

A one-century sedimentary record of N- and S-polycyclic aromatic compounds in the Athabasca oil sands region in Canada

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Abstract

The atmospheric deposition of polycyclic aromatic compounds (PACs) is considered a major pathway to isolated lakes and bogs in the Athabasca oil sands region (AOSR), Canada. However, the suite of PACs measured has been limited. We report the detailed depositional history of nitrogen and sulphur heterocyclic PACs using a Pb-210 dated sediment core (1914-2015) near major developments in the AOSR. We observed (1) an exponential growth in the deposition of heterocyclic PACs to recent times with an average doubling time of 12 years, (2) significant breakpoints in PAC fluxes in the mid to late 1980s, and (3) a synchronous increase of PACs with crude oil production ($r(2) = 0.82$, $p = 0.001$). NPACs were not detected prior to the 1960s in the sediment core studied, suggesting they may hold promise in serving as indicators for atmospheric PAC deposition of industrial origin. Furthermore, a change in heterocyclic PAC distribution profiles beginning in the 1970-1980s, after the onset of mining, resembling a petcoke signature, was also observed. Significant positive correlations ($p < 0.05$) were observed between heterocyclic PACs, and several metal(loid)s, including priority pollutant elements, chromium and beryllium, and rare earth elements, cerium, lanthanum and yttrium ($r(2) > 0.75$), suggesting the potential of a common source or similar transport and fate mechanisms. Significant negative or no correlations were observed between heterocyclic PACs and other metal(loid)s, including vanadium, total mercury and lead, possibly reflecting the impact of broader regulatory controls introduced in the mid-1970s on some metal(loid)s but not on PACs, including the installation of electrostatic precipitators in major upgrader stacks. Crown Copyright (C) 2020 Published by Elsevier Ltd. All rights reserved.

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