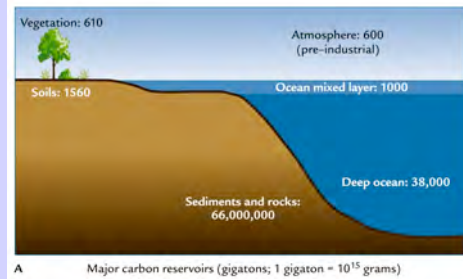


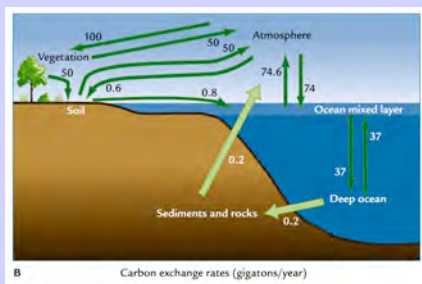
Carbon Cycling

Earth's Thermostat

Major Carbon Reservoirs

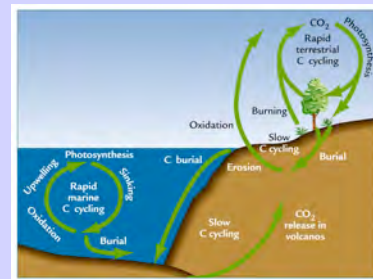


Major Carbon Fluxes

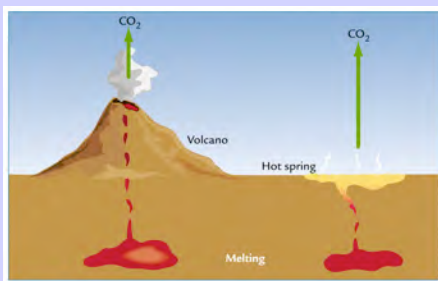


Tiny bit gets sequestered 'permanently' each year

Carbon Sub-Cycles

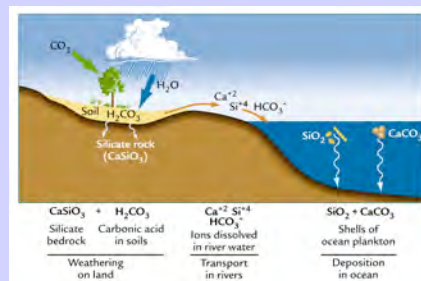


Volcanoes!!



Volcanoes are our friends. They give us everything we need.

Silicate Weathering



Carbonate Weathering

- $H_2O + CO_2 \rightleftharpoons H_2CO_3$
- Water dissolves carbon dioxide, makes carbonic acid
- $CaCO_3 + H_2CO_3 \rightleftharpoons Ca^{2+} + 2 HCO_3^-$
- Limestone dissolves in acid, makes Ca ion and bicarbonate (dissolved)
- $Ca^{2+} + 2 HCO_3^- \rightleftharpoons CaCO_3 + H_2O + CO_2$
- Calcium and bicarbonate taken in by shells, and carbon dioxide bubbles out into water and then air

Silicate vs. Carbonate Weathering

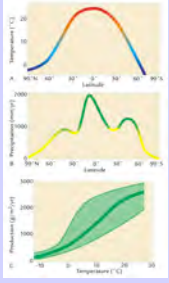
- $CaSiO_3 + H_2O + CO_2 \rightleftharpoons CaCO_3 + SiO_2 + H_2O$
- Silicate turned into carbonate, **takes CO₂ out of system**
- $CaCO_3 + H_2O + CO_2 \rightleftharpoons CaCO_3 + H_2O + CO_2$
- Carbonate changed into carbonate – **no net change!!!**
- Only silicate weathering changes amount of CO₂ in system.

Controls on Chemical Weathering

Weathering of silicates faster at high temperature, so faster near equator

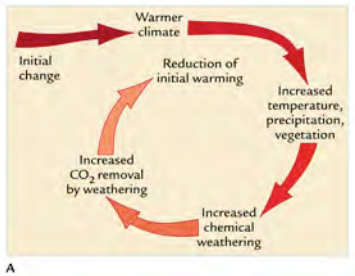
Weathering of silicates faster when wet, so fastest at equator and mid-latitudes

Hot and humid best for weathering of silicates



The figure contains three graphs labeled A, B, and C. Graph A shows weathering rate vs. latitude, with a peak at the equator. Graph B shows weathering rate vs. precipitation, with a peak at the equator and another smaller peak at mid-latitudes. Graph C shows weathering rate vs. temperature, with a peak at high temperatures.

Negative Feedback



The diagram shows a clockwise cycle: Initial change leads to Warmer climate, which causes Reduction of initial warming, leading to Increased temperature, precipitation, vegetation, which causes Increased chemical weathering, leading to Increased CO₂ removal by weathering, which finally leads back to Initial change.

More Negative Feedback

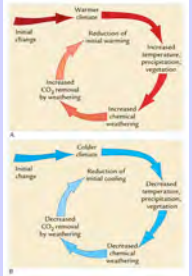


The diagram shows a clockwise cycle: Initial change leads to Colder climate, which causes Reduction of initial cooling, leading to Decreased temperature, precipitation, vegetation, which causes Decreased chemical weathering, leading to Decreased CO₂ removal by weathering, which finally leads back to Initial change.

Global Thermostat

Silicate weathering acts to slow changes in temperature using CO₂ as the mechanism.

Change happens, but it is moderated, so temperatures stay within a limited range.



Two small diagrams labeled A and B. Diagram A shows a feedback loop for warming, and Diagram B shows a feedback loop for cooling, both similar to the larger diagrams in the previous blocks.

