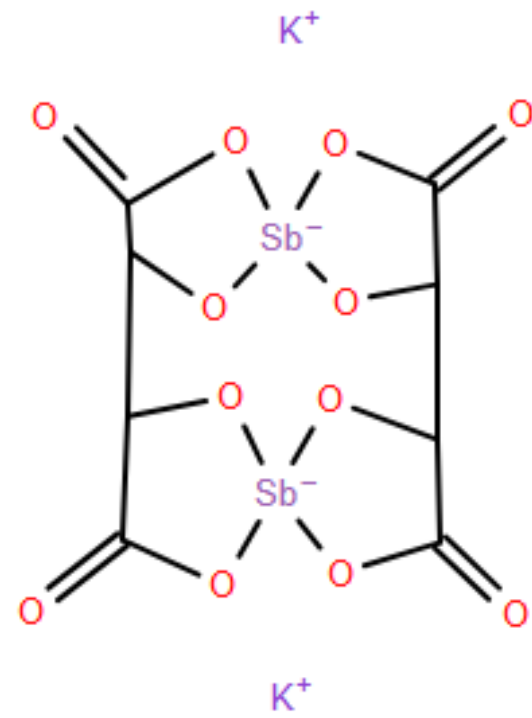
Quoted from Xu et al., 2024



Toxicity by Sb form

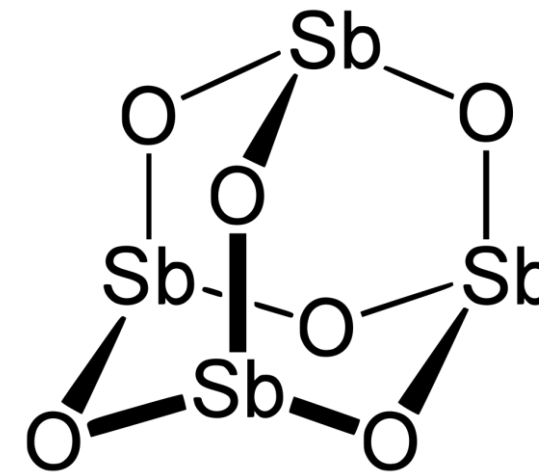
Antimony form	<p>Reproduced from Bailly et al., 1991</p>	Used for POD
Potassium antimony tartrate		HO, NZ, Canadian drinking water MAVs. Patch SGV
Antimony (III) trichloride		
Antimony (III) trioxide		
Antimony (III) trisulfide		
Sodium hexahydroxoantimonate (V)		ECHA dossier; Environment Canada Screening Assessment
Meglumine antimonate (v)	Human cases- side effects, Animal study NOAEL (injection) – 75 mg Sb/kg-bw/day	ECHA dossier
Sodium stibo(V)gluconate	Human cases- side effects, 20 mg/kg/d injection associated with developmental toxicity	ECHA dossier

Speciation impacts on toxicity- relevance for natural forms?



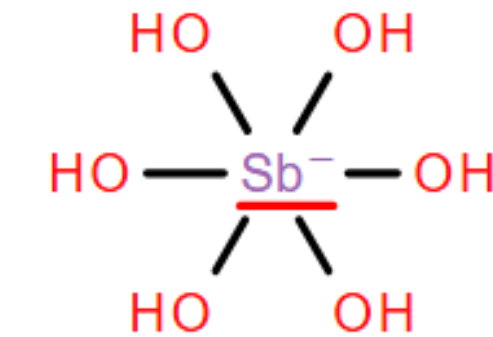
Potassium antimony(III) tartrate

- Highly soluble (83 g/L)
- 10% GI absorption
- Tartrate maintains Sb as (III)
- Sb(III) slower to excrete
- **Not found naturally (with a few exceptions)**



Antimony(III) trioxide

- Poorly soluble(0.37-2.76 mg/L), also slow to dissolve
- <1% GI absorption
- Rapidly oxidised by soil Fe/Mn/Al hydrous oxides to Sb(V) as hexahydroxoantimonate



