Heavy Metals in Your Soil

CAP LTER Data Explorations

Author: Ecology Explorers Team, adapted from work by Zhuo, Prapaipong, and Shock
Time: 15-30 minutes
Grade Level: 9-12

Background:
The Phoenix urban core is composed of several contiguous cities and is situated within the Sonoran Desert. This area is being studied by scientists as part of the long-term ecological research network (LTER) funded by the National Science Foundation. Our project, the Central Arizona-Phoenix LTER (CAP LTER) is focusing on researching the effects of urbanization on the surrounding desert ecosystem and vice versa. The Phoenix area is growing rapidly with a population with 300,000 people in 1950 and 3 million+ in 2005. The area receives annual precipitation of 180 mm (6 inches) and can experience summer temperatures as high as 48 C (115 F). The rain comes twice a year (winter & summer), which contributes to the high species diversity of the Sonoran Desert as compared to the North American deserts. Urbanization of this area has led to decreased agricultural development (formerly focused to the west, south, and southeast of the urban core) and increased water control via dams, reservoirs, and canals.

Trace elements such as lead (Pb), nickel (Ni), and arsenic (As) are found in soils due to the type of rock the soils form from or due to anthropogenic deposition. Most anthropogenic (human-caused) deposition of such trace minerals results from industrial processes and also automobile emissions. Scientists are examining how much and what types of trace minerals in urban soils, are a consequence of automobiles. These graphs display some of the data collected by CAP LTER scientists. These graphs can have fairly random patterns or non-random patterns which help researchers develop hypotheses and predictions about where the trace minerals originate.

Objective:
Students will analyze patterns of heavy metal deposition from soil samples

Standards:
Science

Advanced Preparation:
A review of elements, mass, isotopic decay would be helpful.

Materials:
Student Worksheets

Evaluation:
Observation during the activity and participation in discussion.
Student responses to reflection questions.

Extensions:
Have students determine human, plant & animal limits to exposure to heavy metals such as lead, nickel and arsenic.

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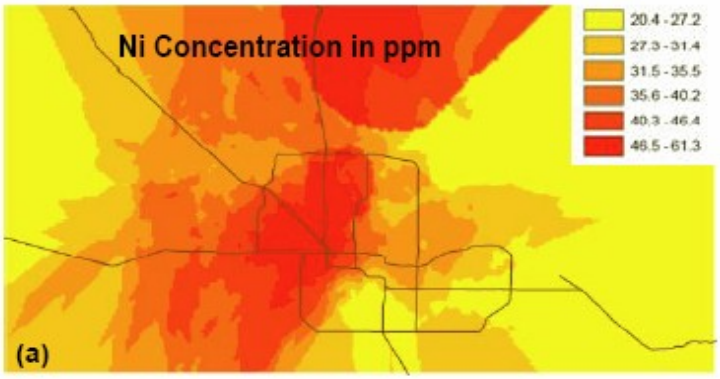
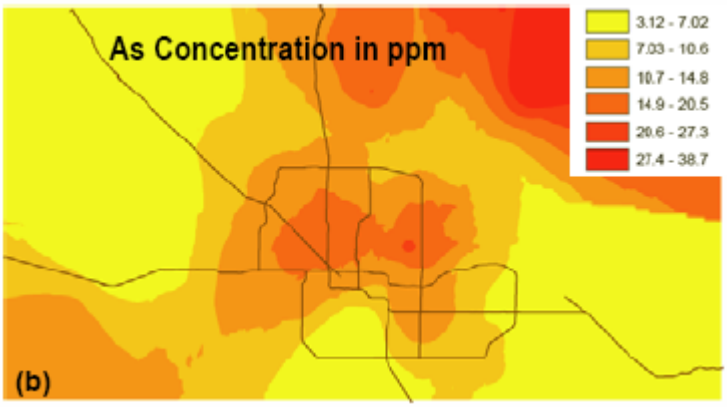
The lines on the map are major roads and freeways. Darker red indicates higher concentrations.

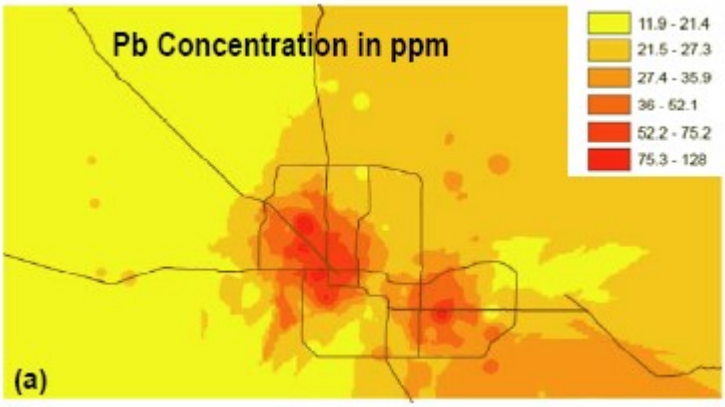
Graph 1: Nickel Concentration



Graph 2: Arsenic Concentration



Graph 3: Lead Concentration



Parts per million (ppm) is a standard measure used in science which is a count of the number of 'parts' of whatever your interested in, per million units of some background substance. For example, if you poured gold flecks into a glass (500 liters) of water you could calculate the number (parts) per hundred liters. This would be written as parts per hundred or pph. Maybe you'd find that for each 100 liters of water you counted 40 gold flecks; you would have 40pph.

Questions:

1. Scientist look for patterns (random vs. non–random) in data to determine hypothesis they can test about the patterns. How would you rank these graphs from the least random pattern to the most random pattern.

2. The McDowell Mountains are to the northeast and the Estrella Mountains are in the southwest; the city center is in a valley. How do you think this topographical arrangement could alter trace mineral deposition?

3. What about the roads; is there a relationship between where they are and where Ni, or Pb concentrations are highest?

4. Lead was a common component in gasoline but was banned from gasoline in the 1970's. How might this explain where lead was concentrated in the Phoenix area?