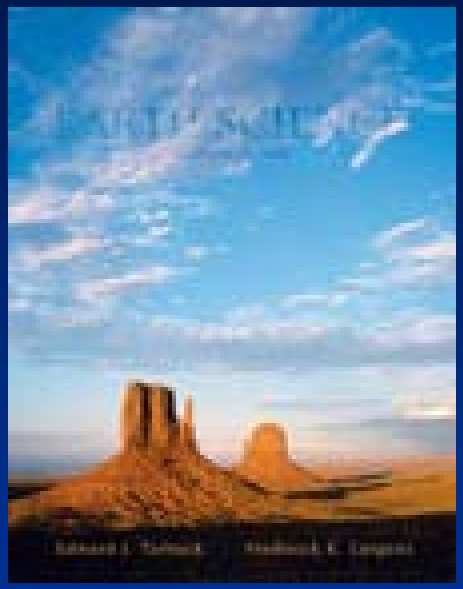


Lecture Outlines PowerPoint

Chapter 11

Earth Science, 12e

Tarbuck/Lutgens

Earth Science, 12e

Geologic Time

Chapter 11

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”

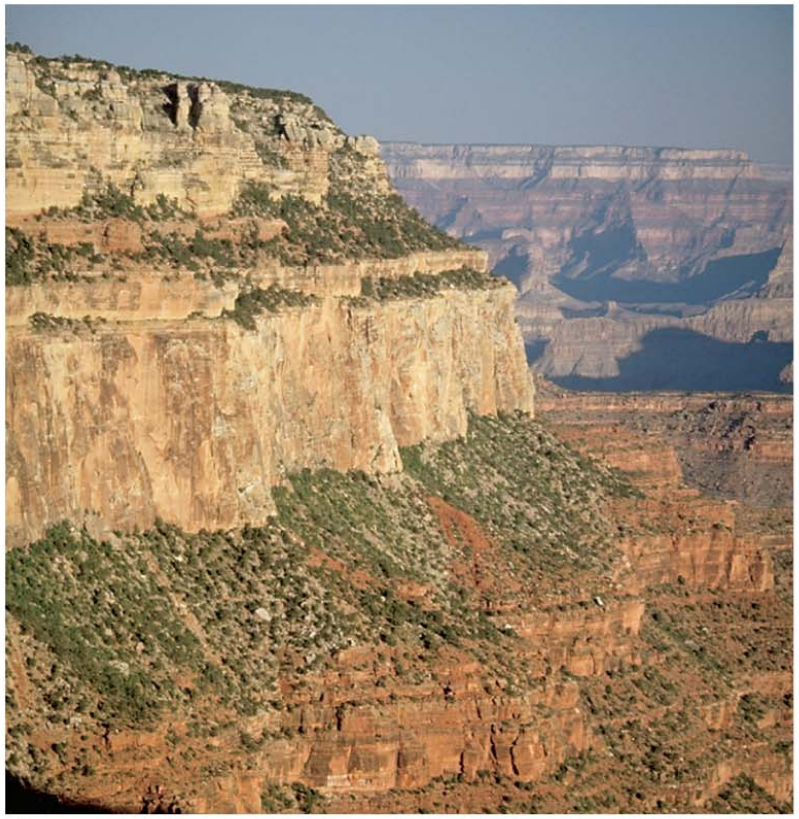
Historical notes

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

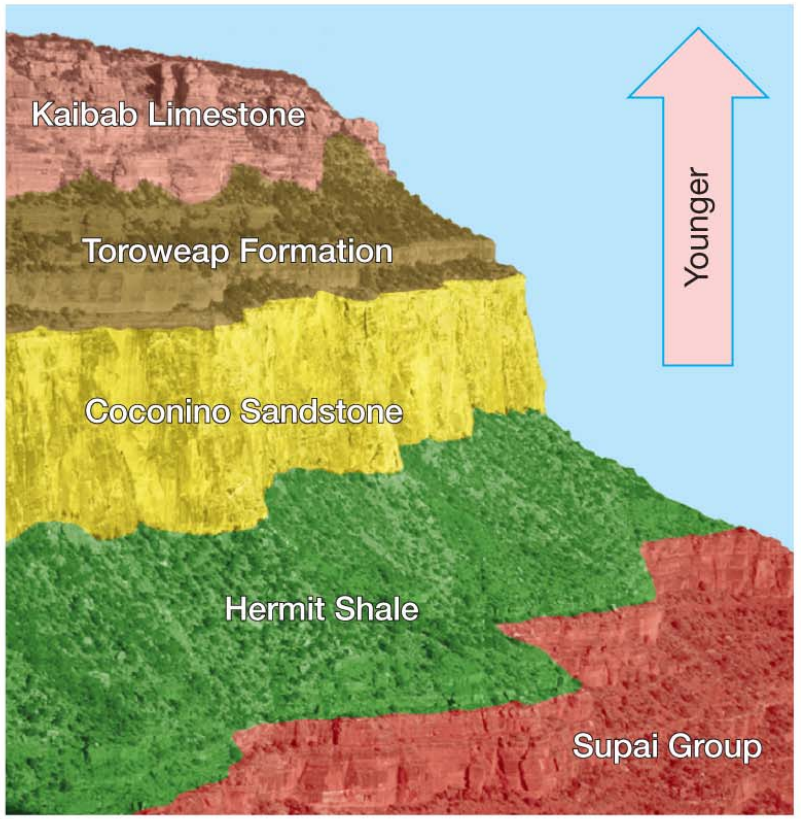
Relative dating

- Placing rocks and events in sequence
- Principles and rules of
  - Law of superposition – oldest rocks are on the bottom
  - Principle of original horizontality – sediment is deposited horizontally
  - Principle of cross-cutting relationships – younger feature cuts through an older feature

Superposition is well illustrated in the Grand Canyon



A.



B.

