

# Relative age – The principle of uniformitarianism

(The present is the key to the past)



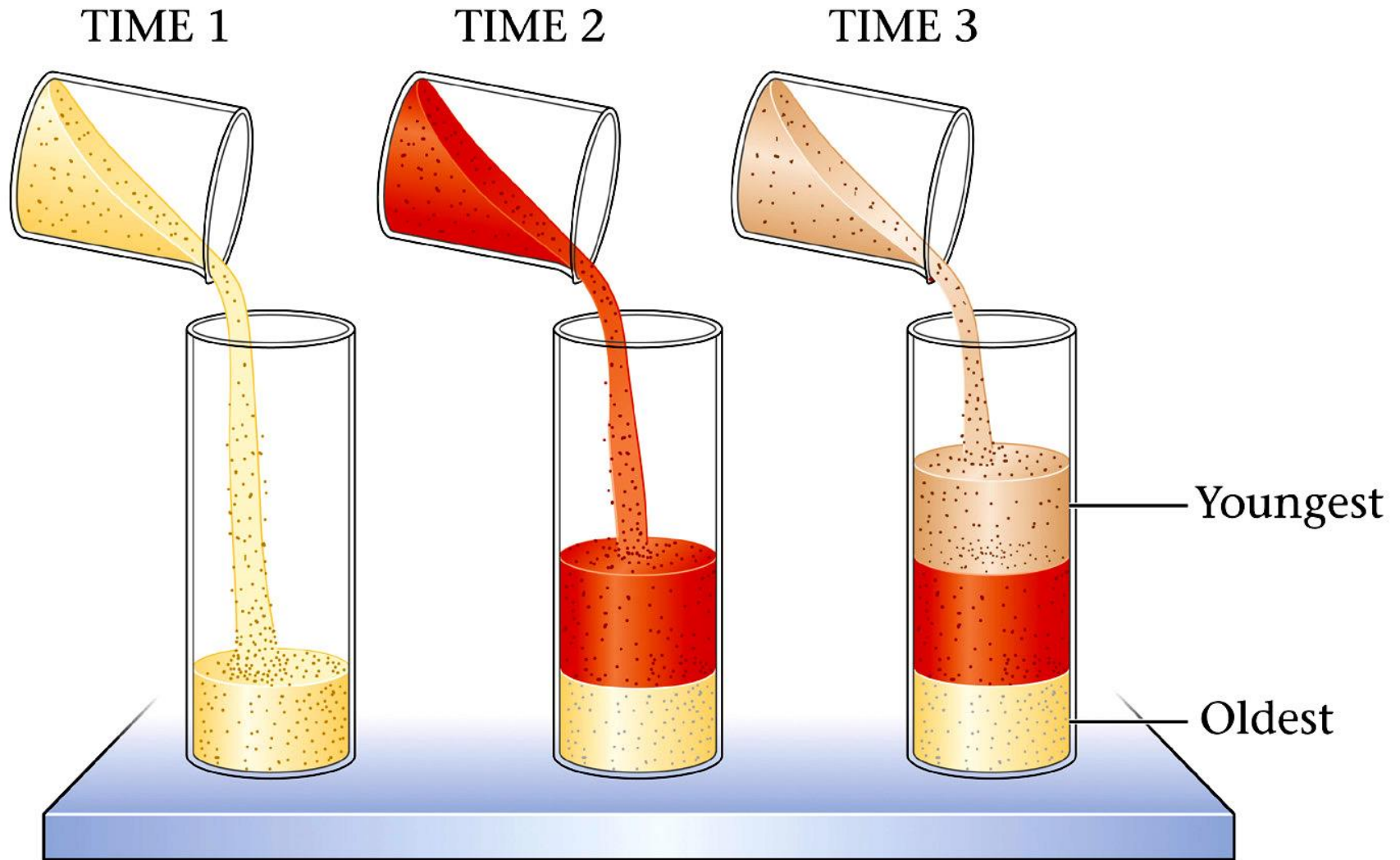
Recent mudcracks



Paleozoic mudcracks

(245 to 570 million years)

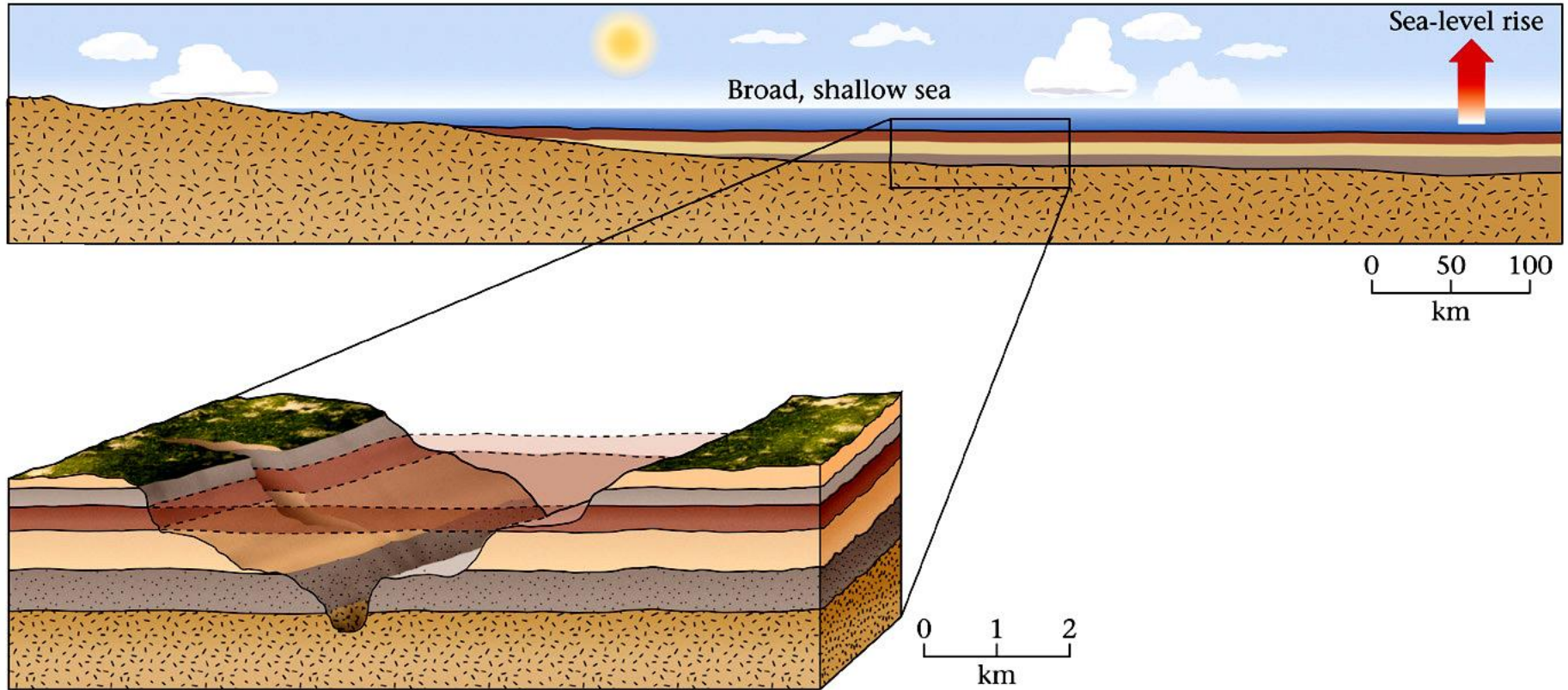
# Relative age – The principle of superposition



