

Lead Isotope Tracing of Heavy Metal Contaminants in the Environment

MEGHA DEVAKUMAR¹, CLAUDINE H. STIRLING¹,
MATT DRUCE¹, JENNIFER GADD², MICHAEL J
ELLWOOD³, MALCOLM R. REID¹, DAVID BARR¹, ADAM
P MARTIN^{4,5}, MELANIE KAH⁶, MARK RATTENBURY⁴
AND ROSE TURNBULL^{4,7}

¹University of Otago

²Hydrotoxy Research

³Australian National University

⁴GNS Science

⁵Earth Systems

⁶University of Auckland

⁷Geological Survey of Western Australia

Anthropogenic heavy metal sources are ubiquitous worldwide, and are evident in Aotearoa New Zealand's environments associated with agriculture, urbanisation, horticulture, and transportation activities. These activities have led to increased heavy metal accumulation in soils, sediments, streams, estuaries and harbours, exerting potentially toxic effects on ecosystems and posing risks to sustaining growth. As an example, anthropogenic lead (Pb) emissions have decreased since leaded gasoline was phased out in the late 20th century in New Zealand, but there are still reported cases of higher levels of lead exposure in children.

Heavy metal contamination is traditionally monitored using metal concentrations and some sources of metals are well known. However, there are major gaps in our knowledge regarding the specific land-use activities contributing to anthropogenic heavy metal contamination. As part of a broader study that takes advantage of the improved discriminatory power of heavy-metal isotope 'fingerprinting' based on the isotope systems of Pb, Cu, Cd and Zn, here we present Pb isoscape maps for soils across Auckland, New Zealand's primary urban centre. Soil samples were collected from the surface and sub-surface from more than 70 sites located 2-4 km apart, and additional soil cores were collected at selected sites. Together, these soil samples provide a record of changing land-use activities from pre-industrial to modern times. The results for soil extracts show Pb concentrations varying from 3 to 392 mg/kg, and significant variations in Pb isotopic compositions. These signatures can be related to variable mixing between geogenic basement lithologies and anthropogenic Pb sources, with Pb-containing wheel weights, road dust, historic paints and landfill leachates as likely major contaminants. A multi-source mixing model is being applied to the paired Pb concentration and Pb isotope results to elucidate the contribution of each unique source to heavy metal accumulation in Auckland's environments.