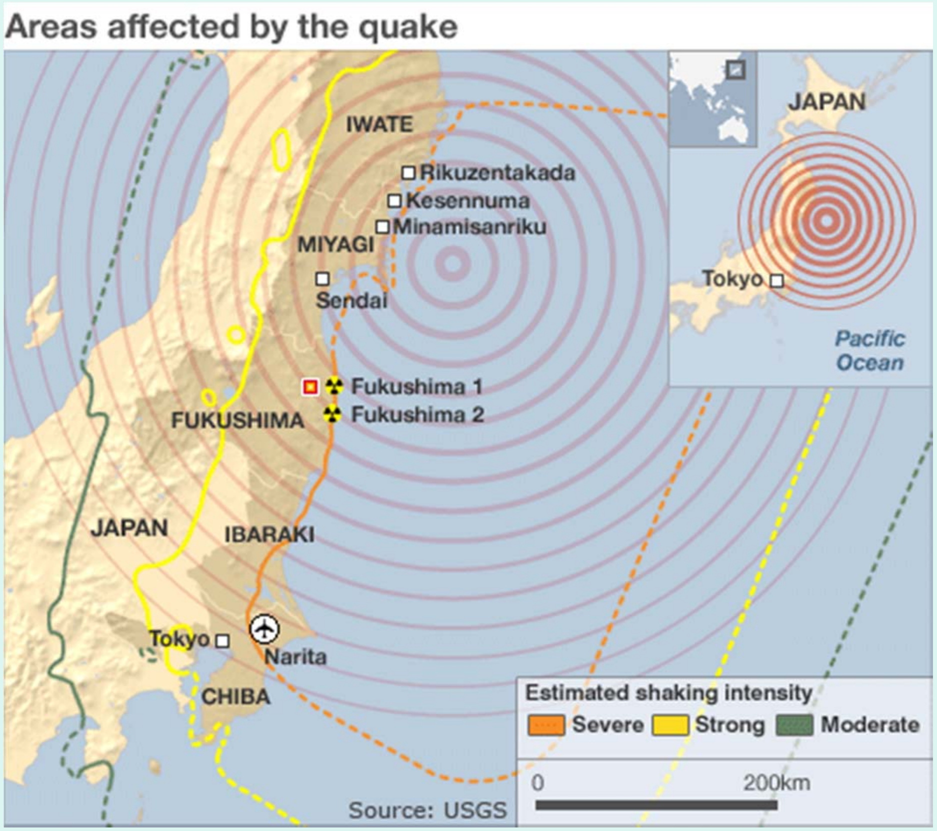
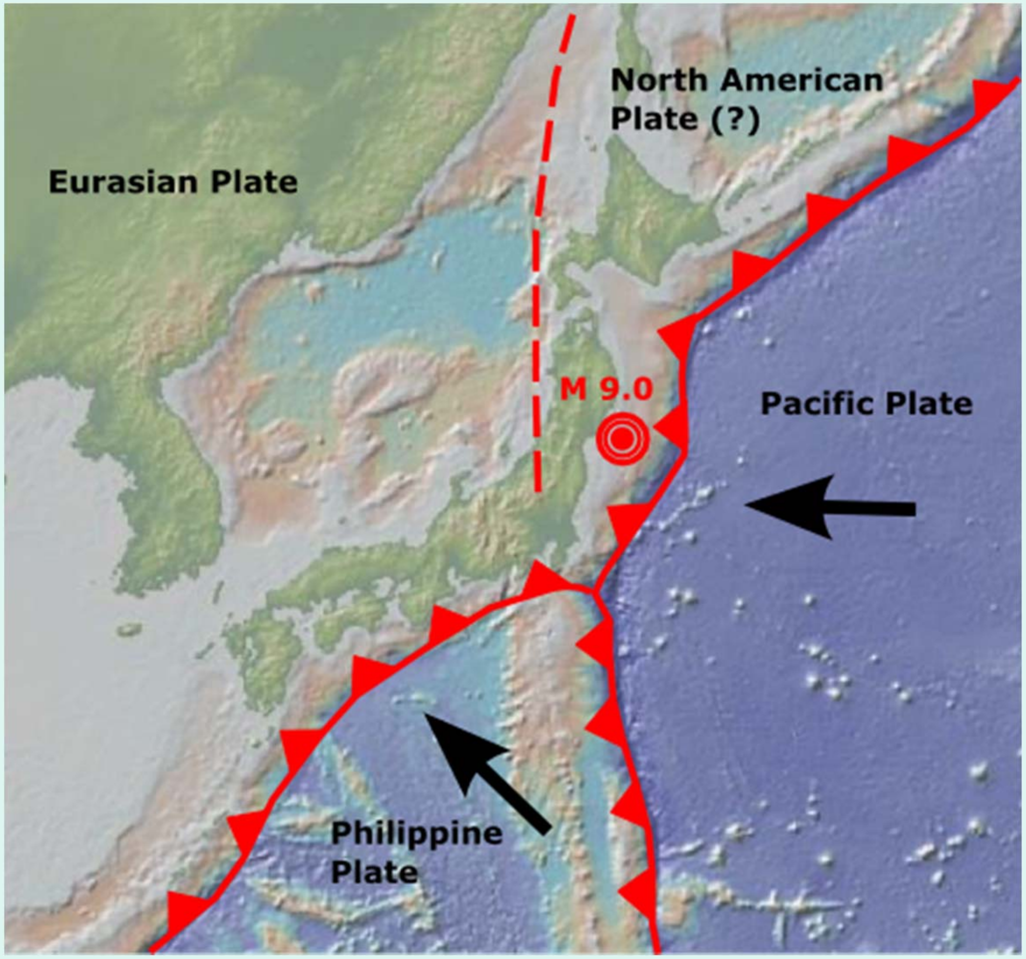
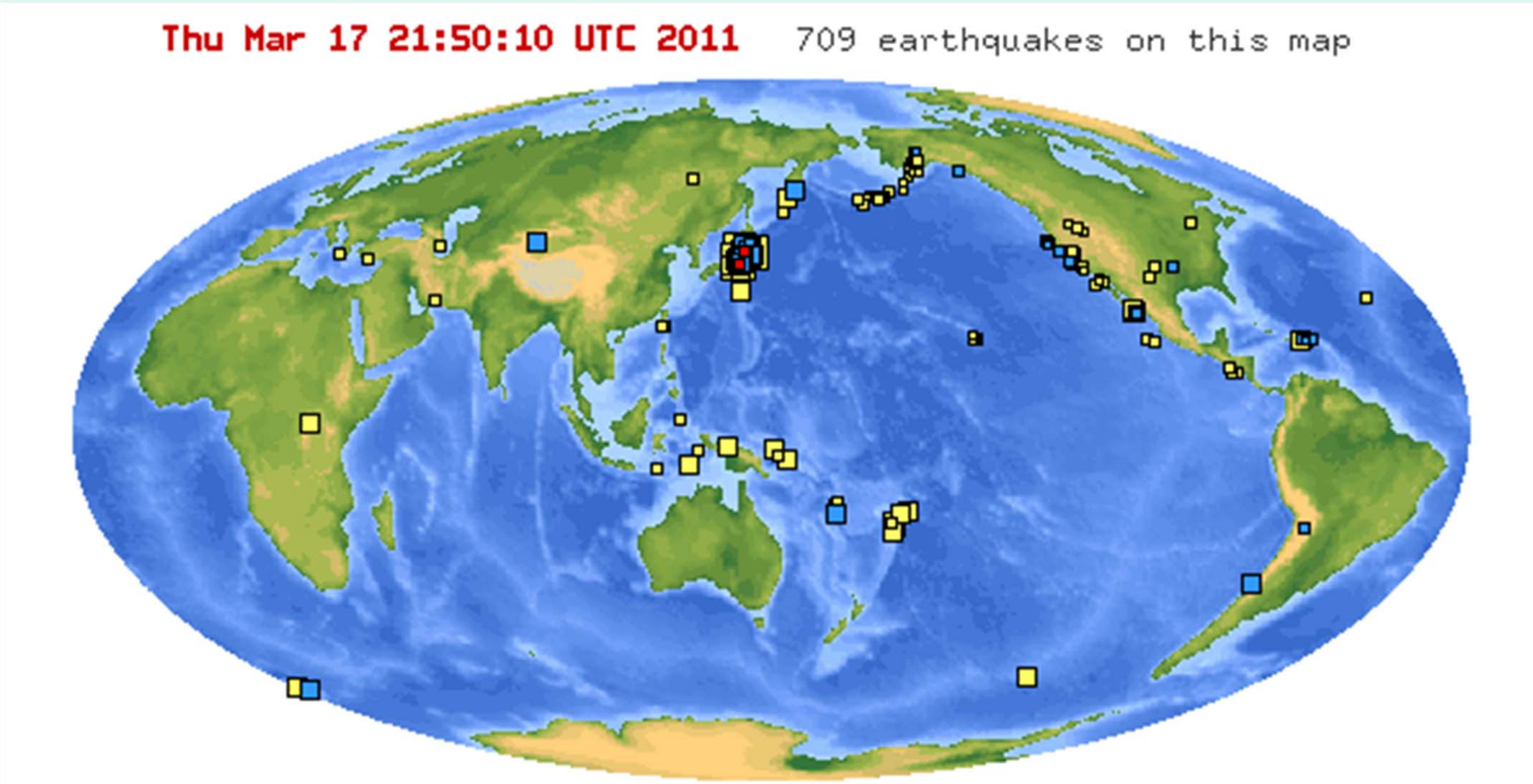
Japan Earth Quake

- 9.0 magnitude quake (the 4th largest since 1990
- Caused when the Pacific tectonic plate subducted under the North American plate
- Eastern Japan shifted about 13 feet
- shifted the earth's axis by 6.5 inches, shortened day by about 1.6 microseconds
- Sank Japan downward by about two feet.

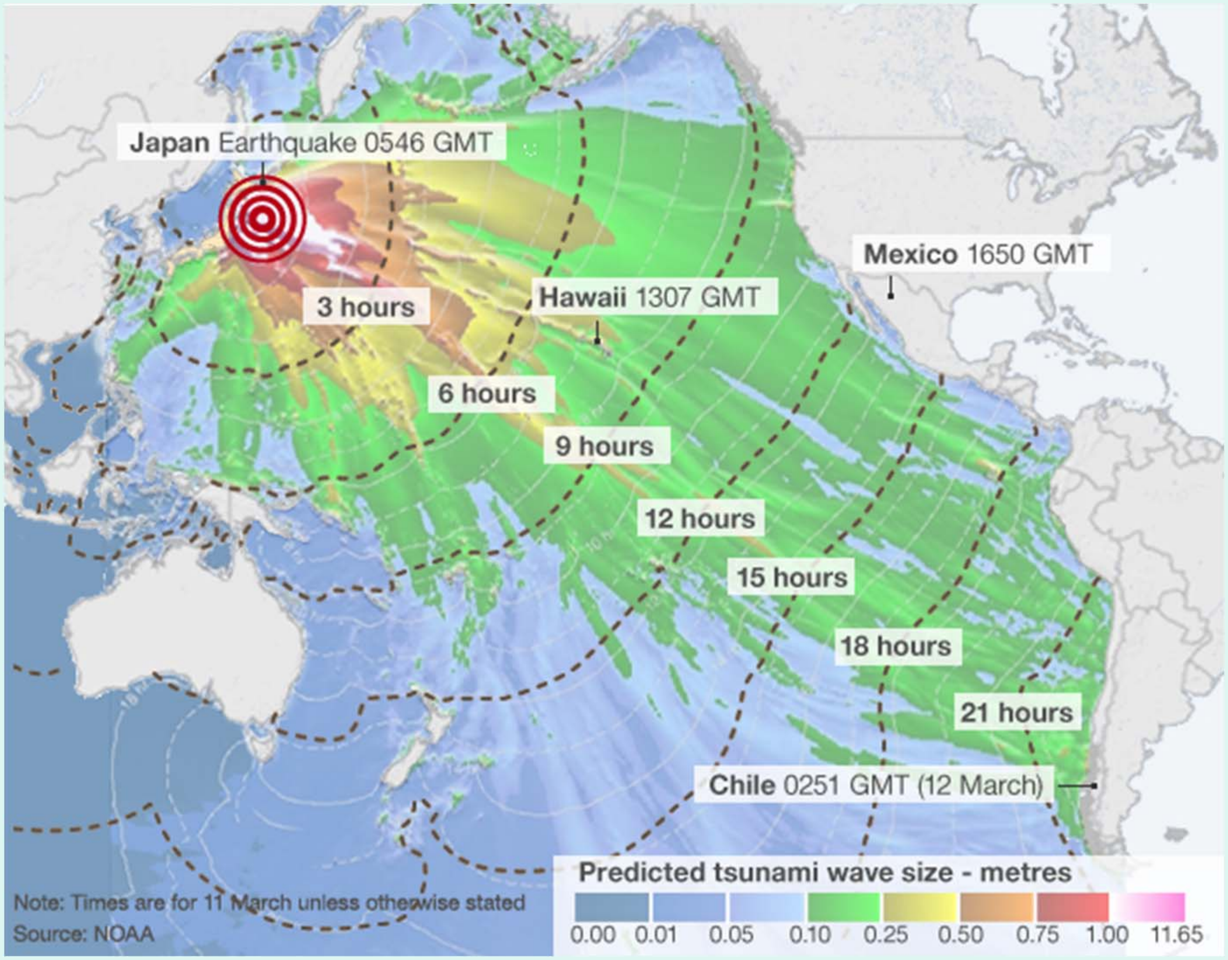



North American
Plate (?)
Eurasian Plate
M 9.0
Pacific Plate
Philippine
Plate

Japan Earth Quake



Japan Earth Quake



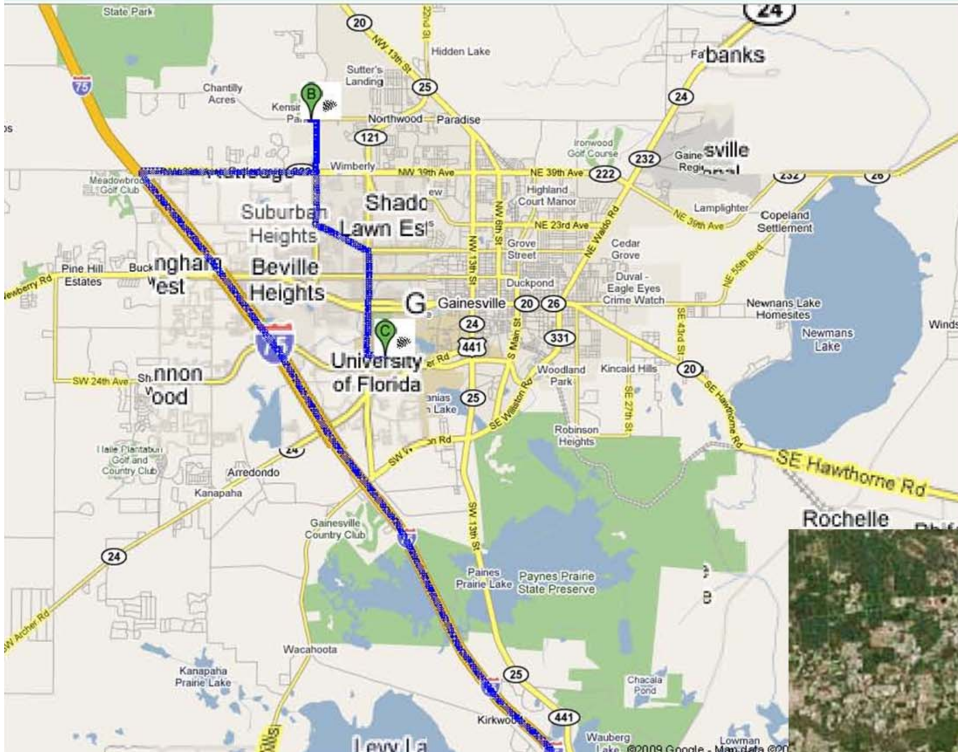
Chapter 7
Fires Within: Igneous Activity

EARTH SCIENCE
GLY 1001
QUIZ Chapter 8

Name________________________ Ed Meyers

Match the following words with their definition and/or description:

