A Teacher’s Guide to Lead in Soil

What is Soil?

- Soil originates from rock. Rock originates from the molten core or magma of the earth’s center. Soil is formed from rock through a process called weathering. Weathering is a process by which soil is broken down into tiny fragments through the action of water, abrasion, gases, and living organisms.
- Soil is the substrate upon which many organisms live, in particular plants. Plants obtain their nutrients from the soil.
- Plant matter over time will decompose and mix with the soil thereby increasing the organic content of the soil.

What Factors Influence the Ability of Contaminants to Attach to Soil?

- The organic content of soil plays an important role in the ability of contaminants to bind to the soil. Usually more contaminants bind to soils with a higher organic content.
- In general, the smaller the particle size of soil, the more contaminants the soil can hold. This is in part due to the increased surface area (per unit volume) of small grained soil. Also, small grained soils (e.g. clays) have a unique surface chemistry that increases their ability to bind contaminants.
- The chemical characteristics of the contaminant itself influences the ability of contaminants to bind to soil.
- Other factors that influence the ability of contaminants to bind to soil include soil acidity and soil salinity.

What Are Soil Contaminants?

- Any contaminant applied to the ground can contaminate soil. Examples include pesticides, gasoline, jet fuel, and metals.
- Pesticides, gasoline, and jet fuels are examples of “organic” contaminants. Organic contaminants generally bind well to soils containing high organic content.
- The ability of metals to bind to soil is highly dependent upon the acidity or pH of the soil.
- One particular metal of concern is lead.
**What Is Lead?**

Check out the following websites:

http://www.aeclp.org

http://www.epa.gov/lead

**Physical Properties**

- Dense, dull bluish-gray metal
- Atomic weight of 82, classified as "Other Metal" on periodic table
- Mined from ore called galena
- Very little naturally released (i.e. volcanic eruptions)
- Is highly inert, heavy, malleable
- Safe for adults to handle in lump form
- Useful for many industries
  - Radiology, shields x-rays, radiation
  - Battery making

**Interactions with the Environment**

- Is everywhere in our environment as a result of industrialization
  - Water
  - Air
  - Soil (the focus of our module)
- Tends to stay where deposited (top 1-3" of soil), does not deteriorate
- Forms crystalline salt on surface which prevents rust, chemical breakdown
- Organic matter and phosphates bind lead in soil
- Hot water can cause some leaching of lead salts
- Does not accumulate in animals' tissues as you go up the food chain as opposed to other heavy metals like mercury, arsenic

**History**

See "Cater to the Children" article, "The Secret History of Lead" article

**Ancient Times**

- Used for weaponry, dishware, piping, medicine.
- Greek God of metallurgy (Haephestus) shown as a cripple due to exposure to toxic fumes
- Lead pipes and wine curing in lead vessels in Rome allegedly caused high rates of miscarriage, insanity, other ills among upper class
Renaissance

- Elizabethan era, white face paint caused hair loss, neurological symptoms

Industrial Era

- First large scale exposures in the workplace, paint manufacture, gasoline additive.

20th Century U.S. Lead Regulation Landmarks

- Paint – concentration of lead in paint declined in 1950’s, but was not banned from paint until 1978 (In some countries it was banned as early as the 1920s)
- Lead solder banned 1989
- Leaded gasoline banned 1990

Lead in Our World Today

Types and Sources of Lead

- Paint
- Auto emissions
- Industry
- Old pipes, solder
- Glazed pottery, tile
- Also, medicines and other weird sources such as crayons, candle wicks, miniblinds, etc – also developing nations still use leaded gasoline (and it can still be gotten here for old vehicles)

What's All the Fuss? The Human Health Effects of Lead

See [http://www.cdc.gov/lead](http://www.cdc.gov/lead)

Lead's Effects Within the Body - Pathophysiology

Mechanics of Lead

- Every system in body is affected, no lead is naturally present in body
- Protein synthesis disrupted
- Nerve conductivity reduced
- Binds with calcium, iron receptors, minimizing absorption
- Stored away in bones, except during pregnancy or severe illness when it is re-released into the bloodstream
- Is excreted via urine, feces, hair
• In single-exposed adults, the half-life of lead in the blood is 25 days, in soft tissue about 40 days and in non-labile bone more than 25 years.