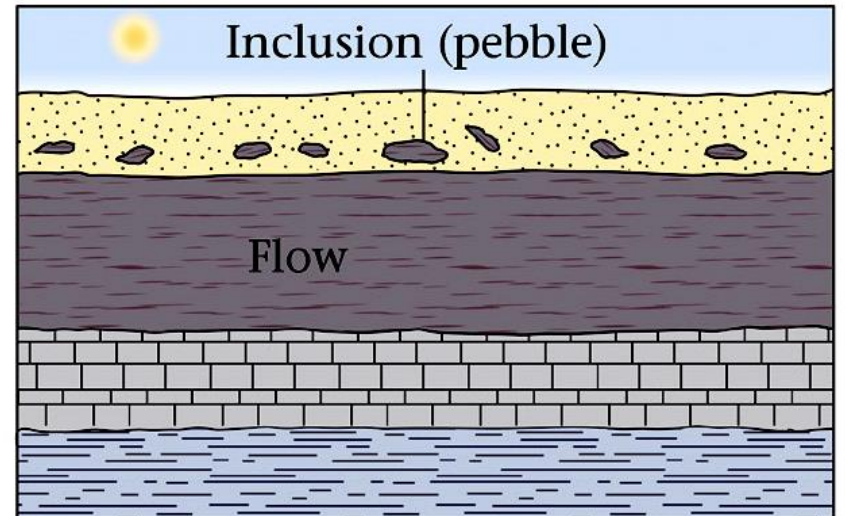
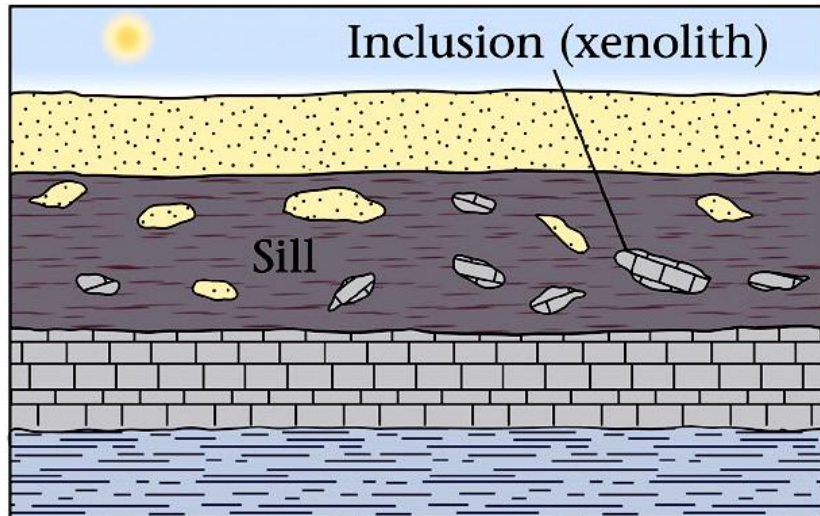
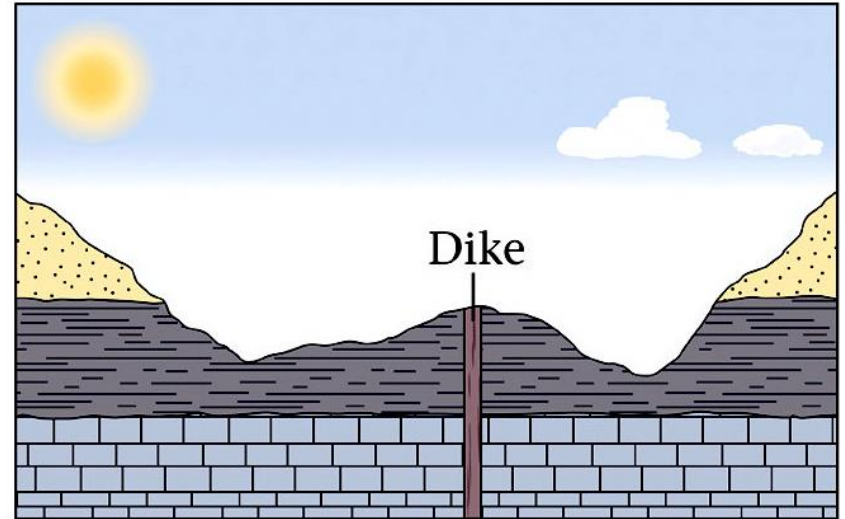
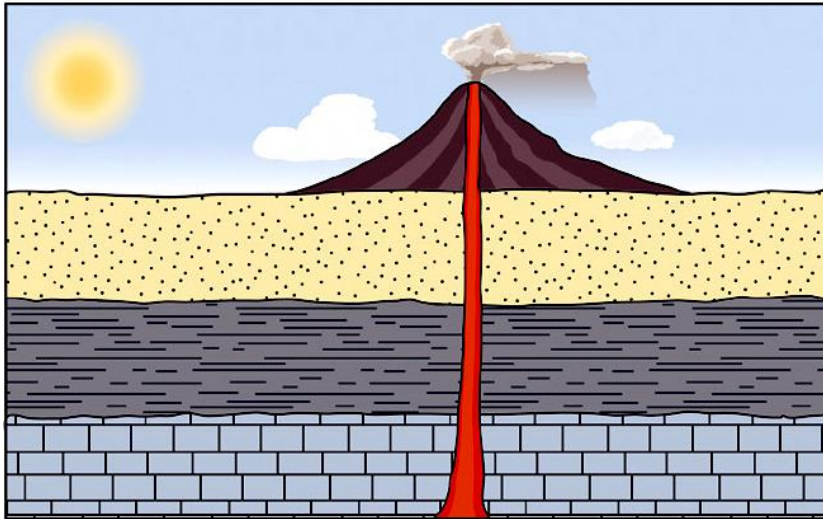
# Relative age – The principle of original horizontality



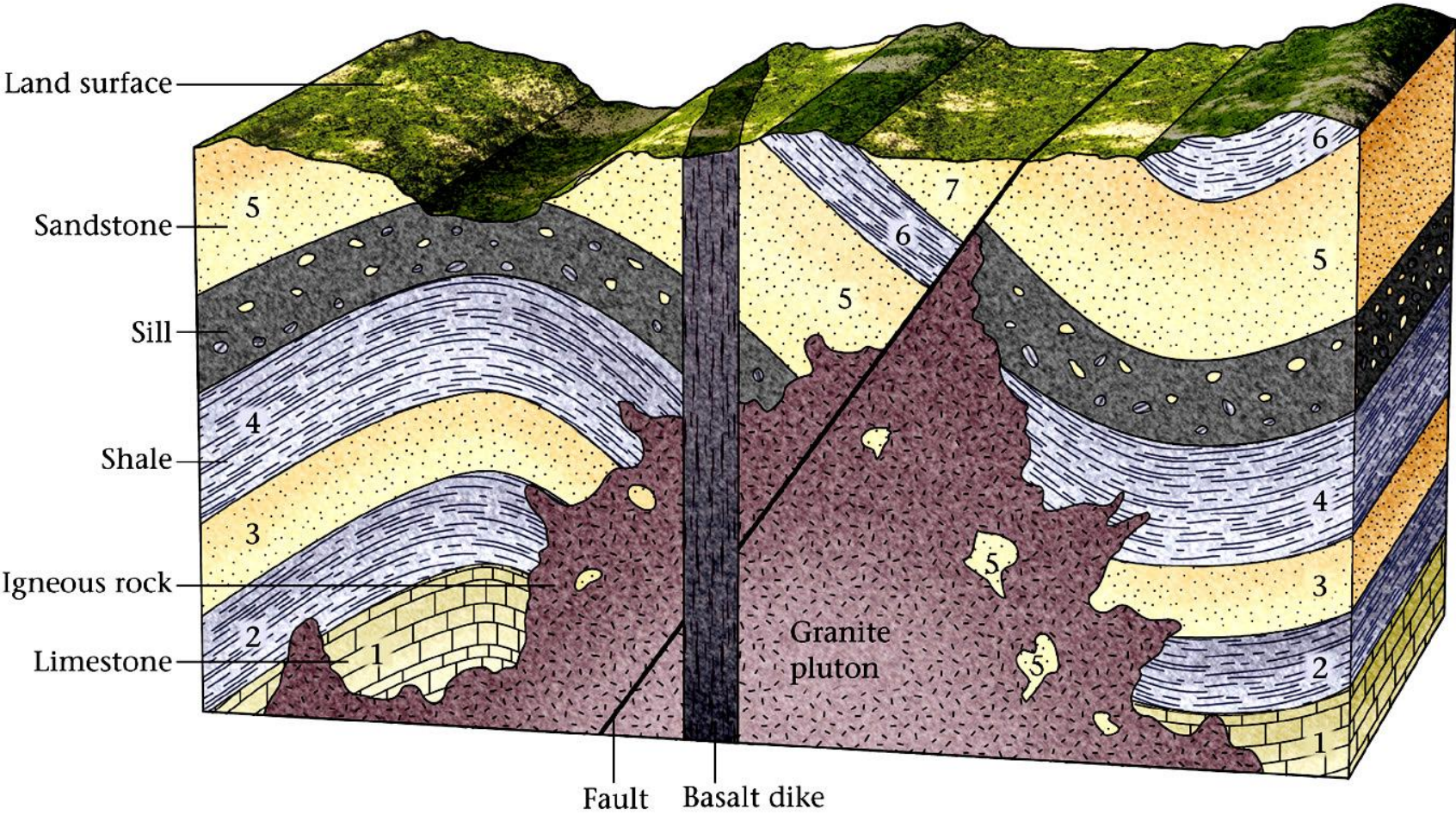
# Relative Age – The Principle of Original Continuity



# Relative age – Crosscutting relationships



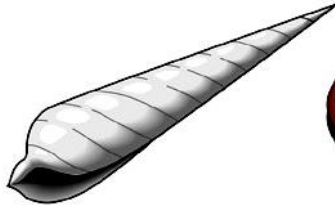
# Relative age – Cross-cutting relationships



