

The Biogeochemical Cycles

What does *that mean*???

- *Chemicals* that *cycle* through the *geological* and *biological* world

Biological

- Bio = Life
- Examples: Plants, Animals, Fungus, Bacteria
- Cycles through the food chain



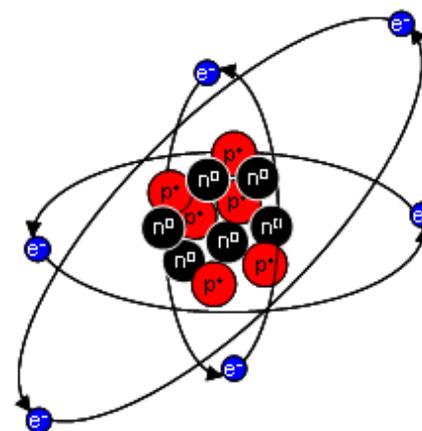
Geological



- Geo = Earth
- Examples: Rocks, Oceans, ect.

Chemicals

- Water
- Nitrogen
- Phosphorous
- Carbon
- Sulfur



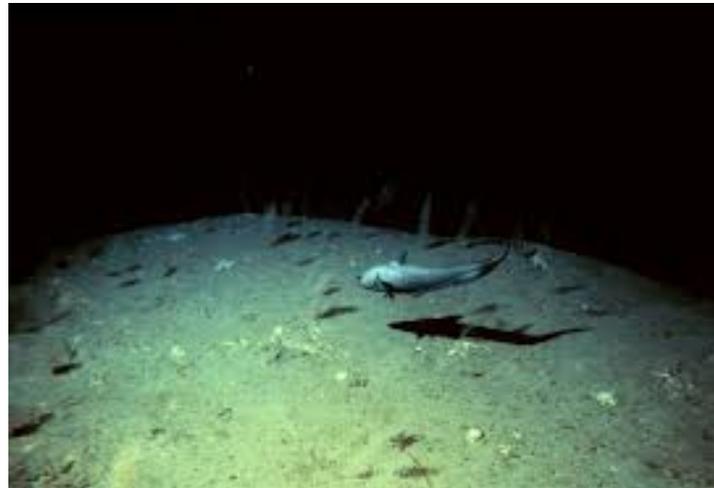
Cycling

- Move through the environment
- Not used up!
- Change form

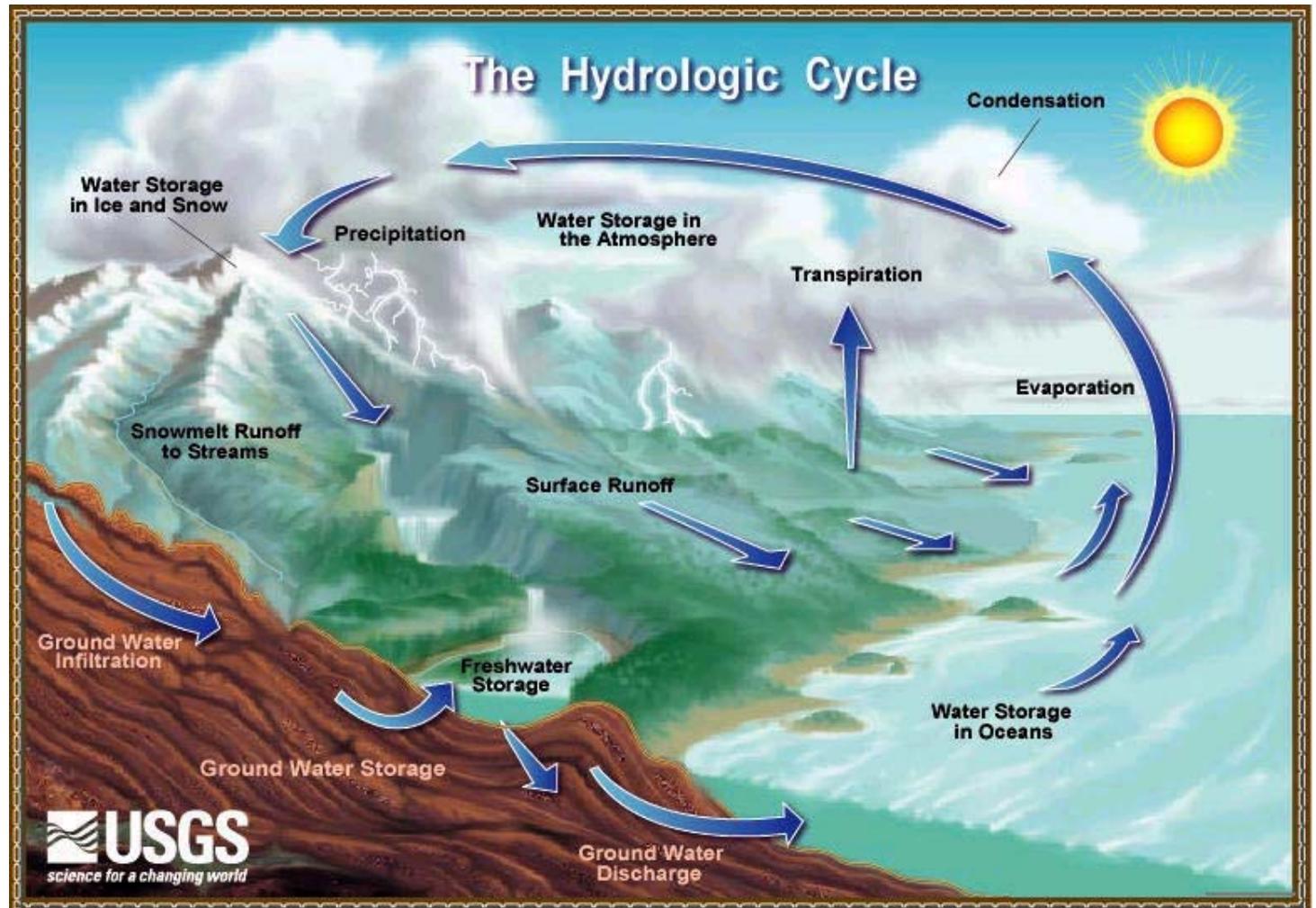


Important Terms...

- Reservoirs or sinks: Part of the cycle where the chemical is held in large quantities for long periods of time
- Exchange Points: Chemical held for a short period of time



Water (or the hydrologic cycle)

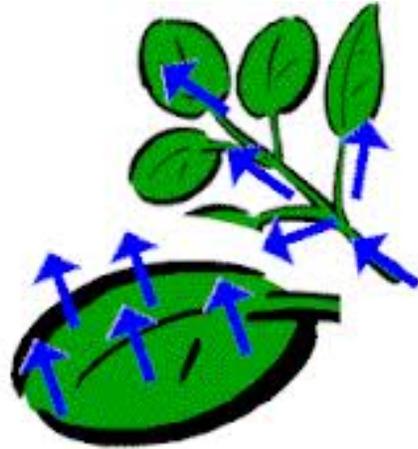


Water, Water, Water



- Evaporation
- Transpiration
- Precipitation
- Condensation

Transpiration



- Transpiration is the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere

The Nitrogen Cycle



Why do we need Nitrogen?

- All life requires Nitrogen
- Nucleic Acids (DNA)
- Amino Acids → Proteins
- Protein Functions???

Nitrogen Forms

- N_2 = Nitrogen Gas
- NH_3 = Ammonia***
- NH_4^+ = Ammonium
- NO_2^- = Nitrite
- NO_3^- = Nitrate***
- Biological N compounds***

Nitrogen Fixation

- $\text{N}_2 \rightarrow \text{NH}_3$
- Nitrogen is fixed into a form that organisms can use
- Fixation:
 1. Biological (“special” bacteria)
 2. Other: Combustion, Volcanic Action, Lightning, & Industrial Processes

Nitrogen Fixing Bacteria



- Cyanobacteria (fixers in ocean)
- *Rhizobium* – bacteria that live in nodules on roots of legumes (fixers on land)
- Enzyme- nitrogenase
- No oxygen

Nitrification

- $\text{NH}_3 \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^-$
- Two step process carried out by soil bacteria
- Furnishes these bacteria with energy