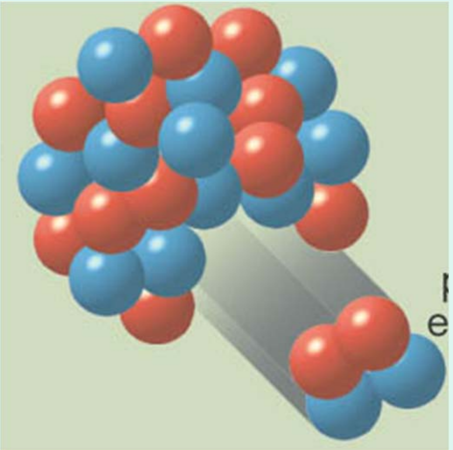
1. ___K___ Angular Unconformity
2. ___A___ Disconformity
3. ___E___ Relative Dating
4. ___F___ Absolute Dating
5. ___H___ Index Fossil
6. ___B___ Correlation
7. ___J___ Nonconformity
8. ___G___ Half life
9. ___I___ Fossil Succession
10. ___C___ Original horizontality

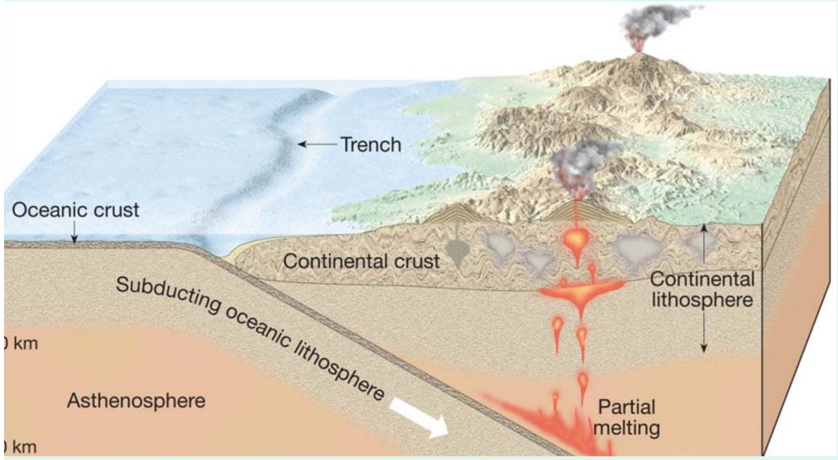

State Park
Hidden Lake
Sutter's Landing
Chantilly Acres
Northwood
Paradise
Ironwood Golf Course
Wimberly
NW 39th Ave
NE 39th Ave
Highland Court Manor
Lamplighter
Copeland Settlement
Suburban Heights
Beville Heights
NE 23rd Ave
Cedar Grove
Grove Street
Duckpond
Duval - Eagle Eyes Crime Watch
Pine Hill Estates
Gainesville
Newnans Lake Homesites
Newnans Lake
University of Florida
Woodland Park
Kincaid Hills
SW 24th Ave
Robinson Heights
SE Hawthorne Rd
Rochelle
Arredondo
Kanapaha
Gainesville Country Club
Paines Prairie Lake
Paynes Prairie State Preserve
Wacahoota
Kanapaha Prairie Lake
Chacala Pond
Kirkwood
Wauberg Lake

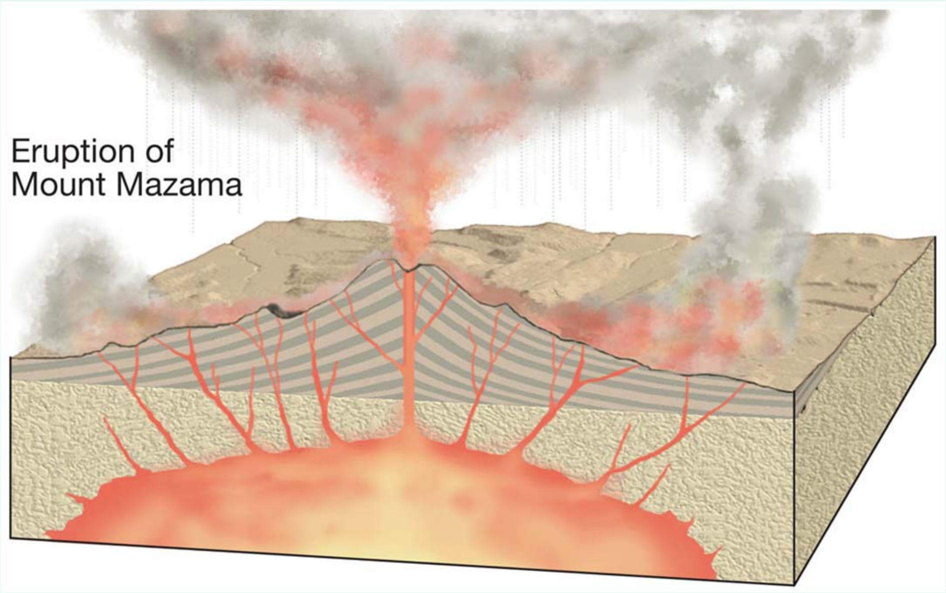

Origin of Magma

Heating of Rocks

- **Friction during subduction**
- **Radioactive decay**
- **Drop in Pressure**







Volcanic Features

Crater and Vent

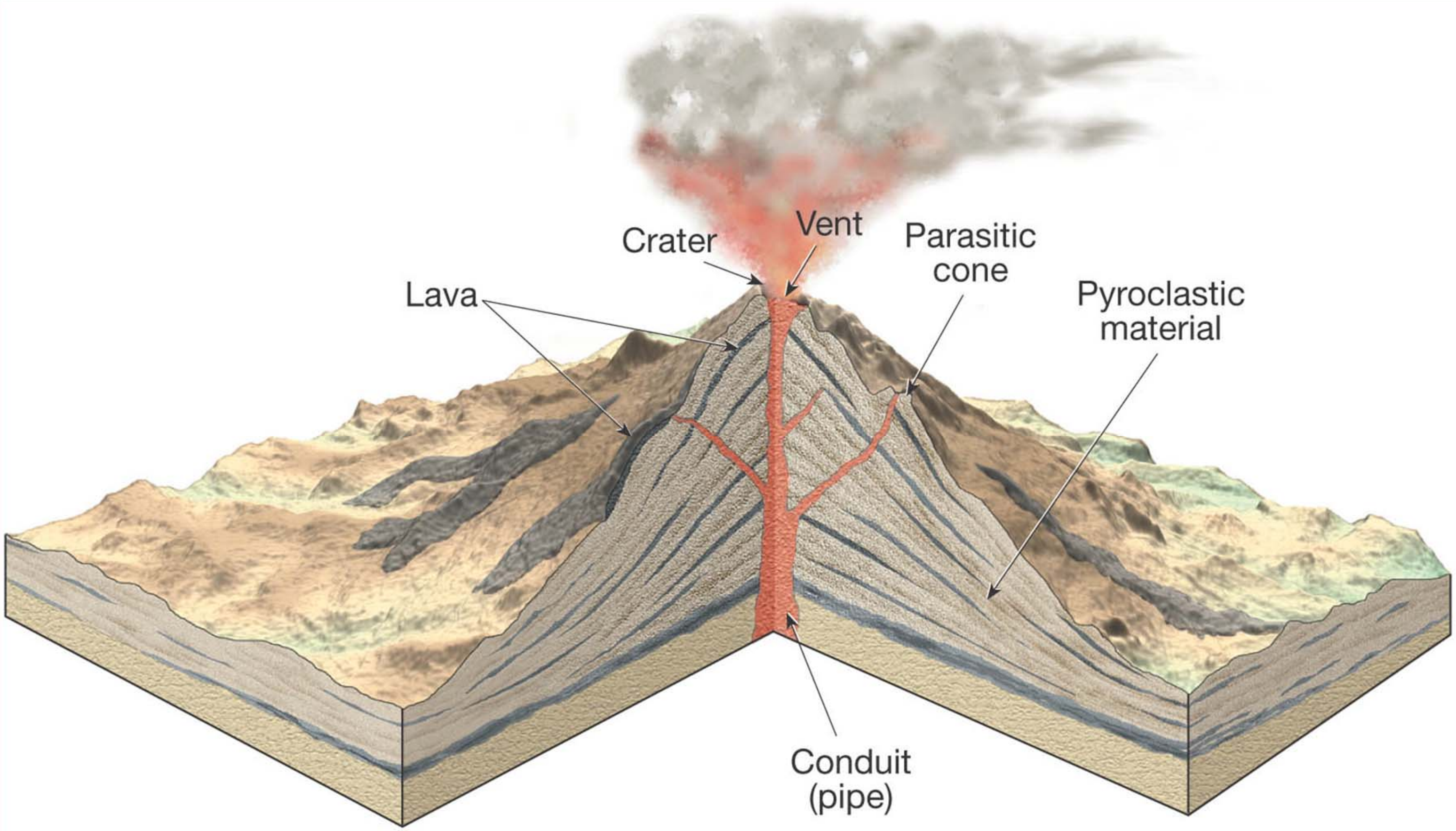


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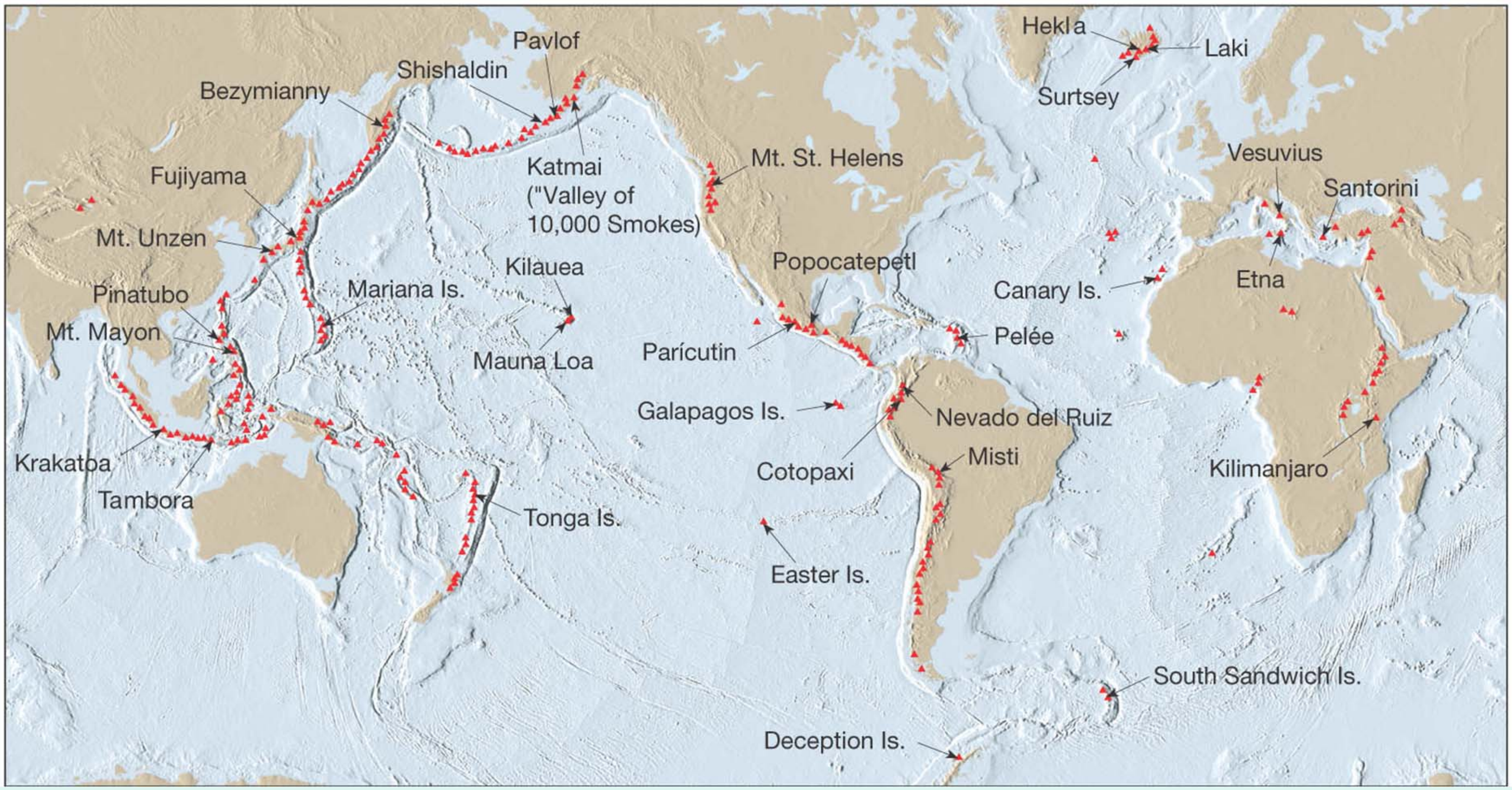
Plate Tectonics and Volcanoes

The type of magma and volcano depend on

1) Tectonic Settings



Types of Volcanoes

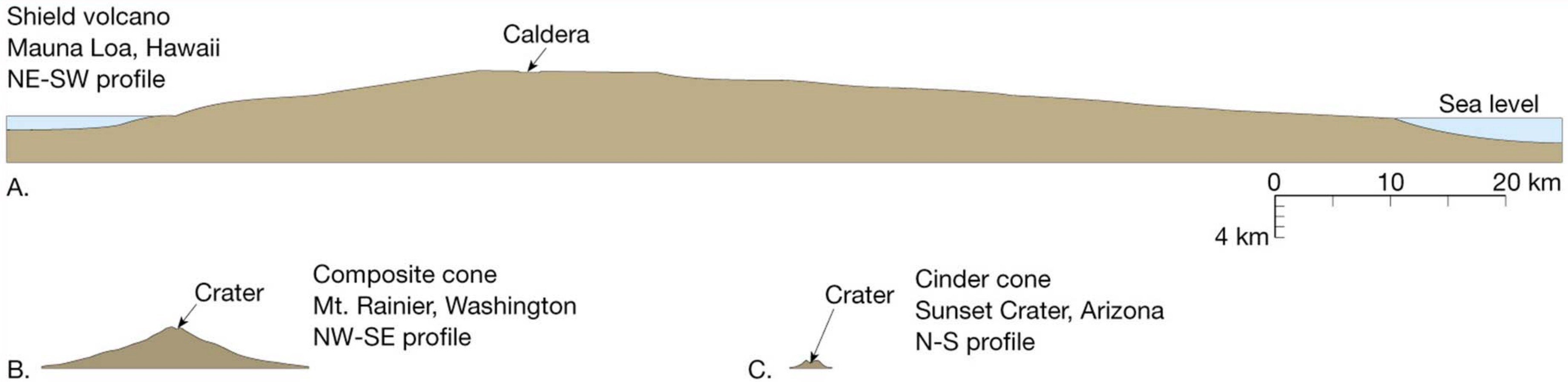
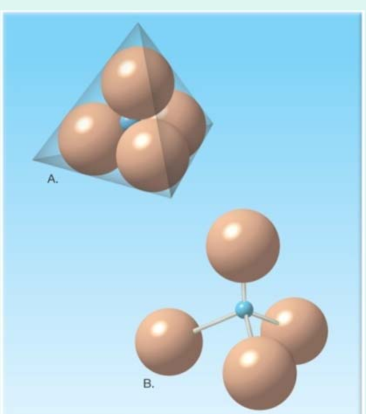


Figure 7.9

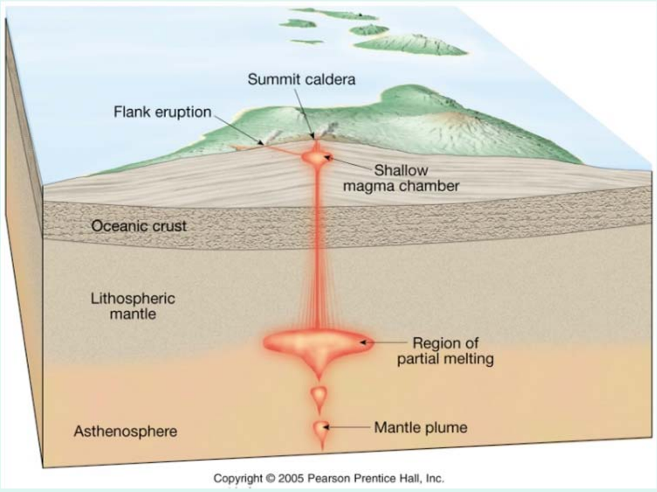
The Nature of Volcanic Eruptions

- ***Viscosity*** **is a measure of a material's resistance to flow**
- **Factors affecting viscosity**
    - **Temperature—Hotter magmas are less viscous**
    - **Composition—Silica (SiO_2) content**
        - **Higher silica content = higher viscosity**
        - **Lower silica content = lower viscosity**



