IMPACT ON THE ENVIRONMENT FROM STEEL BRIDGE PAINT DETERIORATION USING LEAD ISOTOPIC TRACING, PAINT COMPOSIITONS AND SOIL DECONSTRUCTION

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Abstract

Using a combination of high precision Pb isotopic tracing, detailed paint examination, including with scanning electron microscopy, and soil deconstruction we have compared paint on a steel bridge and bulk soil and lead-rich particles separated from soil from the Story Bridge, Brisbane, Australia. The majority of Pb found in the paint derives from Australian sources but some also has a probable US origin. The isotopic data for the bulk soils and selected particles lie on a mixing line with end members the geologically ancient Broken Hill Pb and possible European Pb which is suggested to be derived from earlier Pb paint and industrial activities. Data for gasoline-derived particulates lie on this array and probably contribute to soil Pb. Although paint from the bridge can be a source of Pb in the soils, isotopic tracing, paint morphology and mineralogical identification indicate that other sources, including from paint, gasoline and industrial activities, are contributing factors to the Pb burden. Even though physical characteristics and elemental composition are the same in some particles, the isotopic signatures demonstrate that the sources are different.

Introduction

Deterioration and repair of lead (Pb) paint on steel structures can result in contamination of the ambient environment but other sources of Pb such as from past use of leaded paint and gasoline and industrial activities can also contribute to the contamination. Various industrial activities at Kangaroo Point under the Story Bridge which could have utilised metals (Pb, Zn, Cu, Sn, Sb, As and Hg) include tanning, foundries, agriculture, shipyards, and engineering works. In addition to these industrial sources, Pb in soil could also be derived from paint from the Story Bridge and older residences, especially those built before 1970 when Pb paint was used extensively, and gasoline. Hence, there is potential for a very complex picture for Pb apportionment in the soils and the rationale for the detailed examination of the soils.

Methods

High precision Pb isotopic tracing (TIMS), detailed paint examination, including with scanning electron microscopy (SEM), and soil deconstruction for selection of Pb-rich particles.

Results

Microscopy & SEM characterised up to 6 different paint layers in the bridge of varying elemental composition The lower or inner Pb-rich orange or red layers are the oldest paint (red Pb) and with upper "younger" chromium-rich (zinc chromate) layers. The majority of Pb found in the paint derives from geologically ancient Australian sources (e.g., Broken Hill mines) with $^{206}Pb/^{204}Pb$ isotopic values of 16.0 but in some layers the paint has a probable US origin (MVT Array, Figure 1).

Soil Pb values were up to 1200 mg/kg below the Pb painted bridge. Lead-rich particles in soils are dominantly orange/red (PbO, PbBaPbCaSiAlO) and white/cream (PbSiAlO). The isotopic data for the bulk soils and selected Pb-rich particles lie on a mixing line with end members the Broken Hill Pb and possible European Pb which is suggested to be derived from earlier Pb paint and industrial activities (Aussie Array, Figure 1). Data for gasoline-derived particulates lie on this array and probably contribute to soil Pb.

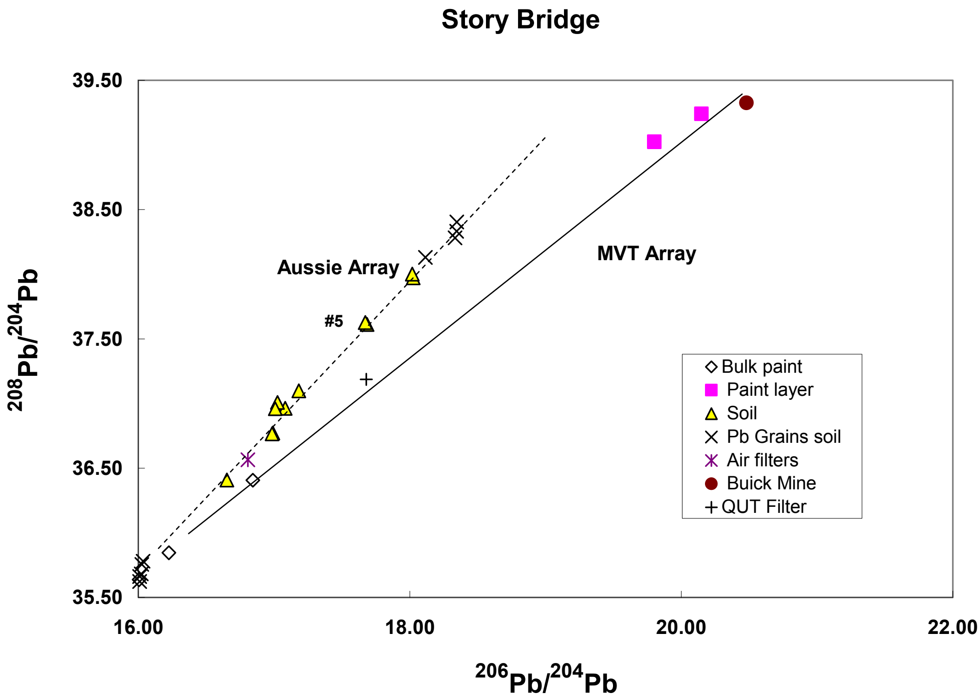

Figure 1. Isotope ratio plot illustrating differences in Pb isotopic composition for compounds from the Story Bridge and soils from Kangaroo Point, Brisbane, Queensland, Australia.

Conclusions

High precision Pb isotopic tracing, elemental and color characterisation of paint materials and microscopic examination are powerful tools in evaluating sources of Pb in soils which, when used separately, such as just measuring Pb isotopes, may not provide accurate answers. Our study has shown that in spite of the similarity in isotopic composition of paint flakes separated from soils and bridge paint, features such as differences in color and elemental composition indicate that bridge paint is unlikely to be the source of the Pb in some soils but is from old Pb paint and/or other industrial activities. Furthermore, even though physical characteristics and elemental composition are the same in some particles such as white/cream flakes, the isotopic signatures demonstrate that the sources are different. Although the majority of Pb found in the paint and soils derives from Australian sources, some also has a probable US origin.

Reference

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