Ammonification

- Biological N compounds \rightarrow NH_3
- Carried out by ammonifying bacteria
- Decompose N compounds & release ammonia into the environment

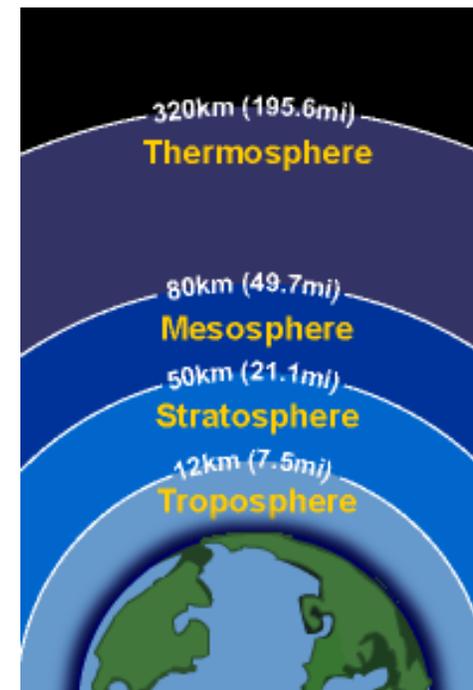
Assimilation



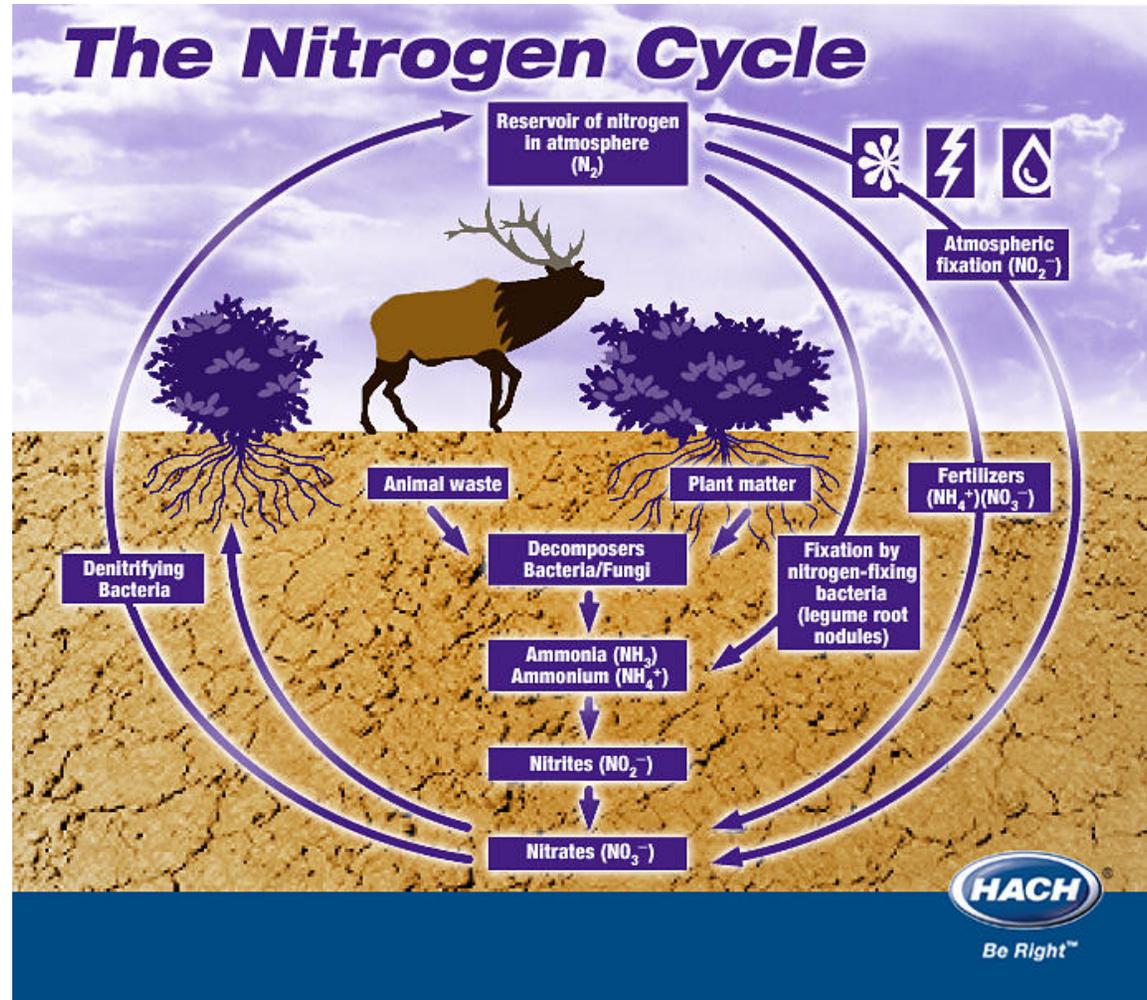
- Incorporation of NH_3 & NO_3^- into plant proteins and nucleic acids (use the N)
- What happens when animals eat the plants?