Volcanic Structures

- **Types of volcanoes**
  - ***Shield volcano***
    - **Broad, slightly domed shaped**
    - **Generally cover large areas**
    - **Produced by mild eruptions of large volumes of basaltic lava**
    - **Example = Mauna Loa on Hawaii**



Anatomy of a Shield Volcano

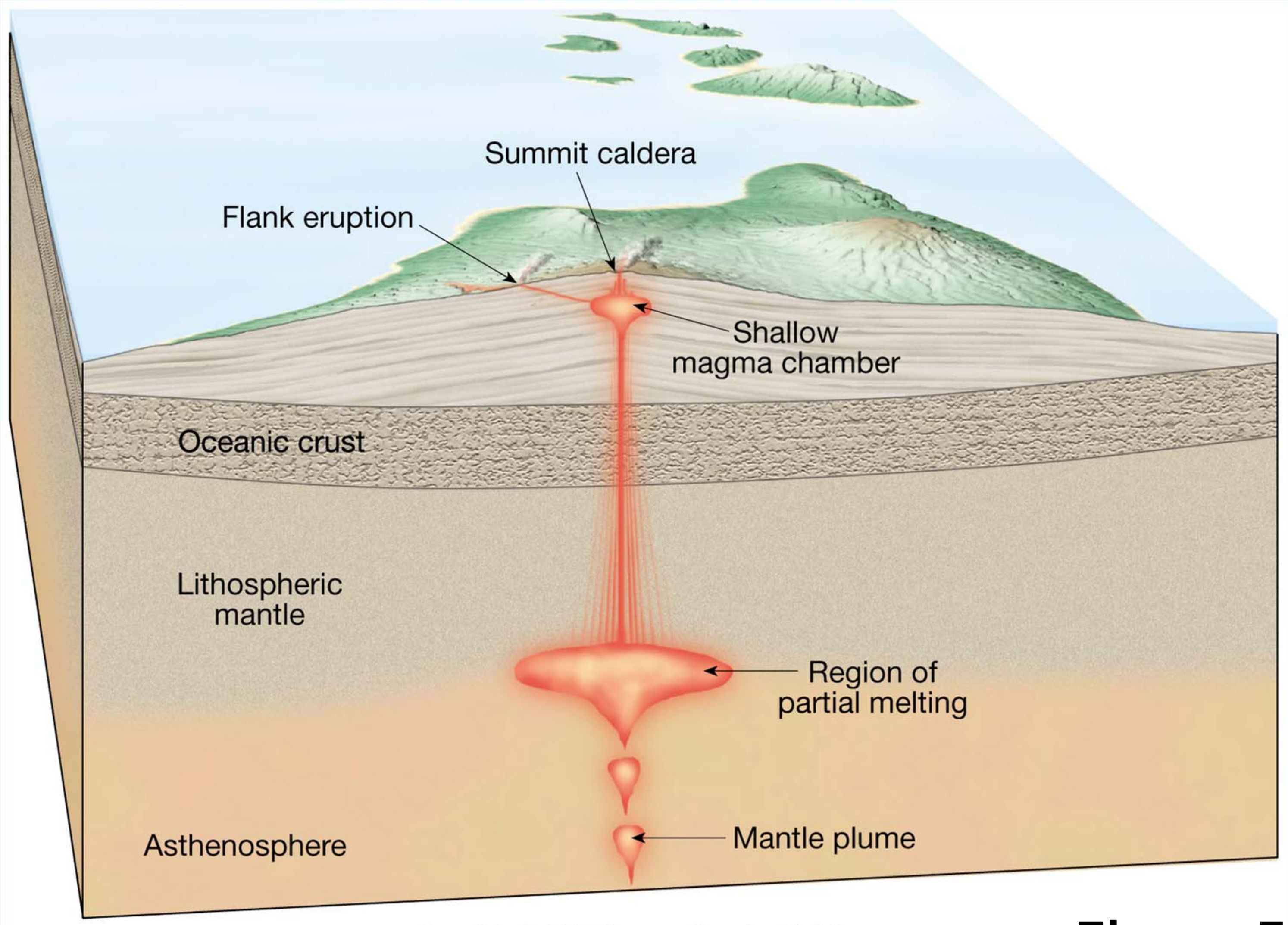
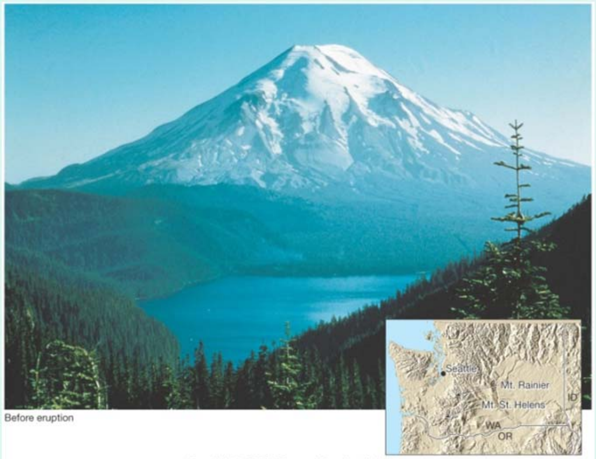


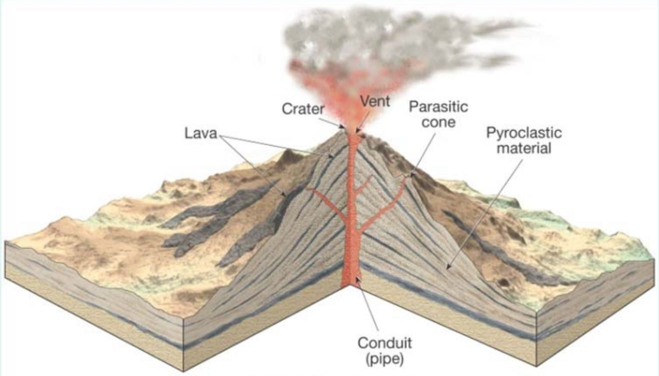
Figure 7.8

Volcanic Structures

- ***Composite cone*** **(stratovolcano)**
  - **Most are located adjacent to the Pacific Ocean (e.g., Fujiyama, Mt. St. Helens)**
  - **Large, classic-shaped volcano (1000s of ft. high and several miles wide at base)**
  - **Composed of interbedded lava flows and pyroclastic debris**
  - **Most violent type of activity (e.g., Mt. Vesuvius)**



Before eruption



Anatomy of a Strata Volcano

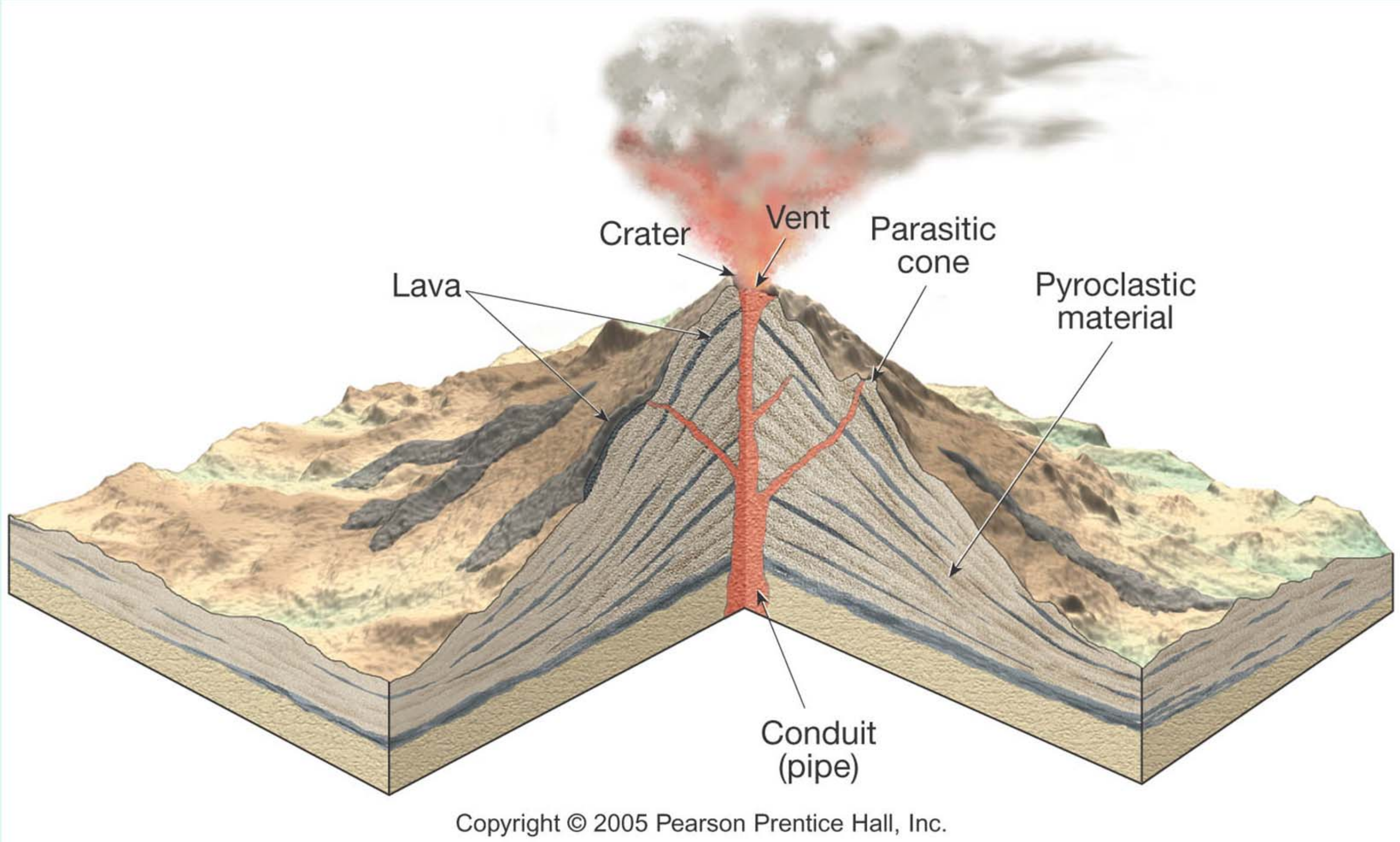


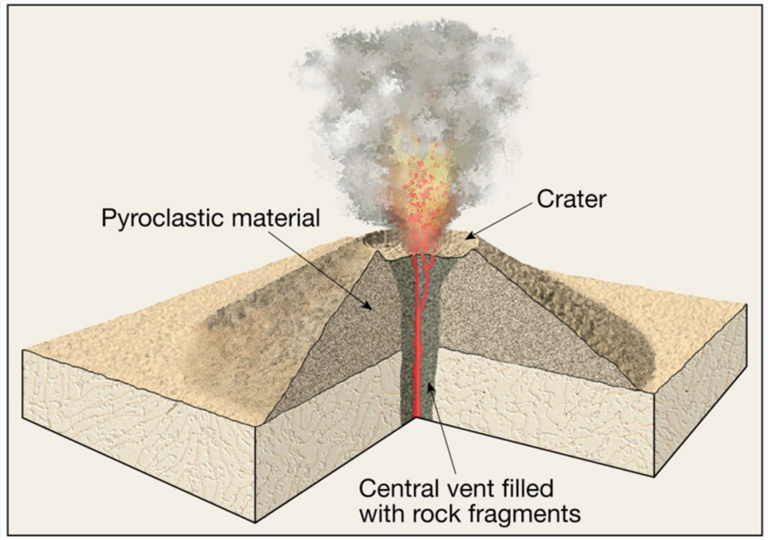
Figure 7.8

Mt. St. Helens—Prior to the 1980 Eruption

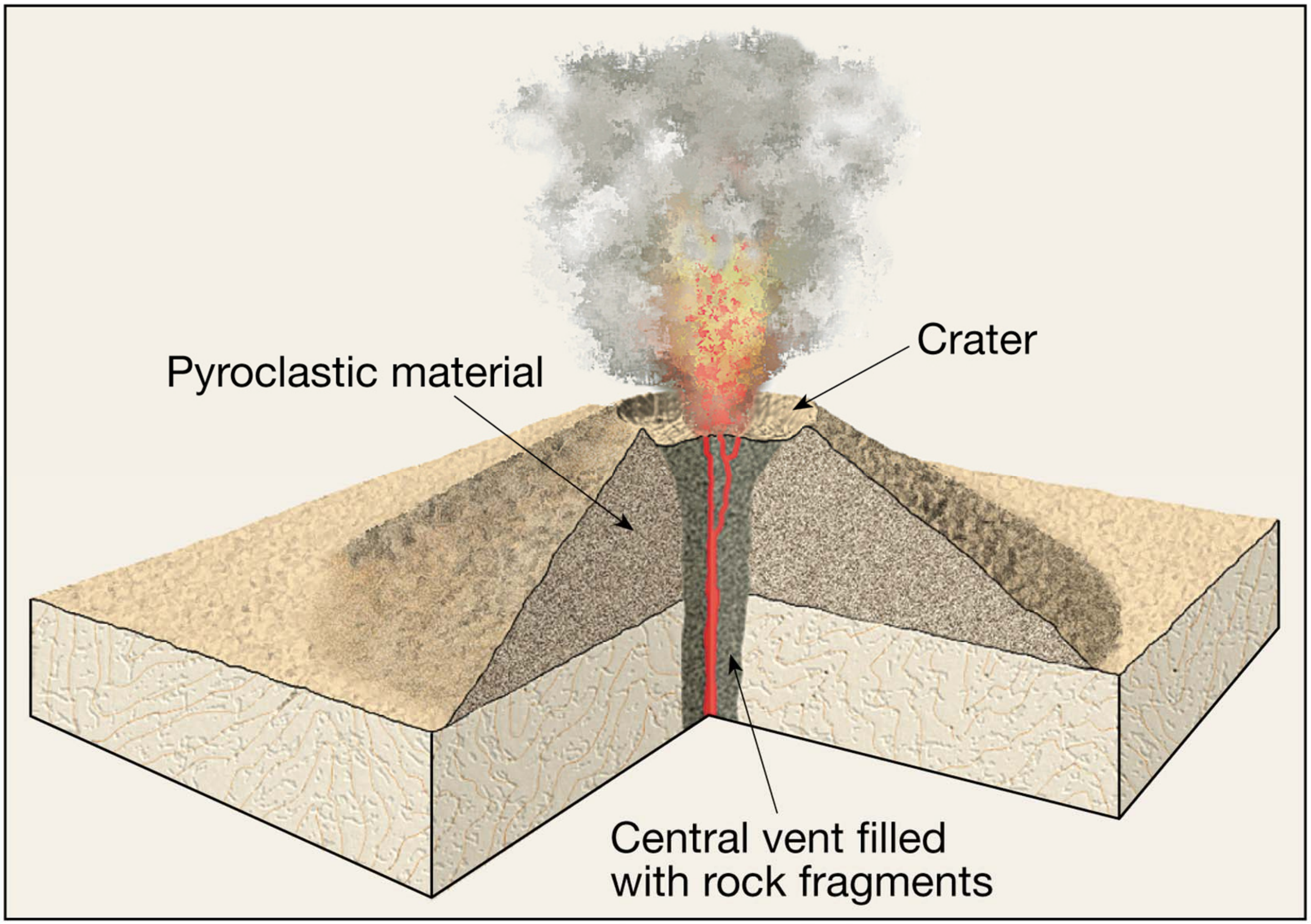
Mt. St. Helens After the 1980 Eruption

Volcanic Structures

- ***Cinder cone***
  - **Built from ejected lava (mainly cinder-sized) fragments**
  - **Steep slope angle**
  - **Small size**
  - **Frequently occur in groups**

