

Antimony in the environment – the new global puzzle

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Recent records in bogs and Arctic polar ice cores show a dramatic increase in antimony in the environment since the Industrial Revolution. Air analyses in major cities show very high concentrations of antimony in air particulates, and soil samples near motorways show enrichment in antimony. As antimony has no known biological function, there is concern as to its long-term effects on ecosystems and humans from these increased levels. The present Research Front provides readers with a clearer picture of what is currently known about the environmental chemistry of antimony and highlights important gaps in current knowledge.

Antimony in the environment: knowns and unknowns

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Antimony first attracted public attention in the mid-1990s amid claims that it was involved in Sudden Infant Death Syndrome. A substantial number of papers have now been published on the element and its behaviour in the natural environment. However, many key aspects of the environmental chemistry of antimony remain poorly understood. These include critical areas such as its ecotoxicology, its global cycling through different environmental compartments, and what chemical form it takes in different environments. More focused research would help the situation. The present review highlights several areas of environmental antimony chemistry that urgently need to be addressed.

Antimony in the soil–plant system – a review

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Soil contamination by antimony (Sb) has become an environmental problem of much concern in recent years, because increasing mining and industrial use has led to widespread soil contamination by this biologically unessential, but potentially carcinogenic element. We reviewed the available literature and found that Sb is generally taken up by terrestrial plants in proportion to the concentration of soluble Sb in soil over a concentration range covering five or more orders of magnitude, a finding that is relevant in particular for the assessment of environmental and health risks arising from Sb-contaminated soils. But very little is known about the mechanisms of Sb uptake by plants.

Ecological threshold concentrations for antimony in water and soil

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Antimony (Sb) is a natural trace element with several industrial applications and anthropogenic emissions can increase Sb concentrations in the environment. In order to assess the potential risks of elevated antimony concentrations to aquatic and terrestrial organisms, toxicity thresholds must be known and environmental criteria defined. Setting such criteria for antimony is not straightforward because the Sb speciation in the standard toxicity test is likely to differ from that in the environment.

Clarification of the predominant emission sources of antimony in airborne particulate matter and estimation of their effects on the atmosphere in Japan

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The remarkable enrichment of potentially toxic antimony (Sb) in inhalable airborne particulate matter has become of great environmental concern among recent air pollution issues. The present study clarifies the predominant sources of Sb by focusing on the similarities in elemental composition, particle size distributions, and microscopic images found in ambient airborne particles and several potential sources. We identify automotive brake abrasion dust and fly ash emitted from waste incineration as dominant sources of atmospheric Sb in Japan. These results will contribute towards an in-depth understanding of the cycles and fates of Sb in the environment.

Bioaccumulation of antimony and arsenic in a highly contaminated stream adjacent to the Hillgrove Mine, NSW, Australia

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Concern over the presence of antimony (Sb) in the environment because of chemical similarities with arsenic (As) has prompted a need to better understand its environmental behaviour and risks. The present study investigates the bioaccumulation and uptake of antimony in a highly contaminated stream near the Hillgrove antimony–gold mine in NSW, Australia, and reports high Sb (and As) concentrations in many components of the ecosystem consisting of three trophic levels, but limited uptake into aboveground parts of riparian vegetation. The data suggest that Sb can transfer into upper trophic levels of a creek ecosystem, but that direct exposure of creek fauna to creek sediment and soil, water and aquatic autotrophs are more important metalloid uptake routes than exposure via riparian vegetation.

Antimony uptake by different plant species from nutrient solution, agar and soil

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Because of its many industrial and other uses, antimony (Sb) is increasingly emitted into the environment through human activities. We studied the uptake of Sb by crop plants from three different substrates: hydroponic nutrient solutions, agar medium, and potting soil. The uptake of Sb increased linearly with Sb in solution or soluble Sb in soil over a wide range of concentrations until it was limited by toxicity. Antimony was much less toxic than its sister element arsenic compared on a molar basis. The results suggest that Sb may be accumulated by some crop plants on heavily contaminated soils at concentrations that may pose a health risk to humans and animals.

Problems with Sb analysis of environmentally relevant samples

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Reliable results of chemical analysis are crucial for a proper environmental risk assessment. The recovery of antimony concentrations in environmentally relevant samples is here shown to be most dependent on the extraction method chosen. A reported low antimony concentration in present or historical samples may be misleading for decision-makers.

Sources of antimony in an urban area

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The global production and use of antimony (Sb) increase together with stocks and emissions, but there are gaps in our knowledge concerning environmental effects. Here, a reconstruction of major Sb flows in an urban area was conducted. The major emission source of Sb identified was wear of brake linings, although other sources may also be of importance, e.g. diffuse emission of flame-retarded goods.

Dynamic DGT speciation analysis and applicability to natural heterogeneous complexes

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The environmental fate and bioavailability of metal ions in natural waters is determined by their thermodynamic stability and kinetic features, both of which are distributed and depend on the metal ion loading of the system. Diffusive gradients in thin film (DGT) is a dynamic technique for metal speciation analysis that measures a certain portion of these complexes as determined by its operational timescale. Reliable interpretation of data furnished by DGT necessitates characterisation of its features for the particular case of heterogeneous complexes.

The influence of aggregation on the redox chemistry of humic substances

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The ability of humic substances (decaying plant and animal matter) to partake in redox reactions in the environment depends on the extent to which the various humic polymers aggregate in solution to form larger particles. This aggregation, in turn, is predicated on the solution conditions, especially ionic strength, the pH, and the types of cations present.

Photodegradation of nonylphenol polyethoxylates in aqueous solution

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Nonylphenol polyethoxylates (NPEOs) are widely used non-ionic surfactants, and they cause environmental concern because some metabolites of NPEOs possess endocrine-disrupting activities. Photodegradation is an important pathway for NPEOs degradation, and different degradation products may lead to different environmental risks. The present paper looks at the kinetics and pathways of NPEO photodegradation in aqueous solutions, focussing on the effects of humic acid, H₂O₂, and Fe^{III}. We found that the presence of different chemicals led to different degradation pathways, and a new mechanism is proposed.