

Antimony in the environment – the new global puzzle

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Recent records in bogs^[1] and Arctic polar ice cores^[2] show a dramatic increase in antimony in the environment since the Industrial Revolution – probably because it is now being used extensively in industry^[3] and for items such as car brake linings^[4] and in fire retardants.^[5] Air analyses in major cities show very high concentrations of antimony in air particulates,^[6] and soil samples near motorways show enrichment in antimony.^[7] As antimony has no known biological function, there is concern as to the long-term effects on ecosystems and humans from these increased levels.

Many basic questions about the environmental chemistry of Sb remain unanswered, in particular, the factors that influence redox transformations in waters and soils and the formation of methylated species by organisms in landfills and sewage.^[8–10] Its impact as an environmental contaminant is unclear and its toxicity to organisms is not well understood. Antimony is a global contaminant and there is an urgent need to improve our understanding of its biogeochemical cycling and behaviour, and risks associated with its presence in environmental systems. As well, data for environmental compartments such as groundwater^[11,12] are sparse. It is clear that the natural biogeochemical cycle of Sb needs to be understood before the effects of global contamination can be assessed with confidence.

It is timely to bring together a series of papers highlighting the biogeochemical cycling of Sb, its sources, transport through environmental compartments, and risk assessment. Thus, we present in the current Research Front a series of papers on various aspects of antimony's environmental chemistry in order to enable readers to get some insight into the topic and its pressing issues. The series includes two Reviews, a Highlight article and five Research papers.

Review articles Filella et al.^[13] in their Review discuss the environmental chemistry of Sb, calling for more focussed research, particularly in the areas of ecotoxicology and speciation analysis. They ask that researchers carefully read the primary literature as myths about Sb are being propagated. A further Review from Tschan et al.^[14] highlights that, although available soil Sb is readily taken up by plants, little is known about

the mechanism by which this occurs. Oorts and Smolders^[15] present a Highlight article in which they critically assess Sb toxicity threshold data. They conclude that using standard Sb toxicity data may not be appropriate because the Sb chemical species used in toxicity testing is often different to that existing in the environment.

Research papers Sources of atmospheric Sb in Japan are identified in the first paper by Iijima et al.,^[16] who report the use of elemental composition and particle size distribution to reveal that the dominant sources of atmospheric Sb in Japan arise from brake abrasion dust and fly ash from waste incineration. Telford et al.^[17] present data for the bioaccumulation and transfer of Sb in a highly contaminated stream near an Sb-Au mine in NSW, Australia. The data indicate that Sb is being transferred to the upper trophic levels of the creek ecosystem and that uptake from water, aquatic autotrophs and sediment is more important than by riparian vegetation. They identify that even when water and sediment Sb concentrations are extremely high, limited uptake into aboveground parts of riparian vegetation occurs. Tschan et al.^[18] present data on the uptake of Sb by crop plants from hydroponic nutrient solutions, agar medium and potting soil. The results show that plant uptake of Sb increases linearly with Sb in solution or soluble Sb in soil over a wide range of concentrations until it is limited by toxicity. Antimony was much less toxic than its sister element arsenic compared on a molar basis. Antimony may thus be accumulated by some crop plants on heavily contaminated soils at concentrations that may pose a health risk to humans and animals. Månsson et al.^[19] reconstruct the major Sb flows in an urban area and conclude that the major emission source of Sb is wear of brake linings, although also other sources such as the diffuse emission from flame-retarded goods may be important. To conclude, Hjortenkrans et al.^[20] emphasise that reliable Sb analyses are crucial for undertaking proper environmental risk assessments and that the recovery of antimony concentrations from environmentally relevant samples is dependent on the extraction method chosen. They suggest that low antimony concentration in present or historical samples may be an artefact of the analysis and misleading for decision makers.



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We hope that the present Research Front provides readers with a clearer picture of what is currently known about the environmental chemistry of antimony, in particular highlighting the gaps in current knowledge. There are clearly many questions yet to be answered concerning the chemistry of antimony in the environment, but I suggest that among the most urgent are:

- (1) What forms does antimony take, and how does it cycle through different environmental compartments?
- (2) What are the mechanisms by which plants and animals accumulate and exclude Sb?
- (3) What are the potential risks of Sb to organisms and environmentally relevant toxicity thresholds?
- (4) What quality controls do we need for reported analytical data?

We look forward to seeing these questions addressed in future publications, both here and elsewhere.

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