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Geochemical behaviour of antimony in the environment

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Introduction

Antimony is coming into increasing usage. Worldwide 140'000 tons are mined annually and used in products such as flame retardants (around 55 %) in non-metal products (around 27 %), such as textiles and plastics, fining agents in glass, and in metal products (18 %) such Pb alloys where it is used as a hardening agent. Antimony is the 11th the list of the most commonly used metals in the United States including Fe, Al, Cu, Pb, Zn etc.

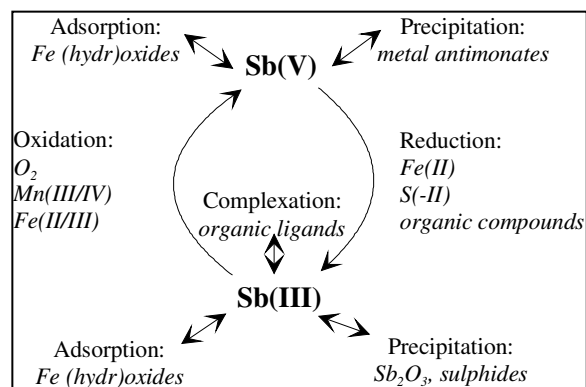


Fig.1 Geochemical reactivity of Sb

Geochemical Properties

Antimony exists in 2 oxidation states, Sb(V) and Sb(III) in the aqueous environment. The oxidised, more soluble, species exists as $\text{Sb}(\text{OH})_6^-$ above pH 2.5. It appears to sorb to (hydr)oxide surfaces under acidic conditions and may precipitate as metal antimonates, the most common being Ca, Pb, Cu and Fe antimonates. Under reducing conditions Sb(III) most probably predominates in solution as $\text{Sb}(\text{OH})_3$ or in association with organic ligands. Antimony(III) may be precipitated as Sb_2O_3 or in association with sulphides. Reduced Sb sorbs strongly to mineral surfaces. Sequential extractions indicate that in soils Sb is strongly associated with Fe (hydr)oxides and organic material. Antimony(III) rarely makes up more than a few percent of total dissolved Sb.

Oxidation is the key process that control Sb mobility. Dissolved Sb(III) is only very slowly oxidised by O_2 , but there is information to suggest that it is rapidly oxidised by Mn(III,IV) and possibly Fe(III) (hydr)oxides. It also appears to be indirectly oxidised when Fe(II) is oxidised by O_2 .

Reference

- [1] Carlin Jr., J.F. (2001) "Antimony" U.S. Geological Survey Minerals yearbooks.

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Heavy metals dispersion in soils from a 800-2500BP years old pollution (Mont-Lozère, France)

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Numerous paleo-metallurgical sites have been reported on the Mont-Lozère massif in southern France. These activities were dated by ^{14}C and appear to be 800 to 1000 years old and some possibly as old as 2500BP. The slag presents a homogeneous typology and comprise mainly Pb (33%), Sb (0.6%) and tens to thousands ppm other metals (As, Cu, Zn, ...). Soils within and nearby 2 sites were sampled in order to understand the dispersion mechanism of the punctual pollution by using their metal concentrations and lead isotopic compositions. Most polluted soil samples show high enrichment factors (EF) for Pb and Sb but much lower and more punctual EF were found for As, Zn, Cd, Cu and Ni. All Pb isotope ratios are highly correlated with the Al/Pb ratios, defining a distinct binary mixing trend between unpolluted soils and the slag for both sites. This makes a complete agreement between the proportion of pollution Pb (74% to 100%) present in soils, independently calculated with Pb isotopes and with Pb-EF. Knowing the Pb concentration of the slag and that of the unpolluted soil, we calculated that the contribution of slag present in each polluted soil samples varies between 0.036% and 58%. The same calculation using Sb concentrations yielded the same results as for Pb ($r^2=0.87$, $m=1$), suggesting that Pb and Sb enrichments in soils result mostly from the physical dispersion of the slag on both sites. Other metal concentrations were not determined in the slag so that it is not possible to make the calculation. It is however possible to compare the metal concentrations in the soils with the amount of slag present in order to document their behaviour relative to Pb and Sb. For both sites, we found a very good correlation for As and Cu but not for Zn, suggesting that As and Cu enrichments are also directly related to the contribution of slag in the samples. Knowing that the Zn concentrations in the slag do not exceed 5000 ppm, most of the Zn measured in the polluted soils is not fully supported by the contribution of slag. It's mainly due to the metal making. This suggests also that remobilization / adsorption of Zn in soils is a relevant process of dispersion / fixation.