

Identifying Sources of Mercury in Peruvian Amazon Aquatic Systems using Mercury Stable Isotopes

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Mercury (Hg) is a highly toxic global pollutant that affects both humans and wildlife, especially those dependent on aquatic food webs. Mercury is used to extract gold from sediments and ores during artisanal and small-scale gold mining (ASGM) in many developing parts of the world. Producing approximately 20% of the global gold supply, ASGM is currently estimated to be the largest primary source of Hg to freshwaters and to the atmosphere. In many Amazonian ecosystems, ASGM is often the source of downstream contamination, but this can be complicated by other potential Hg sources such as increased soil erosion from land-use change and deforestation. Mercury stable isotope geochemistry is a particularly effective tool for source differentiation in regions heavily affected by ASGM due to differences in the isotopic compositions of ASGM-derived Hg versus Hg from soils and erosion. In this study, we assessed the sources of Hg in aquatic ecosystems in Madre de Dios (MDD), Peru, a region with prevalent ASGM. In addition to Hg use during ASGM, many ASGM operations in this region are also associated with varying degrees of deforestation and land disturbance. Aquatic sediment samples collected upstream, downstream, and adjacent to ASGM operations in the MDD river system were analyzed for Hg and Hg isotopes along with soils from forested and deforested areas along the MDD River. Overall, isotopes indicate that sources of Hg in the area are complicated and likely often a mix of ASGM-derived Hg and Hg from erosion of soils. Sediment samples collected near heavily mechanized mining operations generally exhibit higher Hg concentrations with isotopic signatures closer to those observed in soils, suggesting perturbation of the land is contributing more heavily to Hg in these areas. However, there is isotopic evidence for ASGM-derived Hg in some sediments near mining operations with less mechanized approaches. Surprisingly, there are some isotopically heavy Hg isotopic compositions ($\delta^{202}\text{Hg}$ between 0.91 and 2.11‰, $\Delta^{199}\text{Hg} \sim 0\text{‰}$) in a few samples collected upstream in a protected area. The source of this Hg is unclear, but might be related to geologic deposits that are mined throughout the region.