Pyrogenic Remobilisation of Historic Leaded Petrol Emissions

Brief Summary
Lead additives used in petrol between 1934 until the complete phase out of leaded petrol in Australia in 2002 were responsible for 90% of atmospheric lead in urban areas (Department of the Environmental Heritage, 2001). An inventory of emissions in Australian capital cities in 1976 reported almost 4 million kilograms of lead in the atmosphere came from vehicle use in that year alone (Farrington and Boyd, 1981). Atmospheric lead becomes absorbed by the terrestrial environment (dusts, sediments, soils, vegetation and water) where it is considered relatively immobile.

No studies in Australia have examined specifically the potential for the release of industrial lead in ash from uncontrolled bushfires in Australia, which are considered to be increasing in frequency due to climate change. Indeed, only one unpublished study of this kind exists to our knowledge, which has taken place in California. The isotope ratios of lead can be used as a finger printing tool to elucidate the source of lead in environmental materials (Morton-Bermea et al., 2011). The ratios are unaffected by the automobile combustion process and because individual lead ore deposits have a unique isotopic fingerprint, this allows environmental samples containing lead to be traced to its origin using ratios of isotopes $^{204}\text{Pb}$, $^{206}\text{Pb}$, $^{207}\text{Pb}$ and $^{208}\text{Pb}$.

Aims
The aims of this project are:

i. To measure the total amount of extractable lead in ash released from bush fires;

ii. To compare lead concentrations in the ash to background values and to calculate enrichment factors;

iii. To apportion the source of lead in ash to natural or anthropogenic sources using lead isotope ratios as determined by Inductively Coupled Plasma Mass Spectrometer (ICP-MS).

The working hypothesis for this project is that lead in ash from bushfires is sourced predominantly from anthropogenic leaded petrol sources. It is anticipated the results will reveal the pervasive nature of lead emissions on Australia’s relatively pristine natural rural environments and that combustion of forests by uncontrolled bushfires will result in an increase environmental pollution from lead.

Methods
Ash was collected from three locations across Australia that had experienced large intense fire events since February 2011. At each location, samples of ash from large, old burnt out trees were collected to provide the best profile of the fire burnt region covering the time period of leaded petrol use. Soil sub-surface samples at a depth of 40-50 cm were also collected from each field location to obtain natural background references of lead concentration and isotope ratios. One set of ash samples was obtained from the Gippsland region in Victoria and the other two sets from the Perth Hills region in Western Australia.

Lead concentration and isotope ratios for ash and soils samples will be determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Lead isotope ratios in ash will be plotted together with those of the natural lead isotope composition from the same location along with the known isotopic composition of petrol lead used in Australia. The data will then be assessed to ascertain the source of lead in the environment and the potential significance of bushfires for re-emitting lead into the atmosphere.

References