Figure 11.3

Cross-cutting relationships

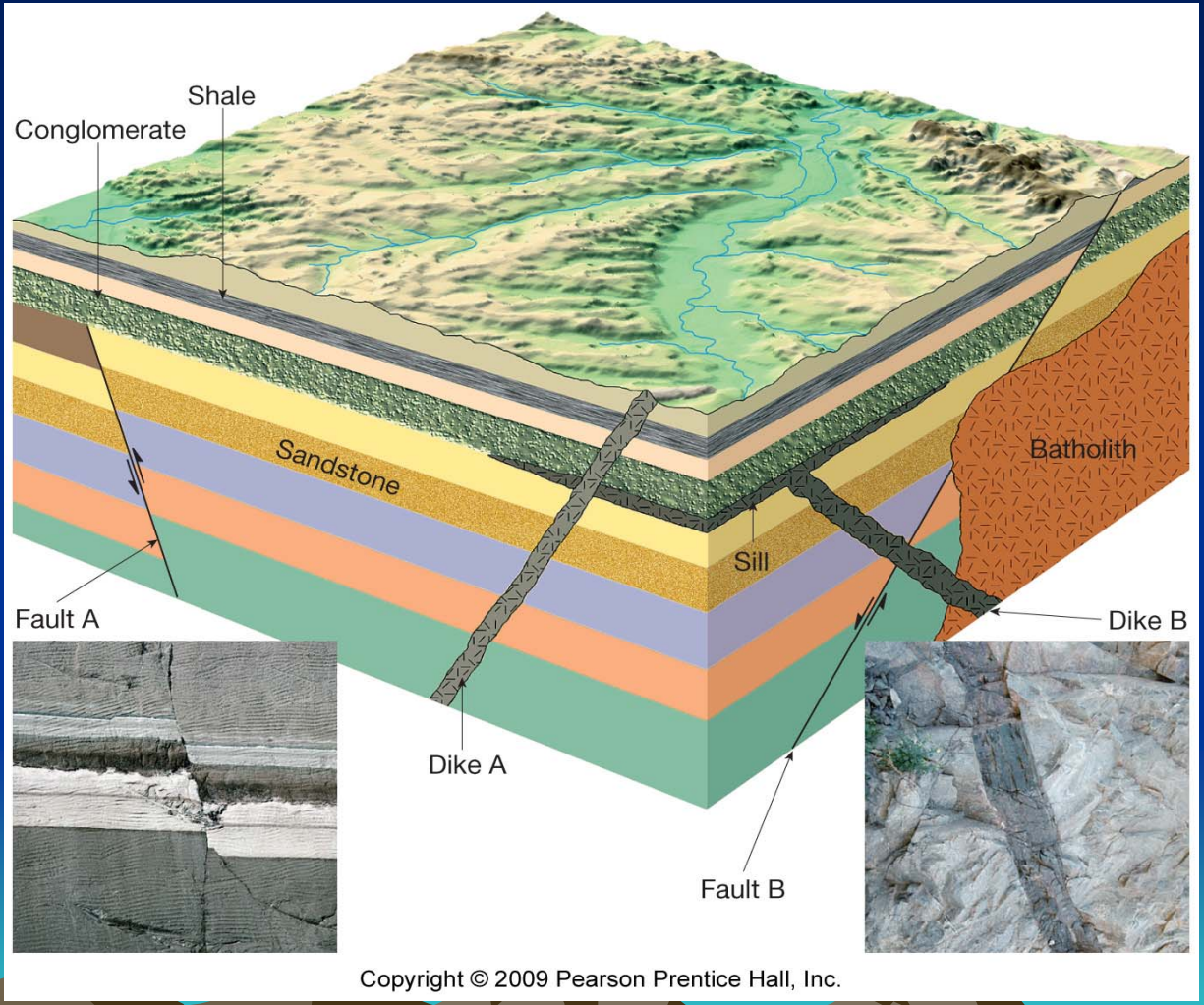
