The Transport, Retention, and Remediation of Contaminants in Air, Soil, and Groundwater

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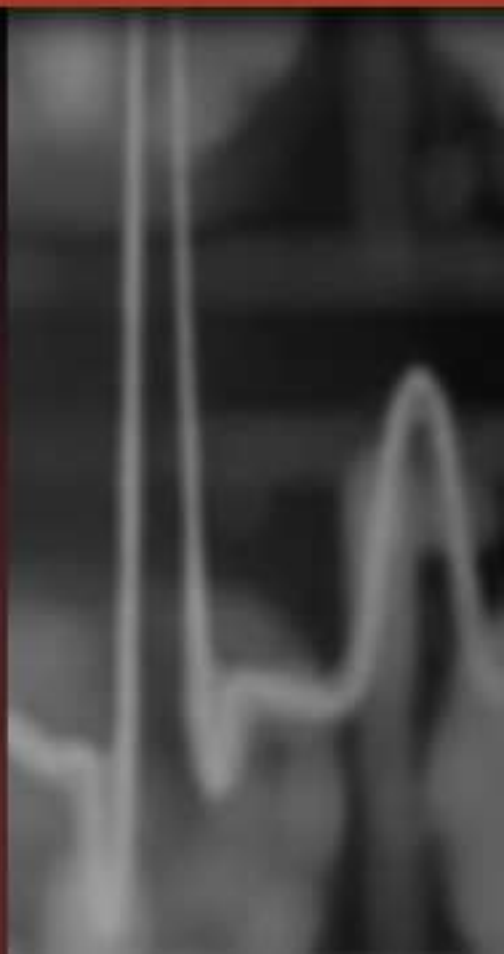

Objectives

- By the end of this lecture, you will be able to:
  - Describe the different classes of pollutants
  - Explain how pollutants move through air, water, and soil
  - Describe how soils can slow down or trap pollutants
  - List the pros and cons of many popular remedial techniques

Presentation Outline

- Classes of pollutants
- Pollution of outdoor and indoor air
- Pollution mobility in soil and groundwater
- Pollutant retention and removal

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Classes of Pollutants

- What is a pollutant? Give me some characteristics of a pollutant.

- Determining whether something is a pollutant is not a simple question!

Classes of Pollutants

- Organic
  - Infections agents
  - Petroleum contamination (BTEX, TPH)
  - Chlorinated solvents (TCE, PCE, etc)
  - PCBs (electrical transformers)
  - Pesticides/Herbicides
- Inorganic
  - Heavy metals (As, Pb, Hg, Cr, etc)
    - These can be naturally occurring!
  - Nutrient pollution (NO_3^-, PO_4^{2-})
  - Greenhouse gases (CO_2, CH_4, N_2O)

Classes of Pollutants

- There are a few uncommon classes of pollutants:
  - Radionucleides
  - Thermal pollution
  - Particulate matter / asbestos
  - Mold
  - Noise/Light pollution

How do pollutants affect you?

- Are you personally affected by pollution?

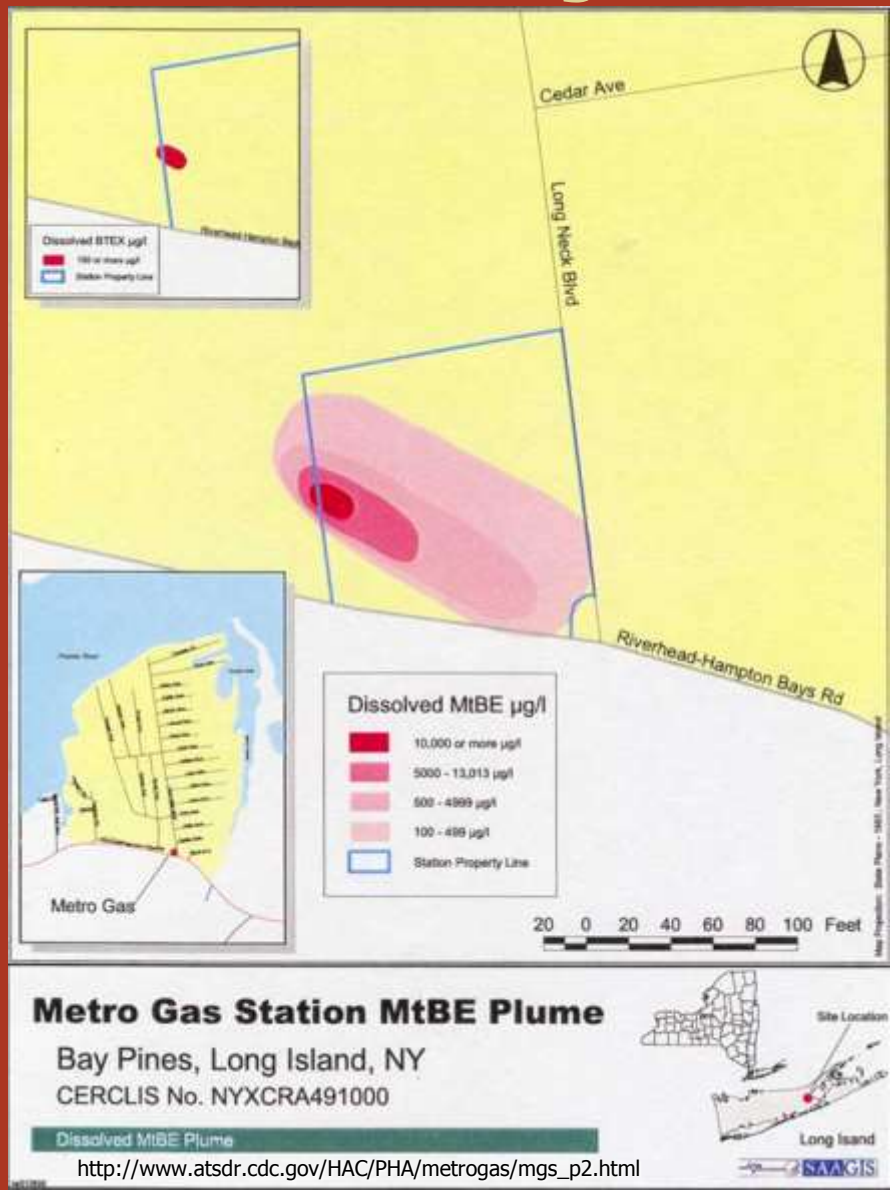
http://www.huffingtonpost.com/jeb-harrison/sea-

http://blogs.cas.suffolk.edu/jstraka/files/2015/10/Fukushima-Daiichi-Nuclear-Plant.jpg

How do pollutants affect you?

This is a map of a GW plume caused by a leak at a gas station in Long Island.

