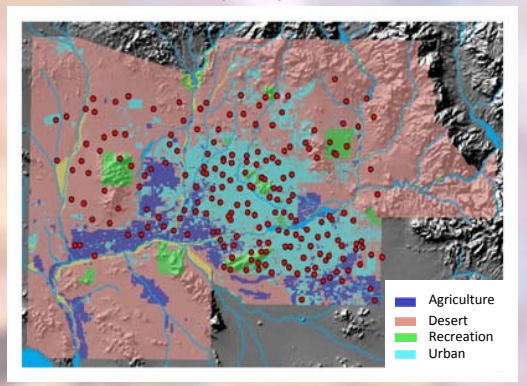
# Factors that Contribute to Distribution Patterns of Trace Elements in Maricopa County

Xiaoding Zhuo, Panjai Prapaipong and Everett Shock

Department of Chemistry & Biochemistry

**200 Point Survey Sample Locations**

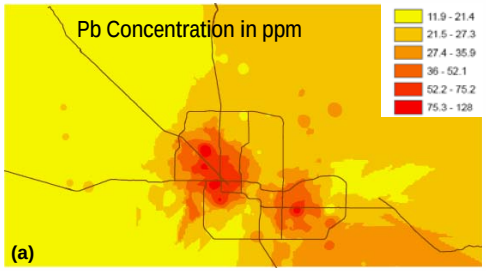


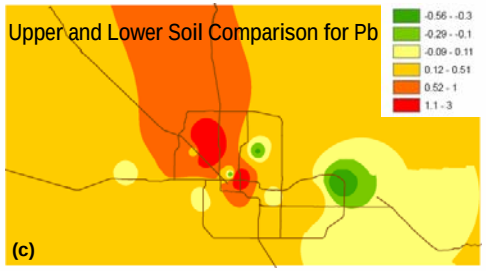

We have generated patterns of trace element distributions across Maricopa County from trace elemental analysis of 200 surface soil samples (upper 10cm) collected during the CAP-LTER 200-point survey in 2005. Samples were digested with mixtures of concentrated acid, solutions were analyzed with inductively coupled plasma mass spectrometry (ICP-MS), and trace elemental data were plotted with geographic information system (GIS) using kriging methods of spatial analysis. The distribution patterns of trace elements vary from strong correlations with automobile and industrial emissions (Pb, Cd, and Cu) to random patterns that probably reflect the natural geological background of the desert (Ni, Mn, and V). Currently we are working to establish the transport routes that each element takes. Local toxic release inventories obtained from the EPA website indicate that, rather than industrial air emissions, local automobile emissions are important source for anthropogenic trace elements. However, more work needs to be done to distinguish the geological background and adsorption capacities of different soils. Ultimately, the goal is to identify sources and sinks in the environment, whether the trace elements are transported from the surrounding desert to the urban area, whether their toxicity and bioavailability change during transport, and whether contaminated soils can become local sources of aerosols containing trace elements.

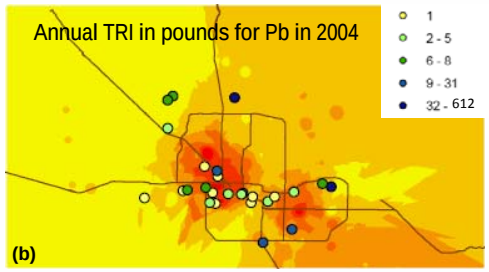
Maximum Emission Factors for Various Vehicles (mg/km)
Schauer et al., 1999 and 2002

| mg/km | CGV | NGV | diesel |
|---|---|---|---|
| V | 2.4 | 11.86 | 24.84 |
| Cr | 0.675 | 5.93 | 8.28 |
| Mn | 0.375 | 0.00 | 6.21 |
| Ni | 0.225 | 0.00 | 2.07 |
| Cu | 0.225 | 0.00 | 4.14 |
| Zn | 1.575 | 17.79 | 16.56 |
| As | 0.45 | 5.93 | 6.21 |
| Ag | 2.4 | 11.86 | 24.84 |
| Cd | 2.025 | 23.72 | 37.26 |
| Pb | 0.675 | 17.79 | 10.35 |

