Mercury emissions from artisanal zinc and mercury smelting in Guizhou, PR China

FENG XINBIN[1], QIU GUANGLE[1,2], LI GUANGHUI[1,2], LI PING[1,2], AND WANG SHAOFENG[1,2]

[1]State Key Laboratory of Environmental Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China
[2]Graduate School, Chinese Academy of Sciences, Beijing 100039, China

Both artisanal zinc smelting and mercury mining activities are still in operation in Guizhou, China. Artisanal (small scale) zinc smelting activities in Hezhang, Guizhou started since 17th century. Zinc production in this area increased during the last decade, and reached 48,098t in 2000. Meanwhile, artisanal mercury mining activities in Wuchuan, Guizhou have also a long history since 1950s. The annual mercury production reached 20 to 70 t in the past few years. The techniques used for both cases are very simple. The ores are heated in a furnace for a few hours, and zinc metal and liquid mercury are produced. There are no pollution control devices employed at all during the melting processes.

A mass balance method is employed to calculate mercury emission factors from both zinc smelting and mercury mining activities. Mercury is an important associate element for zince ores, and the maximum mercury concentration in zinc ore reached 160 mg/kg. The mercury emission factors from artisanal zinc smelting activities vary from 79 to 155 g Hg t^{-1} of Zn produced, which are much higher than the literature vale used to estimate mercury emission from zince smelting in developing countries that is 25 g Hg t^{-1} of Zn produced. We estimated that 30-50% mercury in mercury ores are released into the atmosphere during mercury smelting processes. The miners and local inhabitants may suffer from mercury vapor poisoning, and total mercury concentrations in hair samples collected from the mercury miners reached 20 to 80 mg/kg.

Up to 2003, a few metric tons of mercury was annually emitted to ambient air from zinc smelting in such a small area (<150 km^2) in Hezhang, Guizhou, China. Meanwhile 6 to 21 metric tons of mercury was annually released into the atmosphere in Wuchuan, Guizhou. The mercury emissions from zinc and mercury smelting activities in Guizhou not olny contribute significantly to global atmospheric mercury pool, but also pose a threat to the local ecosystem and to the health of local inhabitants. Much work is needed to scrutinize mercury contaminations from zinc and mercury smelting in Guizhou.

Mercury and methylmercury distribution in sediments affected by historical gold mining, Sierra Nevada, California

M.P. HUNERLACH[1], C.N. ALPERS[1] AND M. MARVIN-DIPASQUALE[2]

[1] U.S. Geological Survey, 6000 J Street, Placer Hall, Sacramento, CA 95819, USA (hunerlac@usgs.gov and cnalpers@usgs.gov)
[2] U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025, USA (mmarvin@usgs.gov)

Mercury (Hg) is widely dispersed in stream sediments affected by historical gold mining in the Sierra Nevada, California. This presentation describes the downstream transport and microbially mediated transformation of elemental mercury, introduced in the 1850s to enhance gold recovery. U.S. Geological Survey studies of Hg bioaccumulation in sport fish have led to the first consumption health advisories in this area. Mercury is transported primarily by the episodic mobilization of fine-grained particles during high rainfall and runoff events. The degree of subsequent inorganic Hg(II)-methylation rates vary depending on the interaction of numerous environmental factors such as dissolved sulfate and iron (likely derived from localized pyrite oxidation) concentrations, pH, redox potential, dissolved oxygen, organic carbon, and microbial community composition and activity.

Sluice and tunnel sediments at hydraulic mine sites typically contain visible elemental mercury (Hg^0) (up to 45 g/kg) and gold-mercury amalgam (AuHg). Methylmercury (MeHg) concentrations are locally elevated, although the ratio of MeHg to total (Hg_T) in these settings tends to be low.

Sediments trapped in two reservoirs downstream of hydraulic mine sites have average Hg_T concentrations from about 200 to 800 ng/g (nanograms per gram). Concentrations of MeHg in the top 4 cm of reservoir sediments range from 0.2 to 7 ng/g. At Englebright Lake (Yuba River), MeHg concentrations > 0.1 ng/g persist to depths as great as 33 meters in cores sampling a 62-year stratigraphic record.

Flood-plain sediments downstream of reservoirs are affected both by hydraulic mining and bucket-line dredging. Creeks traversing the Folsom gold fields have yielded both visible Hg^0 and AuHg from subsurface sediments. Potential rates of Hg(II) methylation and demethylation correlate with sediment organic-carbon concentrations. Methylation rates also correlate with pore- water Fe(II) concentrations, but do not vary systematically with sulfate reduction rates, suggesting either (1) a relationship between iron-reducing bacteria and Hg(II) methylation, or (2) increased availability of reactive Hg(II) in the iron-reducing zone.