990 people within 1-mile were found to have been drinking water containing MTBE, toluene, xylenes, TCE or TCA for 1 year *without knowing it!*



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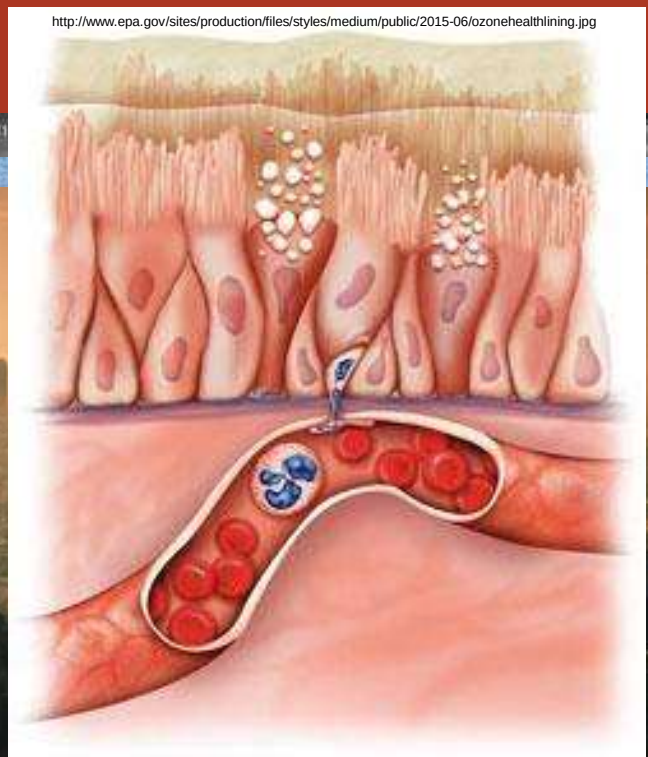
Air pollution

- How does pollution get in our air?
- Power plants and cars are the two main sources of pollutants in outdoor air
  - Heavy metals (Pb & Hg)
  - NO_x & SO_x
  - Particulate Matter
  - Greenhouse gases
  - Ground level ozone



Transport of air pollution

CT and 11 Other States Will Sue EPA Over Soot Rules

November 16, 2011 | Courant Staff Report, The Hartford Courant

The Northeast's long saga of lawsuits over clean air continued Wednesday as Connecticut and 11other states told the U.S. Environmental Protection Agency they will sue the agency for failing to revise standards for particulate matter, or soot, as required by the Clean Air Act.

The law requires the EPA to review and update standards every five years for harmful pollutants.

"Connecticut citizens cannot afford to wait any longer for EPA to do what is required to do by law and by court order," Jepsen said in a written statement late Wednesday. "Unhealthy levels of air pollution are threatening people's lives."

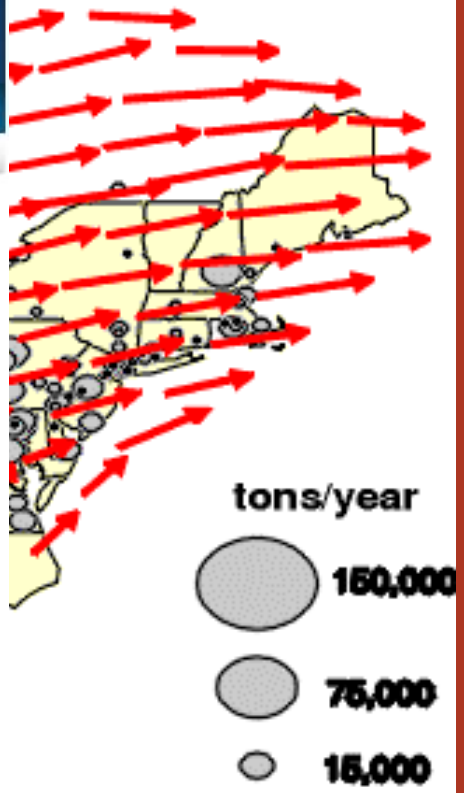
The latest case is one of several over the last 20 years in which in which state attorneys general, mostly in the Northeast, have challenged Midwest power producers and federal regulators over what the suits say are violations of the Clean Air Act. Two years ago, for example, two power companies in Ohio and Indiana agreed in a settlement with Connecticut, New York and New Jersey to spend an estimated $85 million on pollution controls to alleviate acid rain.

The action announced Wednesday includes eight Northeast states and four Western States, including California. A 2009 lawsuit charged that the current standard for fine particulates, first set in 1997 and affirmed in 2006, has not protected children, elederly people and other vulnerable populations. "Exposure to fine particulates can cause serious breathing problems and heart disease," Jepsen's statement said.

Separately, Connecticut and 10 other states asked the U.S. Court of Appeals in Washington D.C. to order the EPA to issue a new standard. That was a requirement under that court's earlier decision after the 2009 lawsuit.

It was unclear whether the actions were related to power plants, other industry, vehicles or a combination. A spokesperson for Jepson could not be reached late Wednesday.

The actions were filed by New York's attorney general. In addition to Connecticut, other states participating in the notice to sue include Delaware, Maryland, Massachusetts, New Hampshire, Rhode Island and Vermont; and



.ct.gov/dep/lib/dep/air/ozone/oztransport.pdf

Transport of air pollution

- Air pollution goes where the air goes!
- The people who breathe the pollution may not be the ones creating it!

http://www.ct.gov/dep/lib/dep/air/ozone/oztransport.pdf

Transport of air pollution

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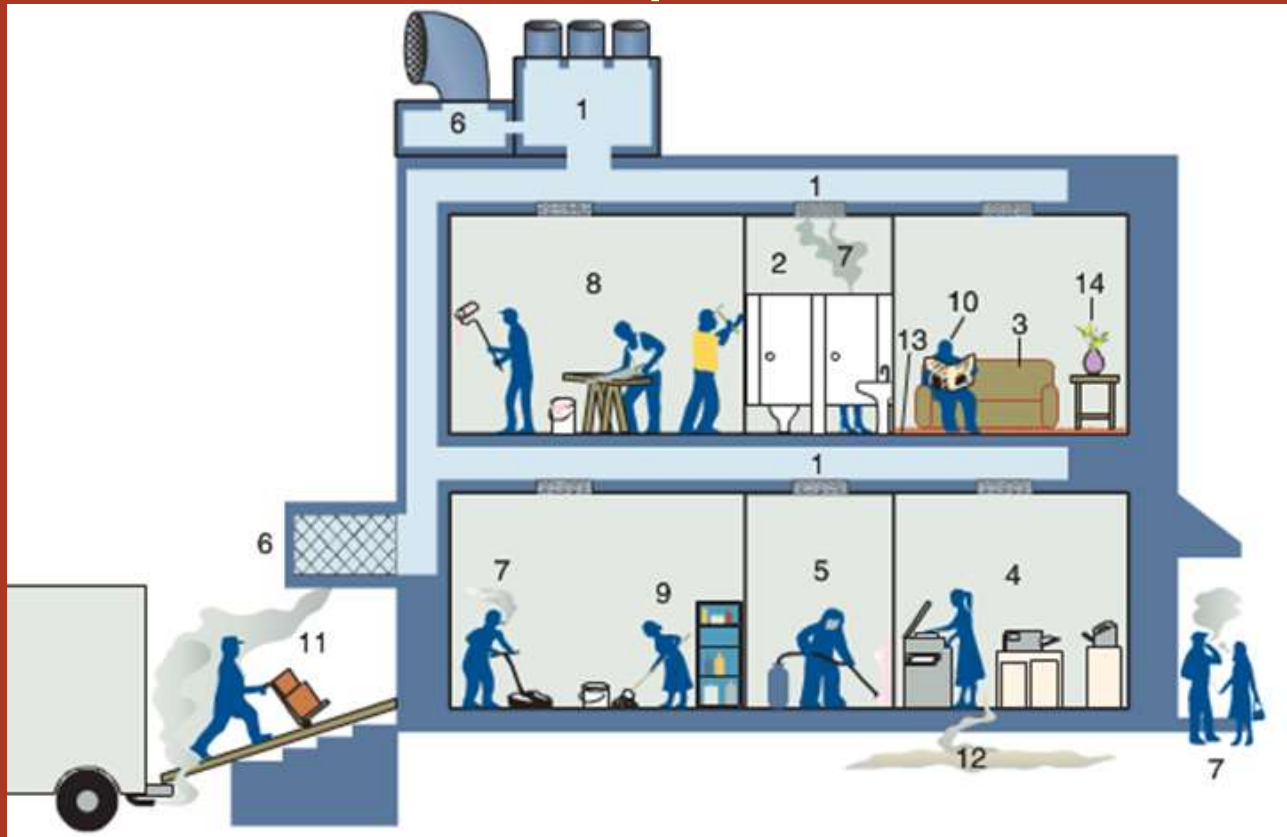
Indoor Air Pollution

