Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36962

Gold-Mining Impact on the Spatio-Temporal Dynamics of Erosion Fluxes and Trace Metals Along the Maroni River, French Guiana

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In French Guiana, gold mining disturbs fluvial hydrosystems. Intensive excavation of riverbank sediments and lateritic horizons, which may host trace metals (TM) such as As, V, or Ni, leads to a marked increase in suspended particulate matter (SPM). This results in enhanced turbidity and higher erosion fluxes [1;2]. Confluences between gold-mining tributary and river systems constitute physicochemical hotspots where adsorption/desorption, dilution, or sedimentation may control trace-metal mobility.

The study focused on SPM and water samples collected at high and low water stages along the Maroni River, particularly at the Maroni/Grand Inini confluence. The objective is to quantify the effect of gold mining on erosion and chemical weathering, and to identify processes driving TM fate during river mixing.

Across the Maroni River watershed, SPM and Total dissolved solids (TDS) concentrations remain very low, influenced by the poorly weatherable Guiana Shield. While SPM is weakly influenced by hydrological conditions, TDS is diluted during the high-water stage. Most metals (Al, Fe, V, Ni) are carried by SPM regardless of the hydrological period. By contrast, Mn and As are mostly transported as dissolved species. Manganese, predominantly concentrated in both lateritic and floodplain soils, is likely mobilized by reductive dissolution of oxides during flood events, whereas As mainly originates from gold mining activities along the Tapanahony and Grand Inini Rivers.

At the confluence, unlike the Maroni river, the Grand Inini river exhibits a counterintuitive signal: higher SPM concentrations during low-flow conditions, attributed to sediment remobilization associated with gold mining, whereas a dilution effect during high-flow conditions attenuates the gold mining signature. Regarding mixing, despite lower discharge, the Grand Inini contribution to the erosion flux accounts for 50% and 20% during high- and low-flow periods, respectively. Metals in SPM present conservative behavior after the confluence. In contrast, dissolved Mn and As exhibit non-conservative behavior, indicating their mobilization or scavenging by biogeochemical processes.

Gold mining in tropical rivers highlights its ability to modify erosion fluxes and the biogeochemical processes controlling TM mobility at the confluence scale.

[1] Dethier E.N. et al., 2023. Nature 620, 787–793.

[2] Mora A. et al., 2019. Bull. Environ. Contam. Toxicol. 102, 210–217