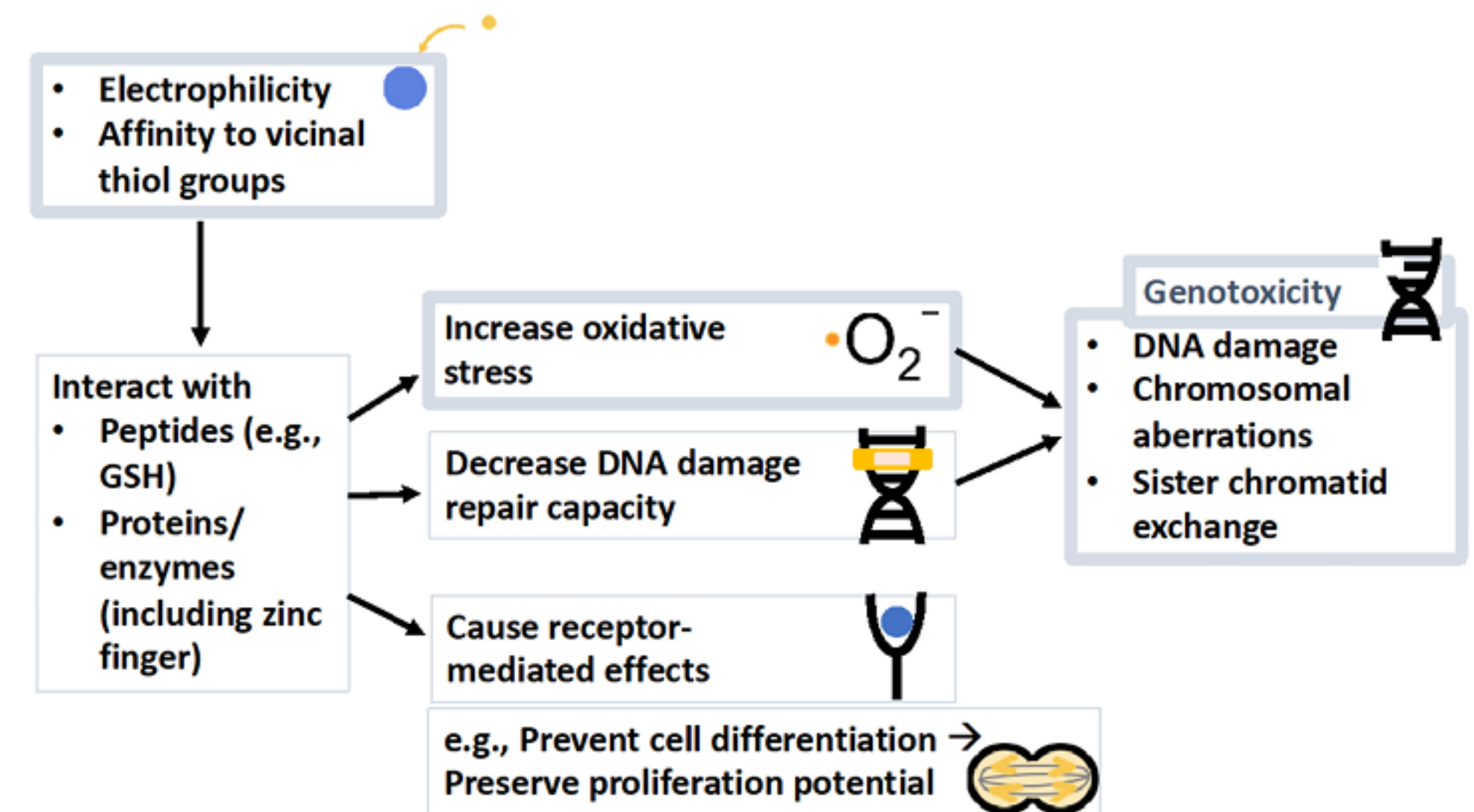
Hexahydroxoantimonate(V)