# Relative age and the fossil record



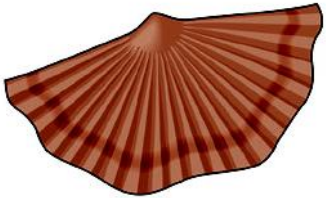
Trilobite



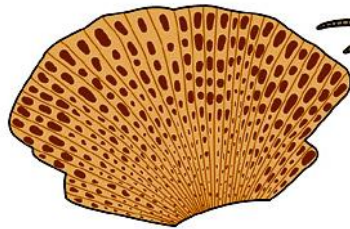
Gastropod



Bivalve



Brachiopod



Bryozoan



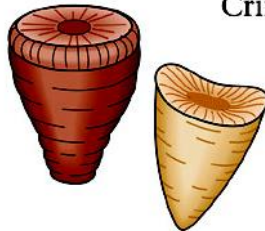
Crinoid



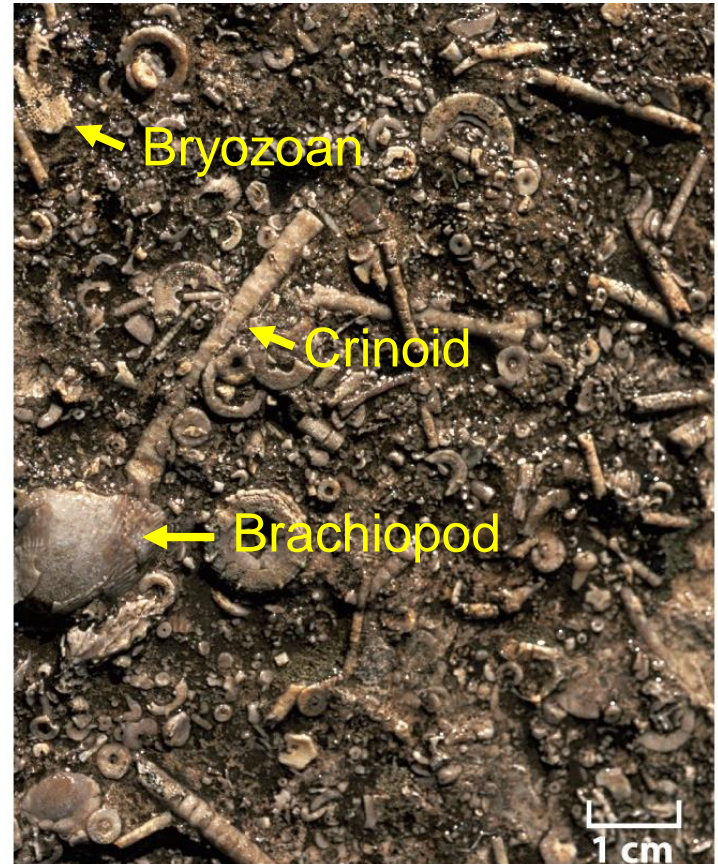
Graptolite



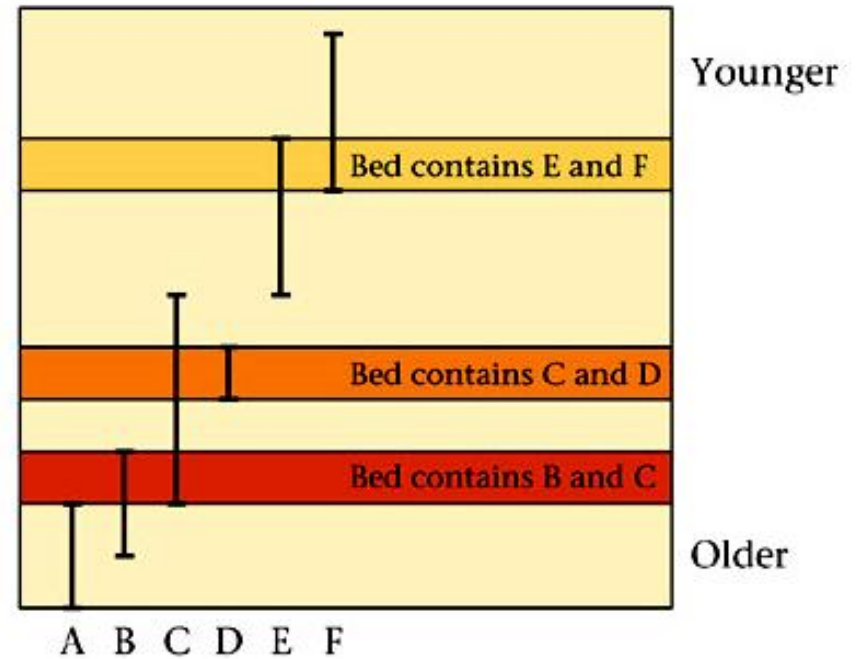
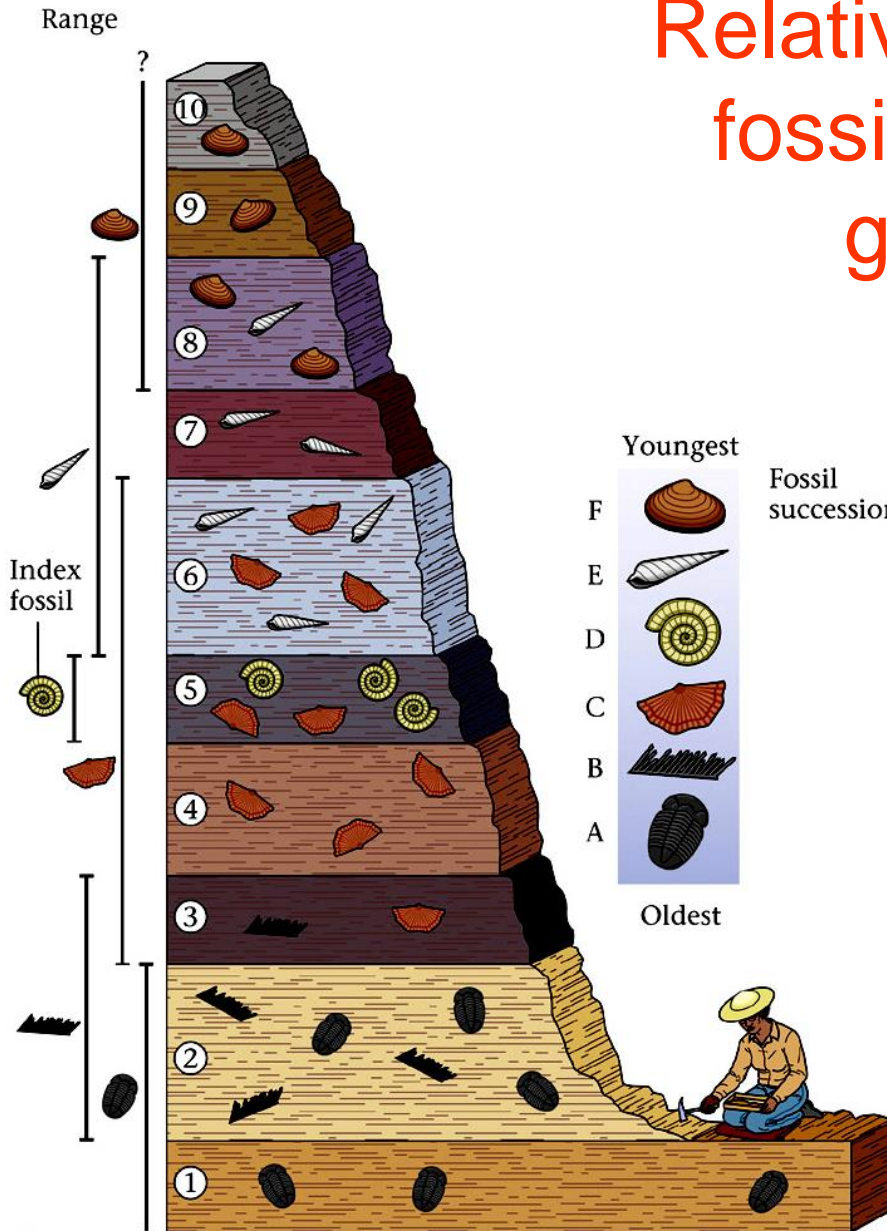
Ammonite



