Sources, Mobility and Bioaccessibility of Potentially Harmful Elements in UK Soils

M.R. Cave, J. Wragg, E.L. Ander, J.D. Appleton and C.C. Johnson

British Geological Survey, Keyworth Nottingham , NG12 3NX

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Potentially harmful elements (PHE) occur both naturally from geogenic sources and from anthropogenic derived pollution. Anthropogenic sources can be further categorised into those derived from point sources. A point source is a single identifiable source which is confined to a very small area such as that arising from disposal of waste material or from an industrial plant. Diffuse pollution arises where substances are widely used and dispersed over an area as a result of land use activities, often associated with urban development. Examples of diffuse pollution include atmospheric deposition of contaminants arising from industry, domestic coal fires and traffic exhaust, and disposal of domestic coal ash. The total concentration and the chemical form and hence the mobility of the PHE in a soil is highly dependent on the source.

Figure 1.1 shows increasing concentrations of Pb in soils in England as the land category changes from rural to urban where urbanisation is measured as the ratio of built land to open space (Ander et al., 2012).

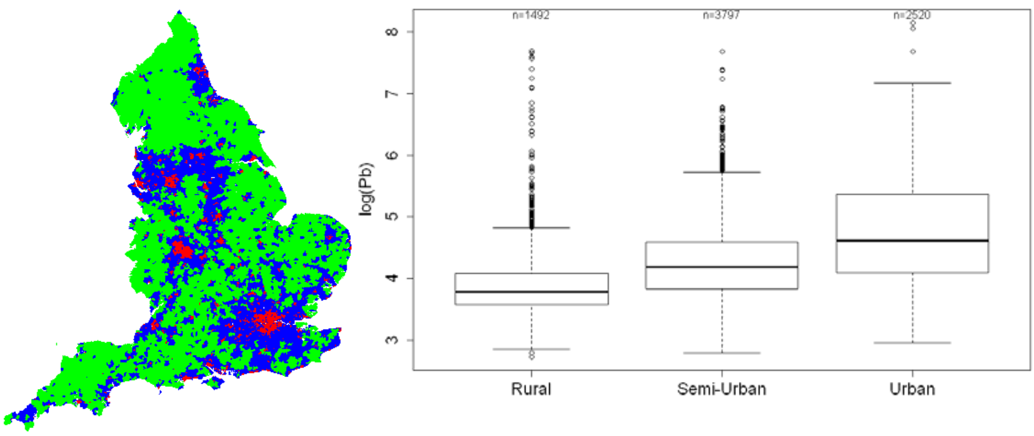

Figure 1.1. Map of England divided into rural (green), semi-urban (blue) and urban(red) categories with a boxplot of the total Pb content of the soils in each category.

Whilst understanding the source of the PHE in a soil is important, it is the form of the element and its fractionation between the physico-chemical components of the soil which ultimately governs its mobility in the environment. Figure 1.2 shows the results of a sequential extraction using the Chemometric Identification of Substrates and Element Distributions (CISED) method (Wragg, Joanna and Cave, 2012) for As and Pb in a soil from near Banbury in the UK located over naturally occurring ironstone. Whilst the total concentration of As is high (c.300 $mgkg^{-1}$) the majority of it is associated with iron oxides and is immobile. The Pb, however, is bound in almost entirely to a more mobile Al oxide phase.

When considering human health effects from elevated concentrations of PHEs, however, the fractionation provides evidence on which phases are likely to be mobile but it is the bioaccessible fraction (i.e. a proportion of the PHE is liberated from the soil by chemical and physical interactions with the body (this is known as the bioaccessible fraction) that is important for risk assessment. For As and Pb the main pathway to enter the body is through soil ingestion.