- How does air pollution get inside buildings?
- Many sources of indoor air pollution
  - HVAC
  - Mold
  - VOCs
  - Pesticides
  - Smoking
  - Paint
  - Cleaning products
  - Idling cars



Indoor Air Pollution

- Has anyone … their home or basement te… adon?
  - How does r… nto your house?
- Many substa… volatilize from soil or GW i… gs (Volatile Organic Cor… or VOCs)
  - These com… easily migrate through bui… ations
  - What happ… hese enter “energy effi… ings?

https://c2.staticflickr.com/6/5125/5345477523_1071dafd9e_b.jpg

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Contaminants in Soil & GW

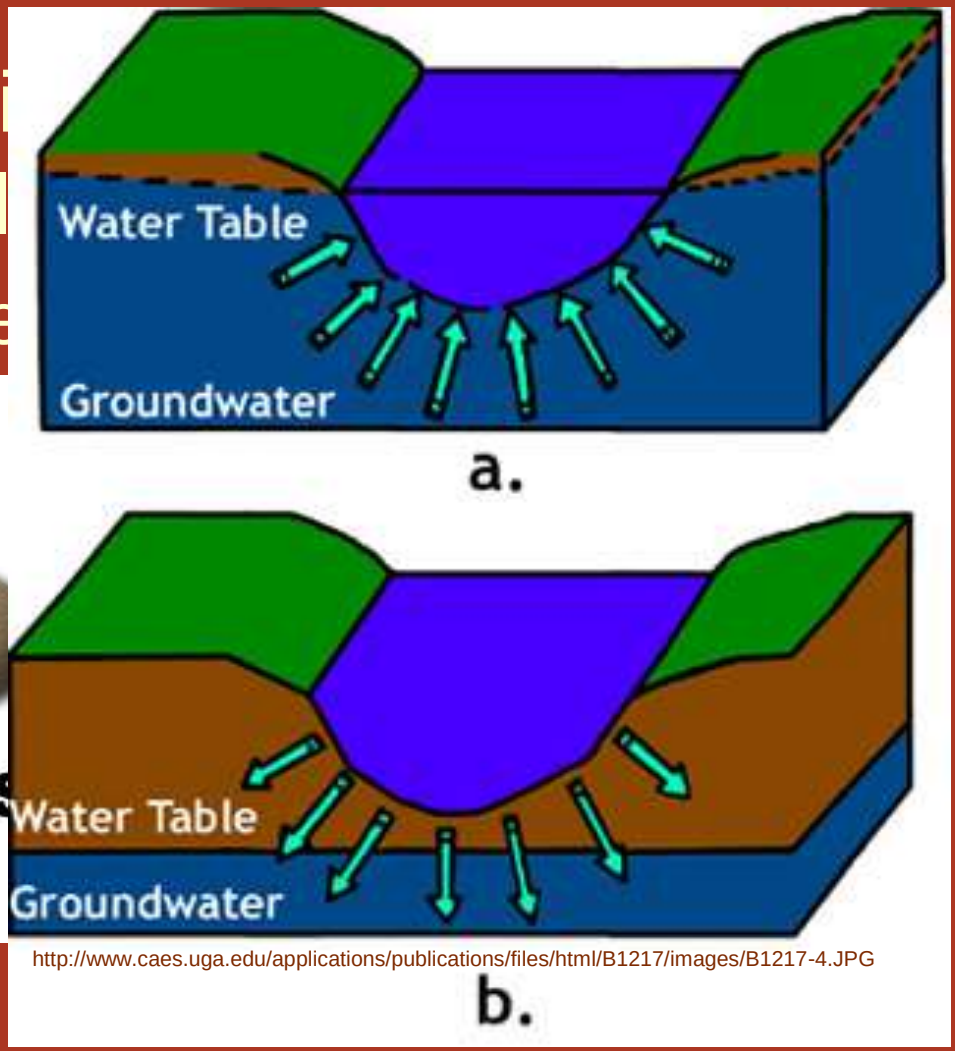
- How do contaminants get in soil & GW?

Contaminants in Soil & GW

- Contaminants di
  where the GW fl
  - Soil particle size

http://www.customturfsolutions.com/system/files/BF2.jpg

the soil?



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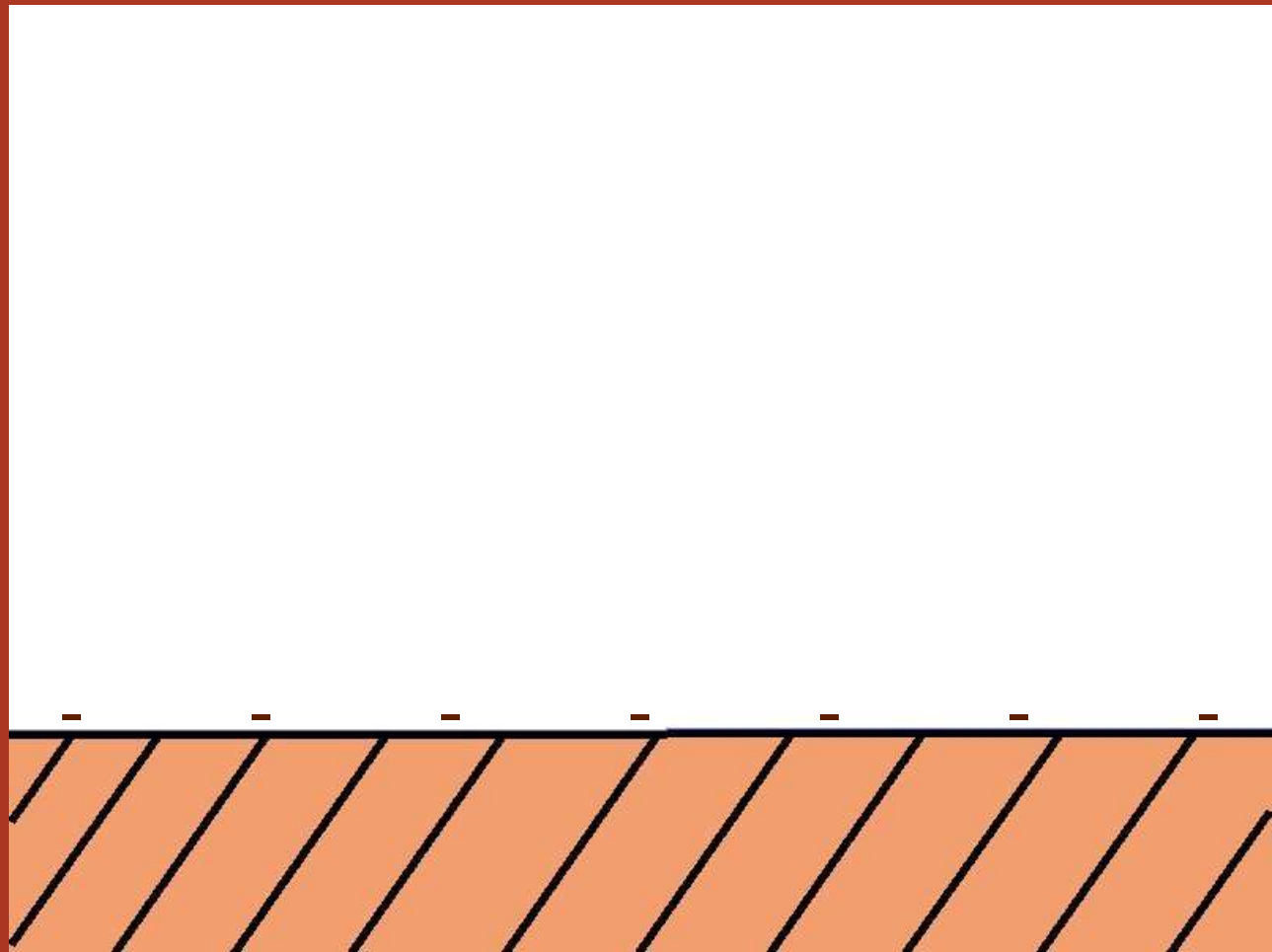
Solid/Liquid Interactions