Coral



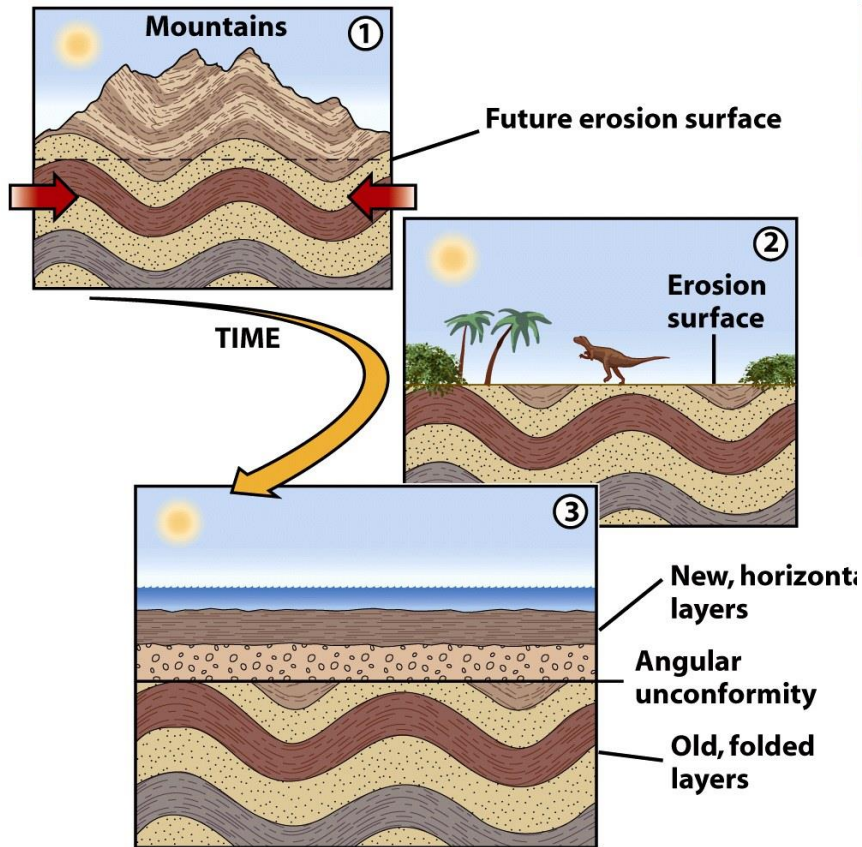
# Relative age – index fossils fossil assemblages, and global correlation