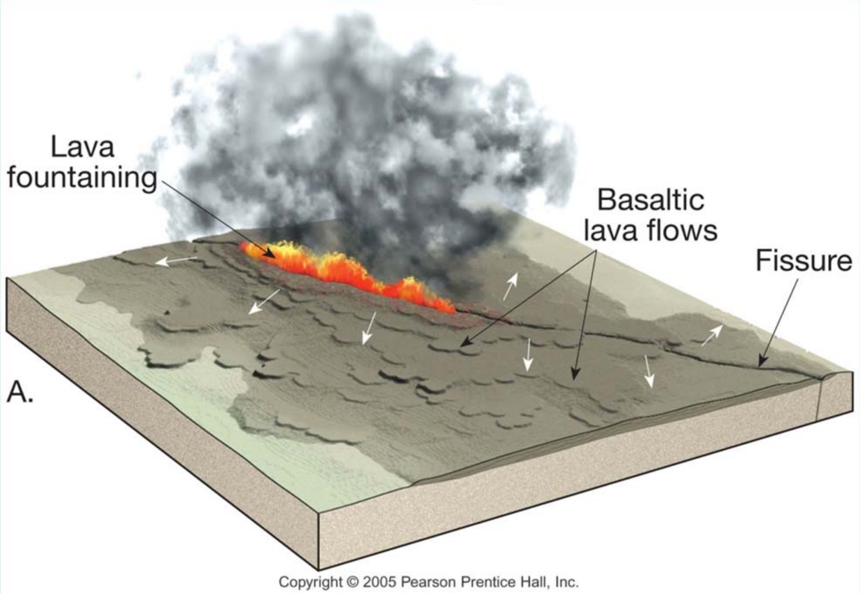


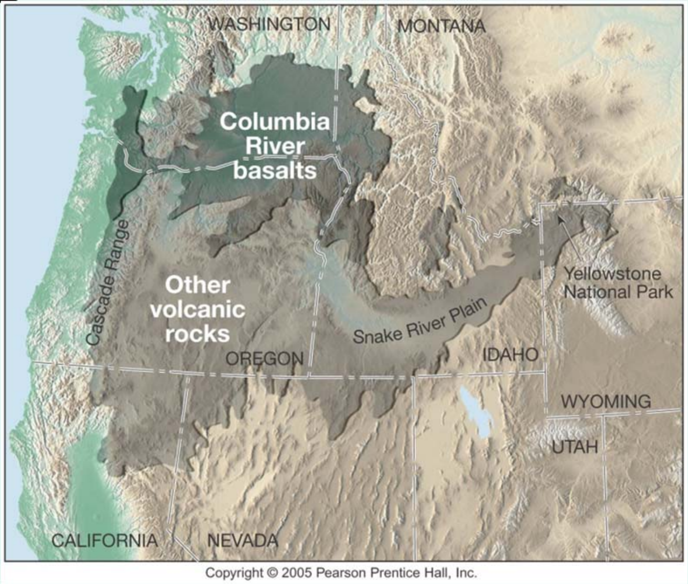
Cinder Cone Volcano



Volcanic Structures

- ***Flood Basalt***
  - **Low viscosity flows**
  - **High Volume of Magma**
  - **No volcanic structure**
  - **Large Volume of Magma**





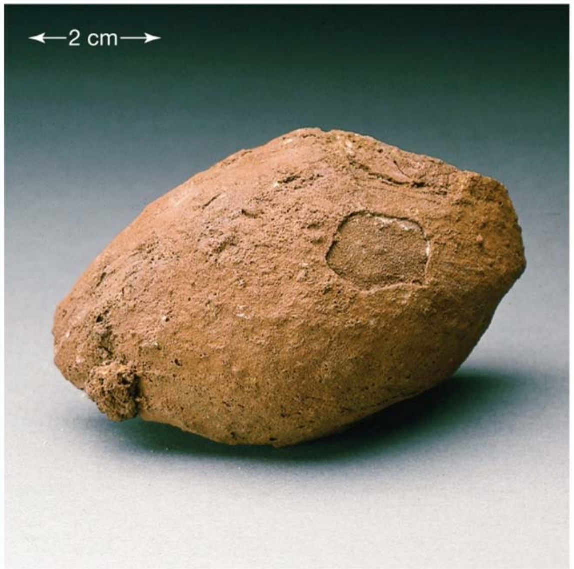
Yellowstone

Materials Extruded from a Volcano

- **Lava flows**
  - **Basaltic lavas exhibit fluid behavior**
  - **Types of basaltic flows**
    - ***Pahoehoe* lava (resembles a twisted or ropey texture)**
    - ***Aa* lava (rough, jagged blocky texture)**
- **Dissolved gases**
  - **1%–6% by weight**
  - **Mainly H_2O and CO_2**

Materials Extruded from a Volcano

- **Pyroclastic materials—"Fire fragments"**
  - **Types of pyroclastic debris**
    - ***Cinders*—Pea-sized material**
    - ***Lapilli*—Walnut-sized material**
    - **Particles larger than lapilli**
      - » ***Blocks*—Hardened or cooled lava**
      - » ***Bombs*—Ejected as hot lava**



Materials Extruded from a Volcano

- **Pyroclastic materials—"Fire fragments"**
  - **Types of pyroclastic debris**
    - **Ash and dust—Fine, glassy fragments**
    - ***Pumice*—Porous rock from "frothy" lava**

A Nueé Ardente on Mt. St. Helens

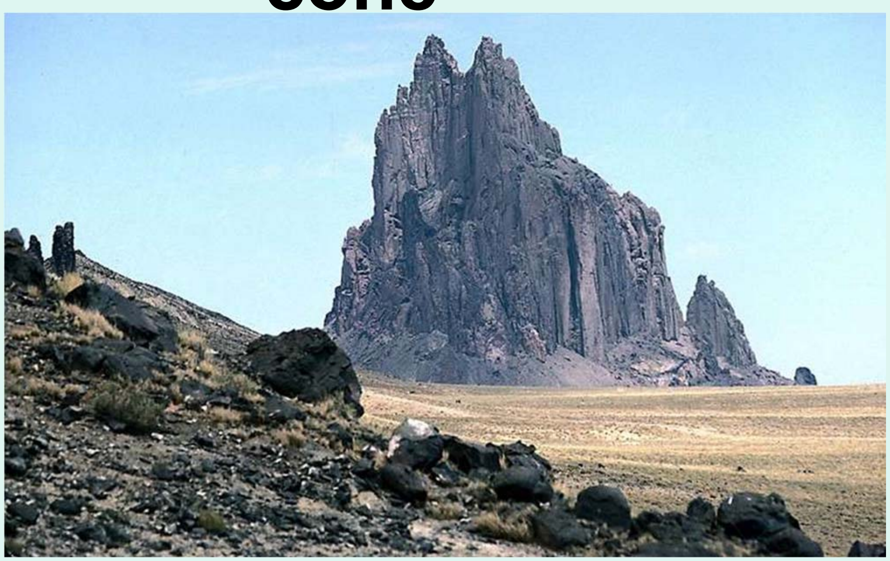
Volcanic Structures

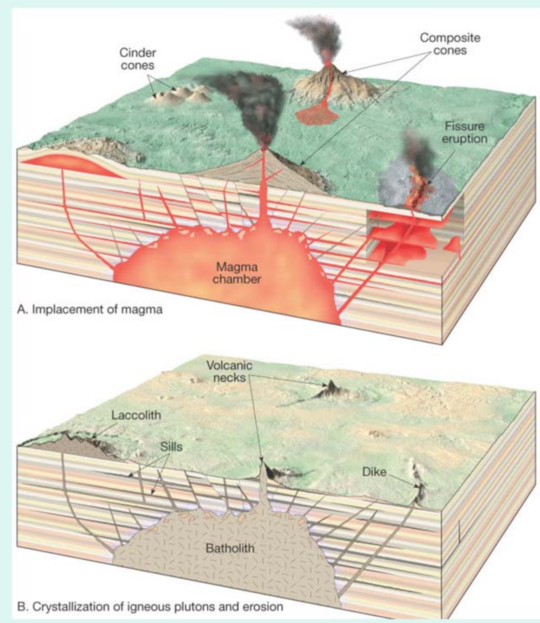
- *Lahar*—Volcanic mudflow
  - Mixture of volcanic debris and water
  - Move down stream valleys and volcanic slopes, often with destructive results

Other Volcanic Landforms

Volcanic pipes and *necks*

- **Pipes—Short conduits that connect a magma chamber to the surface**
- **Volcanic necks (e.g., Ship Rock, New Mexico)—Resistant vents left standing after erosion has removed the volcanic cone**





Mud cracks

Other Volcanic Landforms

Volcanic pipes* and *necks

Intrusive Igneous Activity

Most magma is emplaced at depth in the Earth

- **Once cooled and solidified, is called a *pluton***

Nature of plutons

- **Shape—Tabular (sheetlike) vs. massive**
- **Orientation with respect to the host (surrounding) rock**
  - ***Concordant* vs. *discordant***

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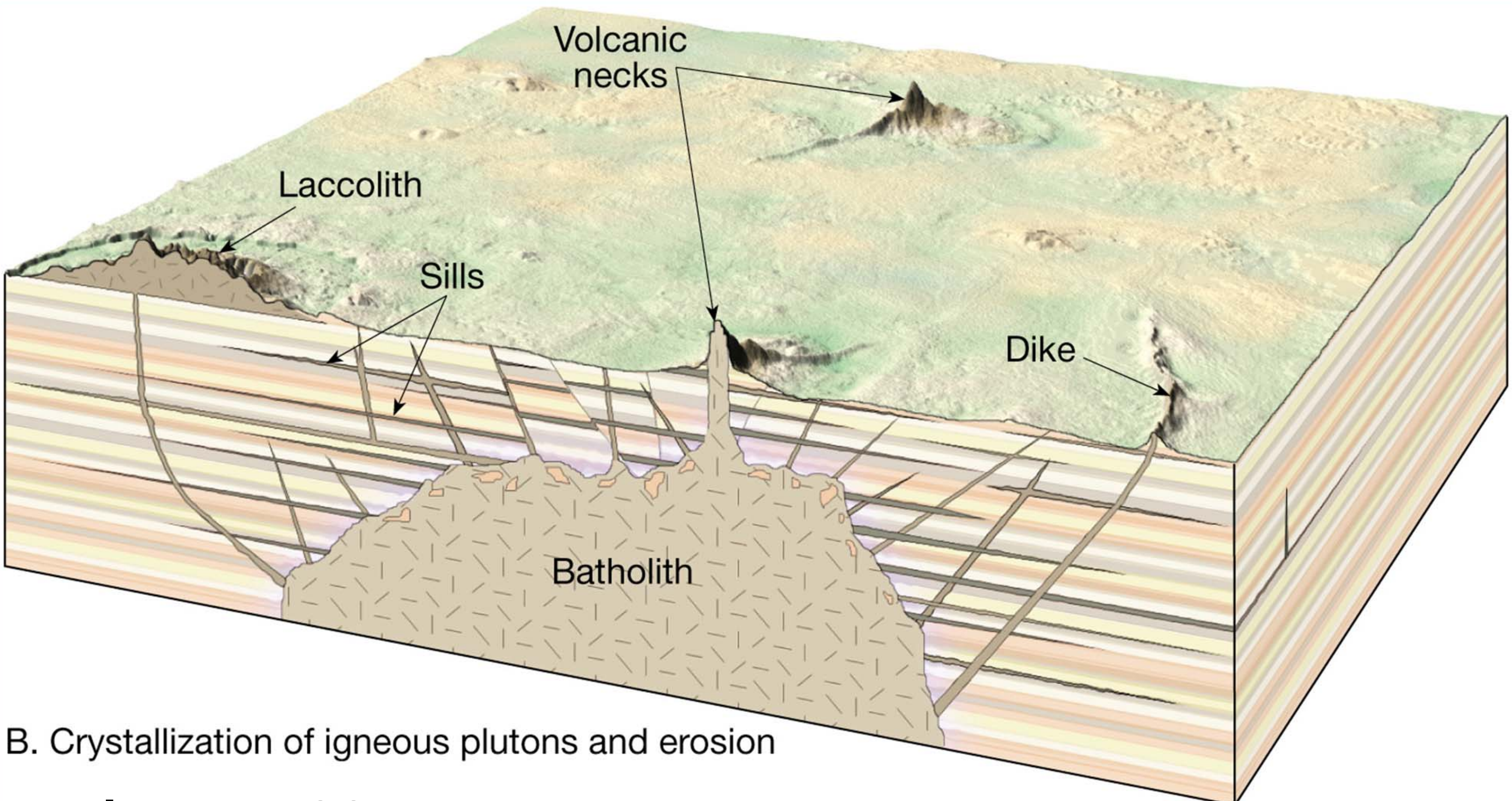
Intrusive Igneous Activity

- **Types of intrusive igneous features**
  - ***Dike*—A tabular, discordant pluton**
  - ***Sill*—A tabular, concordant pluton (e.g., Palisades Sill in New York)**
  - ***Laccolith***
    - **Similar to a sill**
    - **Lens or mushroom-shaped mass**
    - **Arches overlying strata upward**

Igneous Structures



B. Crystallization of igneous plutons and erosion

Figure 7.22 B

A Sill in the Salt River Canyon, Arizona

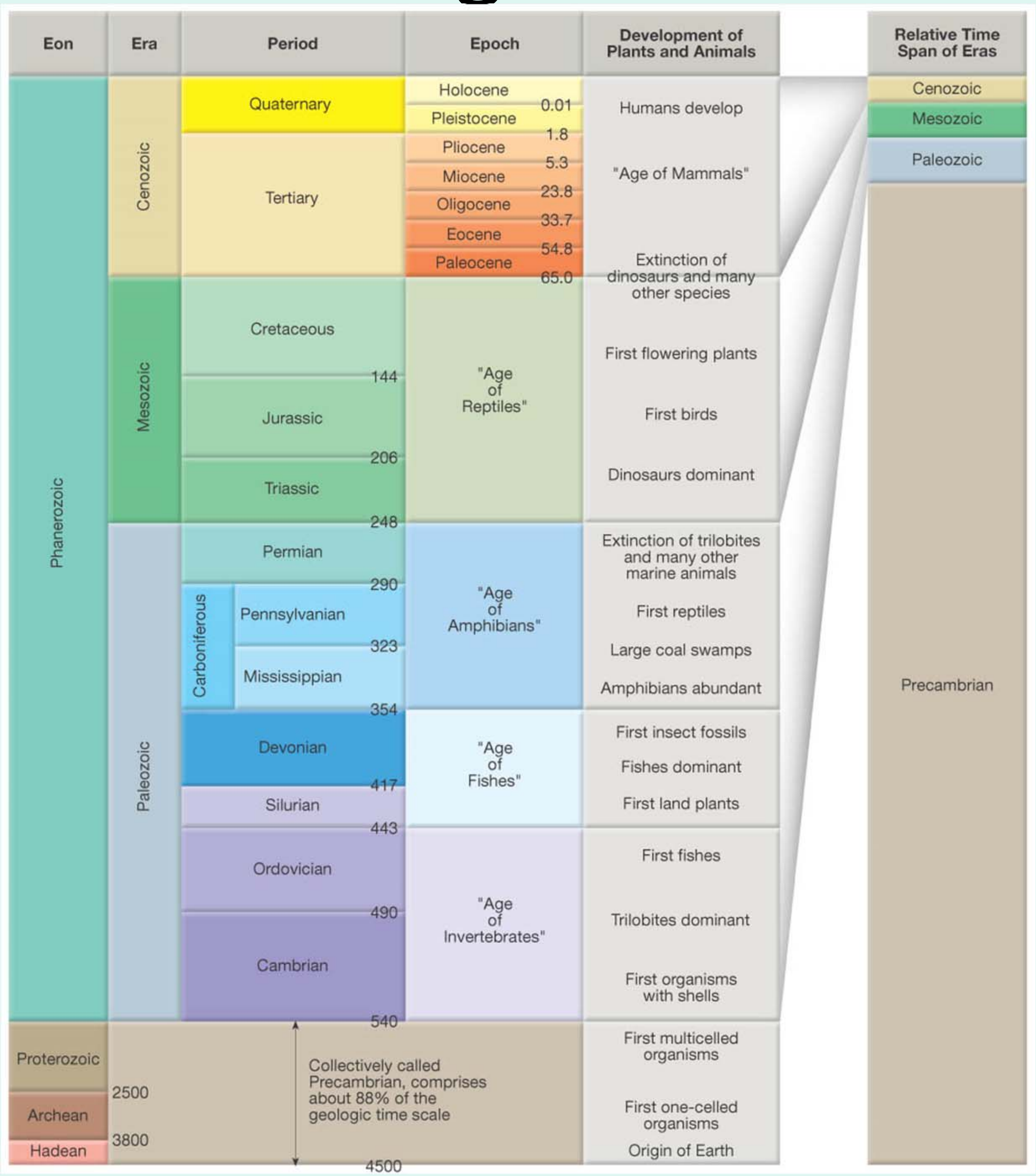
Figure 7.23

Intrusive Igneous Activity

- **Intrusive igneous features continued**
  - ***Batholith***
    - **Largest intrusive body**
    - **Surface exposure > 100+ km^2 (smaller bodies are termed *stocks*)**
    - **Frequently form the cores of mountains**

