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Tracing uptake of gaseous elemental Hg released from artisanal and small-scale gold mining into trees and soils of the Peruvian Amazon using mercury stable isotopes

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Because of mercury (Hg) use and release during artisanal and small-scale gold mining (ASGM), Hg is a health concern in many regions of the developing world including the Amazon. Globally, ASGM is also estimated to be the largest primary source of Hg pollution to both the atmosphere and to water. Unfortunately, there are still many gaps in our understanding of the biogeochemical cycling of Hg in Amazonian ecosystems including those with ASGM. In addition, ASGM is associated with land use change including deforestation and alteration of water ways, which can release Hg stored in soils via erosion into downstream ecosystems. Furthermore, as ASGM is often unregulated and sometimes illegal, significant constraints are placed on accessibility and the instruments that can be used for data collection. To trace the fate of Hg released during ASGM, our group sampled atmospheric gaseous elemental Hg (GEM) using a passive air sampler at over 100 sites as well as fresh vegetation, litter, soils, and river sediments in the Madre de Dios region of Peru for both Hg concentrations and Hg isotopes. Because Hg from ASGM is isotopically distinct, the contribution of ASGM derived GEM to the local and regional GEM pool could be estimated and was typically over 80%. We were also able to observe uptake of ASGM derived Hg by trees and vegetation in forests near ASGM activities and transfer of some of this Hg into the soil. The Hg isotopic composition in the remaining GEM in the atmosphere was also affected by vegetation uptake of GEM (isotopically shifted more positive), confirming this uptake as a major removal process of GEM from the atmosphere and source of Hg to terrestrial ecosystems. Both river bottom and suspended sediments in the region had Hg isotopic compositions reflecting a mixture of direct inputs of Hg from ASGM (i.e., from tailings ponds) and Hg from soil erosion. These results demonstrate how Hg isotopes can help improve our understanding of the fate of ASGM derived GEM in the atmosphere, vegetation, and soils, as well as trace what pools of Hg are entering aquatic ecosystems.