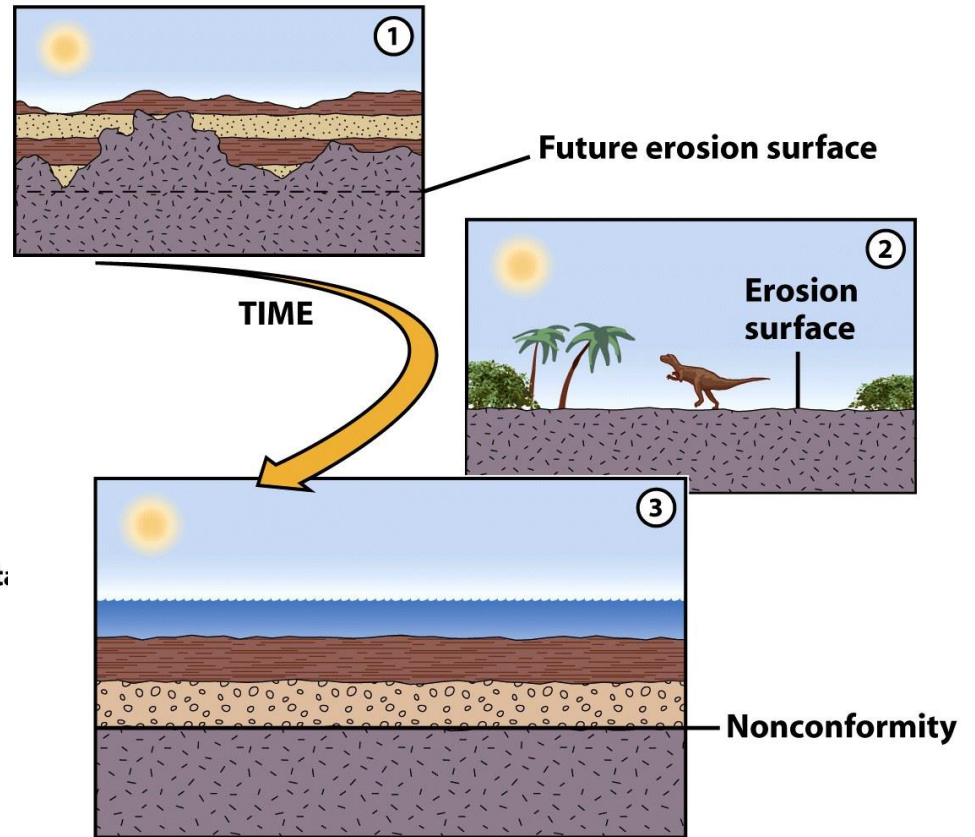


# Unconformities and gaps in time

## Angular unconformity



## Non-conformity



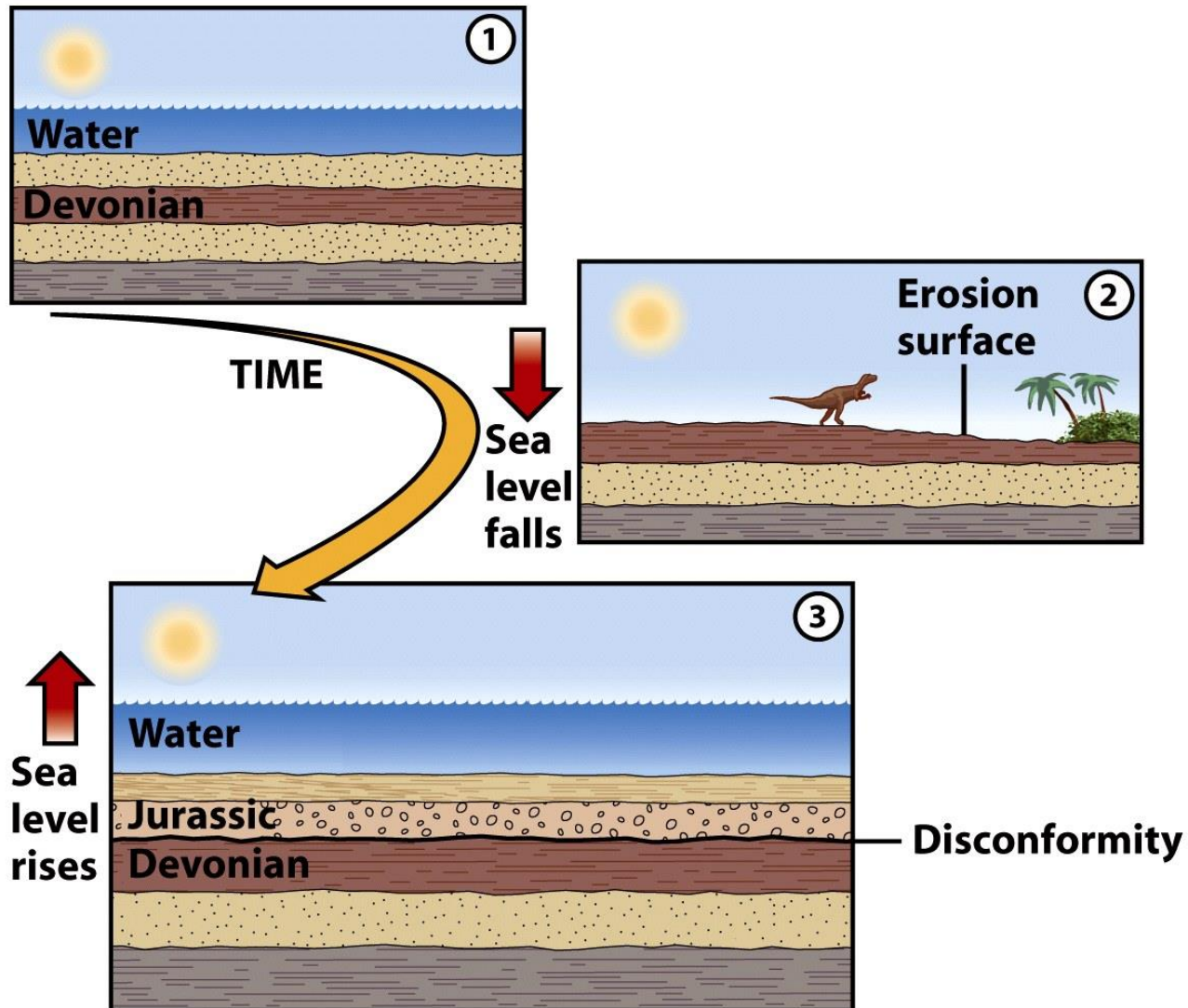
# Angular Unconformity



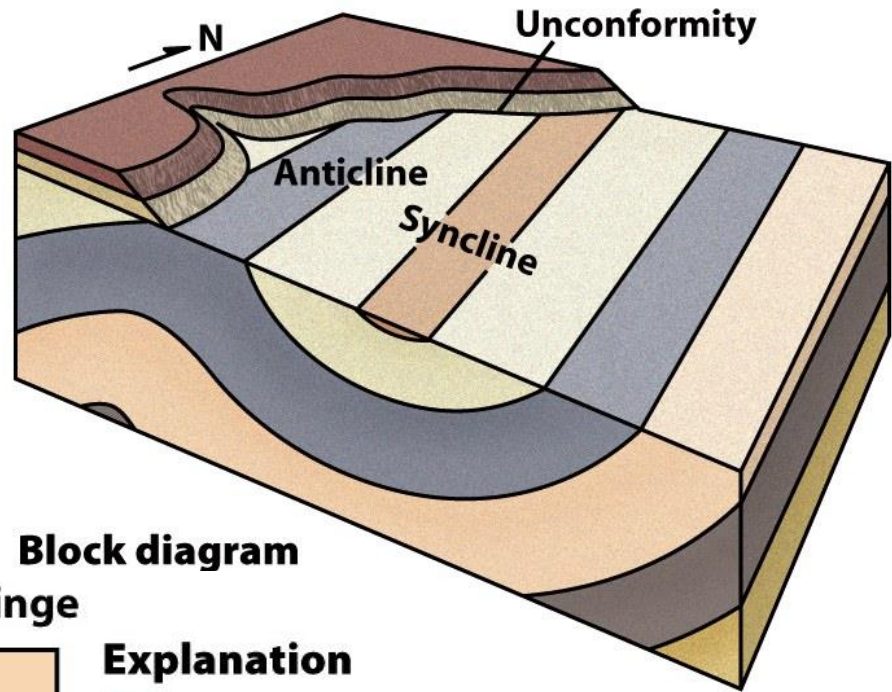
Sandstone 375 Ma

Limestone 450 Ma

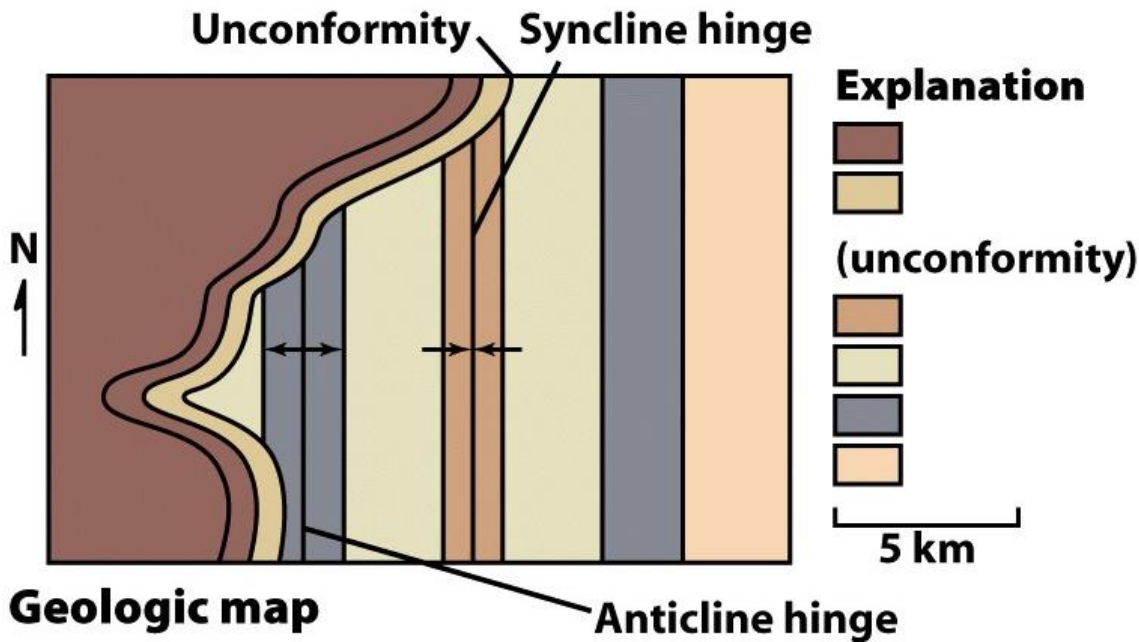