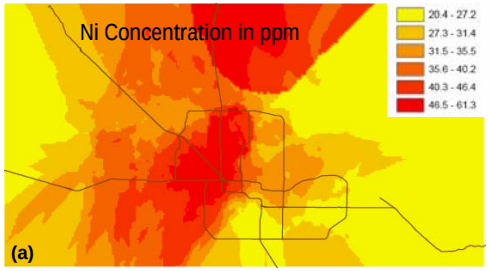
CGV: catalyst equipped gasoline vehicle. NGV: noncatalyst equipped gasoline vehicle. With traffic count available at the ADT website, new comparison of vehicle emission and trace element distributions can be made.

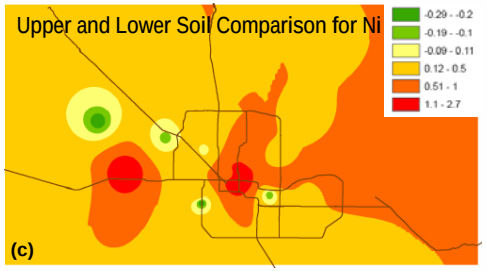


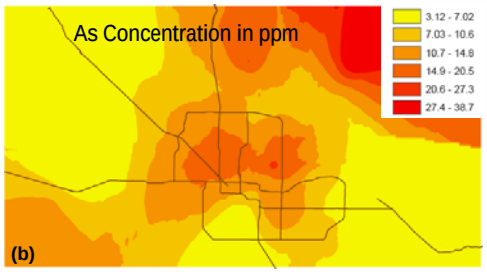



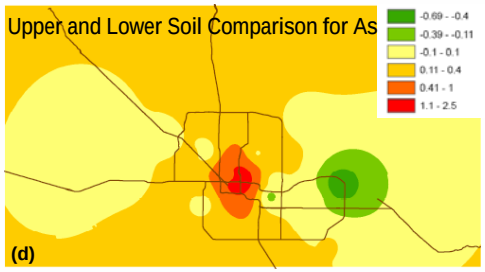




Twenty of the 200 lower soil samples were selected from six different land-use histories, analyzed for trace element concentrations, and compared with surface soil. Numbers are calculated as (upper-lower)/lower, and are plotted by the IDW (Inverse Distance Weighting) method with GIS. The greens mean that the concentrations in the upper soil are lower, the orange and red mean higher concentration in the upper soil, and the light yellow means that the concentrations at both levels are the same. Most areas show higher trace element concentrations in the top soil than the deeper soil, which suggests possible sources from aerosols and other human activities.




Spatial distribution of Pb (a), comparison of this spatial distribution with its annual local Toxic Release Inventory (TRI) air emission obtained from the EPA website (b), and comparison of upper and lower soil concentrations (c). Pb has notable high upper soil concentrations in the urban center and along Interstate17, which matches closely its spatial distribution. The annual TRI of most elements are close to zero except for Pb and Cu. However, the total amounts of these metals from twenty years of TRI are still trivial considering the amount of Pb and Cu in the soil, which demonstrates that other sources, from geologic background to automobile emissions, dominate the trace element abundances in the soil.

The spatial distributions of Ni (a) and As(b) show high concentrations both in the urban and desert areas, however the pattern for Ni is less distinct. Comparing the variations in concentrations of these elements in the upper and lower soil samples (c, d) with their spatial distribution helps to reveal the extent to which these elements have urban signals . However, in the surrounding desert, the observed trends in concentration variation between upper and lower soil samples differs from the pattern for Pb, which might result from strong geological background and aerosol deposition. We are evaluating the mineralogy, soil profiles, and sequential extraction methods to further constrain the sources.