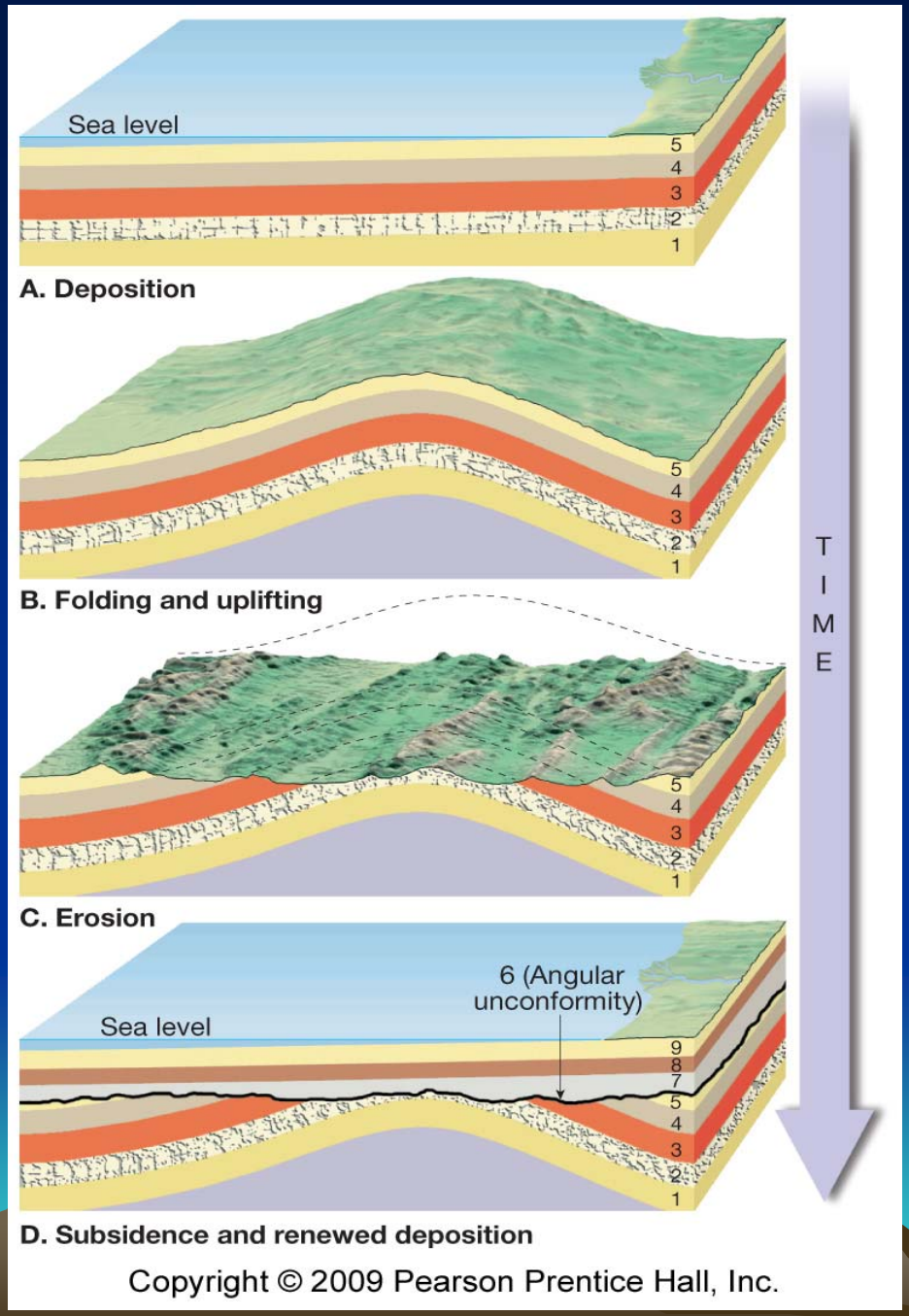