Ion Adsorption

Groundwater

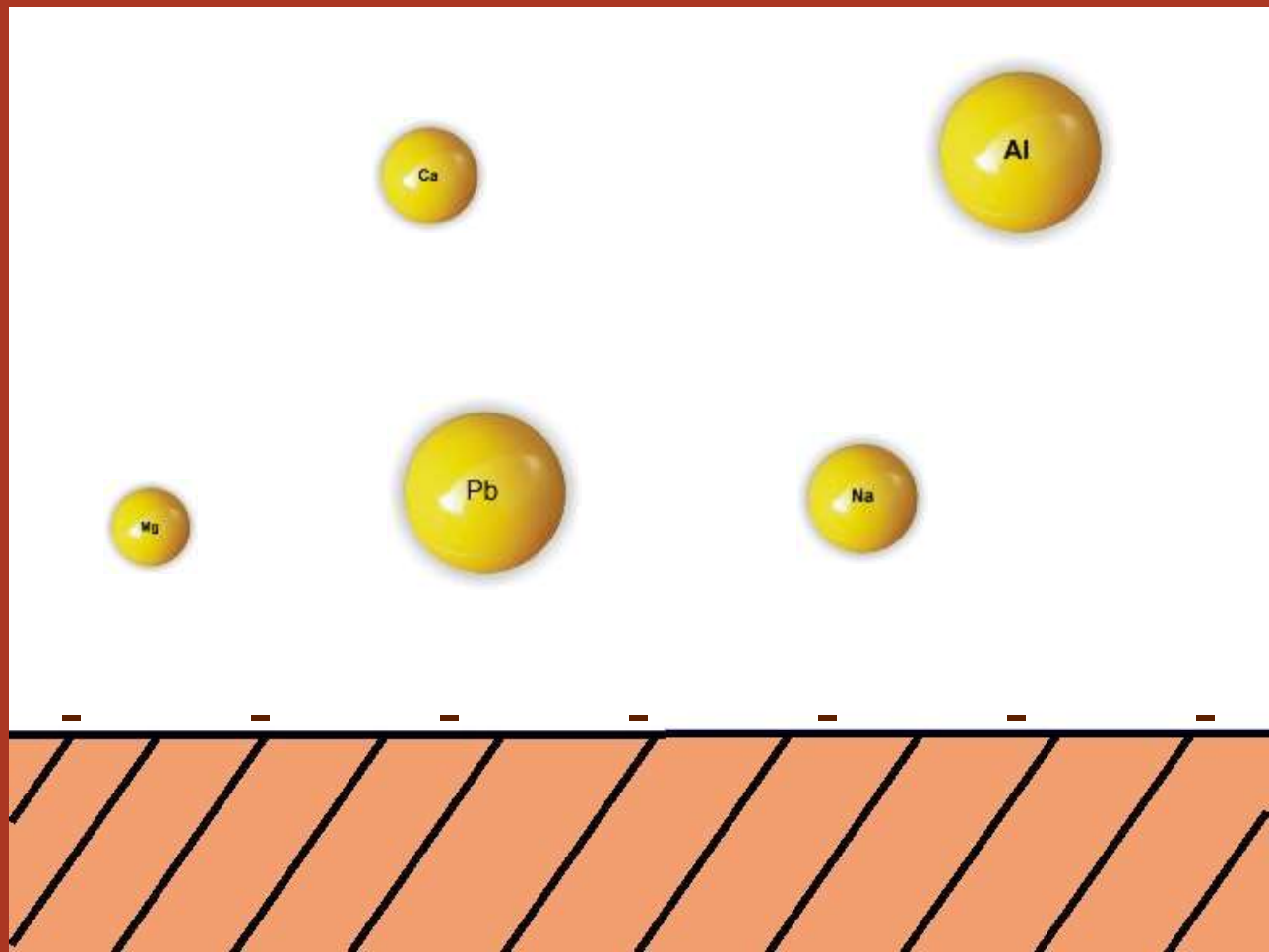


Negatively charged mineral surface

Solid/Liquid Interactions

Ion Adsorption

Groundwater



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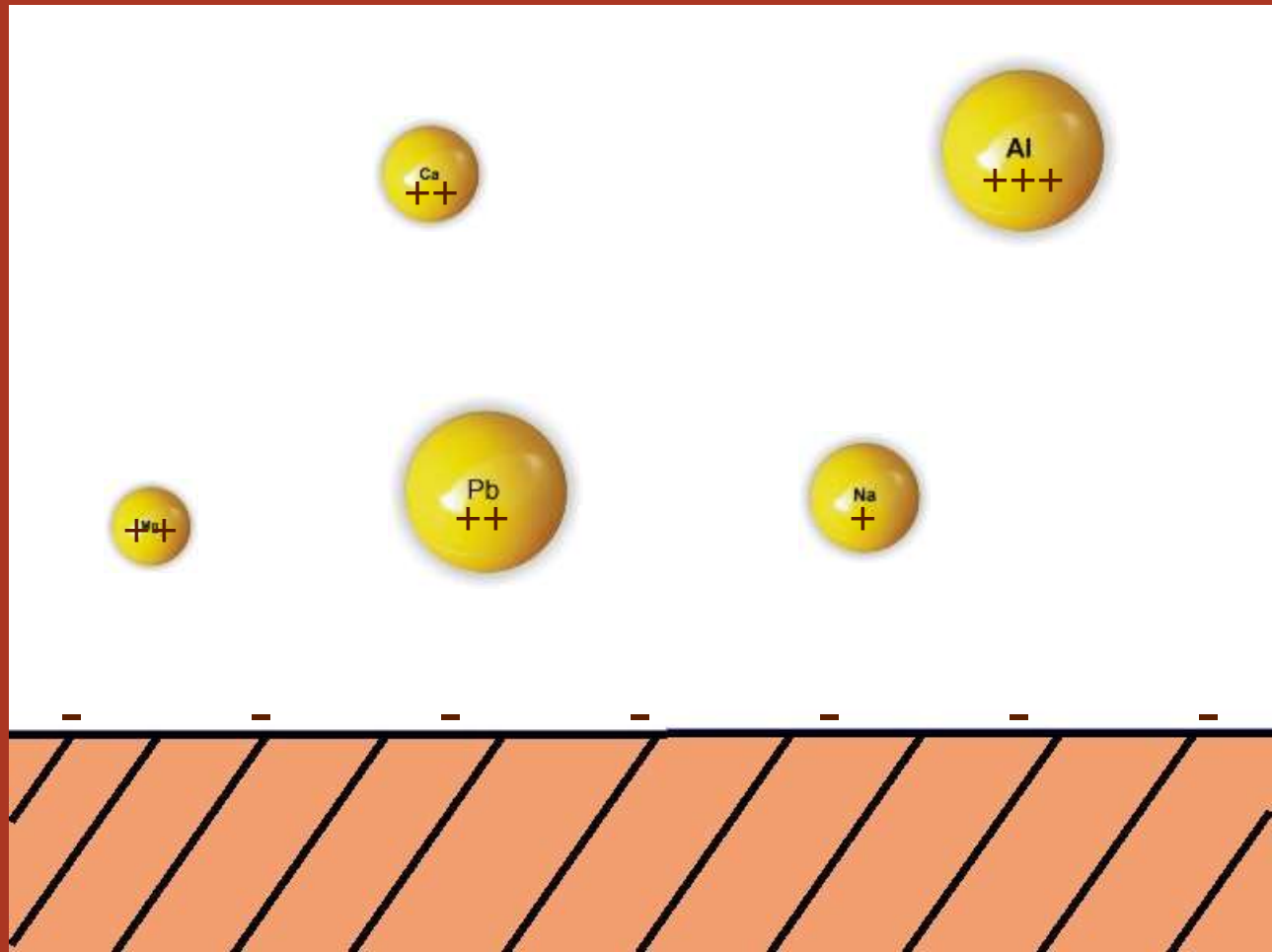