Chapter 8
Geologic Time

Geologic Time



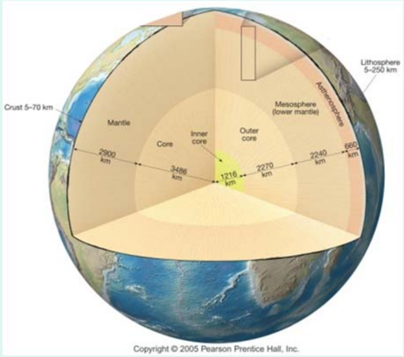
Historical Estimates of Geologic Time

Augustine of Hippo (354-430 AD) established the AD and BC time scale

James Ussher, mid-1600s, concluded Earth was only a few thousand years old – landscapes created by disasters that no longer occur presently

Historical Estimates of Geologic Time

George Louis de Buffon (1707 -1788) estimated the earth to be 96,000 years old based on cooling rates of iron

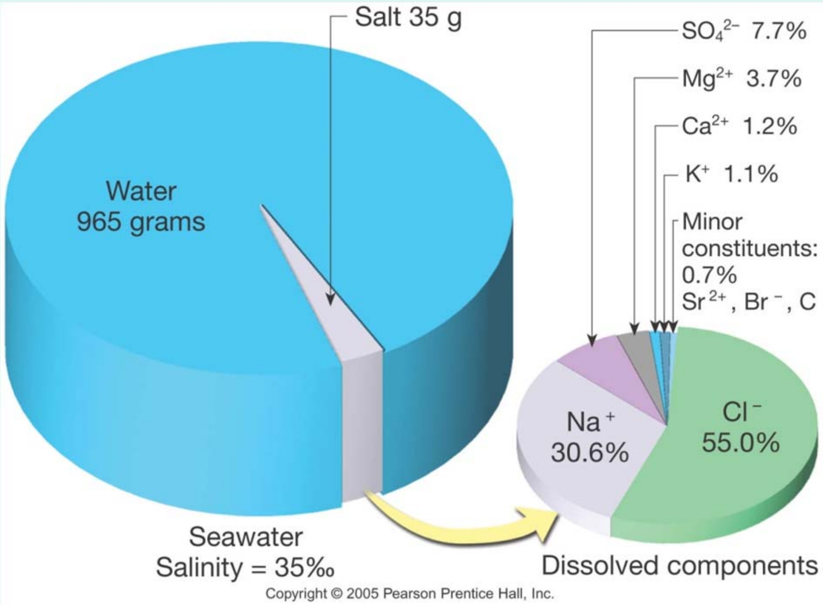


Abraham Werner (1749-1817) All rocks were precipitated in an orderly sequence from a world wide ocean

Primitive Rocks	**Oldest Rocks**
Transition Rocks	**Early fossils and sed rocks**
Secondary Rocks	**Later fossils and sed rocks**
Alluvial Rocks	**Unconsolidated Sediment**

Historical Estimates of Geologic Time

John Joly (1899) earth 90 million years old based on ocean salinity



Historical Notes

Catastrophism

- Landscape developed by catastrophes
- James Ussher, mid-1600s, concluded Earth was only a few thousand years old

Modern geology

- Uniformitarianism
  - Fundamental principle of geology
  - "The present is the key to the past"

Historical Notes

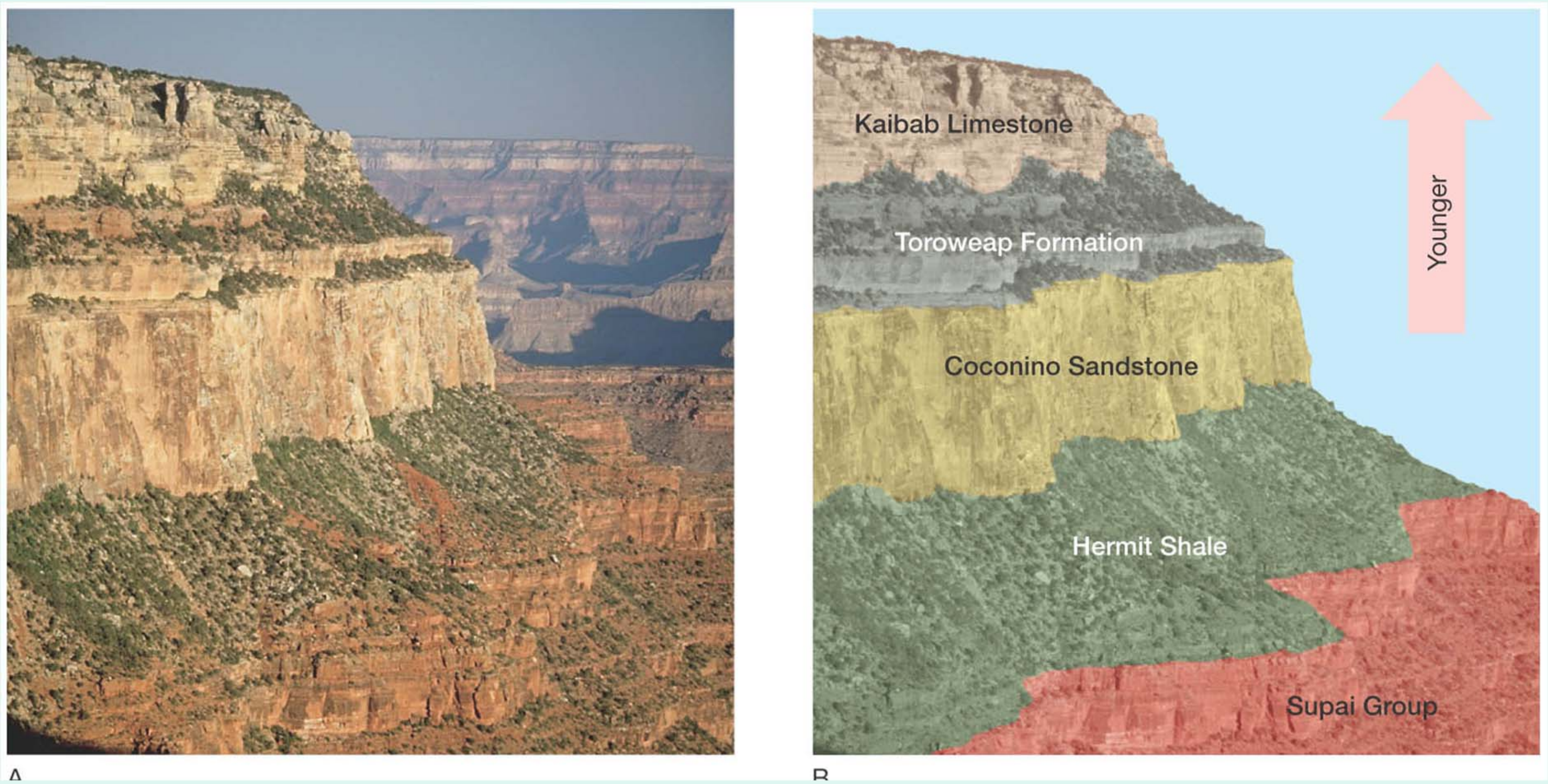
- Modern geology
  - James Hutton
    - *Theory of the Earth*
    - Published in the late 1700s

Charles Lyell – also advanced the theory of Uniformitarianism

Relative Dating

- **Law of superposition**
  - **Developed by Nicolaus Steno in 1669**
  - **In an undeformed sequence of sedimentary rocks (or layered igneous rocks), the oldest rocks are on the bottom**

Superposition Is Well Illustrated by the Strata in the Grand Canyon



Relative Dating

- **Principle of original horizontality**
  - **Layers of sediment are generally deposited in a horizontal position**
  - **Rock layers that are flat have not been disturbed**

Relative Dating

- **Principle of cross-cutting relationships**
  - **Younger features cut across older features**

Cross-Cutting Relationships

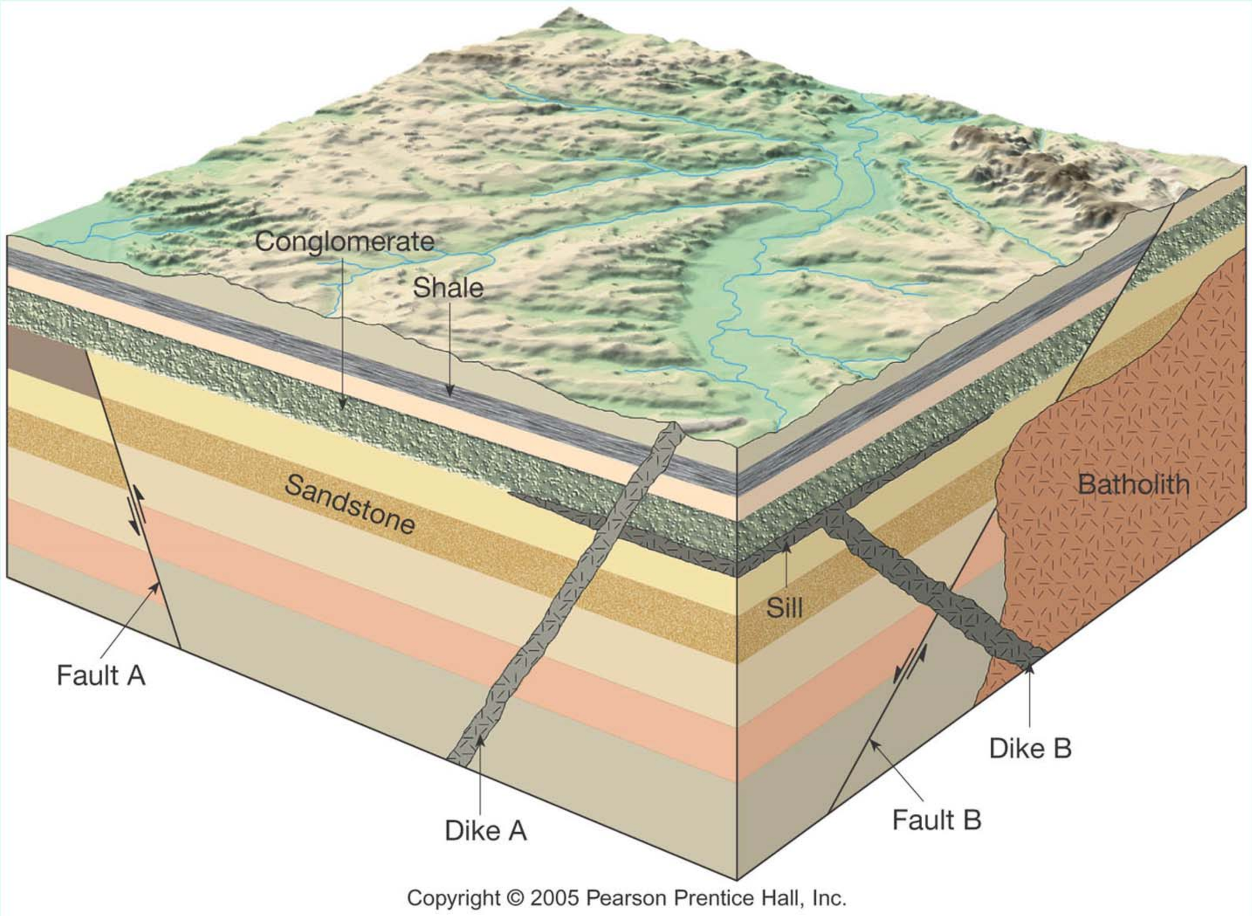


Figure 8.4

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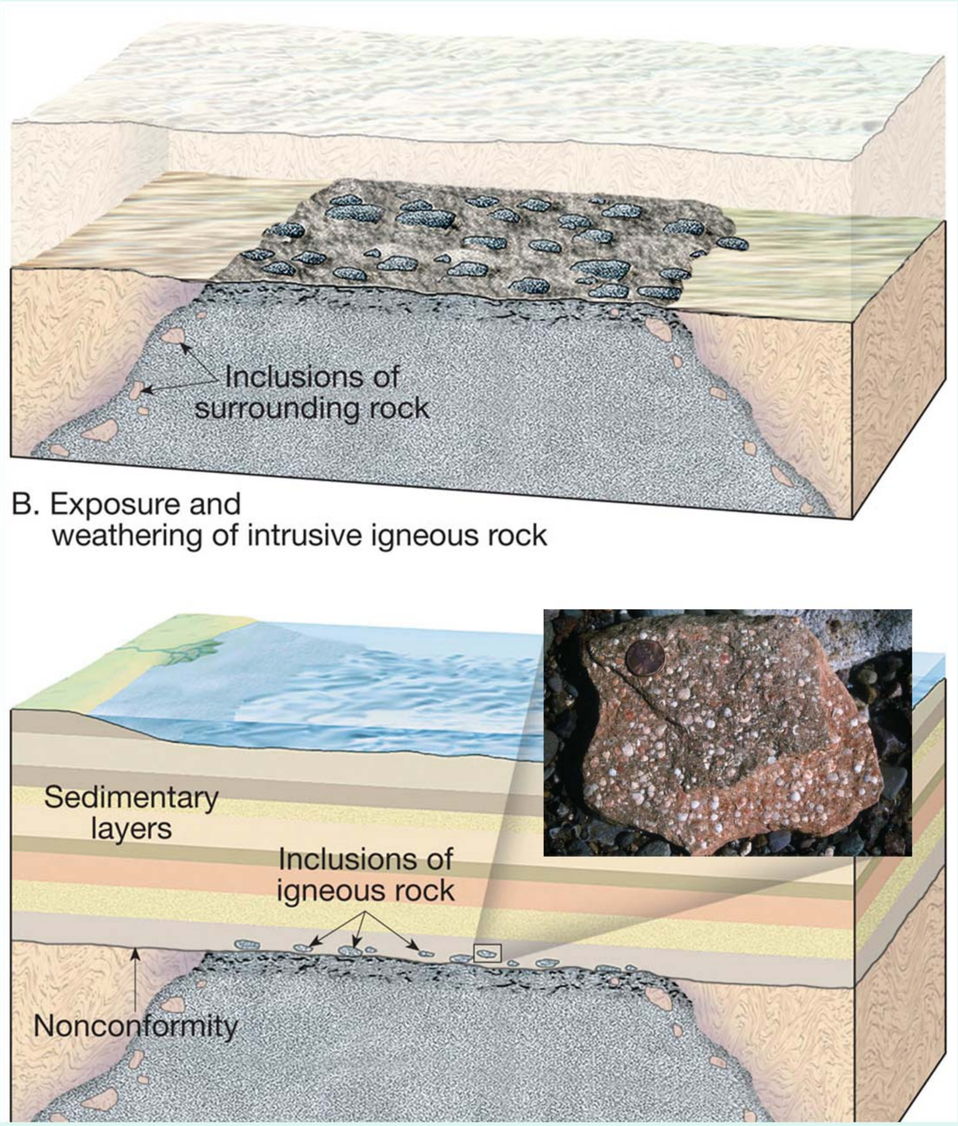
Relative Dating

- Inclusions
  - An inclusion is a piece of rock that is enclosed within another rock
  - Rock containing the inclusion is younger

Relative Dating - Inclusions



Relative Dating

Unconformity

- **An unconformity is a break in the rock record produced by erosion and/or nondeposition of rock units**

Relative Dating

- **Unconformity**
  - **Types of unconformities**
    - ***Angular unconformity*—Tilted rocks are overlain by flat-lying rocks**
    - ***Disconformity*—Strata on either side of the unconformity are parallel**
    - ***Nonconformity*—Metamorphic or igneous rocks in contact with sedimentary strata**