Figure 11.5

Relative dating

- Principles and rules of
  - Inclusions – one rock contained within another (rock containing the inclusions is younger)
  - Unconformities
    - An unconformity is a break in the rock record
    - Types of unconformities
      - Angular unconformity – tilted rocks are overlain by flat-lying rocks
      - Disconformity – strata on either side are parallel



Formation of an angular unconformity

Figure 11.8

Relative dating

- Principles and rules of
  - Unconformities
    - Types of unconformities
      - Nonconformity
        - Metamorphic or igneous rocks below
        - Younger sedimentary rocks above

Several unconformities are present in the Grand Canyon

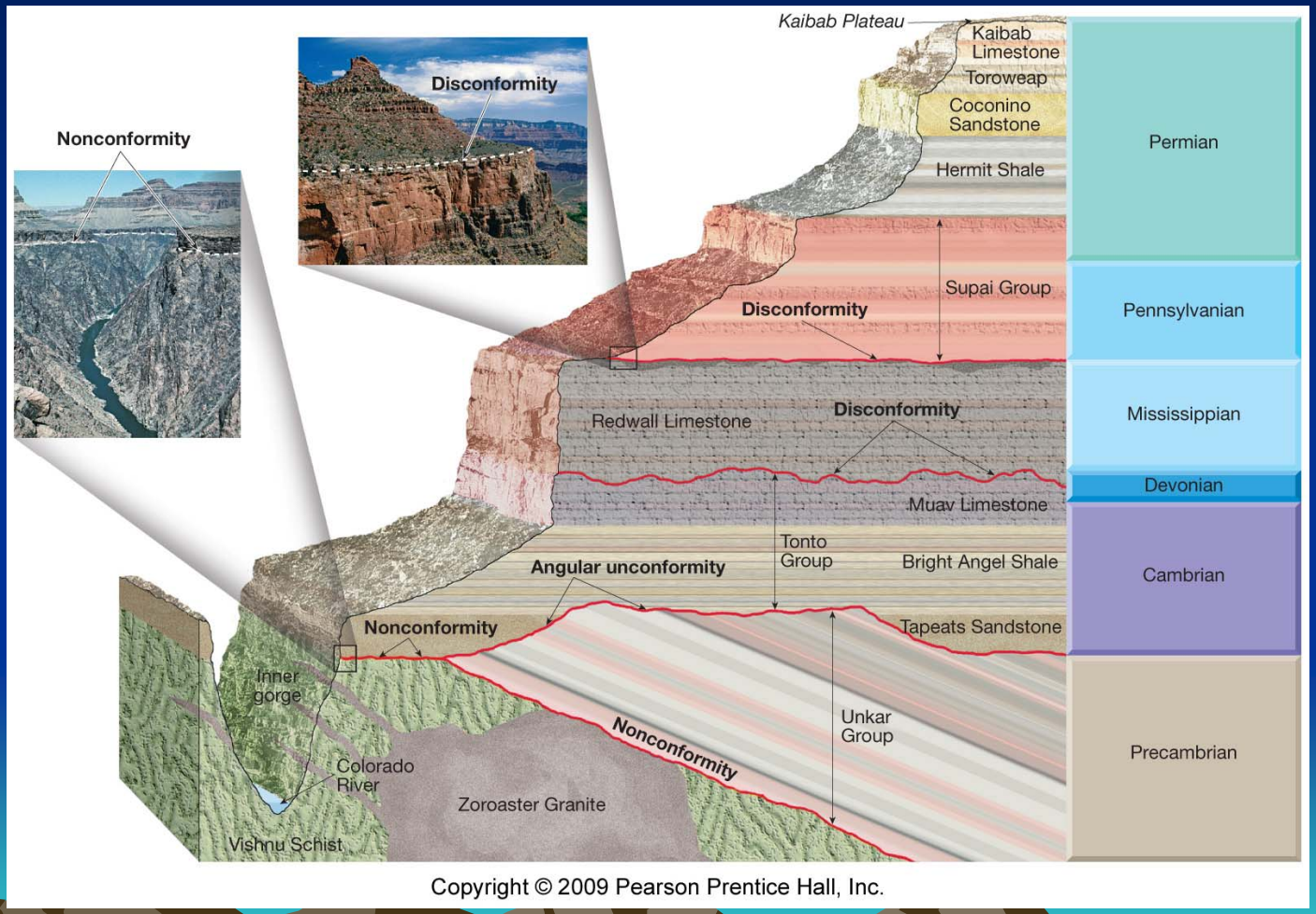


Figure 11.7

Correlation of rock layers

- Matching rocks of similar age in different regions
- Often relies upon fossils

Fossils: evidence of past life

- Remains or traces of prehistoric life
- Types of fossils
  - Petrified – cavities and pores are filled with precipitated mineral matter
  - Formed by replacement – cell material is removed and replaced with mineral matter
  - Mold – shell or other structure is buried and then dissolved by underground water
  - Cast – hollow space of a mold is filled with mineral matter

Fossils: evidence of past life

- Types of fossils
  - Carbonization – organic matter becomes a thin residue of carbon
  - Impression – replica of the fossil's surface preserved in fine-grained sediment
  - Preservation in amber – hardened resin of ancient trees surrounds an organism

Cast and mold of a trilobite

B.

Figure 11.13 B

Fossils: evidence of past life

- Types of fossils
  - Indirect evidence includes
    - Tracks
    - Burrows
    - Coprolites – fossil dung and stomach contents
    - Gastroliths – stomach stones used to grind food by some extinct reptiles

Fossils: evidence of past life

- Conditions favoring preservation
  - Rapid burial
  - Possession of hard parts
- Fossils and correlation
  - Principle of fossil succession
    - Fossils succeed one another in a definite and determinable order
    - Proposed by William Smith – late 1700s and early 1800s