Denitrofication

- $\text{NO}_3^- \rightarrow \text{N}_2$
- Denitrofying bacteria return N to atmosphere



The Big Picture



Humans and the N Cycle

- N-based fertilizer
- Run-off → Eutrophication
→ Algal Bloom



The Carbon Cycle

Where is Carbon?

- Atmosphere
- Dissolved in the ocean
- Rocks (limestone)
 - Organisms

Why Carbon

- Basis of organic compounds
(carbs, lipids, proteins,
nucleic acids)

Photosynthesis

- Autotrophs “fix” carbon from atmosphere into chemical compounds (sugar)
- Moves through food chain



Cellular Respiration



- Carbon from organisms put back in atmosphere

Combustion



- Burning of fossil fuels
(*sequestered C* as opposed to *surface C*)
- Release C into atmosphere
- Problems????

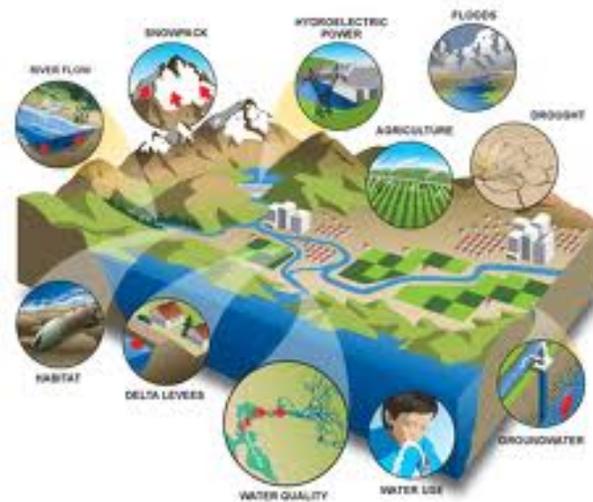
Carbon Sinks

- Wood of trees
- Shells of marine organisms (limestone)
- Fossil Fuels (remains of ancient organisms)