# Disconformity



# Developing a Geological Map



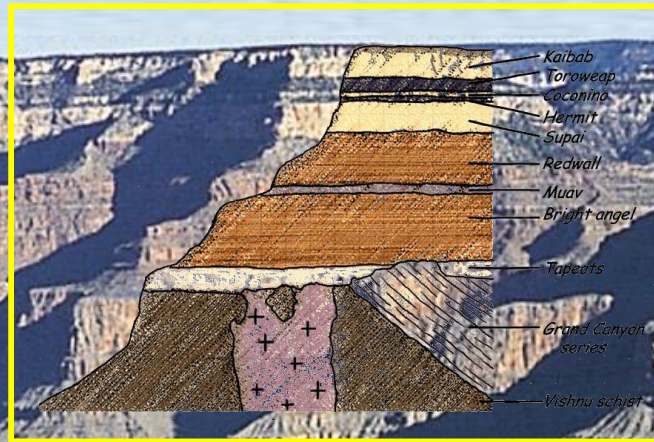
**Block diagram**



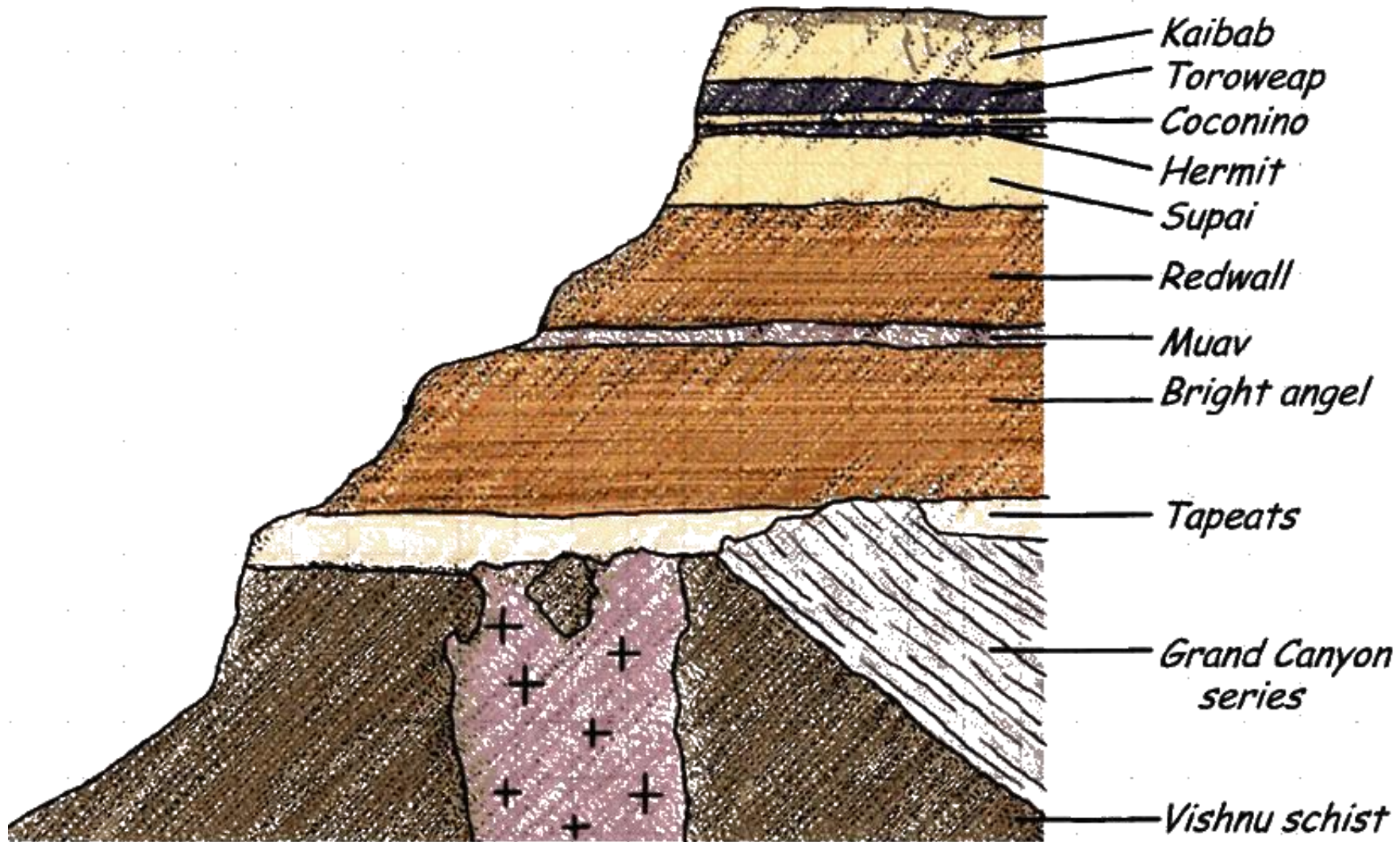
**Geologic map**

**Anticline hinge**

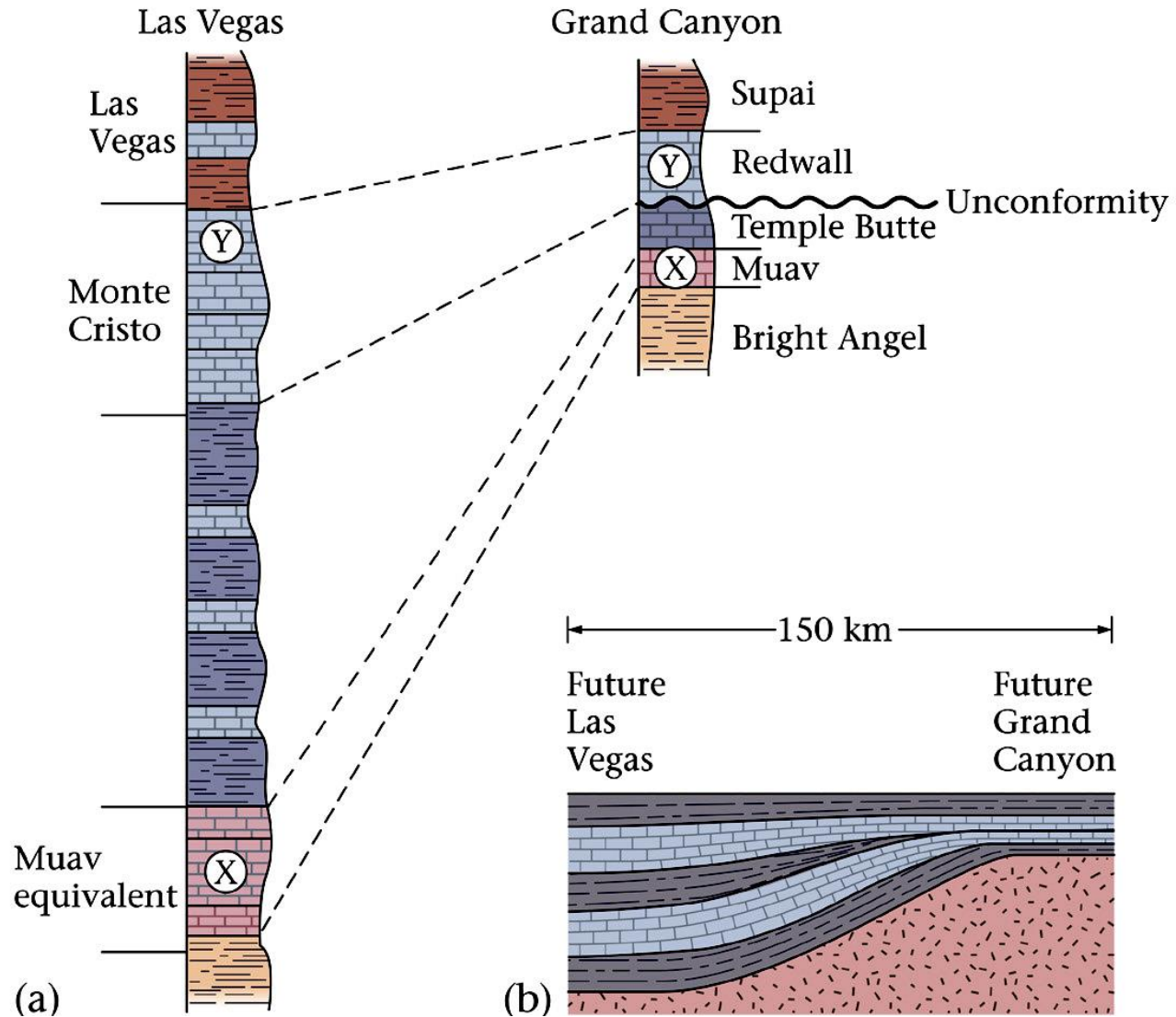
# Stratigraphic succession at the Grand Canyon



