Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35742

From Emissions to Legacy Reservoirs: Long-Term Metal(loid) and PAHs Dynamics in Northwestern Québec's Greenstone Belt.

JOSUÉ J JAUTZY[1], JOELLE MARION[2], NICOLAS BENOIT[2], JÉROME LAGANIÈRE[3], JASON M E AHAD[1], CARSTEN MEYER-JACOB[4], TIZIANO LOLLI[5], MARTA MARCHEGIANO[6] AND ANNE CRÉMAZY[5]

[1]Geological Survey of Canada, Natural Resources Canada, Québec
[2]Geological Survey of Canada, Natural Resources Canada
[3]Laurentian Forestry Center, Natural Resources Canada
[4]Université du Québec en Abitibi-Témiscamingue
[5]Institut National de la Recherche Scientifique
[6]University of Granada

Historical and current mining and smelting activities in northwestern Québec have left a complex legacy of metal(loid) deposition across this region. The Abitibi region encompasses one of the world's largest greenstone belts and hosts globally significant gold and base-metal deposits that have supported, and still support, intensive mining and smelting operations for more than 100 years. With the depletion of major local copper deposits, smelting activities have gradually shifted toward processing electronic waste and imported ores, complicating the trace-element and isotopic fingerprints of atmospheric emissions.

To disentangle historical from modern inputs, we combine well-dated ombrotrophic peat cores, lake sediment cores, and surrounding watershed soils to reconstruct century-scale deposition histories of both traditional pollutant metal(loid)s (As, Cd, Cu, Hg, Ni, Pb, Zn) and technologically relevant elements (REE, Ag, Cr, Co, Ga, In, Li, Mo, Pd, Pt, Sb, Se, Sn, Te, Tl, V, Zr.). We further use lead-isotope systematics in these environmental archives to discriminate emissions derived from Archean Abitibi sulfides from other sources and complement the lake-sediment profiles with compound-specific isotopic analysis of polycyclic aromatic hydrocarbons (PAHs) to assess their potential for distinguishing the historical evolution of the smelter feedstock from metal remobilization by forest fires.

Despite early diagenetic effects inherent to peat and sediment profiles, our multi-archive approach reveals a clear contrast in environmental responses. Ombrotrophic peat records a purely atmospheric depositional signal, capturing the strong decline in metal fluxes associated with regulatory improvements and technological upgrades at a major regional smelter. In contrast, headwater lake sediments within a 50-km radius continue to record elevated metal(loid) fluxes, up to five times pre-industrial levels, without evidence of decline. This persistent signal reflects the remobilization of legacy smelter-derived contaminants stored in surrounding soils and their ongoing transfer to aquatic systems.

Together, these results demonstrate that while atmospheric emissions have sharply decreased, legacy metal(loid) reservoirs in the terrestrial environment continue to sustain metal(loid) fluxes to lakes, underscoring the long-term environmental imprint of 20th-century smelting in the Abitibi region.