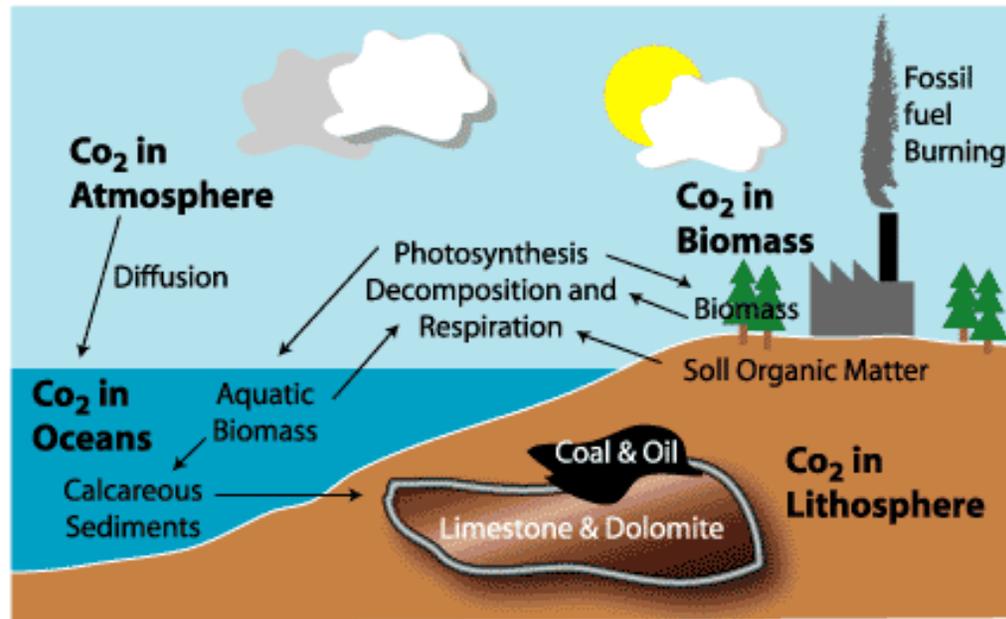


Global Warming

CARBON ENTERS ATMOSPHERE AT A RATE GREATER
THAN THE NATURAL CARBON CYCLE CAN HANDLE



The Carbon Cycle



The Sulfur Cycle

- Scientists still do not have a clear understanding of this cycle.
- Why do we need sulfur???
- Important part of proteins!!!

Forms of Sulfur

- SO_4^{2-} : Sulfate
- H_2S : Hydrogen Sulfate
- So_x : Sulfur Oxides
- DMS : Dimethyl Sulfate

Sulfur Sinks...

1. Underground sedimentary rocks & minerals
 - Slowly erode & release S compounds into the ocean
2. The ocean



Sulfur & the Atmosphere

- Sulfur is a minor part of the atmosphere
- S compounds are reactive and therefore short-lived
- Released into atmosphere by:
 1. Sea Spray
 2. Marine Algae
 3. Forest Fires
 4. Volcanoes
 5. Dust Storms

Sulfur & Organisms

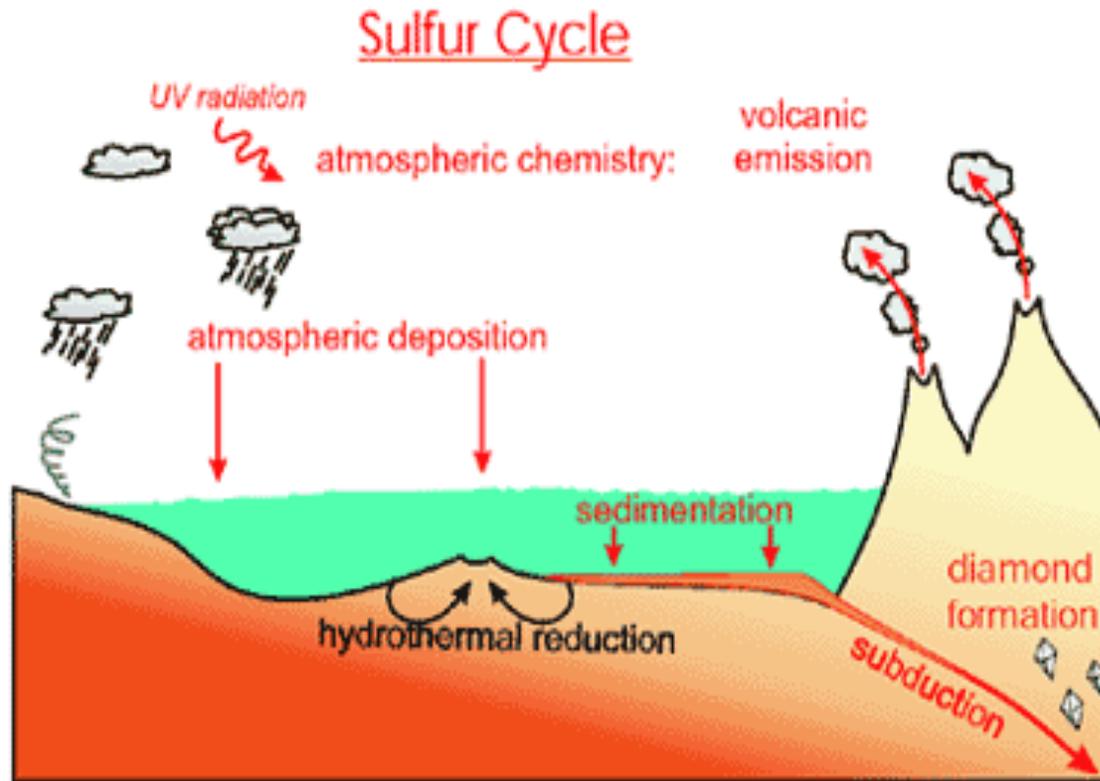
- Organisms contain a tiny fraction of S
- Plants absorb sulfate and assimilate into proteins
- In the ocean, marine algae release DMS into atmosphere (helps form clouds)
- Bacteria drive S cycle (especially in environments with little oxygen)