Determining the ages of rocks using fossils

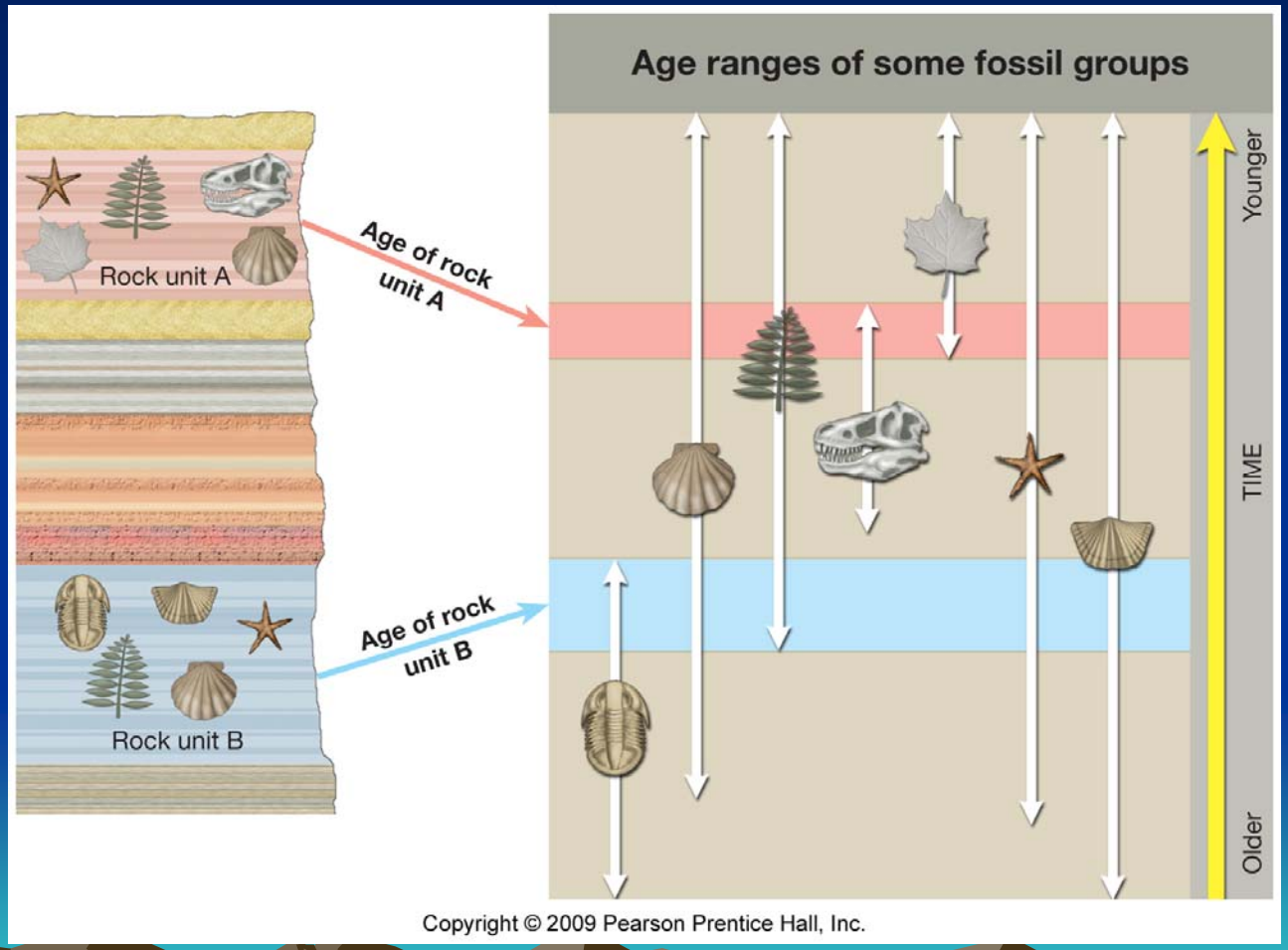


Figure 11.14

Fossils: evidence of past life

- Fossils and correlation
  - Index fossils
    - Widespread geographically
    - Existed for a short range of geologic time

Radioactivity and radiometric dating

- Atomic structure reviewed
  - Nucleus
    - Protons – positively charged
    - Neutrons
      - Neutral charge
      - Protons and electrons combined
  - Orbiting the nucleus are electrons – negative electrical charges

