Estimating atmospheric lead concentrations and isotopic composition using two lichen genera over the past 120 years in Australia

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Lead isotope ratio is a valuable tool for identifying sources of atmospheric lead pollution. In this study, *Cladonia* and *Usnea* lichens are used as reliable biomonitors of atmospheric lead pollution throughout the Greater Sydney region (NSW, Australia). Lead concentrations and their isotopic compositions were determined for the lichens that had been collected and archived from 1885 to 2010.

Lead concentrations in *Cladonia* lichens range from 2.6 to 570 mg/kg, while in *Usnea* lichens it vary from 1.0 to 181 mg/kg. Median lichen lead concentrations prior to the introduction of leaded petrol in 1932 in Australia were *Cladonia* 12.5 mg/kg; *Usnea* 15.6 mg/kg. Concentrations rise during late the 20th century in line with the increased industrial emissions of lead (*Cladonia* 18.8 mg/kg, 1971-1999; *Usnea* 21.5 mg/kg, 1939-1999) and then decrease in the 2000s (*Cladonia* 4.8 mg/kg; *Usnea* 1.7 mg/kg) due to the drawdown of leaded petrol use.

Lead isotope composition ratios of lichens ($^{206}Pb/^{207}Pb$: 1.167 – 1.121; $^{208}Pb/^{207}Pb$: 2.456 – 2.396 for *Cladonia*; $^{206}Pb/^{207}Pb$: 1.139 – 1.129; $^{208}Pb/^{207}Pb$: 2.424 – 2.415 for *Usnea*) indicate that natural background lead ($^{206}Pb/^{207}Pb$: 1.176 – 1.123; $^{208}Pb/^{207}Pb$: 2.459 – 2.413) was the main source of lead in the oldest lichens sampled. During the 1970s-1990s leaded petrol emissions formed the dominant source of lead in lichens, producing lead isotopic composition values of $^{206}Pb/^{207}Pb$: 1.083 – 1.122; $^{208}Pb/^{207}Pb$: 2.361 – 2.399 in *Cladonia*; and $^{206}Pb/^{207}Pb$: 1.072 – 1.108; $^{208}Pb/^{207}Pb$: 2.346 – 2.380 in *Usnea* lichens. The lead isotopic composition of contemporary lichens (2000-2010) does not reflect pre-leaded petrol values and reveals that historic leaded petrol emissions remain a persistent source of anthropogenic contamination in the Greater Sydney region.