Environmental Assessment of Mercury Dispersion, Transformation and Bioavailability in the Lake Victoria Goldfields, Tanzania

Author(s)
J.R. Ikingura, H. Akagi, J. Mujumba, C. Messo

Abstract

Environmental dispersion and transformation of mercury discharged from gold mining operations has been investigated in field and laboratory studies in order to provide better understanding of the degree of mercury (Hg) pollution and bioavailability in the Lake Victoria goldfields (LVGF) ecosystems. This paper reviews results already published elsewhere and presents additional data on Hg dynamics in the LVGF. Studies conducted at the Mugusu and Rwamagaza artisanal mines indicated different degrees of Hg contamination and dispersion in environmental matrices. Mercury concentration in contaminated river sediments near the Mugusu mine varied from 6.0 to 0.5 mg/kg on a dry weight basis. The highest Hg contamination levels (165–232 mg/kg) were associated with mine tailings at the Rwamagaza mine. Mercury concentrations in fish representing different dietary habits on the southwestern shore of Lake Victoria at the Nungwe Bay were very low (2–35 μg/kg) and thought to represent background levels. These and other results suggested that the use of Hg in gold extraction in the LVGF has not caused high Hg levels in lake fish. The study of Hg in lichens showed *Parmelia* lichen to be an effective bioindicator for atmospheric Hg contamination due to Hg emissions from gold-amalgam firing and purification operations. The Hg levels in the lichens around the Mugusu mine ranged from 3.1 to 0.1 μg/g; the highest levels were recorded in the lichens sampled close to gold-amalgam processing sites. The regional background level in the*Parmelia* lichen was 0.05–0.10 μg/g, with a mean level of 0.07 μg/g.

Studies of Hg transformation in the mine tailings revealed unexpectedly high methylmercury (MeHg) levels in the tailings (629–710 ng/g), which indicated that oxidation and methylation of metallic Hg in the tailings occurred at significant levels under tropical conditions. Re-equilibration of the tailings with freshwater (FW) indicated the MeHg was firmly bound in the tailings and therefore very little MeHg was released to the water column (0.2–1.5 ng/L). The methylation of Hg in tropical loamy clay soil contaminated with $HgCl_2$ (5 mg Hg/kg) yielded MeHg concentrations of 11 and 14 ng/g when inundated with seawater and FW, respectively, for 4 weeks. Little MeHg was transferred from the soil to the equilibrated water ($\leqslant$0.4 ng/L). Atmospheric exposure of the soil pre-inundated with FW resulted in net degradation of MeHg during the 1st week of exposure, followed by net production and accumulation of MeHg in the soil (up to 15.5 ng/g) during atmospheric desiccation. Mercury uptake by fish from the Hg^0-contaminated aquatic sediment–tailings system in the aquarium experiment was found to be low, suggesting the low availability of MeHg for bioaccumulation in the system. These and other results provide useful insights into Hg transformation, mobility and bioavailability in tropical aquatic systems affected by Hg pollution from gold mining operations.

Keywords

Mercury;
Bioavailability;
Lake Victoria;
Gold mining