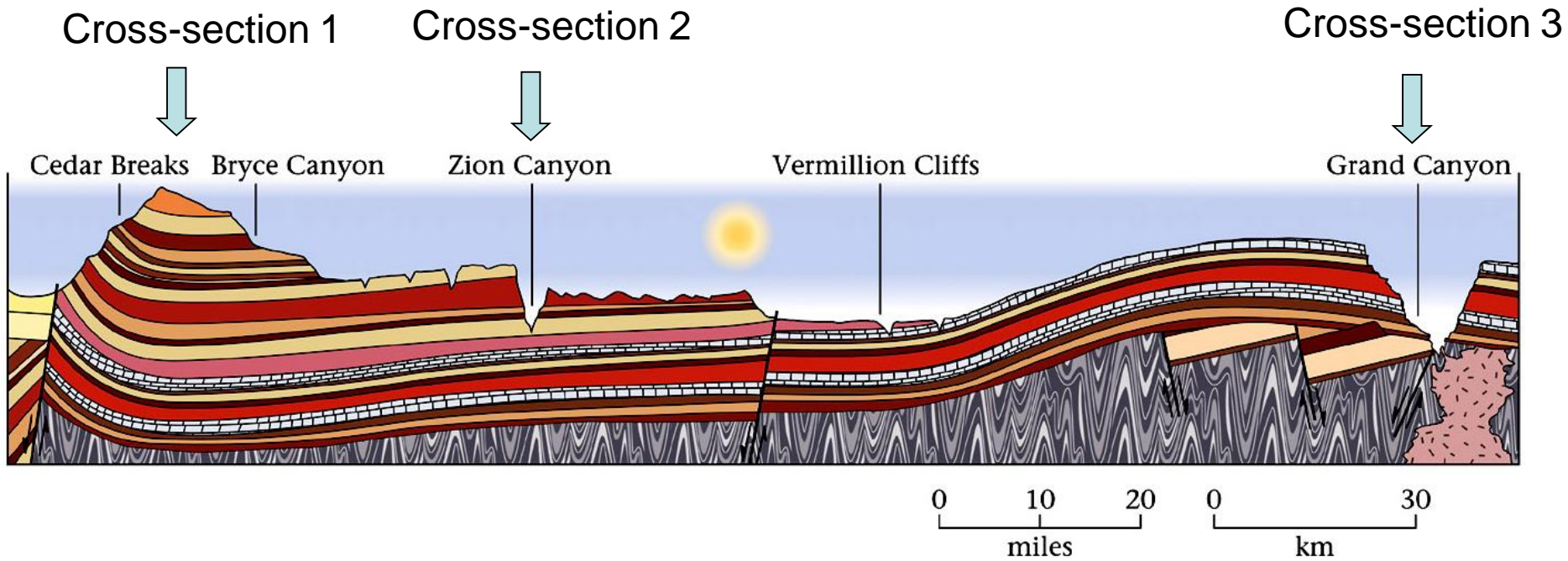
# Grand Canyon Stratigraphy



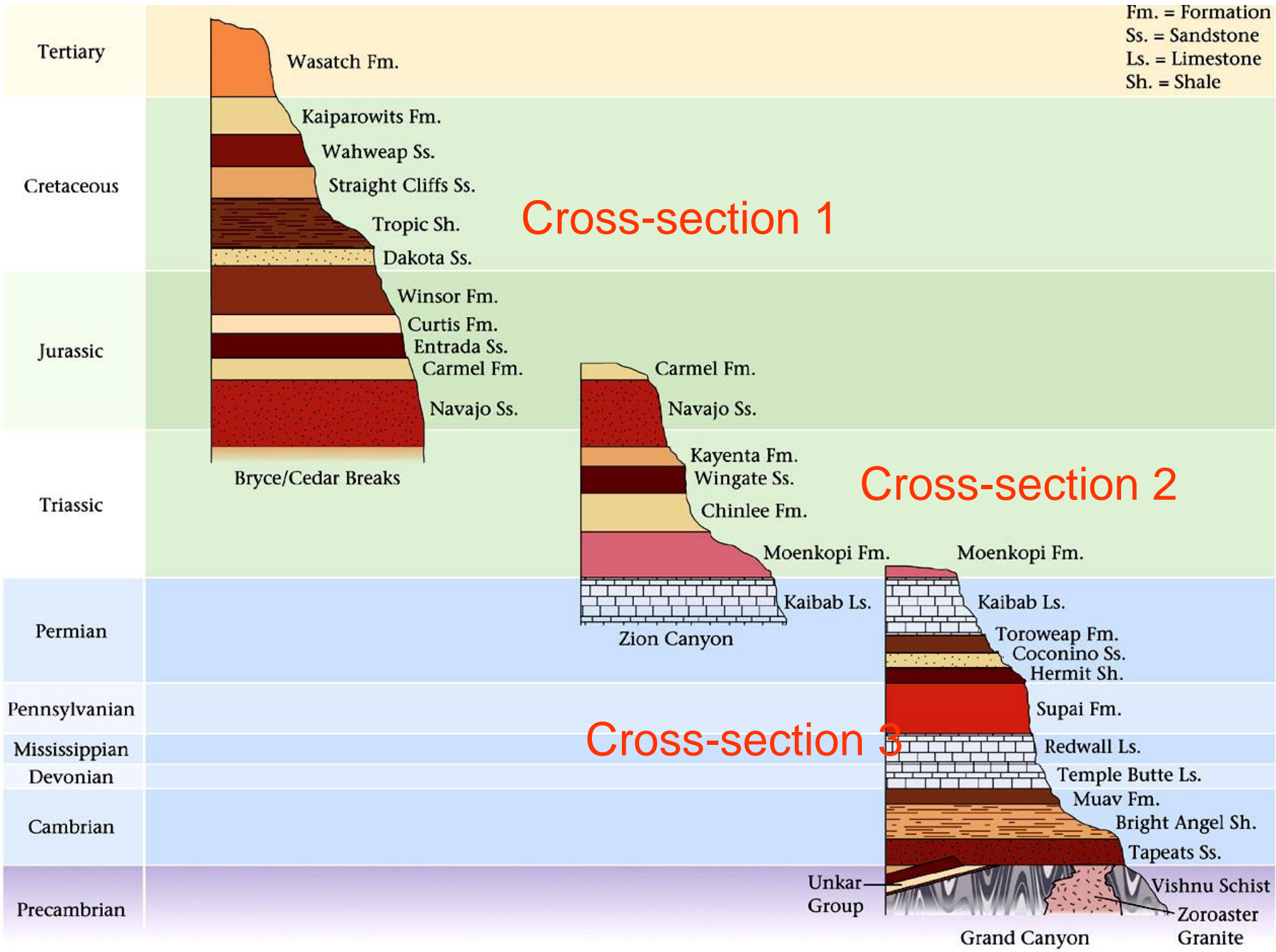
# Stratigraphic correlation



# Stratigraphic Correlation







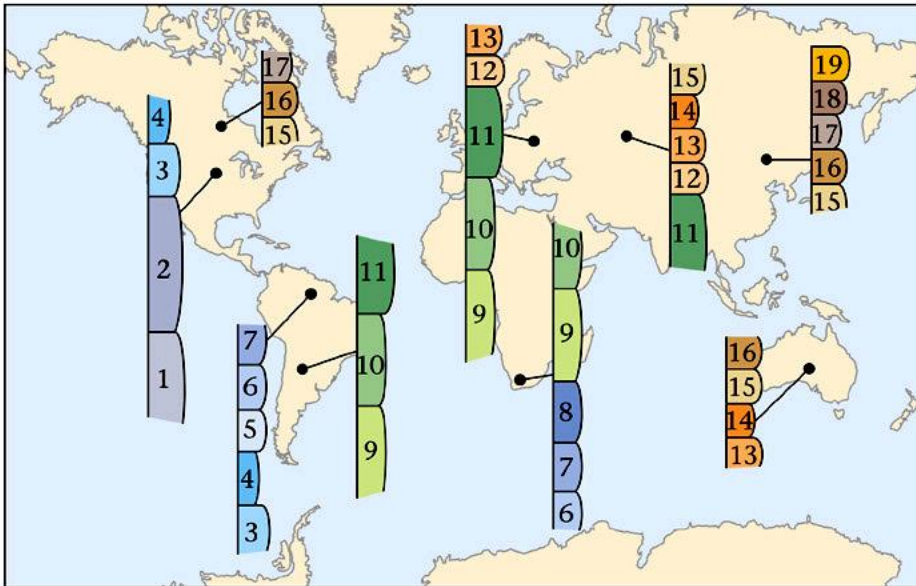
Cross-section 1

Cross-section 2

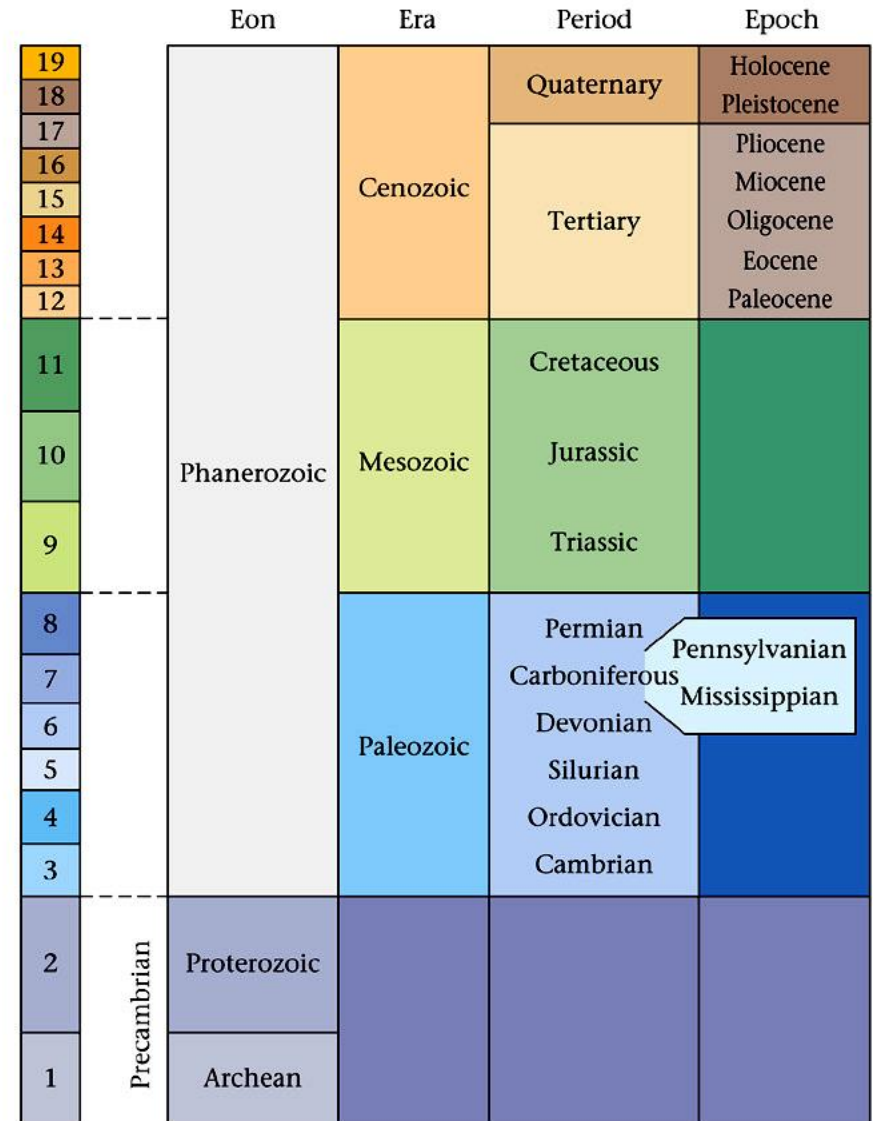
Cross-section 3

# Global Stratigraphic Correlation

The role of fossil assemblages



(a)

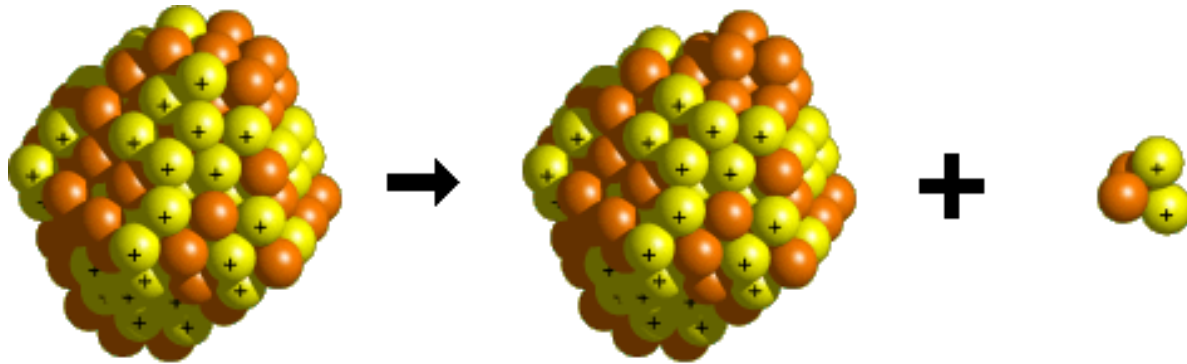


(b)

