Study: Relative lead isotope ratios in household dust

Aim

To determine the relative lead isotope ratios in household dust to assess if lead-based paint contributed to unusually high lead levels.

Background

In October 2018, students from Macquarie University carried out a study of lead levels in vacuum cleaner dust, yard soils and verge soils in Broken Hill. They identified a strong relationship between lead concentration in soil and dust, and distance of the property from the Line of Lode – a seven kilometre, lead-rich orebody that bisects Broken Hill and is the site of historical and contemporary mining activities. Four of the homes had lead concentrations in the vacuum cleaner dust that were about twice as high as other properties at similar distance from Line of Lode, but there was no clear reason for the higher concentrations. One potential source for the higher lead concentrations is lead-based paint.

Lead-based paint that is in poor condition, or disturbed during renovations, is widely recognised as a major source of lead exposure (NSW LRG, 1997; WHO, 2010). Most homes and buildings in Broken Hill are likely to contain lead-based paint as they were built prior to the 1970s when it was phased out.

In the 1990s Gulson et al (1996) found that about a third of Broken Hill children with blood lead levels of 15 µg/dL (micrograms of lead per decilitre of blood) or higher had significant exposure from non-orebody sources – paint and petrol. Currently, around a third of homes referred to the Broken Hill Environmental Lead Program for remediation have lead-based paint hazards which require abatement, with lead-based paint appearing to be the primary source of exposure in about 10% of these homes.

There is little current direct evidence about the extent to which lead-based paint may be contributing to elevated lead levels in house dust. This is an important gap in knowledge, and the vacuum dust samples collected by the students provide an opportunity for assessing the extent to which lead-based paint is contributing to lead levels in house dust, and thus to children's risk of lead exposure.

Method

As lead has several different isotopes and different lead ore-bodies have different characteristic ratios of one isotope to another, analysis of isotope ratios has been used to help identify the source of lead (Zhou et al 2018; Gulson et al 1996). A combination of isotope ratio analysis and scanning electron microscope analysis will be used to identify the likely source of lead in the vacuum dust samples.

Lead levels in 20 samples of vacuum cleaner dust - the 4 samples with unexpectedly high lead concentration for distance from Line of Lode and 4 comparison samples for each from similar distances from the Line of Lode - were subjected to isotope ration analysis.

Findings

Isotope ratios for the vacuum dust samples were found to be largely similar to the Broken Hill orebody but became more different with greater distance from the Line of Lode, indicating greater contribution from other sources.

Source apportionment estimates, based on similarity of isotope ratios with the Broken Hill orebody, found most of the vacuum dust samples had upwards of 95% of their lead from the orebody, including three of the samples with unusually high lead concentration. One sample was an exception, with an estimated 60% lead from the ore body.

Other sources of lead could be leaded petrol or 'background' Broken Hill lead (naturally deposited in the soil), or paint, which has a wide range of isotope values.

Conclusion

Analysis to date suggests that the main source of lead in the vacuum dust samples was the Broken Hill orebody, but that other sources increase in importance with increasing distance from the Line of Lode. It's important to note that the source contribution to the orebody lead in the dust could be from historical/contemporary mining emissions and activities.

Future work will include plotting the known range of lead isotope ratios for paint samples previously collected in Broken Hill and examining the samples under scanning electronic microscope to further differentiate between potential sources of lead.

References

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