Radioactivity and radiometric dating

- Atomic structure reviewed
  - Atomic number
    - An element's identifying number
    - Number of protons in the atom's nucleus
  - Mass number
    - Number of protons plus (added to) the number of neutrons in an atom's nucleus
    - Isotope
      - Variant of the same parent atom
      - Different number of neutrons and mass number

Radioactivity and radiometric dating

- Radioactivity
  - Spontaneous breaking apart (decay) of atomic nuclei
  - Radioactive decay
    - Parent – an unstable isotope
    - Daughter products – isotopes formed from the decay of a parent

Radioactivity and radiometric dating

- Radioactivity
  - Radioactive decay
    - Types of radioactive decay
      - Alpha emission
      - Beta emission
      - Electron capture

Types of radioactive decay

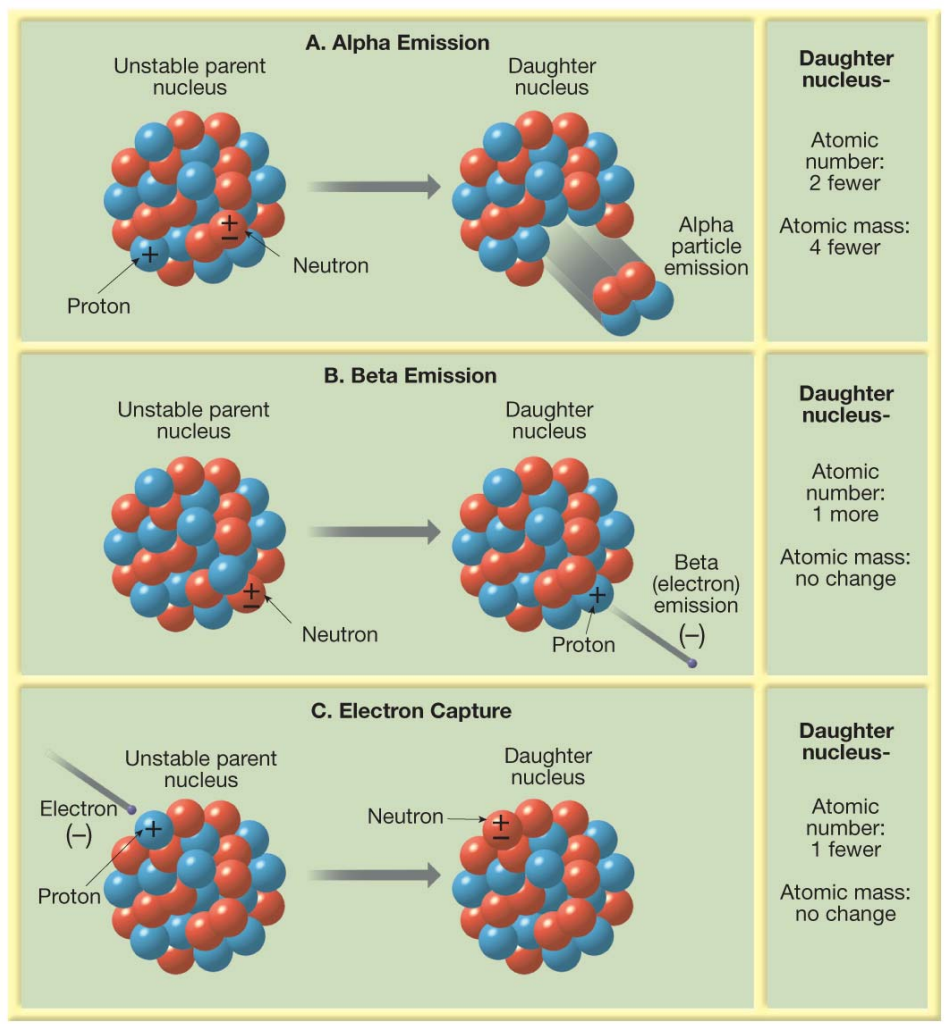


Figure 11.15

Radioactivity and radiometric dating

- Radiometric dating
  - Half-life – the time for one-half of the radioactive nuclei to decay
  - Requires a closed system
  - Cross-checks are used for accuracy
  - Complex procedure
  - Yields numerical dates

