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A stable isotope tracking of geogenic and anthropogenic mercury in sediments along an Amazonian watershed impacted by gold mining (French Guiana)

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Artisanal and small-scale gold mining (ASGM) is associated with mercury (Hg) contamination in the environment of French Guiana. Since 1850's, gold mining activities have been reported to increase Hg concentration in the aquatic ecosystem through the use of anthropogenic Hg sources and/or its mobilization from geogenic sources by soil erosion. Hg bioaccumulates and biomagnifies in the aquatic food chain and threatens the population's health through fish consumption. Despite Hg use prohibition since 2006, it is still used by illegal gold miners in the process of gold extraction. Hence, estimation of the exact extent of Hg emissions by this activity is challenging. Over the last three decades, due to rising gold prices, gold mining has expanded across the Maroni River, one of the main watersheds of the Guiana Shield. Hence, it is crucial to provide a deep understanding of how gold mining affected Hg cycling over the past decades. We therefore collected surface fluvial sediments from this watershed to also compare with those previously collected about 20 years ago.[1] We determined total Hg concentration (THg), and both mass-dependent (δ^{202}Hg) and -independent isotopes fractionation (Δ^{199}Hg), and geochemical parameters such as carbon, major and trace elements concentration, and grain size distribution in >80 sites, including pristine locations, and sites downstream ASGM areas. THg varied from 65 to 310 ng g^{-1}, averaging 153±57ng g^{-1}. A significant correlation is observed between THg and δ^{202}Hg, suggesting a strong influence between Hg accumulation and isotopic composition in the Maroni watershed. δ^{202}Hg enriched in heavier Hg isotopes from the upstream (-2.41±0.16‰) to the downstream (-0.73±0.16‰) of the watershed, supporting increasing influence of anthropogenic Hg emissions from gold mining activities (similar discrimination for Δ^{199}Hg from -0.70±0.09‰ to -0.09±0.09‰). A binary isotopic mixing model revealed that the contribution of anthropogenic Hg in sediments remained in the same order of magnitude during the last two decades. This contribution increased from upstream to downstream in the watershed. Overall, our results demonstrate that the (il)legal gold mining activities may contribute up to 50% of Hg inputs in such major river system.

[1] N.Nitschke, S.Guédron, E.Tessier, D.Tisserand, S.Campillo & D.Amouroux (2024), ACS ES&T Water