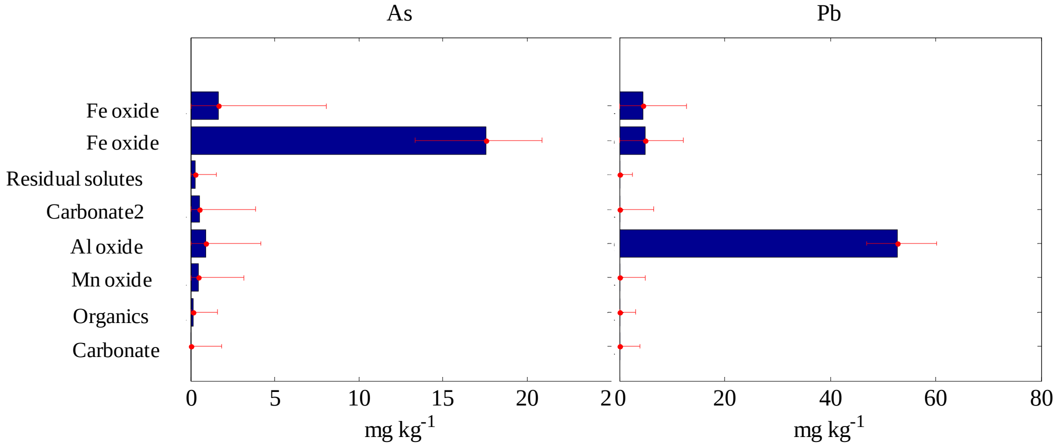

Figure 1.2. Fractionation of As and Pb in a soil from Banbury UK.

Figure 1.3 shows total Pb concentrations in two particle size fractions for soils in London plotted against the bioaccessible Pb as measured by a bioaccessibility test which mimics the conditions in the human gastro-intestinal tract (Wragg, J. et al., 2011). The overall bioaccessibility as measured by the slope of the regression is shown to be ca. 60%

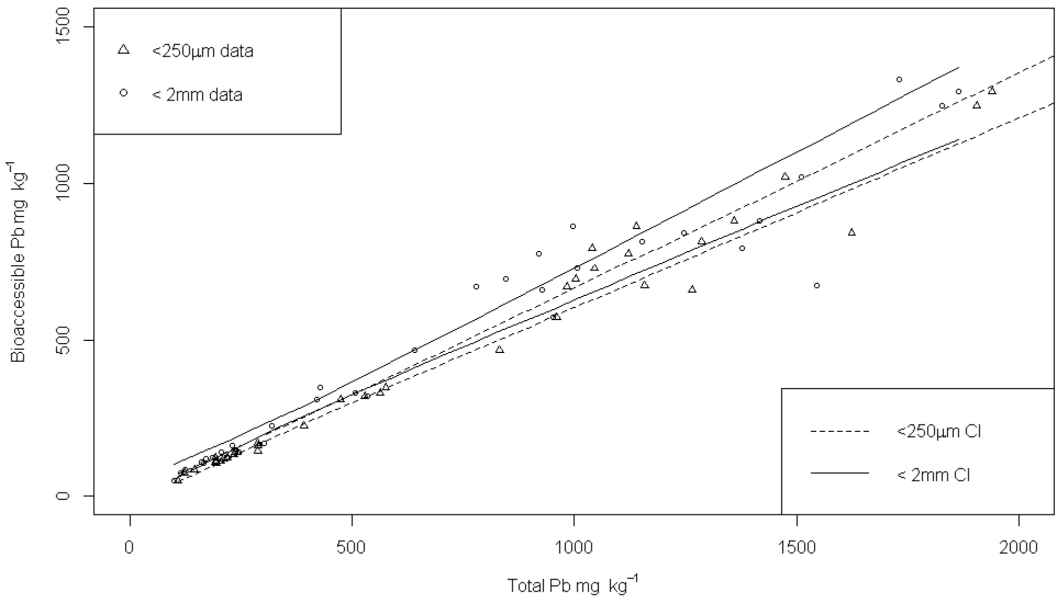

Figure 1.3. Plot of total Pb against bioaccessible Pb for different size soil fractions from London. Solid and dashed lines show the 95 percentile confidence intervals for linear regression lines.

References

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