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Resurgent atmospheric lead emissions from the Global South

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Historical lead (Pb) emissions from tetraethyl lead additives in petroleum during the twentieth century significantly increased environmental Pb levels, resulting in widespread global Pb contamination. The nationwide phasing out of Pb-additives since the 1970s has progressively reduced the environmental Pb content in the global ocean and atmosphere. However, post-2015 observations reveal relapsing Pb concentrations in selected oceanic sectors in the Northern Indian and South Atlantic Oceans (Cape Basin)[1,2]. These near-recent increases are likely linked to urbanization and industrial use of Pb-emitting raw materials within the Global South. In the Indian Ocean, the likely sources are Pb-bearing coal combustion emissions from China and India[2]. The increased Pb in Cape Basin waters[1], however, must be from alternative lead sources from South Africa, given that no noticeable change in coal-bearing lead emissions has been observed.

To identify potential sources of toxic Pb from South Africa, this study examined recently collected aerosols (total suspended matter, PM_{10}, $PM_{2.5}$) from the Northern and Eastern provinces, which usually influence the elemental fluxes to the southeast Atlantic sectors via atmospheric transfer and ocean currents. Urban aerosols sampled from the Johannesburg region, a major industrialized hub, exhibit substantial enrichment in Pb (Enrichment factor$_{\text{continental crust}}$ > 50), consistent with a likely anthropogenic contribution of lead. The labile Pb fraction in aerosols (>70%) further indicates Pb sourced from combustion activities and road dust, while their V/Pb ratios (0.05-0.3 <1) suggest vehicular emissions rather than coal combustion, though. Given that modern-day petroleum is lead additive-free, contemporary vehicular lead emissions likely arise from non-exhaust emissions from vehicles and their interaction with road material, which could be combined with legacy Pb. We, therefore, hypothesize that abrasion of road materials (bitumen/asphalt) is an under-recognized process that could contribute substantial hydrocarbon-derived Pb into the atmosphere[3]. Progressively increasing vehicle density and traffic intensity within the Global South may amplify such non-exhaust emissions. Further investigations of road dust and the lead isotopic signature of aerosol would provide a clearer picture.

[1]Samanta et al. (2023), Scientific Reports 13, 5465.
[2]Yadav et al. (2025), Marine Pollution Bulletin 215, 117874.
[3]Samanta et al. (2022), Applied Geochemistry 136, 105164.