Humans & the Sulfur Cycle

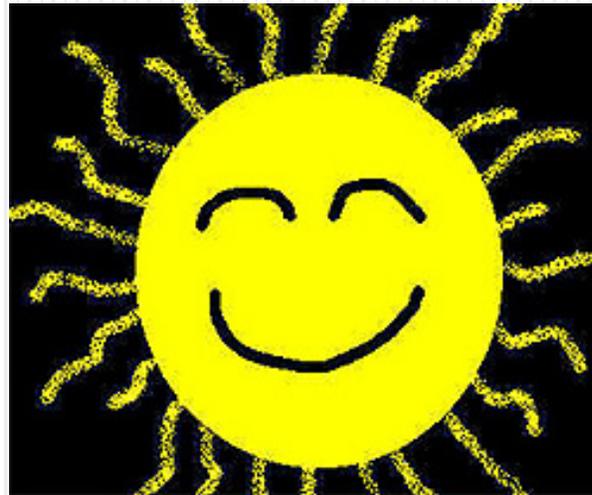
- Burning coal releases sulfur
- Leads to acid deposition & associated problems



The Big Picture...



Just one more....



The Phosphorous Cycle

Where is P???

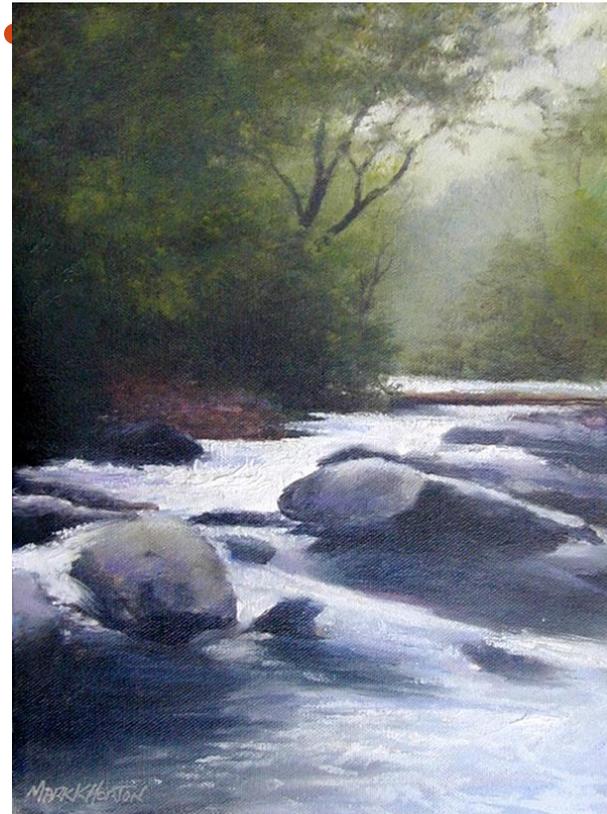
- No gaseous state (which means???)
 - Land
 - Ocean
 - Organisms

Why P

- Biological molecules
 - DNA
 - RNA
 - ATP

On Land...

- Water runs over rocks (erosion) and carries away inorganic phosphate (PO_4^{3-})
- Deposits in soil
- Picked up by plants
- Enters food chain!



...And in Water

- Dissolved in water
- Absorbed by plants and algae
- Enters food chain!

How does it get between land and water???

