RESPONDING TO THE 2010 NIGERIAN LEAD POISONING OUTBREAK LINKED TO ARTISANAL GOLD ORE PROCESSING: CONTRIBUTIONS FROM THE EARTH SCIENCES

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In spring 2010, a pattern of ongoing childhood deaths (up to 400) and illness (355+) was noted by Medecins Sans Frontieres (MSF) in villages of Zamfara State, Nigeria, and was determined to be due to lead (Pb) poisoning. The cause was artisanal gold ore processing, which had recently been mechanized. Gold ores are first hand crushed, then pulverized in a flourmill (the recent mechanization), then washed and the gold extracted by amalgamation. In May 2010, US CDC deployed a rapid response team to two of the hardest-hit villages, to help assess the extent of the problem, understand exposure pathways and evaluate mitigation options. MSF and CDC found unprecedented levels of acute lead poisoning, particularly in young children, with blood lead levels nearly as high as 400 μg/dl; >10 μg/dl is indicative of lead poisoning. The CDC/ATSDR team collected many samples, including raw and ground ores, soils, waters, and dust sweep samples. The USGS is working with CDC to determine mineralogical and geochemical characteristics of the samples, to assist in understanding exposure pathways, assessing other villages for similar contamination, mitigating exposures, and cleaning up contaminated areas.

Mineralogical analyses show the ores are lightly to moderately oxidized quartz veins. Primary Pb sulfide (which is not bioaccessible) is present from 1 to ~30 vol% in ore samples. Weathering prior to mining created a complex secondary Pb mineral assemblage dominated by highly bioaccessible Pb carbonate, with lesser Pb phosphate, oxide, sulfate, vanadinate, and tungstate minerals. The same Pb minerals are abundant in dust sweep samples collected from eating areas of many family compounds where the ores were processed, indicating severe processing-related contamination and a logical exposure route via hand/mouth transmission and incidental ingestion. Bulk Pb concentrations in sweep samples are up to 12 wt %, with most indicated to be bioaccessible by physiologically based extraction tests using simulated gastric fluids. Bulk mercury (Hg) is also high in sweep samples (up to 60 ppm), due to contamination from Hg lost during amalgamation; some is water-soluble and bioaccessible in simulated gastric fluids. Dermal Hg uptake during amalgamation, Hg inhalation during amalgam smelting, and Hg contamination of soils, water wells, and waterways (with conversion to more bioavailable and toxic methyl Hg) may also be problematic from a health perspective in addition to the Pb poisoning.