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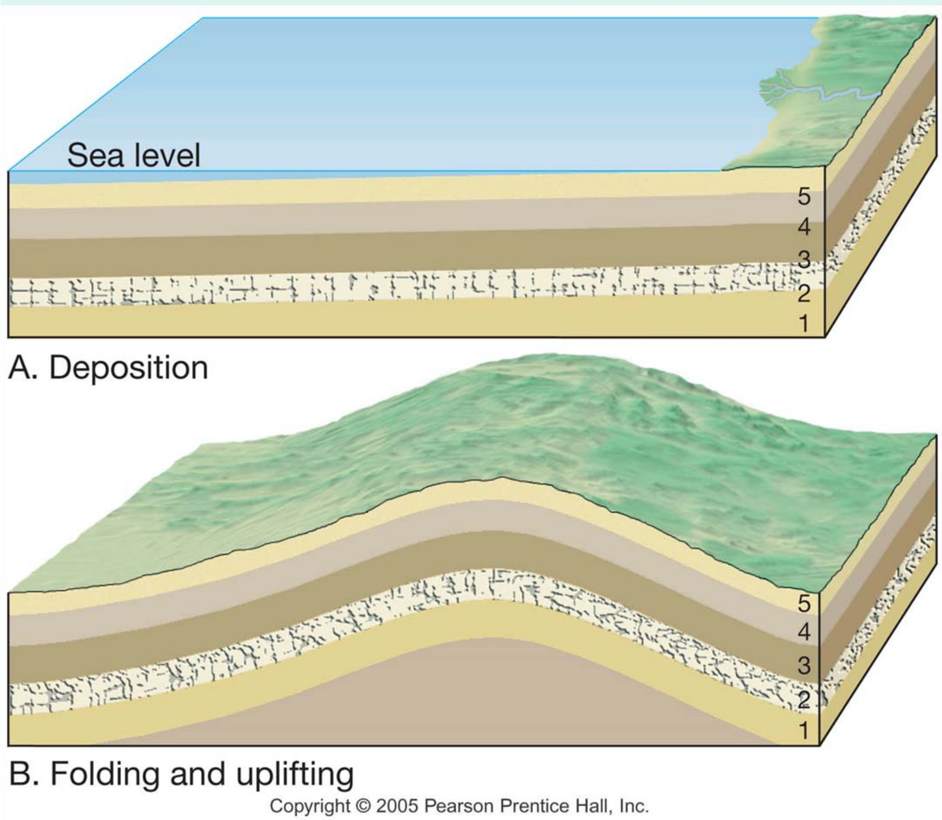
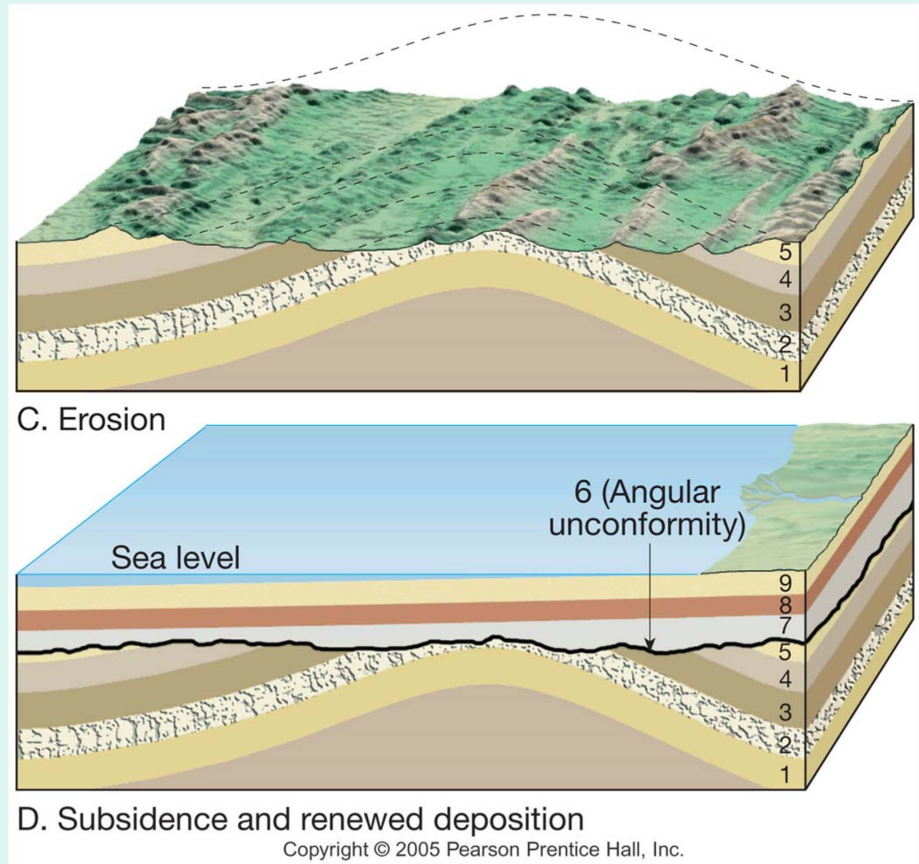
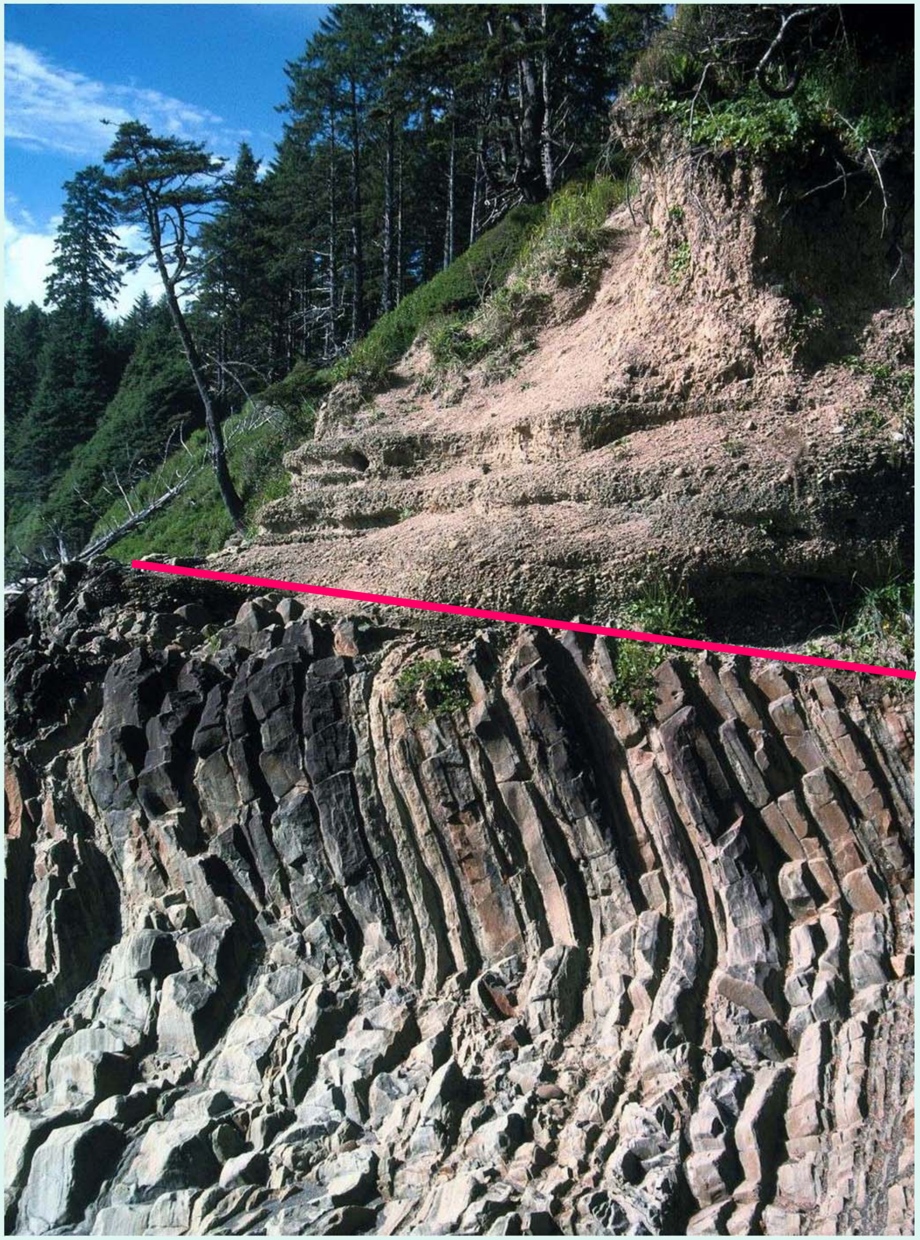
Relative Dating - Angular Unconformity

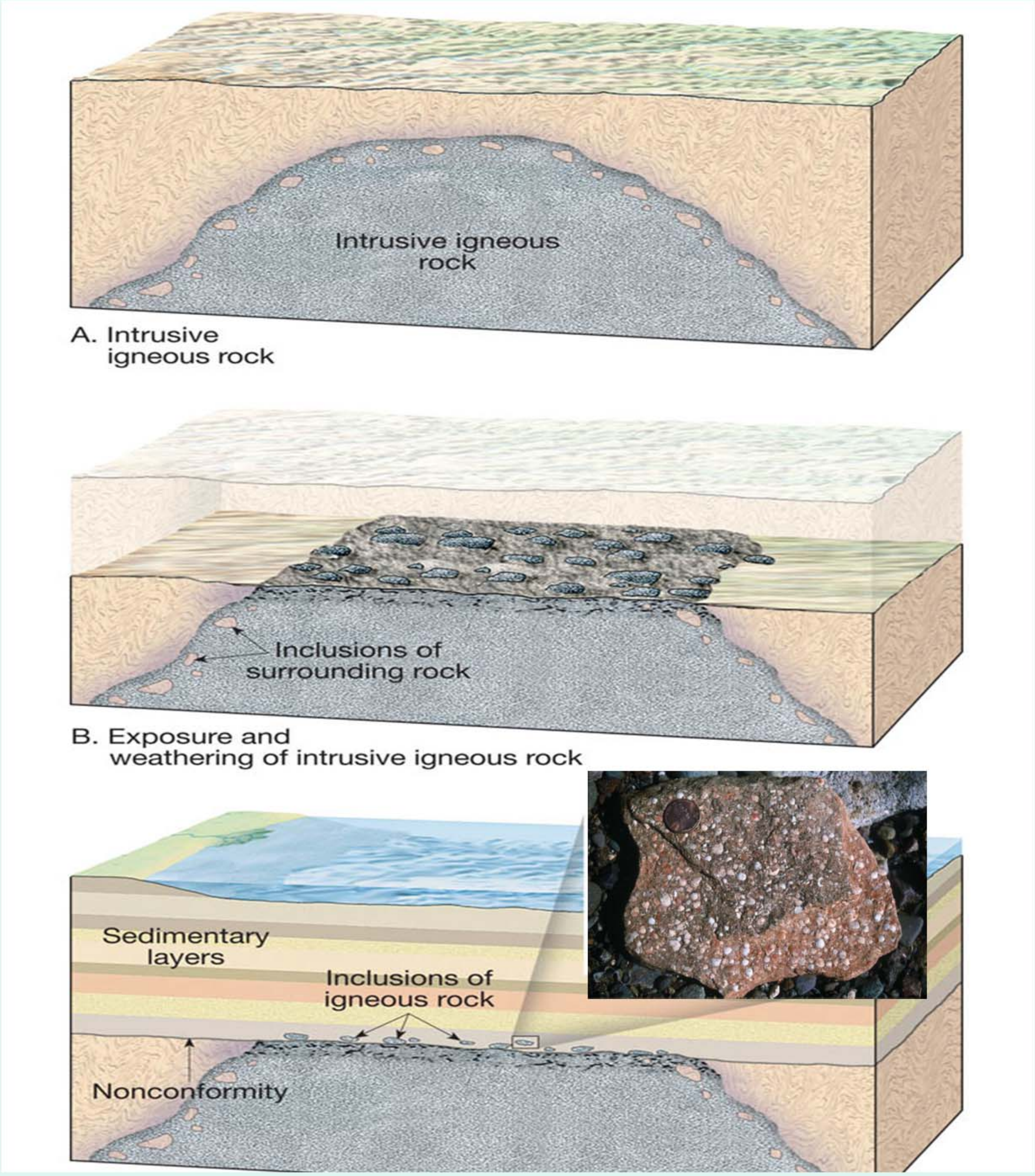




Relative Dating - Angular Unconformity



Relative Dating – Nonconformity

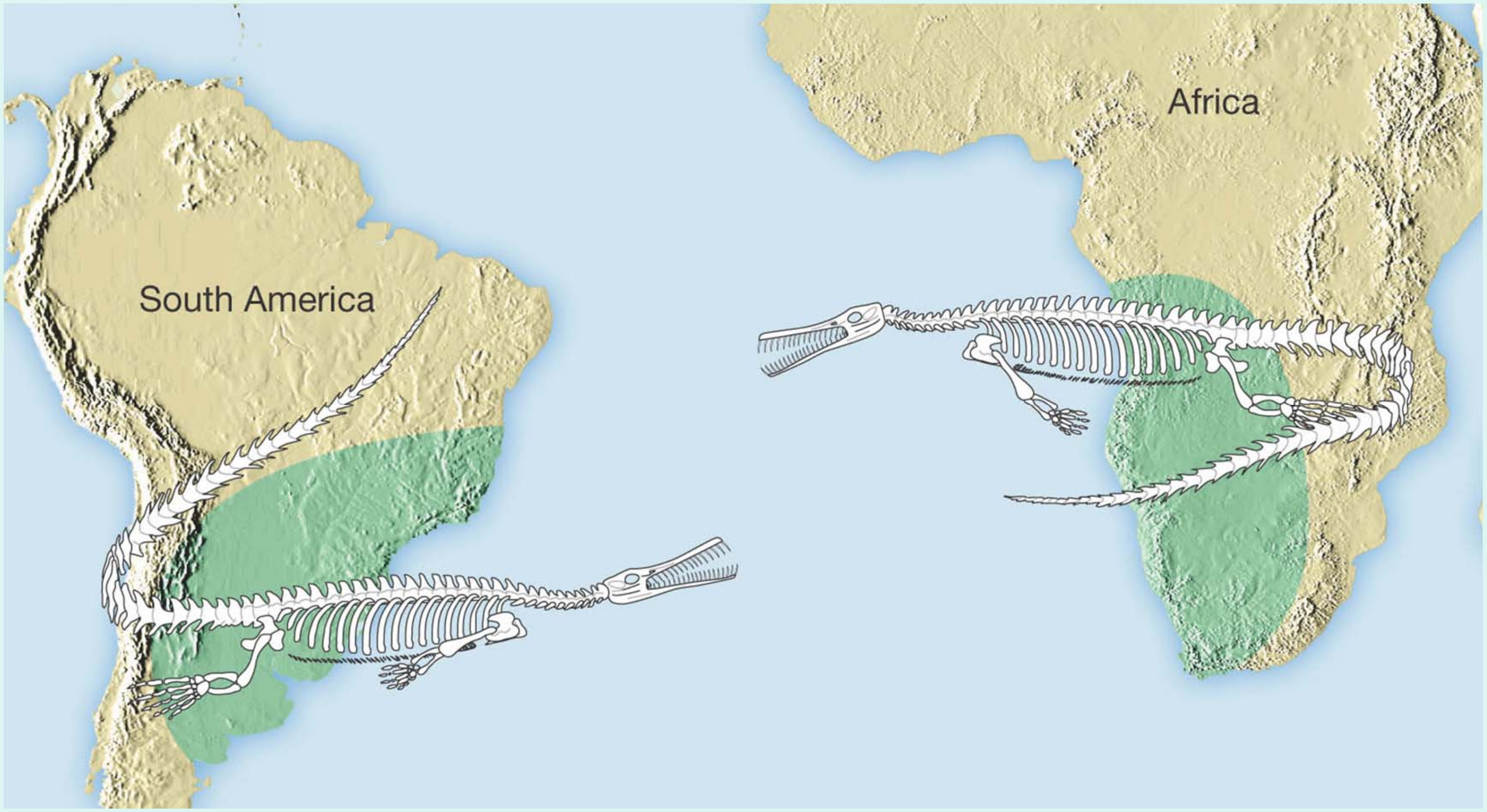


Relative Dating - Nonconformity

Relative Dating – Disconformities

Fossils and Correlation

Matching of rocks of similar ages in different regions is known as *correlation*



Fossils and Correlation

Correlation often relies upon fossils

William Smith (late 1700s) noted that sedimentary strata in widely separated area could be identified and correlated by their distinctive fossil content

Fossils and Correlation

- ***Principle of fossil succession*—Fossil organisms succeed one another in a definite and determinable order, and therefore any time period can be recognized by its fossil content**
- ***Index fossil*—Geographically widespread fossil that is limited to a short span of geologic time**

