A review on Pb-bearing nanoparticles, particulate matter and colloids released from mining and smelting activities

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Abstract

Lead (Pb) is one of the most paradoxical elements, both having diverse practical uses, as well as being extremely toxic to humans, and especially to children. The use of Pb records a steady growth with annual production currently exceeding 10 million metric tons. In spite of the environmental awareness of modern society, humans are still exposed to Pb through its emission by smelting and mining activities, and also by Pb-bearing mine wastes and soils. Here, we review the chemical and mineralogical forms of Pb generated from smelting and mining processes and subsequently altered in tailings, slag piles, and soils. In smelter plumes, Pb is emitted to the atmosphere either in the form of smaller nano-size particulate matter (PM) often associated with S, or larger micrometer Pb-bearing PM matter accompanied by oxide-silicate matrices. Pb-bearing phases in mine tailings and impacted soils depict a greater mineralogical and chemical complexity than those emitted from smelters and the larger particle size of this PM also leads to a lower Pb bioavailability. High resolution observations in aquatic system, soils and rock coatings impacted by smelting and mining activities show the presence of Pb-bearing phosphates, sulfides, sulfates, carbonates, and oxide nanoparticles. Larger micrometer size particles of Pb-bearing minerals form often through the aggregation of Pb-bearing nanoparticles, a process commonly referred to as crystallization through particle attachment. Mobilization of Pb within soil columns is strongly affected by the transport of colloids, especially those composed of organic matter and Fe-hydroxides because Pb is taken up efficiently by these two soil components. The extraordinary variability and complexities of all of these processes suggest that future reduction of Pb contamination in the environment and its

impact on human health mainly depends on eliminating or greatly reducing Pb-release from smelting operations and tailings impoundments.

Keywords

mining, smelting, nanoparticles, environment, human health