Geologic Column

# Radioactive Isotope Decay

## Alpha decay



Large, unstable nucleus



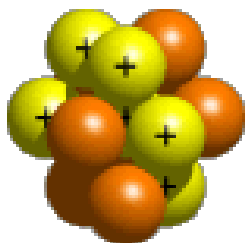
Smaller, more stable nucleus



Alpha particle

## Beta - minus decay

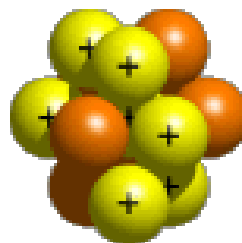
**Carbon-14**



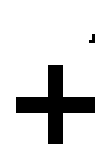
6 protons  
8 neutrons



**Nitrogen-14**



7 protons  
7 neutrons



Antineutrino



Electron



# Radiometric Age Dating

Radioactive decay

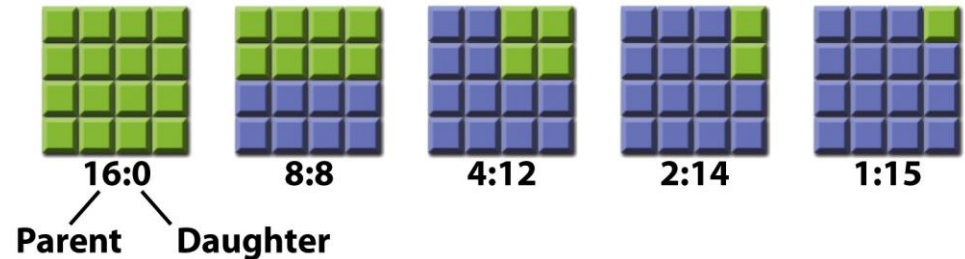
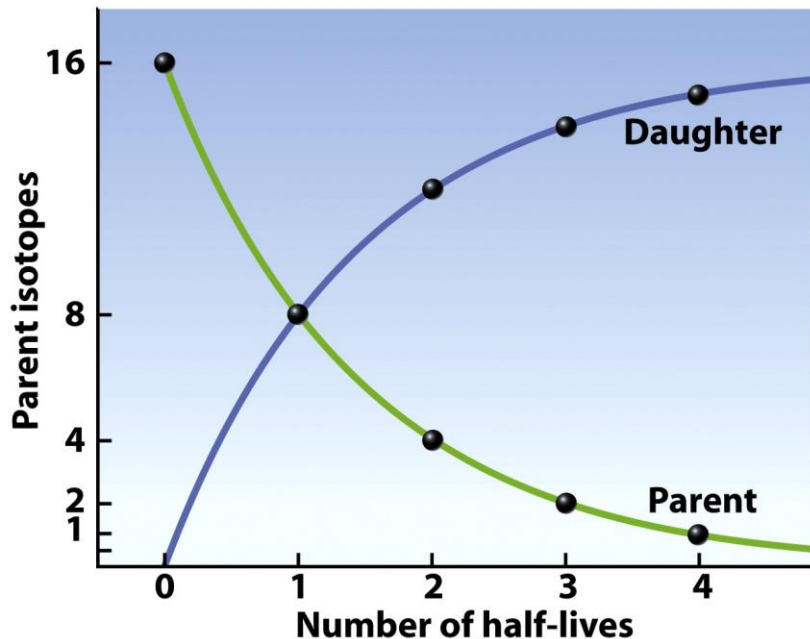
$$N = N_0 e^{-\lambda t}$$

(N = number of parent atoms at time t;  $N_0$  = initial number of parent atoms;  $\lambda$  = rate constant or proportion of atoms destroyed per year)

Half-life

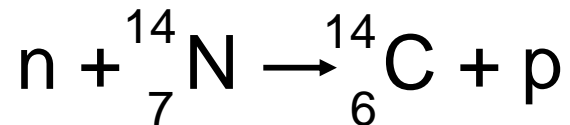
$$\frac{1}{2} = e^{-\lambda t/2}$$

Parent    Daughter    Half-life



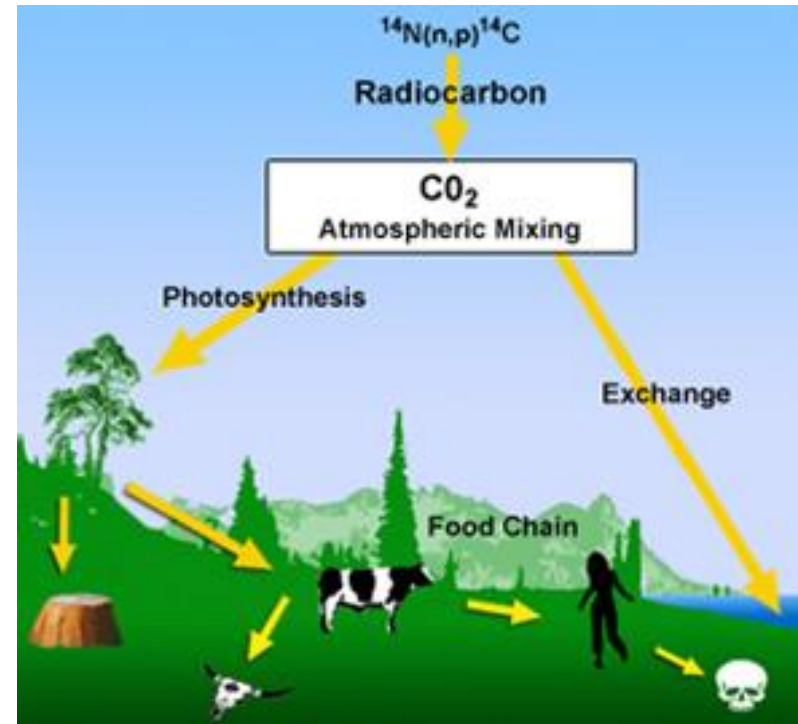
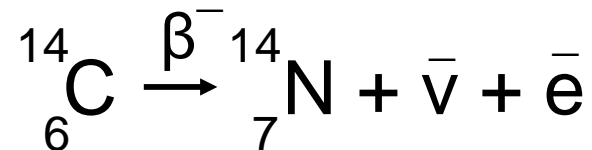
# Radiocarbon ( $^{14}\text{C}$ ) Dating

Neutrons produced from cosmic radiation undergo nuclear reactions with nitrogen in the atmosphere to produce carbon 14.

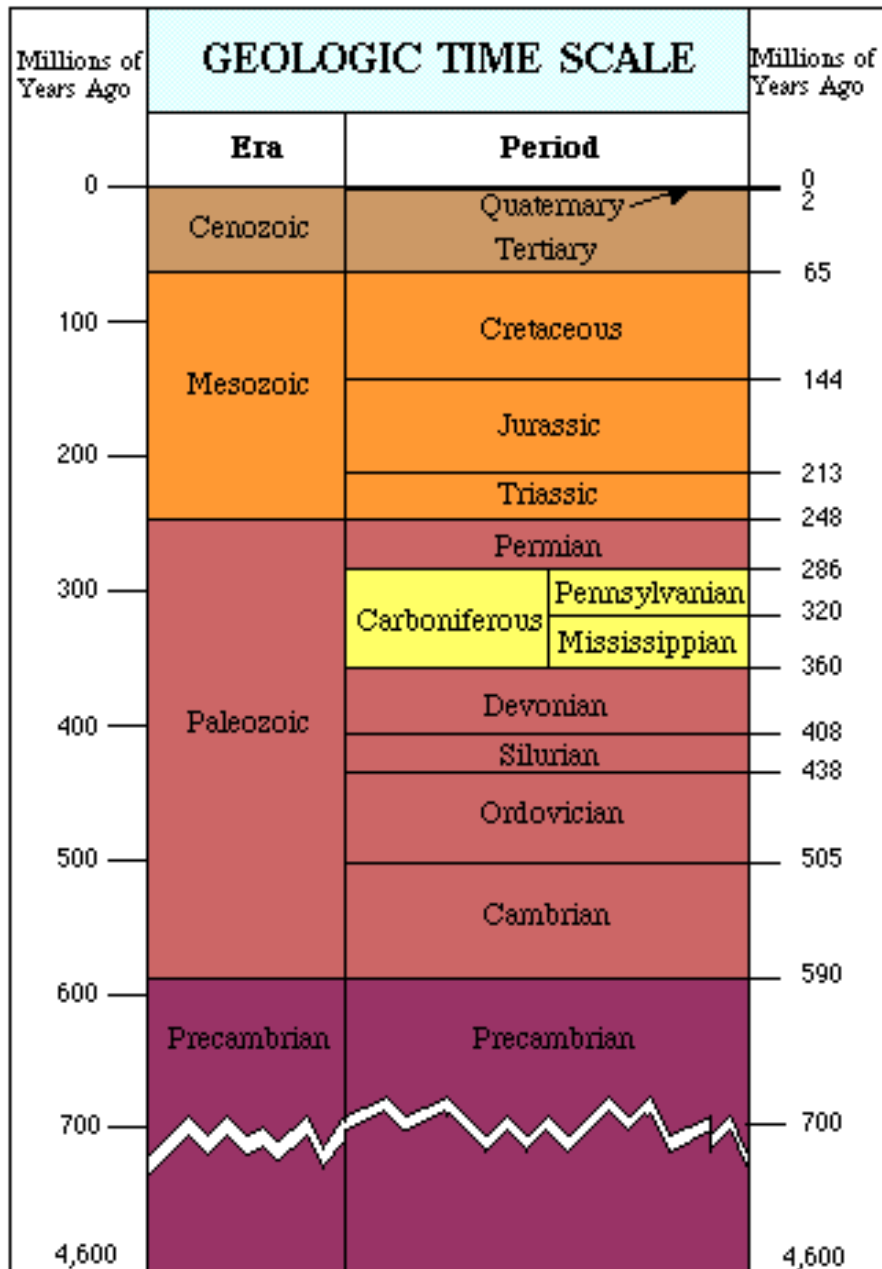


Plants take up carbon 14 by absorbing  $\text{CO}_2$

After death the proportion of carbon 14 slowly decreases due to beta-minus decay



# Geological Time Scale



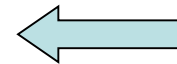
End of the Dinosaurs

First Dinosaurs, Mammals, Birds

First Reptiles  
First Amphibians

First Land Plants

First Fishes



Proliferation of shelly fossils

First Invertebrates

# Geological Time