Dating Rocks Using Overlapping Fossil Ranges

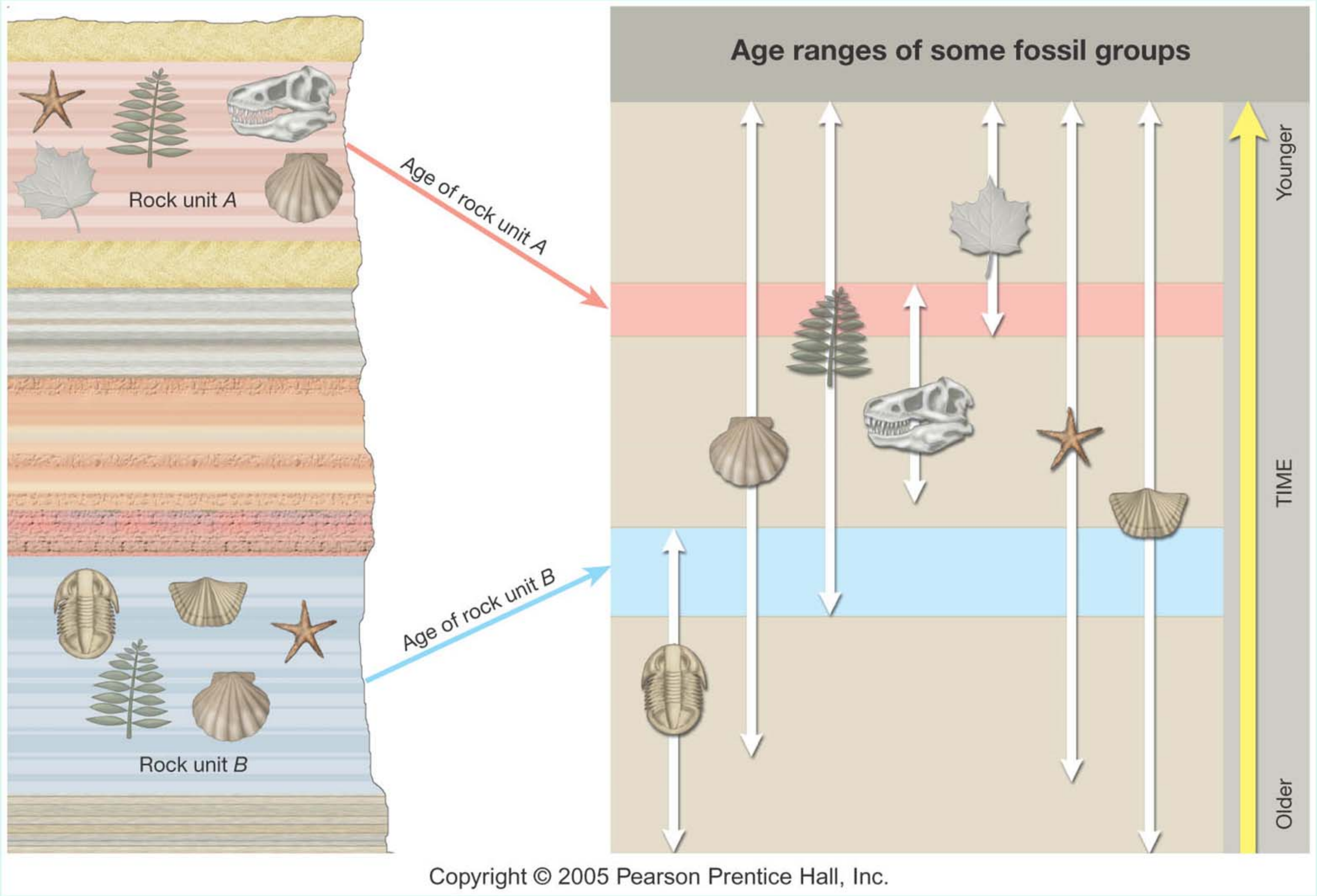
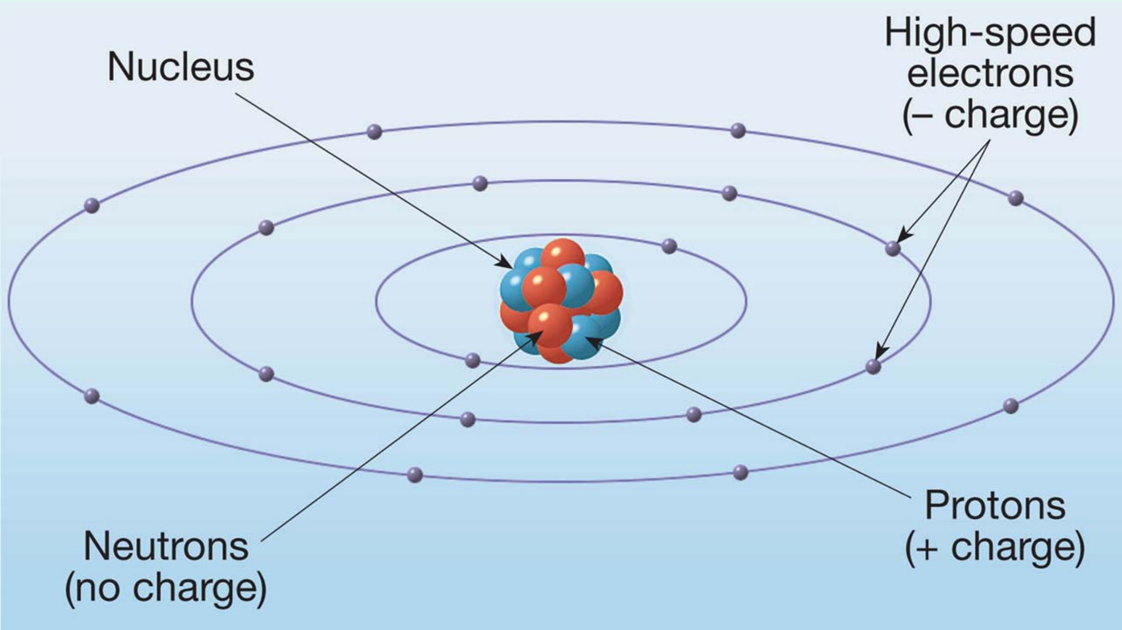


Figure 8.10

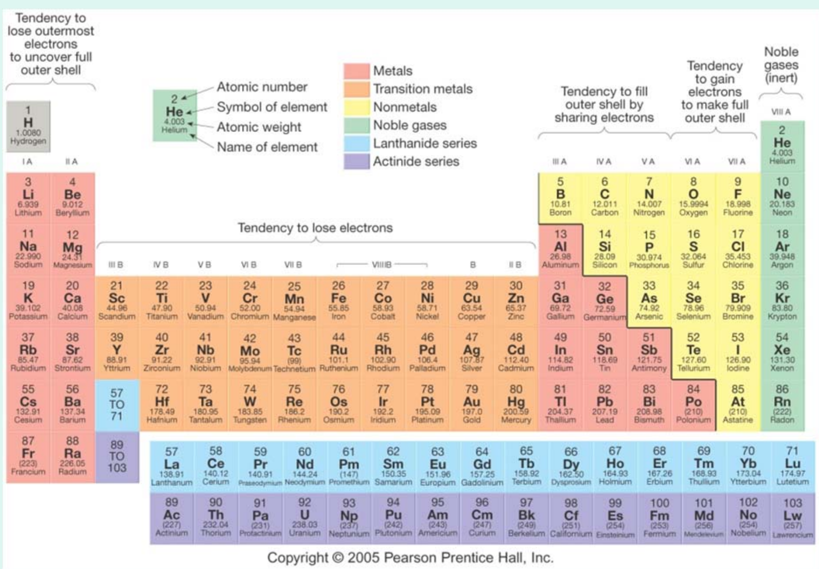
Dating with Radioactivity

- **Reviewing basic atomic structure**
  - ***Nucleus***
    - ***Protons*** **= + charged particles with mass**
    - ***Neutrons*** **= neutral particles with mass**
    - ***Electrons*** **= - charged particles that orbit the nucleus**



Dating with Radioactivity

- **Reviewing basic atomic structure**
  - ***Atomic number***
    - **Element's identifying number**
    - **Equal to the number of protons**
  - ***Mass number***
    - **Sum of the number of protons and neutrons**



O^{16}_{8} U^{235}_{92}

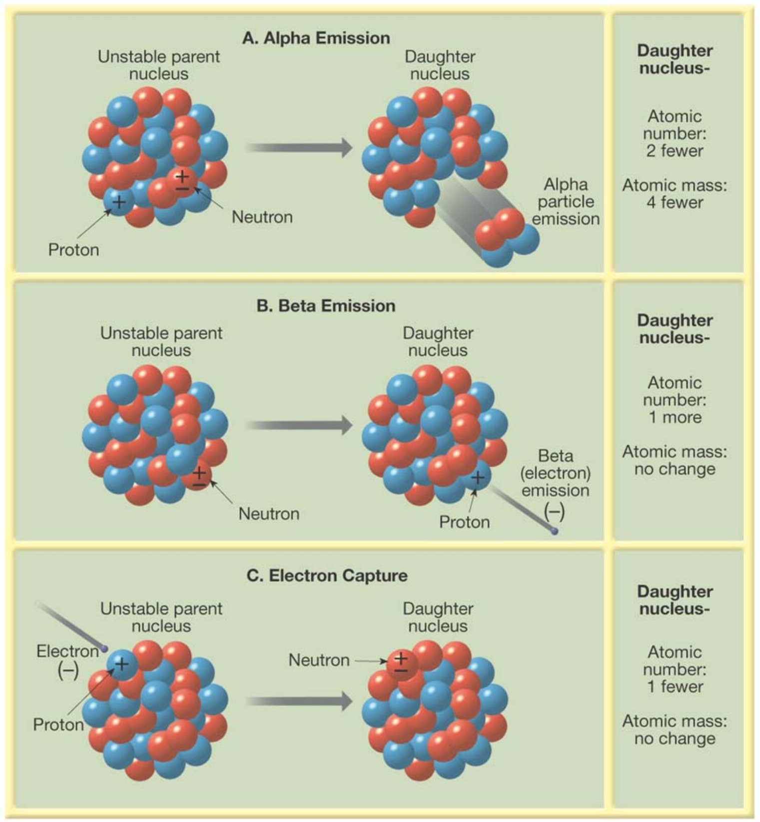
Dating with Radioactivity

- **Reviewing basic atomic structure**
  - ***Isotope***
    - **Variant of the same parent atom**
    - **Differs in the number of neutrons**
    - **Results in a different mass number than the parent atom**

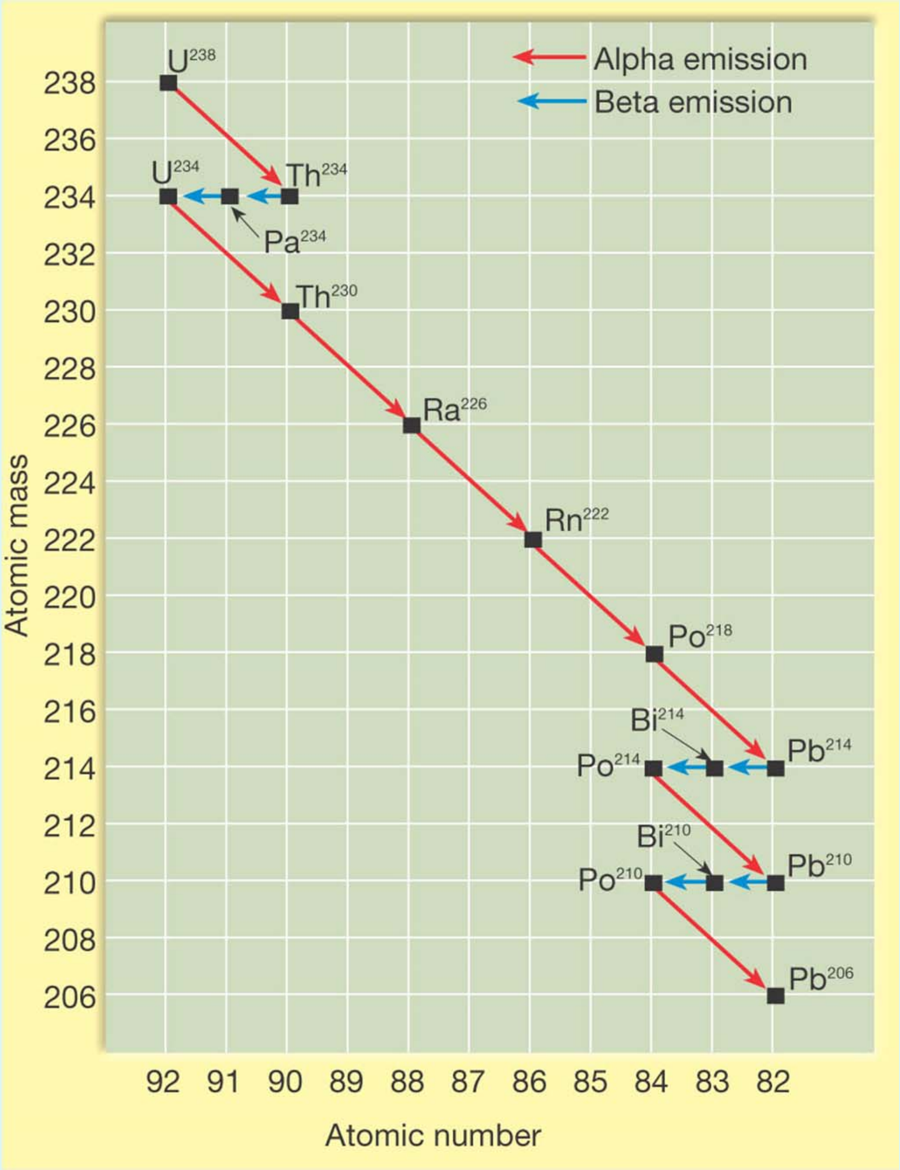
U^{235}_{92} U^{236}_{92} U^{237}_{92}

Dating with Radioactivity

- **Radioactivity**
  - **Spontaneous changes (decay) in the structure of atomic nuclei**



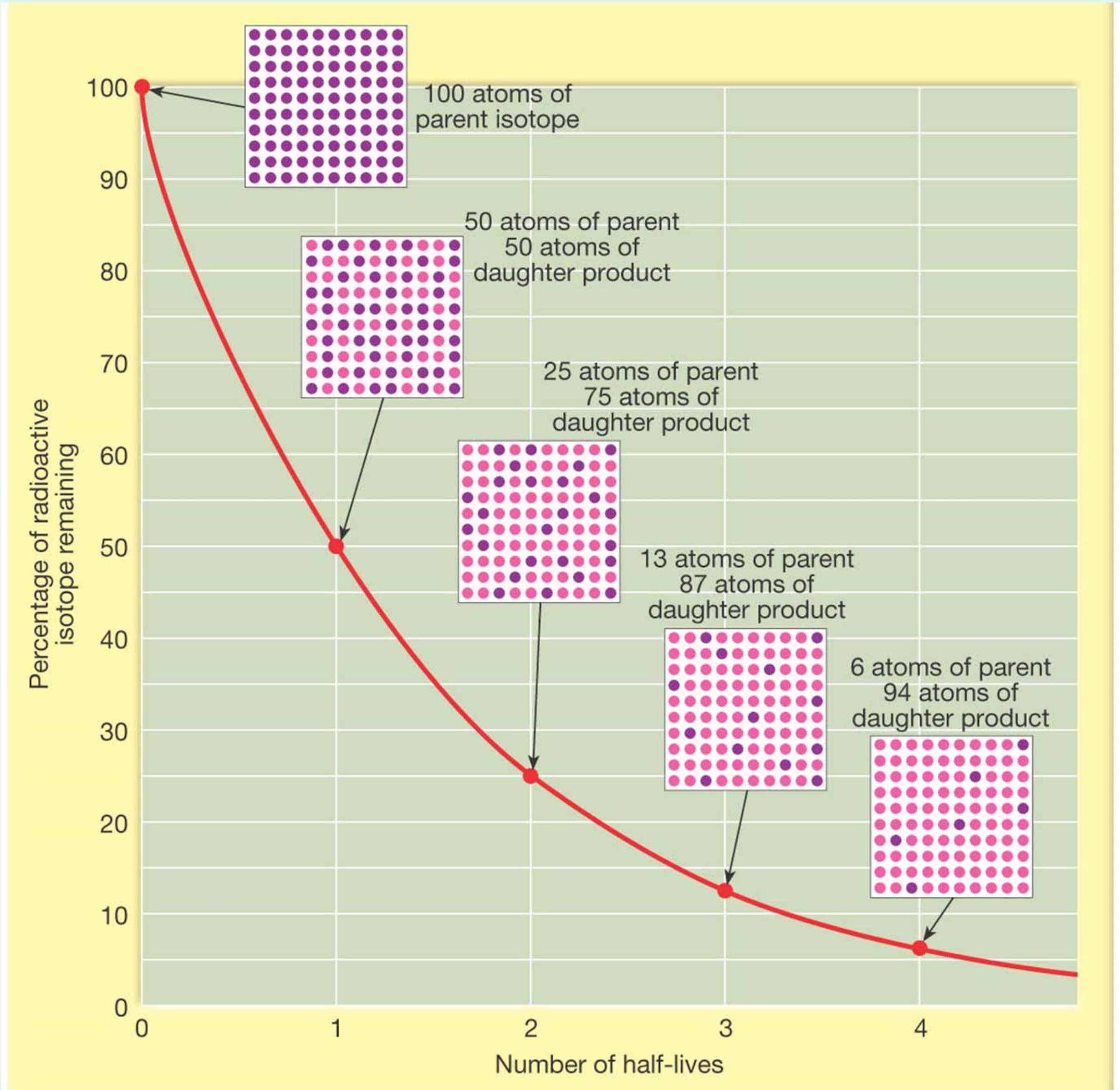
Dating with Radioactivity



Dating with Radioactivity

- ***Parent* —An unstable radioactive isotope**
- ***Daughter product*—The isotopes resulting from the decay of a parent**
- ***Half-life*—The time required for one-half of the radioactive nuclei in a sample to decay**