- Salts are moderately soluble(0.59 g/L as Na salt)
- Sb(V) IVBA/RBA in gold mine calcine sands <5% (Kastury et al., 2024)
- Sb(V) rapidly excreted

there is no anticipated exposure to APT or antimony trichloride from environmental media, food, drinking water or products available to consumers. Thus, studies conducted using APT or antimony trichloride were not considered relevant for risk characterization. Health Canada, 2020

Genotoxicity/Carcinogenicity?

- Epidemiological associations for antimony smelting and lung cancer
- Most *in vivo* studies have reported Sb (III and V) negative for genotoxicity, but *in vitro* generally positive
- Inhalation studies in rodents with antimony trioxide increased lung cancer rates
- US NTP(2018) & IARC(2023): probable that antimony trioxide is carcinogenic. Sb(V) not classifiable as to carcinogenicity
- **Threshold/non-threshold?** – Direct genotoxicity is debated. Sb clearly causes chronic lung inflammation and oxidative stress. Indication from *in vivo/in vitro* studies of a threshold
- Canada, WHO, EU and Australia (NICNAS) currently assess as threshold (non/indirect-genotoxic). EU REACH reassessment underway



Key Mechanistic Information for Antimony(III) Trioxide Carcinogenicity -
Reproduced from NTP(2018)

Derviving possible Human Health SGVs

Parameter	Value	Source
Threshold/ Non-threshold	Threshold	Absence of genotox for Sb(V). Opinion that Sb(III) genotoxic/carcinogenicity is indirect through ROS generation
Oral health-based guidance value (mg/kg bw/day)	0.049	Sb(V) NOAEL 49 mg/kg bw/day adjusted with 1000 uncertainty factor
Background intake toddler (mg/kg bw.day)	0.002494	Upper-bound NZ dietary exposure (Pearson & Ashmore, 2019)
Background intake adult	0.000797	
Dermal absorption factor	0.001	Use of a relative dermal to oral absorption value of 10%, applied to the 1% oral absorption rate. (Health Canada, 2020)
Plant uptake	BCF as for arsenic	Possible shared uptake pathway Wilson et al., 2014. - Sb not detected in various crops when As was at comparable concentrations in soil.



Human Health SGVs

Land Use Scenario	Soil Guidance Value (mg/kg)			
	Soil Ingestion	Dermal	Produce	Combined
Residential (10% produce)	12,610	>1 kg/kg	120,093	11,400
Parks / recreation	44,134	>1 kg/kg	n/a	44,000
Commercial / industrial outdoor worker	107,094	>1 kg/kg	n/a	107,000

- In most situations Sb will accompany As or Pb, these likely the limiting contaminant
- Sb > 11,400 mg/kg could occur at mine sites and firing ranges



