Isotope Studies for the Sources of Urban Pb in the Soil of Maricopa County

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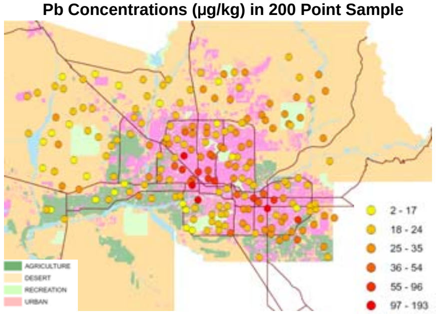
Abstract: Soil is one of the largest recipients of urban pollutants in the environment. Our preliminary study of Pb distribution in the soil of Maricopa County has exhibited strong urban influences on the hot spots of high Pb concentration. Eighty soil samples randomly selected from the 200-point survey were analyzed for Pb isotopic compositions with Inductively Coupled Plasma Mass Spectrometry. The result shows that desert samples have large variations in isotope ratios (0.70 to 0.90 for 207Pb /206Pb, and 1.80 to 2.15 for 208Pb /206Pb) with a small concentration range (10 to 30 ppm), while urban samples have small variations in isotope ratios (0.80 to 0.85 for 207Pb /206Pb, and 2.00 to 2.10 for 208Pb /206Pb) but a big concentration range (10 to 200 ppm). The isotopic pattern for desert samples is similar to published bedrock minerals in Arizona. Our hypothesis is that urban Pb is from a single unknown source, because the isotopic composition is so tightly constrained. We are analyzing samples of roadside and railroad soil profiles to test if this urban input is from historical leaded gasoline, burning of coal, or other sources.

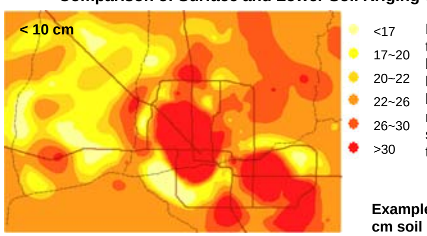
Pb Concentrations (μg/kg) in 200 Point Sample



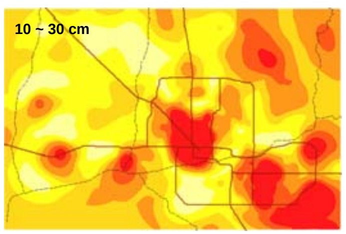
Sample Analysis:

- Surface (10 cm) and lower (10 to 30 cm) soil, dried, sieved, and ground
- Digested with mixture of concentrated HCl, HNO_3, and HF in microwave
- Analyzed with ICP-MS
- Plotted with GIS and R package

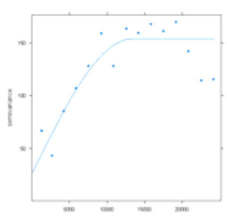
Comparison of Surface and Lower Soil Kriging Contours



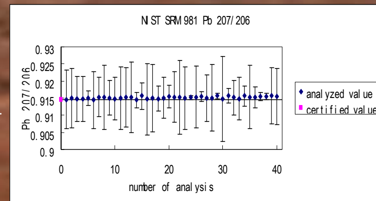
Pb spatial distribution. The two hot spots of Pb are both in urban centers. The lower soil map shows boundaries of hot spots more clearly. Isotopic study of Pb is needed to trace the sources.

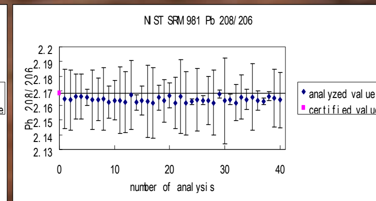


Example of fitting Pb surface 10 cm soil data with variogram



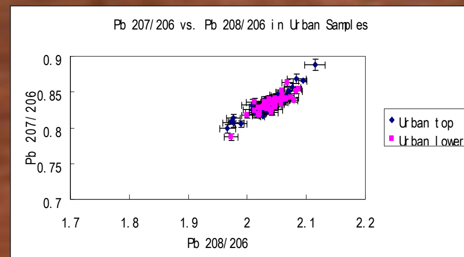
NIST SRM 981 Pb Standard Test for Accuracy and Stability of Isotopic Analysis

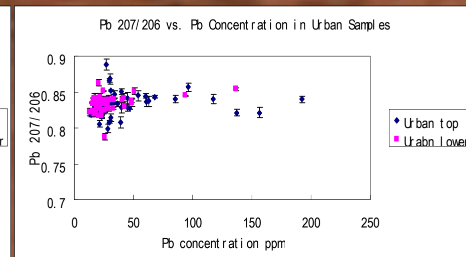


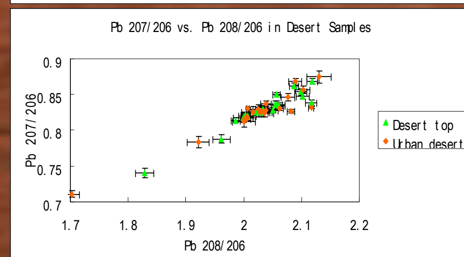


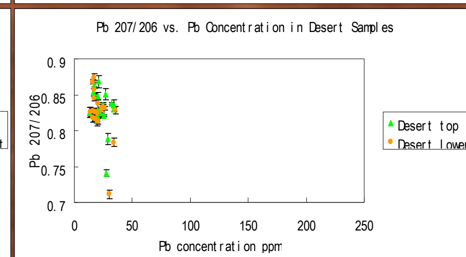
3ppb, 4ppb, and 5ppb solutions were analyzed between every five samples. Each accepted value has RSD smaller than 1%. Top and lower soil from eighty locations were analyzed.

Comparison of Pb Isotope Ratios between Urban and Desert Samples



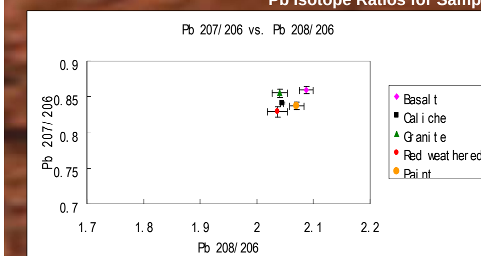


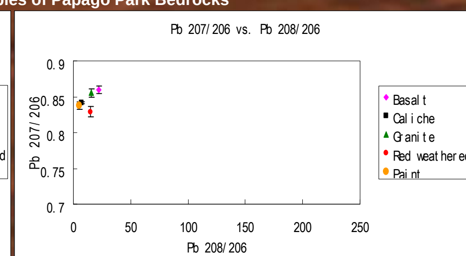




While desert samples scatter along a wider range of isotopic composition with small concentration range, urban samples tend to overlap at a much smaller range with three times the concentration range, indicating similar source of Pb in the urban.

Pb Isotope Ratios for Samples of Papago Park Bedrocks





Different bedrock samples from Papago Park and one paint sample from my apartment show similar isotope patterns: they have small isotope and concentration ranges. Thus urban Pb input might be from one source that has similar isotope ratios as the desert background.

Research in Progress:

- Depth profile of roadside soil along highway 60 and rail road
- Bedrocks from Estrella, North Mountain, Camel Back, Mcdowell, South Mountain, White Tank Parks

Railroad and Highway Sample locations

Picture of railway sample site

Picture of highway 60 roadside

Mateo working with soil cores