Symptoms

• Low-level exposure often has no apparent symptoms → increasing severity of symptoms with increasing dose with death occurring at 100-150 mg/dl in adults, sooner in children.
• Acute -- Kidney failure, high blood pressure, neurological problems, abdominal cramps, insomnia
• Chronic -- learning disabilities, drop in IQ, insomnia, abdominal cramps, hearing loss

How Lead Causes Illness -- Epidemiology of Lead

Adults

• Usually acute poisoning due to work-related exposure
• Types of occupations:
  o Painters, especially auto or marine paint (still leaded)
  o Contractors remodeling old homes
  o Industry utilizing lead, i.e. battery manufacturing
• Hobbies, gun use, car repair, pottery, stained glass
• Use of traditional medicines containing lead

Children - The Population Uniquely Vulnerable to Lead

Ages 1-6 most vulnerable to chronic lead poisoning

• Children absorb more of the lead they take in
• Critical neurologic development occurring is permanently hampered if lead is present
• Impact is long-term -- learning disabilities, attention span problems, hyperactivity, aggressiveness, impaired memory - a vicious cycle

Normal childhood behavior = exposure to lead

• Putting objects in mouth
• "Pica" -- eating non-food items containing lead, such as paint chips, dirt
• Outside play, contact with pets
• Crawling

Urban Poor - At High Risk for Lead Poisoning

• Rental housing in poor condition
• Frequent moving, low income = minimal medical screening, follow-up
• Often concentrated in living areas near highways, industry
• Reduced access to health care
• Undernourishment known to increase lead absorption

What Can Be Done? Measuring, Monitoring and Treatment

Measurement

• Blood test only way to diagnose lead poisoning
• Finger-stick done first, positive result confirmed with blood test from vein
• Units = Micrograms per deciliter (µg/dl)
  1-9 µg/dl Normal
  10 µg/dl CDC "level of concern"
  15-19 µg/dl home visit, inspection, educational intervention
  20-44 µg/dl environmental remediation, medical evaluation
  45-69 µg/dl chelation
  70 + µg/dl medical emergency

Monitoring

• Blood test reflects the exposures of the previous 1-3 months
• X-ray can show amount of lead stored in bones, an exposure history
• After home visit, investigation, and education child is re-tested, followed to ensure lead level drops after intervention

Treatment

• Medical therapy for lead poisoning is called "chelation" from Latin for "key"
• Succimer given orally-- chemically "binds" the lead and is excreted by the kidneys in the urine
• Adults receive EDTA intravenously, "challenges" body, i.e. draws it out of bones, re-exposes brain.
• People given chelation MUST NOT return to leaded environment. Source must be found and eliminated

Lead in the Soil

See http://www.epa.gov http://www.aeclp.org

Usually soil lead hazards are identified only when a case of lead poisoning is diagnosed, at 400 parts per million the EPA recommends remedial action be taken:
Remediation (from "remedy") also called abatement = the idea is to LIMIT CONTACT

- Soil can be removed and buried
- Child can be removed from environment
- Soil can be covered, capped with clean fill, grass, shrubs
- Hazardous paint could be removed (by a trained contractor)
- Area wetted down, dust control measures taken, waste wrapped up and disposed of properly, clean up with TSP
- Peeling paint can also be covered by special chemicals (This is called encapsulation) or new walls can be built over the peeling paint
- Lead-containing paint in good condition or out of reach of children is usually safe.

Prevention - the less lead one has contact with the better…

- Control dust in the house with regular wet mopping
- Wash hands before eating, after play
- Wash toys regularly
- Wipe down windowsills, surfaces with TSP, water
- Avoid peeling paint, play areas with bare soil
- Supervise children's play, choose a good daycare
- Eat a diet rich in calcium, iron, Vitamin C
- Eat frequently, do not skip meals
- Do not garden in soil not known to be safe
- Limit contact with adults' clothing if contaminated with lead from the workplace
- Eliminate sources of lead from the home - Old tile flooring, deteriorating mini blinds, imported ceramic ware, traditional medicine (azarcan, greta)

Our Community - What Lead is Doing to Us in Miami

See Weed and Seed video segment
See Sfakianaki article, Trepka article

Miami’s Risk Factors

- Miami has many residential areas that are old and in poor repair
- 25% of Miami’s children live in poverty
- Tile floors in poor condition believed to be a new risk factor (i.e. lead glaze)
- Large number of immigrants bring in practices from areas with more common uses of lead
  - Cottage industry
  - Medicinal uses
• Hot weather means people are outside, windows open all year long, access to dust increased

Epidemiology of Miami’s problem

• 500 cases a year identified by the Miami-Dade County Health Department, more undiagnosed
• Many cases originate outside of Miami -- immigrant families from Cuba, Haiti etc.
• Data from Jackson Hospital indicate that the prevalence of lead poisoning among Miami children in some central parts of the county is almost double the national rate (8.4% vs. 4.4%)
• Certain zip codes have been targeted as high-risk areas. See map in GIS segment.