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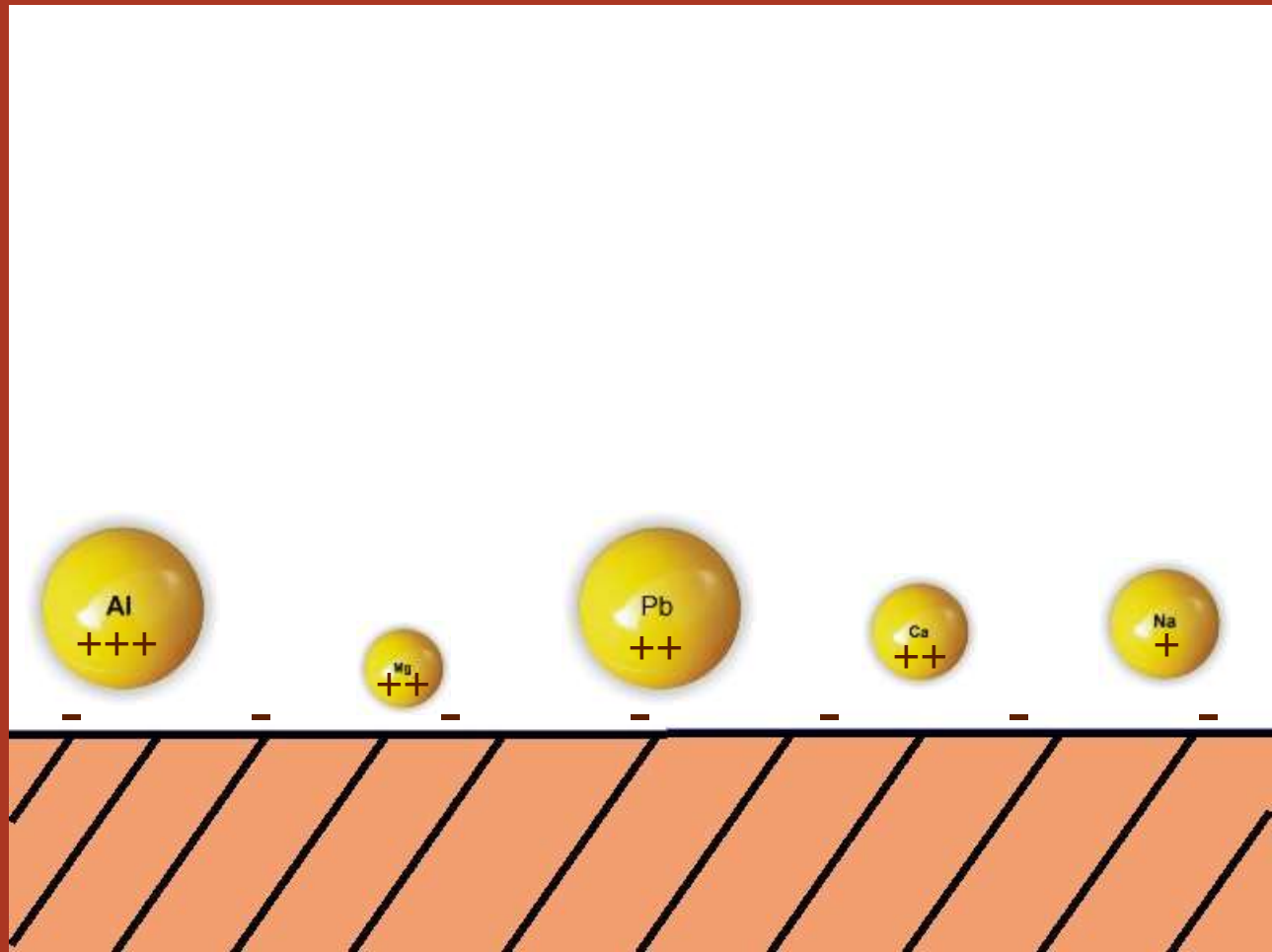
Ion Adsorption

Groundwater



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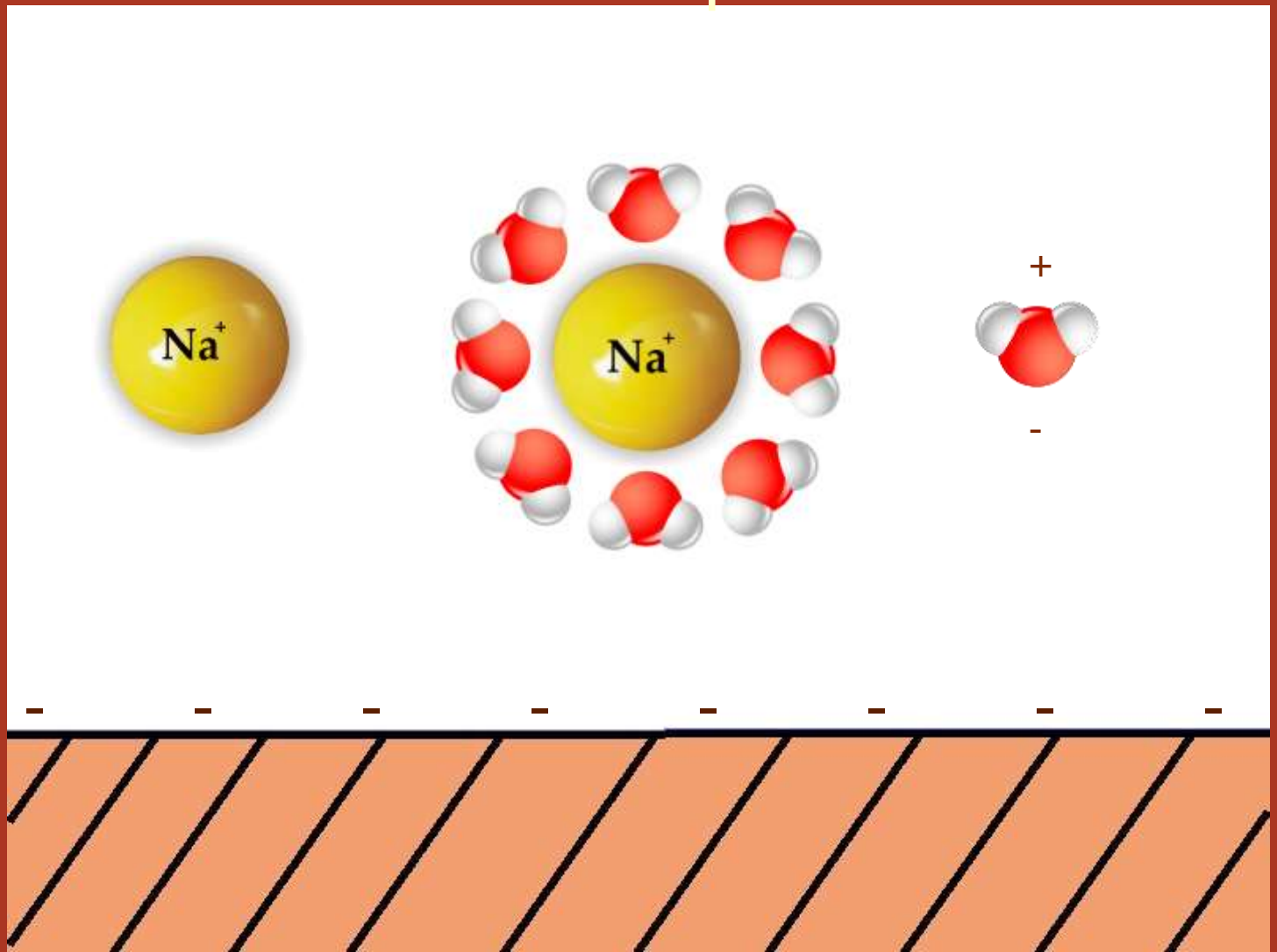
Solid/Liquid Interactions