Dating with Radioactivity



Dating with Radioactivity

Radiometric dating

- **Principle of radioactive dating**
  - The percentage of radioactive atoms that decay during one half-life is always the same (50 percent)
  - However, the actual number of atoms that decay continually decreases
  - Comparing the ratio of parent to daughter yields the age of the sample
  - Decay is not affected by external forces

Dating with Radioactivity

Table 8.1 Radioactive isotopes frequently used in radiometric dating

Radioactive Parent	Stable Daughter Product	Currently Accepted Half-life Values
Uranium-238	Lead-206	4.5 billion years
Uranium-235	Lead-207	713 million years
Thorium-232	Lead-208	14.1 billion years
Rubidium-87	Strontium-87	47.0 billion years
Potassium-40	Argon-40	1.3 billion years

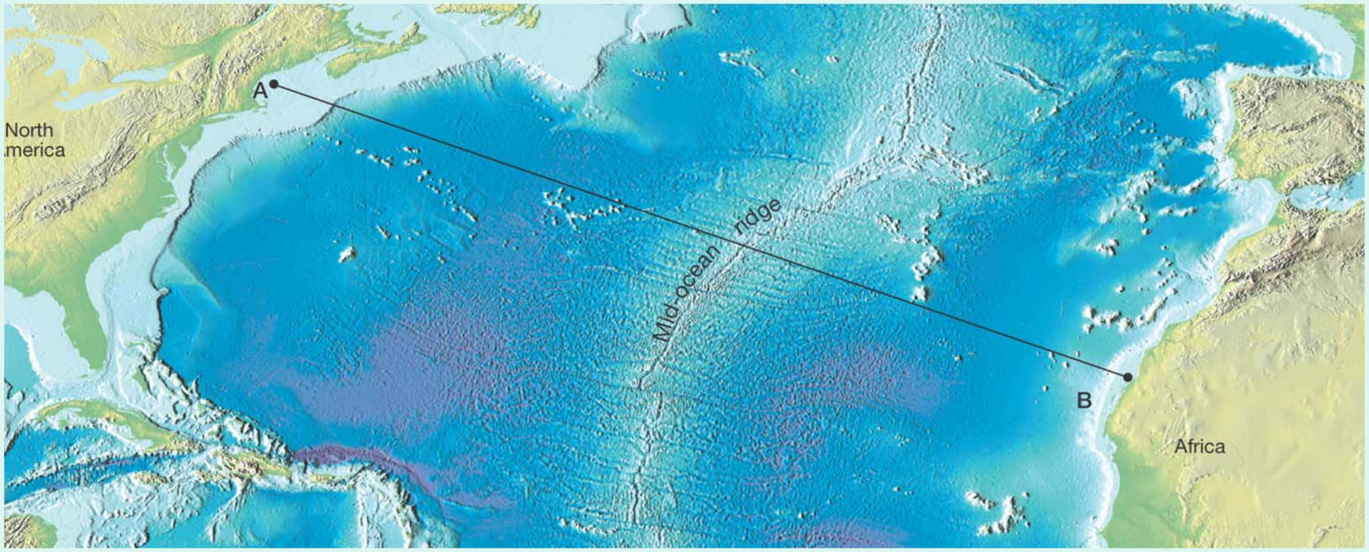
Dating with Radioactivity

- **Radiometric dating**
  - **Sources of error**
    - **A closed system is required**
    - **To avoid potential problems, only fresh, unweathered rock samples should be used**

Dating with Radioactivity

Importance of radiometric dating

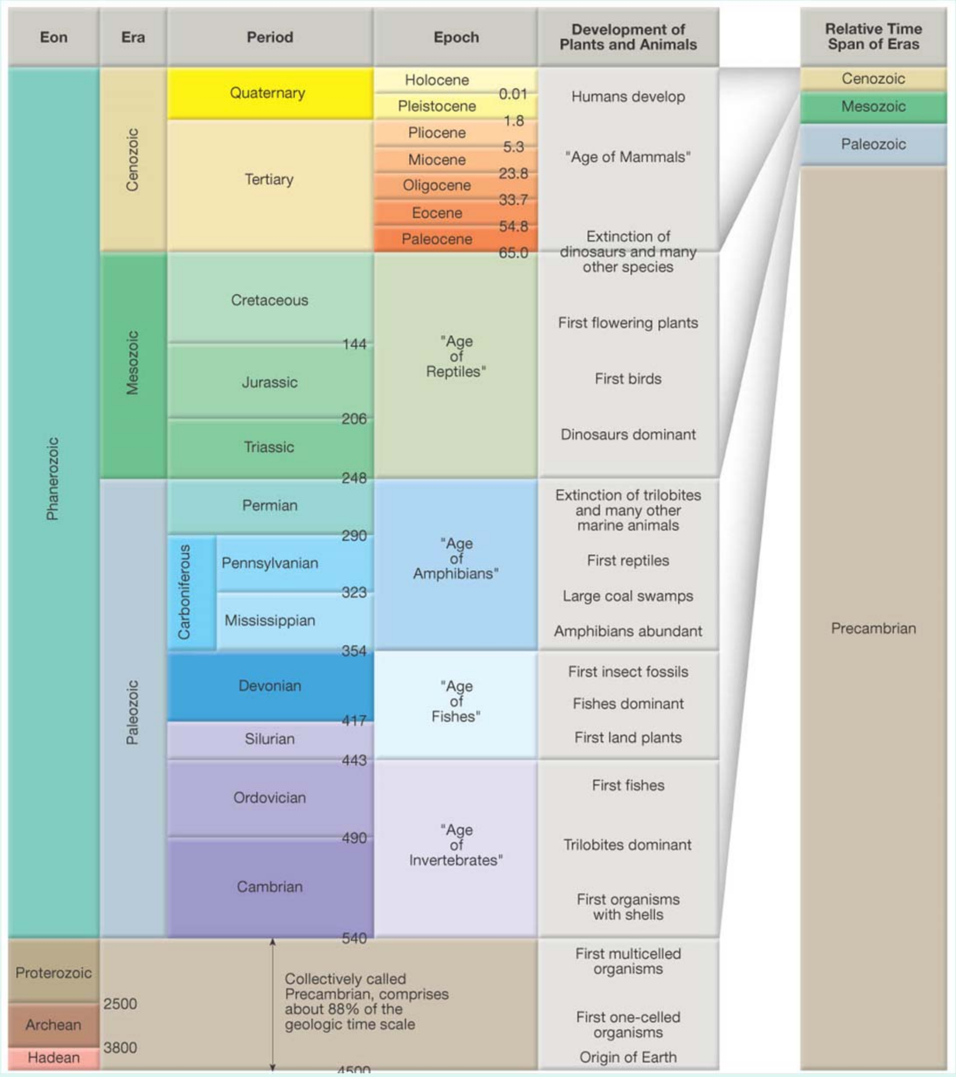
- Rocks from several localities have been dated at more than 3 billion years
- Confirms the idea that geologic time is immense



The Geologic Time Scale

- **The geologic time scale—A "calendar" of Earth history**
  - **Subdivides geologic history into units**
  - **Originally created using relative dates**
- **Structure of the geologic time scale**
  - ***Eon*—The greatest expanse of time**

The Geologic Time Scale



The Geologic Time Scale

- **Structure of the geologic time scale**
  - **Names of the eons**
    - ***Phanerozoic* ("visible life")—The most recent eon, began about 540 million years ago**
    - ***Proterozoic***
    - ***Archean***
    - ***Hadean*—The oldest eon**

The Geologic Time Scale

- **Structure of the geologic time scale**
  - ***Era*—Subdivision of an eon**
  - **Eras of the Phanerozoic eon**
    - – ***Cenozoic* ("recent life")**
    - – ***Mesozoic* ("middle life")**
    - – ***Paleozoic* ("ancient life")**
  - **Eras are subdivided into *periods***
  - **Periods are subdivided into *epochs***

The Geologic Time Scale

- **Precambrian time**
  - **Nearly 4 billion years prior to the Cambrian period**
  - **Not divided into smaller time units because the events of Precambrian history are not known in great enough detail**
    - **First abundant fossil evidence does not appear until the beginning of the Cambrian**

The Geologic Time Scale

- **Difficulties in dating the geologic time scale**
  - **Not all rocks can be dated by radiometric methods**
    - **Grains comprising detrital sedimentary rocks are not the same age as the rock in which they formed**
    - **The age of a particular mineral in a metamorphic rock may not necessarily represent the time when the rock formed**

The Geologic Time Scale

- **Difficulties in dating the geologic time scale**
  - **Datable materials (such as volcanic ash beds and igneous intrusions) are often used to bracket various episodes in Earth history and arrive at ages**

Bracketing Sedimentary Ages Using Igneous Rocks

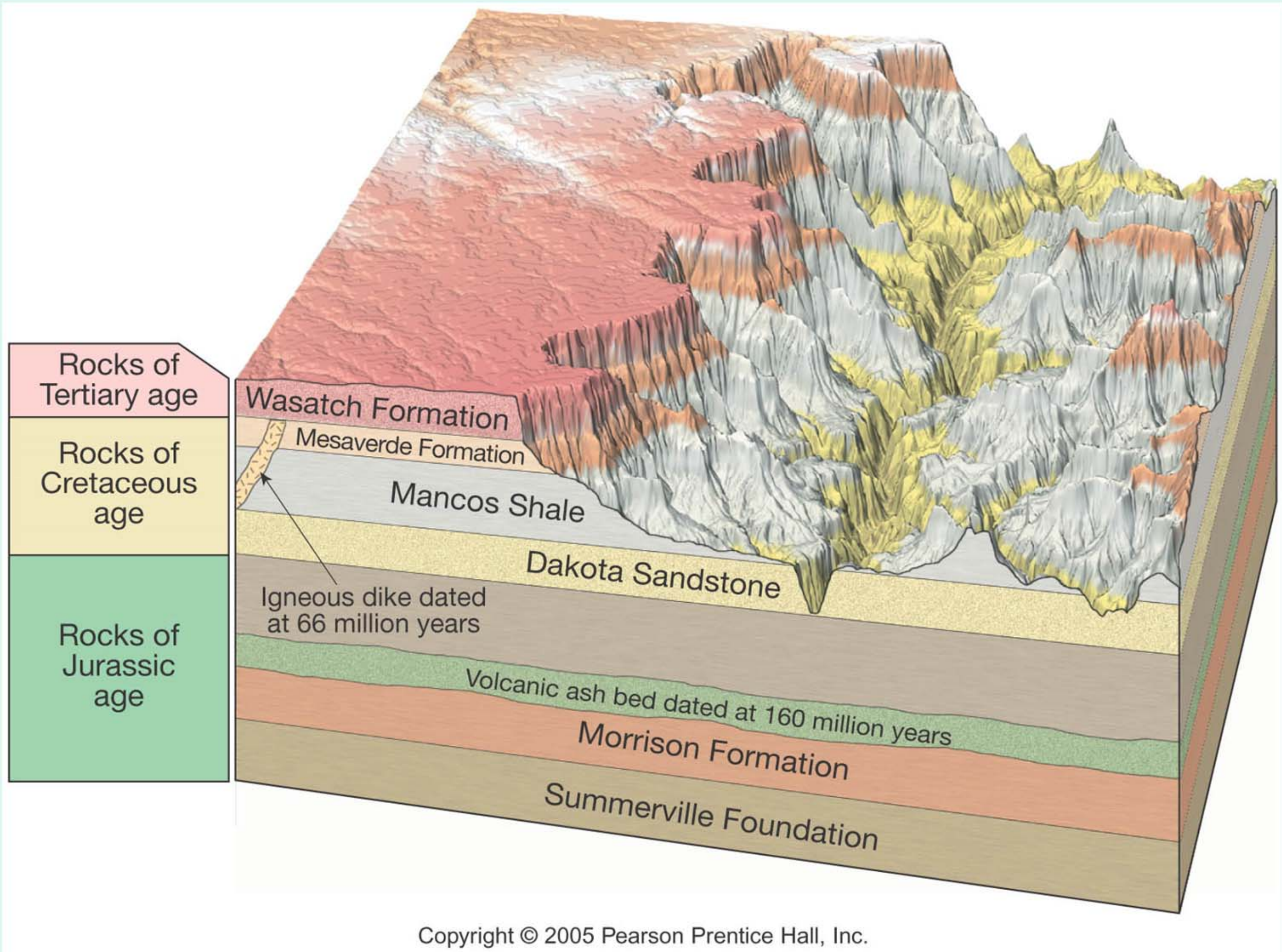


Figure 8.16

Fossils: Evidence of Past Life

- ***Fossil* = traces or remains of prehistoric life now preserved in rock**
- **Fossils are generally found in sediment or sedimentary rock (rarely in metamorphic and never in igneous rock)**
- ***Paleontology* = study of fossils**

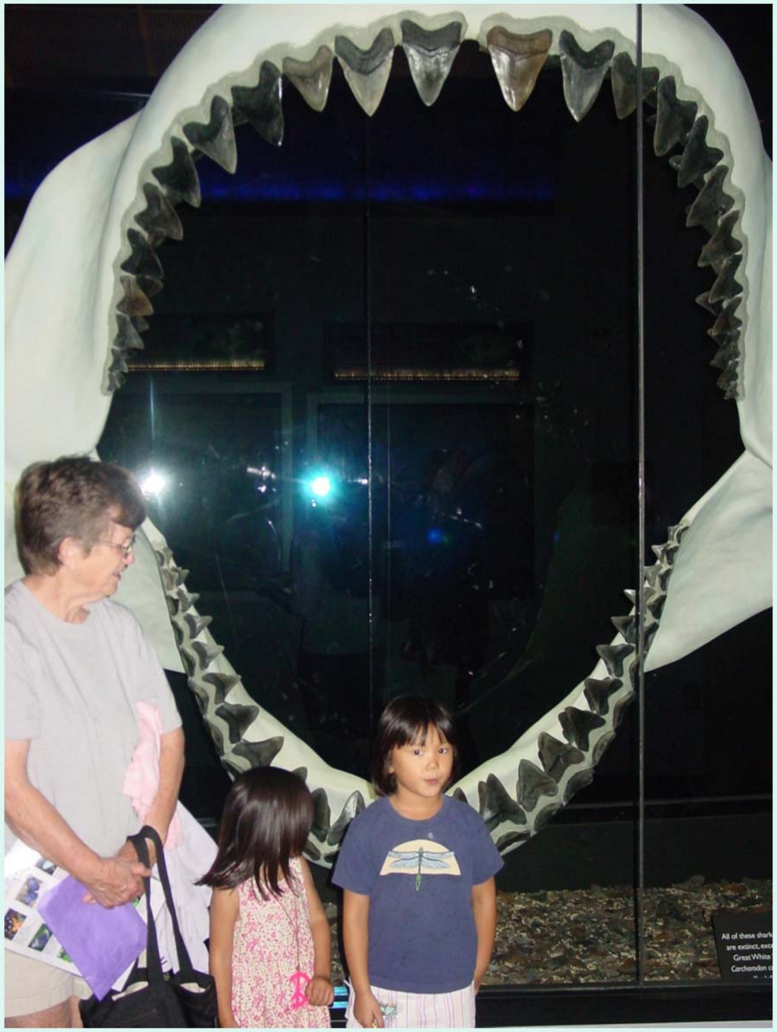
Fossils: Evidence of Past Life

- **Geologically fossils are important because they**
  - **Aid in interpretation of the geologic past**
  - **Serve as important time indicators**
  - **Allow for correlation of rocks from different places**

Fossils: Evidence of Past Life

Conditions favoring preservation

- **Rapid burial**
- **Possession of hard parts (skeleton, shell, etc.)**



End of Chapter 8