Contaminant bioaccessibility from dusts in mining and smelting districts of Namibia

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Mining and smelting districts of northern Namibia are located in the dry climatic region, where strong winds are responsible for dispersal of contaminated dust particles. We investigated dusts from mines and metal smelters from this area using a combination of mineralogical techniques and in vitro bioaccessibility leaching in simulated gastric fluid (SGF) to assess the exposure risk for humans. Bulk concentrations of metal(loid)s in the mine tailing materials varied in the range of hundreds to thousands of ppm, but the bioaccessible concentrations were very low. Slag materials contained much higher levels of contaminants (5000 ppm As, 2.4 wt% Pb, 6.2% Zn) and bioaccessible fractions (BAF) for these contaminants attained 43%, 49% and 29%, respectively. The highest contaminant concentrations were reported for the smelter dusts sampled near bag house flue gas cleaning system (43.7 wt% As, 4 wt% Pb, 2 wt % Zn). Being predominantly composed of soluble arsenolite (As_2O_3), smelter dusts were highly reactive and BAF values were elevated, especially for As attaining 60% of total concentration. Based on these results, a potential risk can be recognized, particularly from ingestion of smelter dusts. Daily intakes via oral exposure, calculated for an adult (70 kg, ingestion rate 50 mg dust per day) exceeded the tolerable daily intake (TDI) limits for Pb (2.3×) and As (187×) in the case of these materials, whereas only limited risk was detected for mine tailings and slags. The workers in the smelter are protected with the masks and their exposure to As-bearing dusts is probably limited, but the safety measures should also be taken outside the factory and the risk related to the ingestion of polluted soil-derived dusts by local residents should be evaluated in the future.