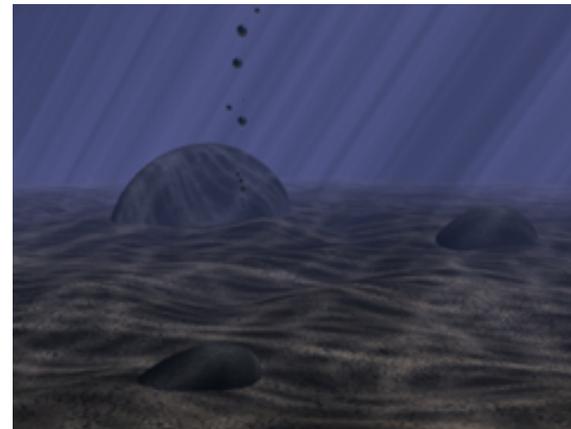


one way is...
Sea Bird Poop → Guano



Phosphorous Sinks

- The sea floor

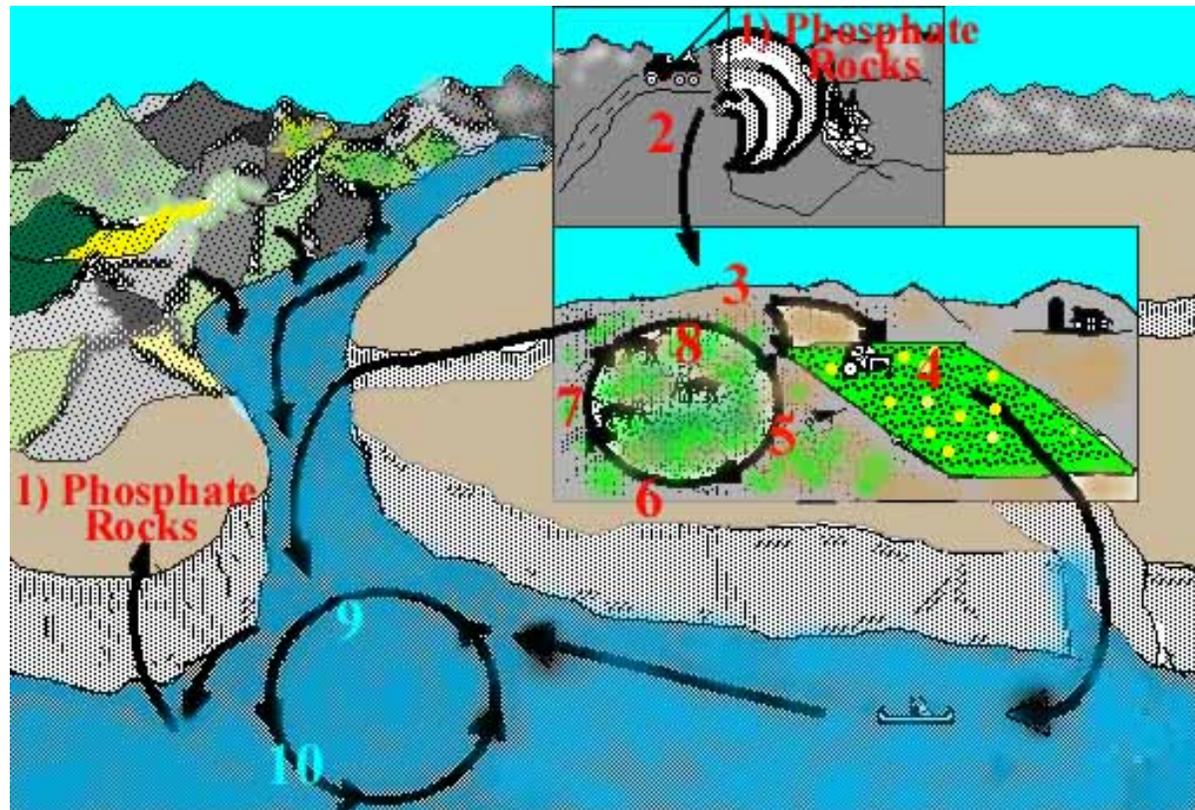


Humans & the P Cycle

- Accelerate long-term loss from land (agriculture, waste disposal)
- Fertilizers



The Phosphorous Cycle



THE END!!!!!!