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Compound-Specific Isotope Analysis Reveals Sources of Polycyclic Aromatic Compounds in the Athabasca River

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The emission of contaminants such as polycyclic aromatic compounds (PACs) from surface mining and upgrading activities in Canada's Athabasca oil sands region (AOSR) has raised concerns about their impact on the surrounding environment. PACs, which are found naturally in crude oil, are also generated by the incomplete combustion of organic matter, and thus have a variety of possible sources. Effective environmental management requires techniques that can accurately identify and potentially quantify the relative proportions of different sources of PACs in environmental samples. In this study, we apply dual ($\delta^{13}C$, $\delta^{2}H$) compound-specific isotope analysis (CSIA) to identify and quantify the sources of PACs in surface sediments along the main stem of the Athabasca River at sites upstream, nearby and downstream of bitumen surface mining operations. Concentrations of alkylated PACs were elevated compared to unsubstituted parent PACs, demonstrating the importance of oil sands-derived inputs from both natural and mining-related sources. Previous work showed that petroleum coke (petcoke) – the carbonaceous by-product of bitumen upgrading – was the principal source of mining-related PACs deposited to lake sediments in the Peace-Athabasca Delta [1] and AOSR lake snowpack [2], with minor inputs from gasoline or diesel soot. In contrast, $\delta^{13}C$ data from Athabasca River sediments indicates that in addition to petcoke, gasoline/diesel soot is a major source of mining-related PACs. Unprocessed oil sands and wildfires also contribute to the $\delta^{13}C$-PAC signal. Further insight into PACs source apportionment is expected from ongoing work involving compound-specific $\delta^{2}H$ analysis and Bayesian isotopic mixing models.

References:

[1] Jautzy, et al. (2015). *Environ. Sci. Technol.* 49, 12062−12070.

[2] Ahad, et al. (2021) *Environ. Sci. Technol.* 55, 5887−5897.