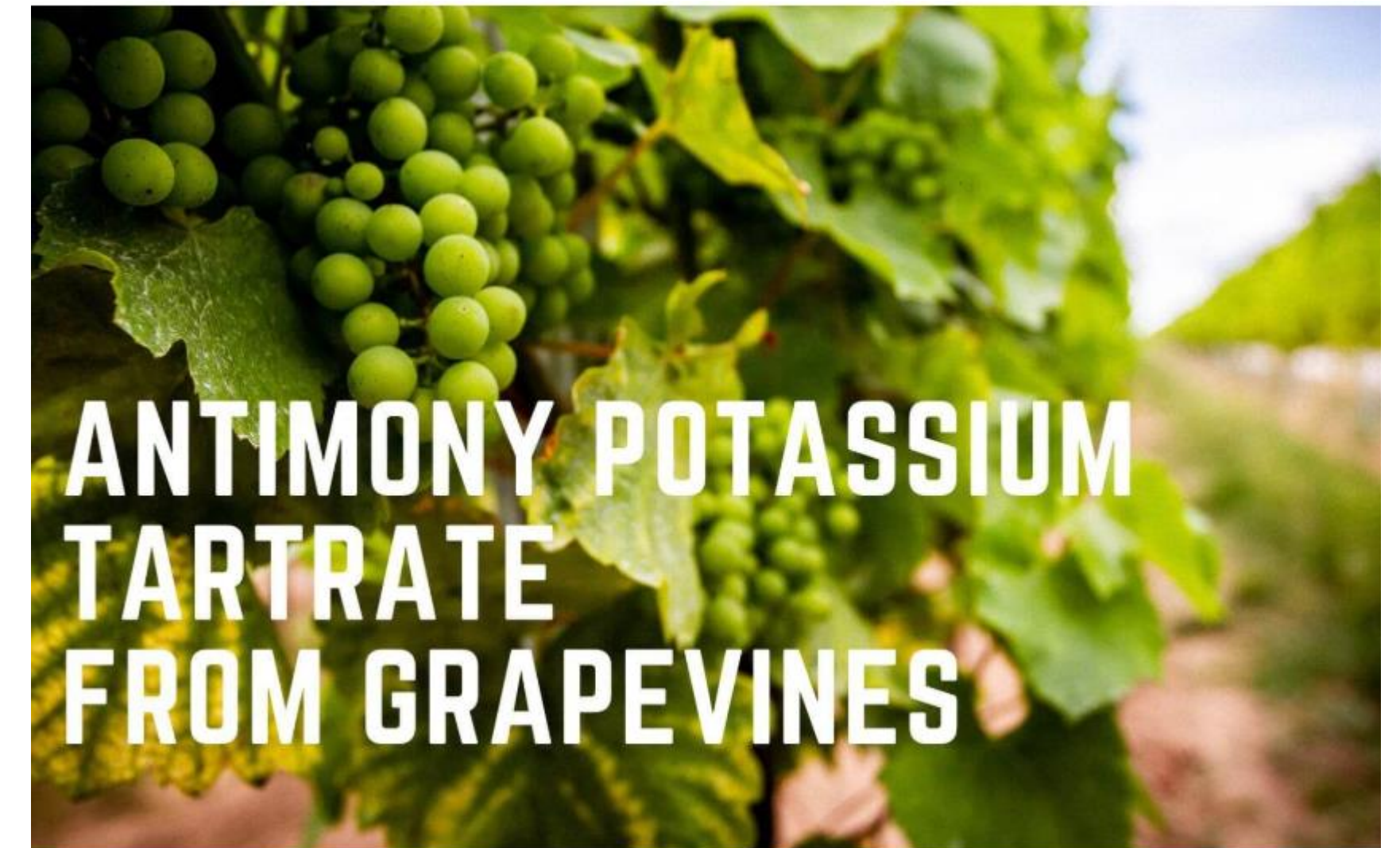
The exceptions

1. Viticulture

- Potassium antimony(III) tartrate forms when antimony in contact with high tartaric acid liquids
- Citrates also stabilise Sb(III) in the same way
- Risk for viticulture/citrus growing?

2. Soil remediation

- Tartaric acid for Pb and Cd soil remediation (soil washing & phytoremediation enhancement)
- Mitigating crop Al toxicity
- Unintentional risk of increasing the toxicity of Sb



Cfm Oskar Tropitzsch GmbH, source <https://www.cfmot.de/en/antimony-potassium-tartrate-from-grapevines/>

Tartaric acid in, aluminium out

Cheaper, eco-friendly method to tackle soil toxicity

Source <https://www.downtoearth.org.in/> - 2011



Outstanding questions

- Role of antimony methylation. Methyl species have been detected but no information on significance to health
- Understanding epidemiological observations
- Significance of co-occurrence with arsenic

Other aspects

- Ecological impacts
- Phytotoxicity
- Groundwater abstraction





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