

## Publication

Antimony sinks in the weathering crust of bullets from Swiss shooting ranges

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Shooting ranges represent sites heavily polluted by Pb, Sb, Cu, Ni, and Zn, which are released during the weathering of bullets. The pristine bullets are made of a Pb-Sb core, Fe mantle, and minor amounts of Cu, Ni, and Zn in an interlayer between the core and mantle. At two selected sampling sites (Losone and Lucerne, both in Switzerland), corroding bullets were collected to determine the sinks of Sb within the weathering crust of the bullets. Bulk Sb concentrations in the crust were found to be as high as 1.3 wt.%. The oxalate-extractable fraction of Fe showed that the amorphous Fe oxides (e.g., ferrihydrite) prevail over goethite and lepidocrocite, which were identified by bulk X-ray diffraction experiments. Crystalline Pb phases are litharge (only found by X-ray diffraction) and cerussite, which result from weathering of the Pb core. No distinct Sb minerals were identified by X-ray diffraction. Investigations with electron microprobe (EMP) showed that Sb is mostly accumulated in those regions in the weathering crust where there is also a high concentration of Fe. in the weathering crust from Losone, such Fe-rich regions with Sb are represented by material that cements or rims silicate mineral grains. The cement was identified as lepidocrocite by micro-Raman analysis. At Lucerne, Sb is found in Fe-oxide aggregates, in sawdust particles where it may be bound to organic matter, or in aggregates enriched in Pb and depleted in Fe. Bulk EXAFS experiments suggested that the Fe oxides are the most important sink for Sb. Our modelling of Sb next-nearest neighbours suggests two types of inner-sphere complexes on the surfaces of Fe oxides. These are edge- and corner-sharing adsorption complexes. Hence, the predominant sink of Sb in the weathering crust of the bullets at the selected shooting ranges is Fe oxides, amorphous or crystalline. (C) 2008 Elsevier B.V. All rights reserved.

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