Ion Adsorption



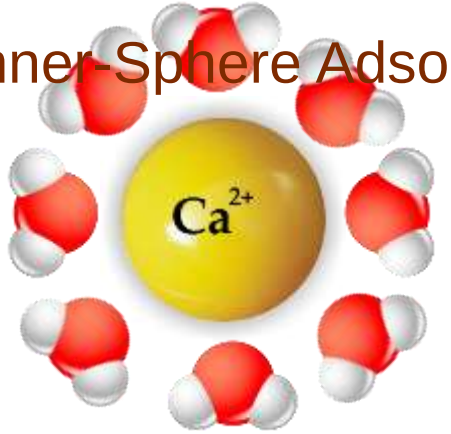
Solid/Liquid Interactions

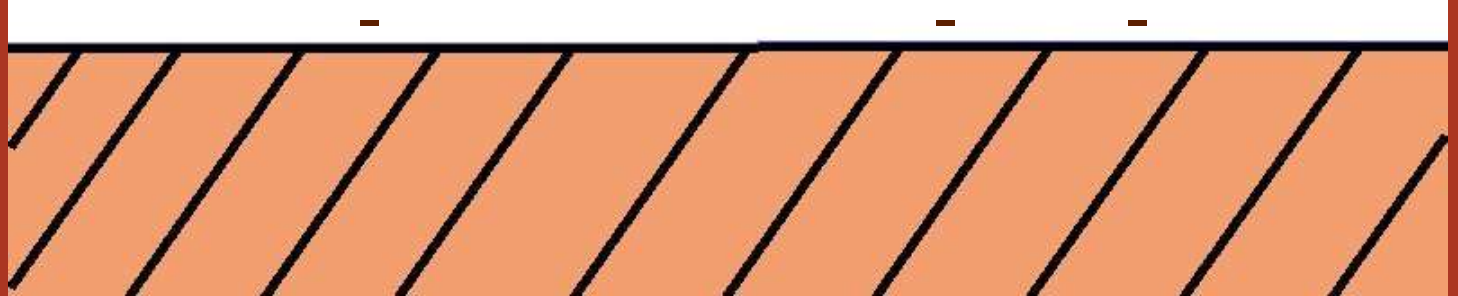
Ion Adsorption

The Na and Ca both want to adsorb, but they use different mechanisms

Outer-Sphere Adsorption

Inner-Sphere Adsorption





Solid/Liquid Interactions

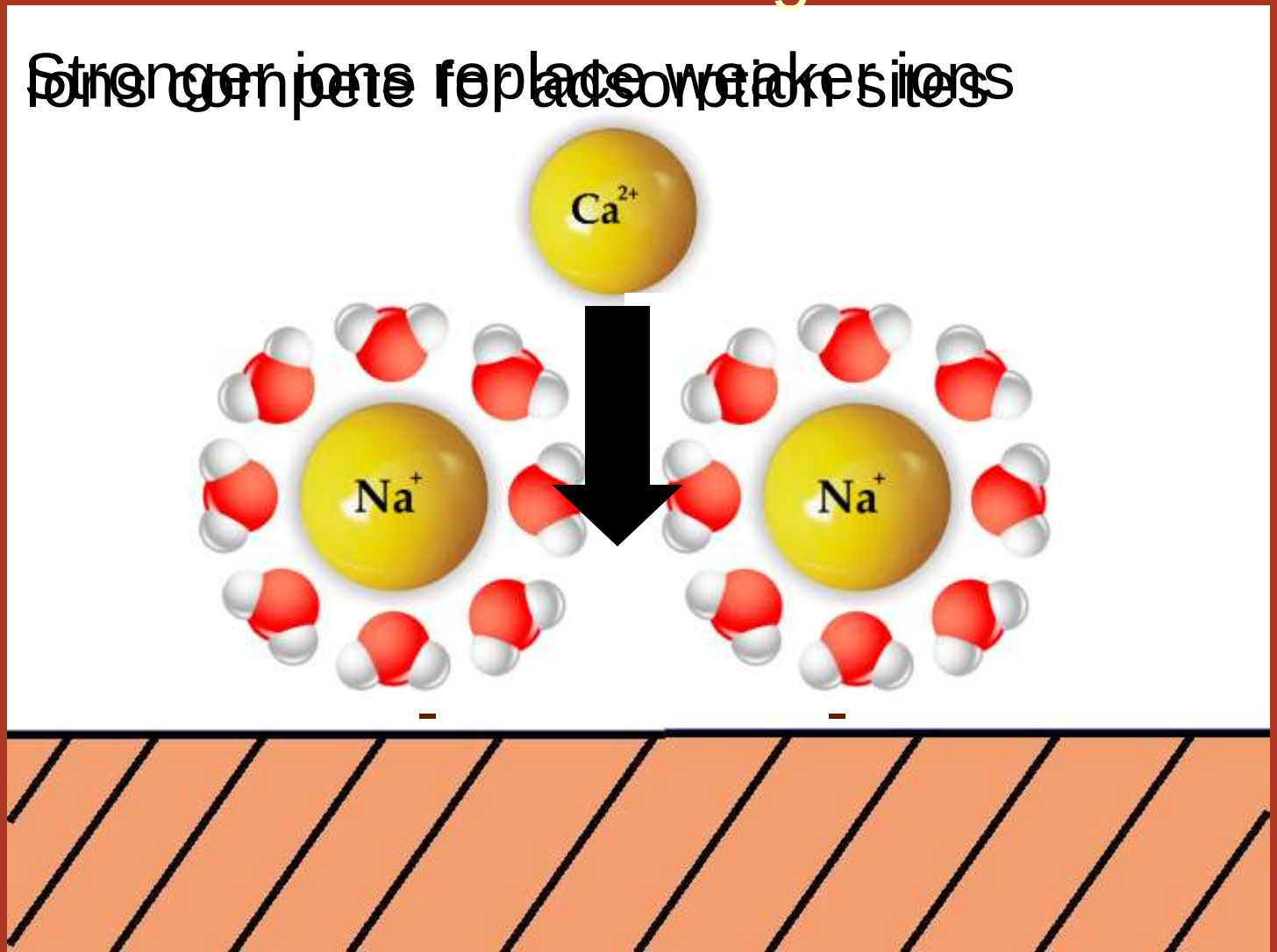
Ion Exchange

Solid/Liquid Interactions

Ion Exchange

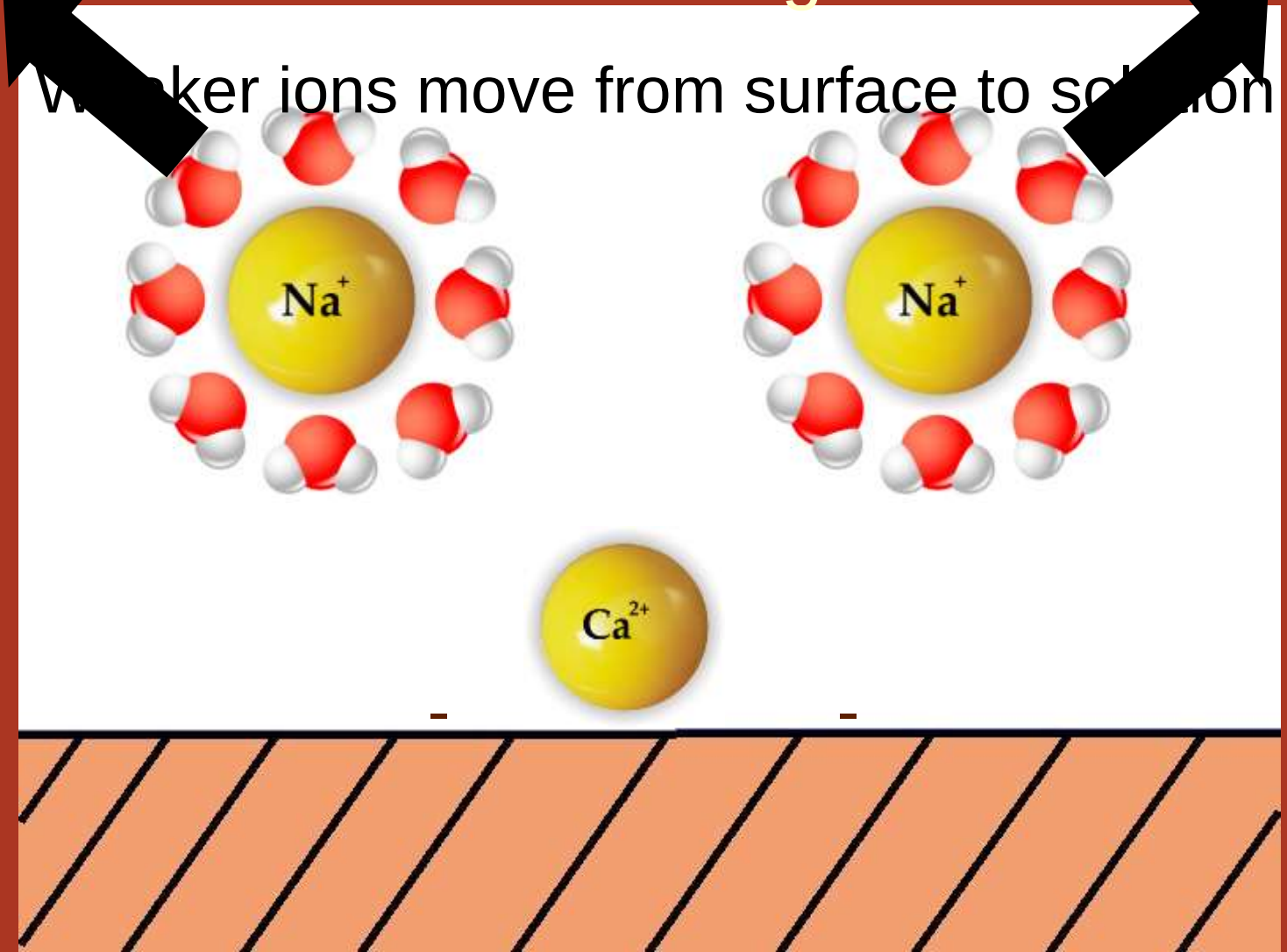
