Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34653

Methane Radiocarbon Measurements From Capped Landfills Indicate Substantial Fossil Carbon Biodegradation

JOSHUA ZVI WASSERLAUF, PETER M J DOUGLAS, GRANT CLARK AND JACOB ASOMANING

McGill University

Landfills are major anthropogenic sources of atmospheric methane (CH_4). Current greenhouse gas inventories generally attribute landfill CH_4 emissions solely to modern, biodegradable biomass. Materials such as plastics that are derived from petroleum (i.e. “fossil carbon”) are assumed to resist microbial degradation in landfills. Experimental studies, however, suggest biodegradation of plastics and other fossil carbon can occur under certain environmental conditions. The microbial biodegradation of fossil carbon in anaerobic landfill environments and the resulting greenhouse gas emissions remain poorly characterized.

We report preliminary radiocarbon ($\Delta^{14}C$) analyses of CH_4 and carbon dioxide (CO_2) emissions collected in soil flux chambers as evidence of the degradation of fossil carbon within two capped landfills near Montreal, Quebec: a portion of a large commercial landfill capped between 2004 and 2014 and an older landfill converted to a park in 1949. Materials manufactured from petroleum contain ancient carbon with no ^{14}C and their biodegradation yields CH_4 or CO_2 similarly depleted in ^{14}C. In contrast, modern biogenic materials such as food waste yield CH_4 with modern ^{14}C levels. The ^{14}C content of landfill-derived CH_4 can therefore distinguish between fossil (e.g. plastic) and modern (e.g. food) carbon sources.

The CH_4 and CO_2 from capped landfill zones showed $\Delta^{14}C$ values between -50 to -210‰, consistent with the incorporation of 5 to 20% fossil carbon into microbial respiration byproducts. All measurements came from soils with significant atmospheric fluxes, with CH_4 fluxes ranging 0.01 to 51 mmol $CH_4/m^2/day$. Comparison of these results with a simple model of greenhouse gas production in landfills suggests that the degradation rate of fossil carbon is higher than typically assumed. Our results imply that ^{14}C measurements of landfill gas are a useful tool to assess fossil carbon input. Exploring radiocarbon values of CH_4 from older landfill sectors could indicate whether microbes metabolize more fossil carbon as labile, modern biomass is depleted.