Stronger ions replace weaker ions

Ions compete for adsorption sites



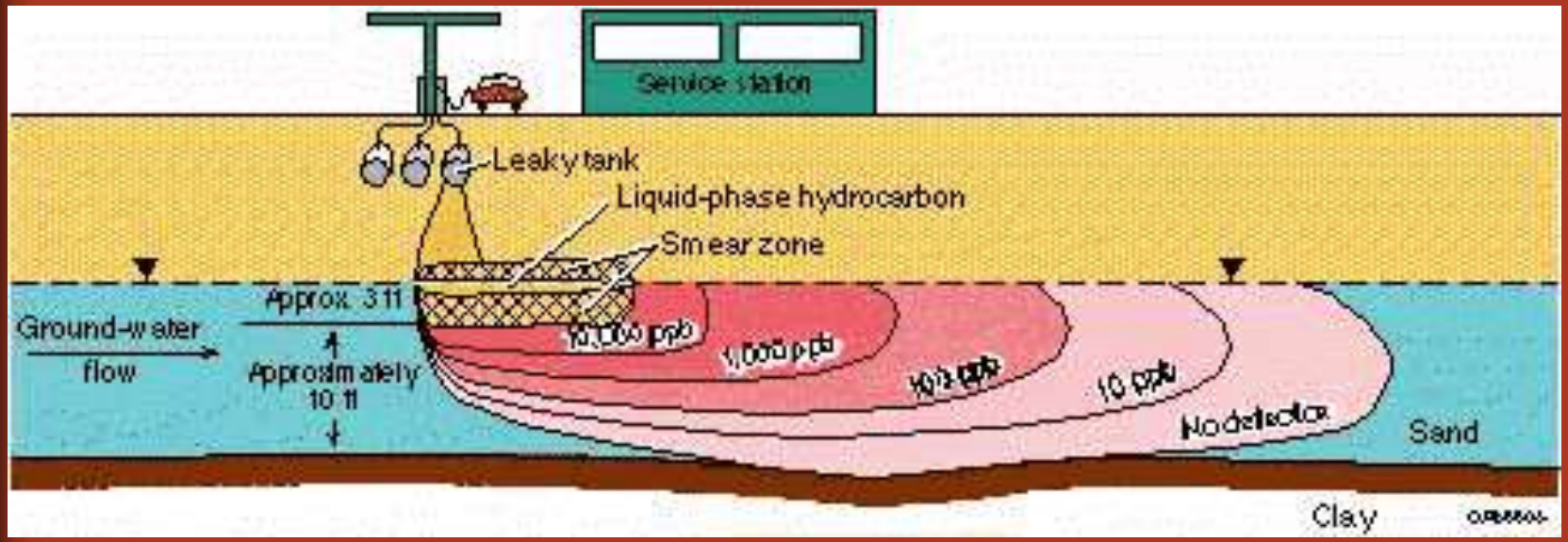
Solid/Liquid Interactions

Ion Exchange



Solid/Liquid Interactions

- As contaminants move with GW, they interact with the soil
- The more strongly a contaminant interacts with soil, the slower it will move



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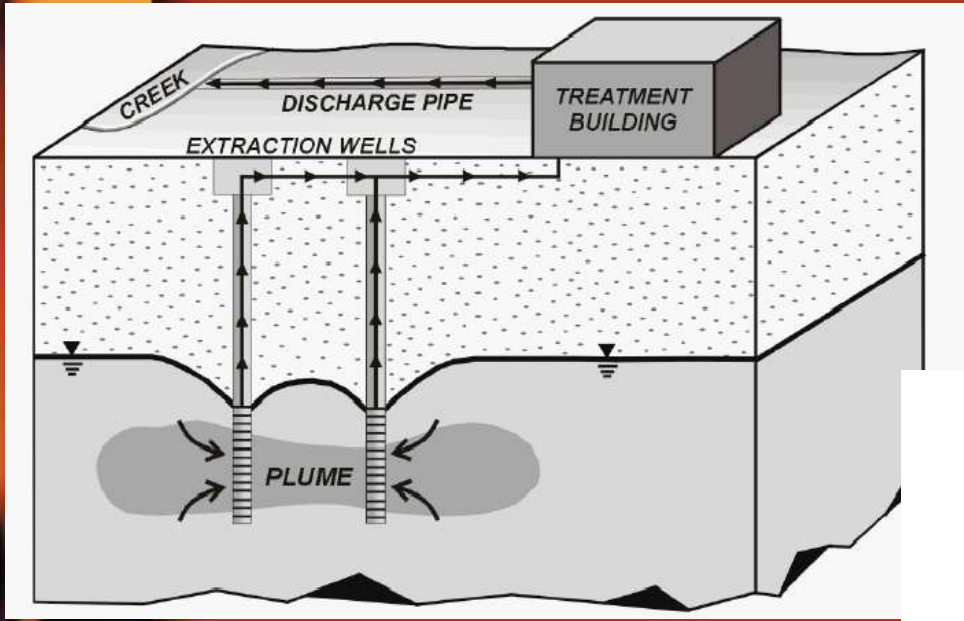
Remedial Technologies

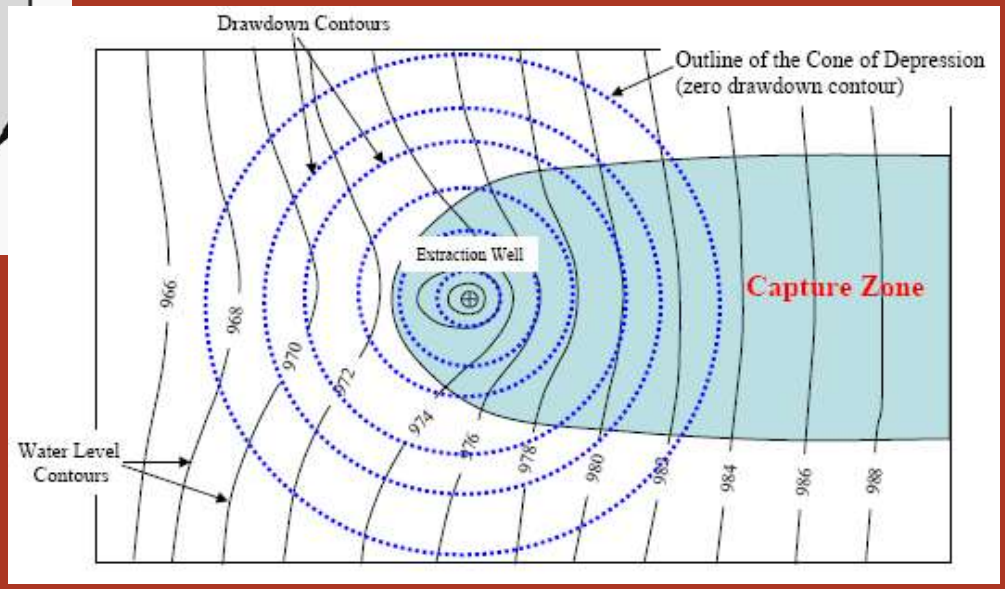
- Pump & Treat



Drill wells into the cont. GW.

Pump out GW, pass it through a system, release it.

Need to measure the "capture zone" and ensure it gets the entire plume.



Remedial Technologies

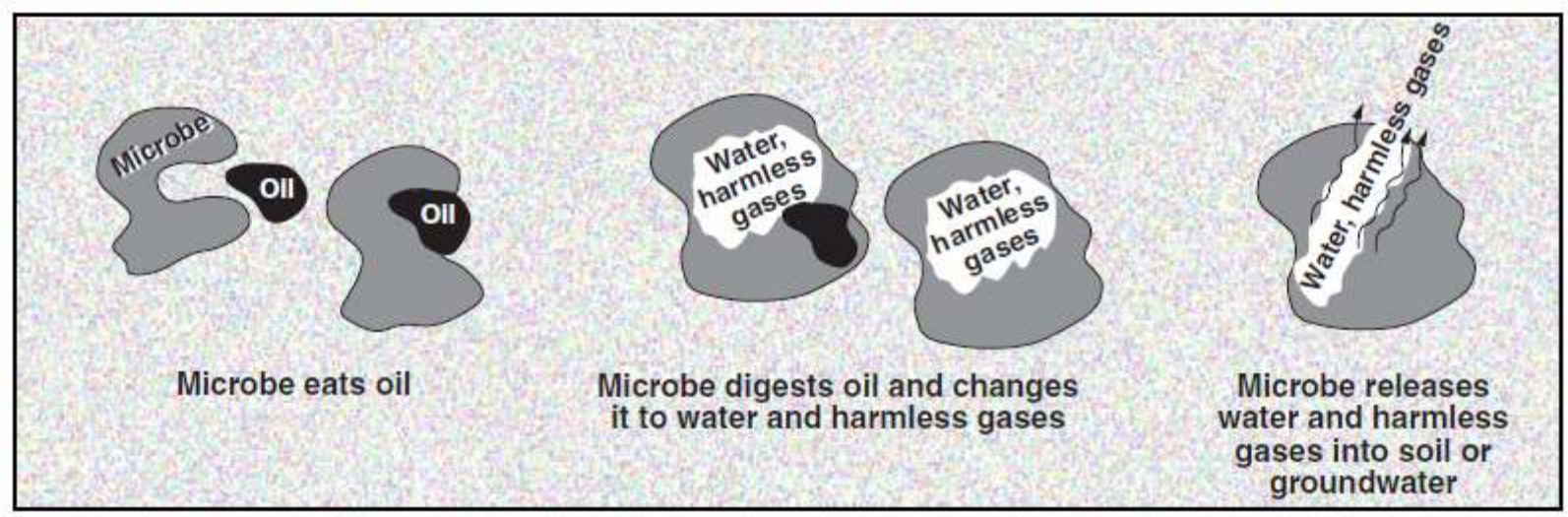
- Dig & Haul

Some cont. can't be treated and can only be disposed of. Jobs can be small…

…or large. Dewatering can be expensive if you are below the water table.
Only 100% sure rem. method.

Remedial Technologies

- Bioremediation

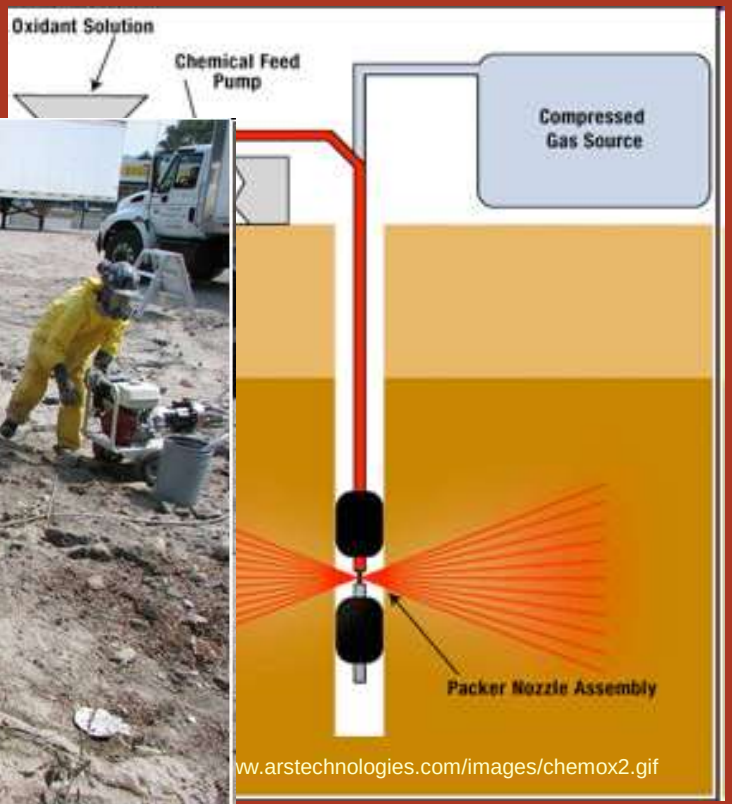


- Microbes don’t work for free! You must provide food (carbon) and an electron acceptor (usually oxygen).

Remedial Technologies

- Chem Ox

- Inject a highly reactive substance into GW and let it break down cont.
- Sounds simple…



http://www.arstechnologies.com/images/chemox2.gif

Remedial Technologies

- Many other interesting remedial technologies…
  - SVE/AS
  - Phytoremediation
  - Permeable Reactive Barriers
  - Electrokinetics
  - Solidification / Vitrification

Objectives

- By this point, you should be able to:
  - Describe the different classes of pollutants
  - Explain how pollutants move through air, water, and soil
  - Describe how soils can slow down or trap pollutants
  - List the pros and cons of many popular remedial techniques


Questions?