The radioactive decay curve

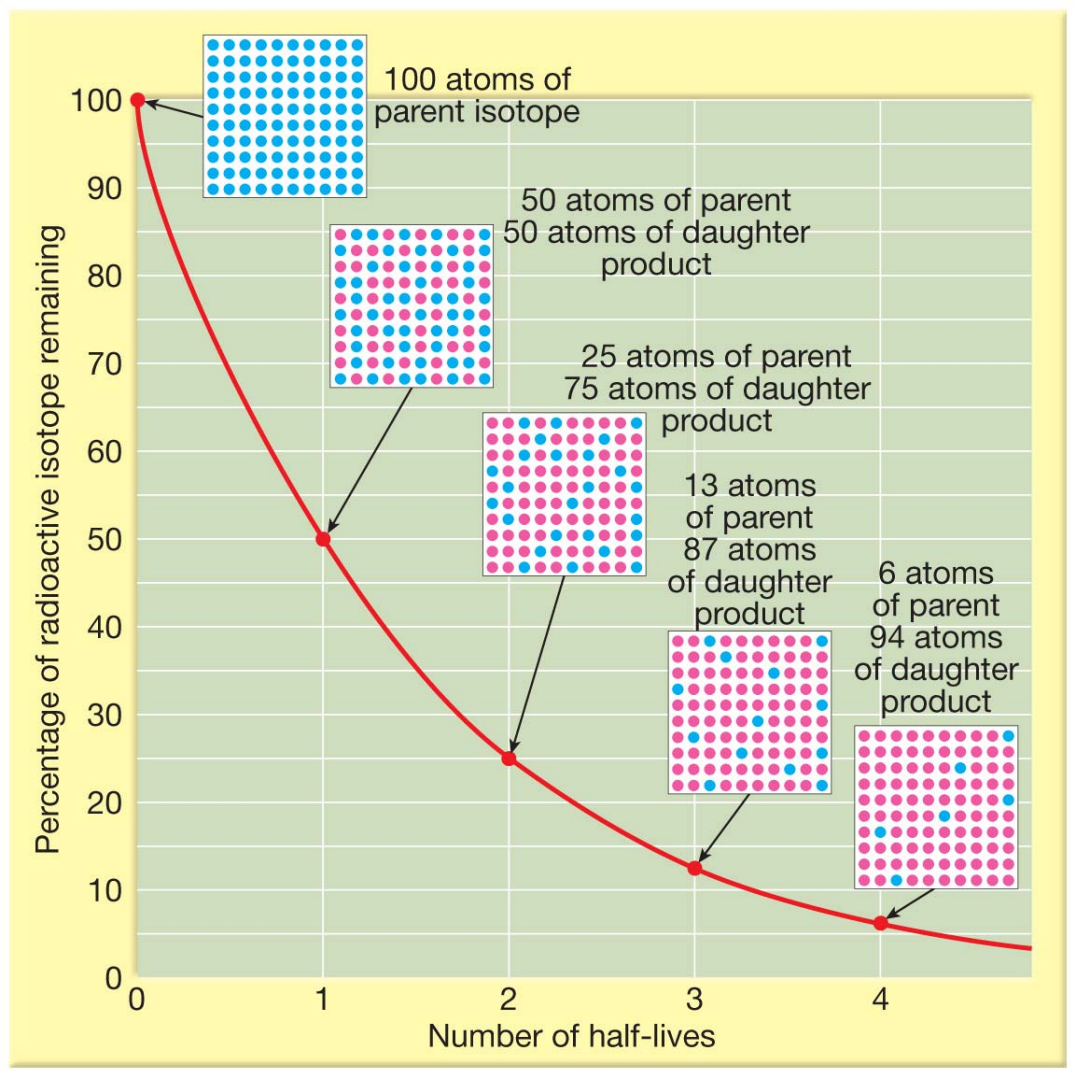


Figure 11.17

Dating sedimentary strata using radiometric dating

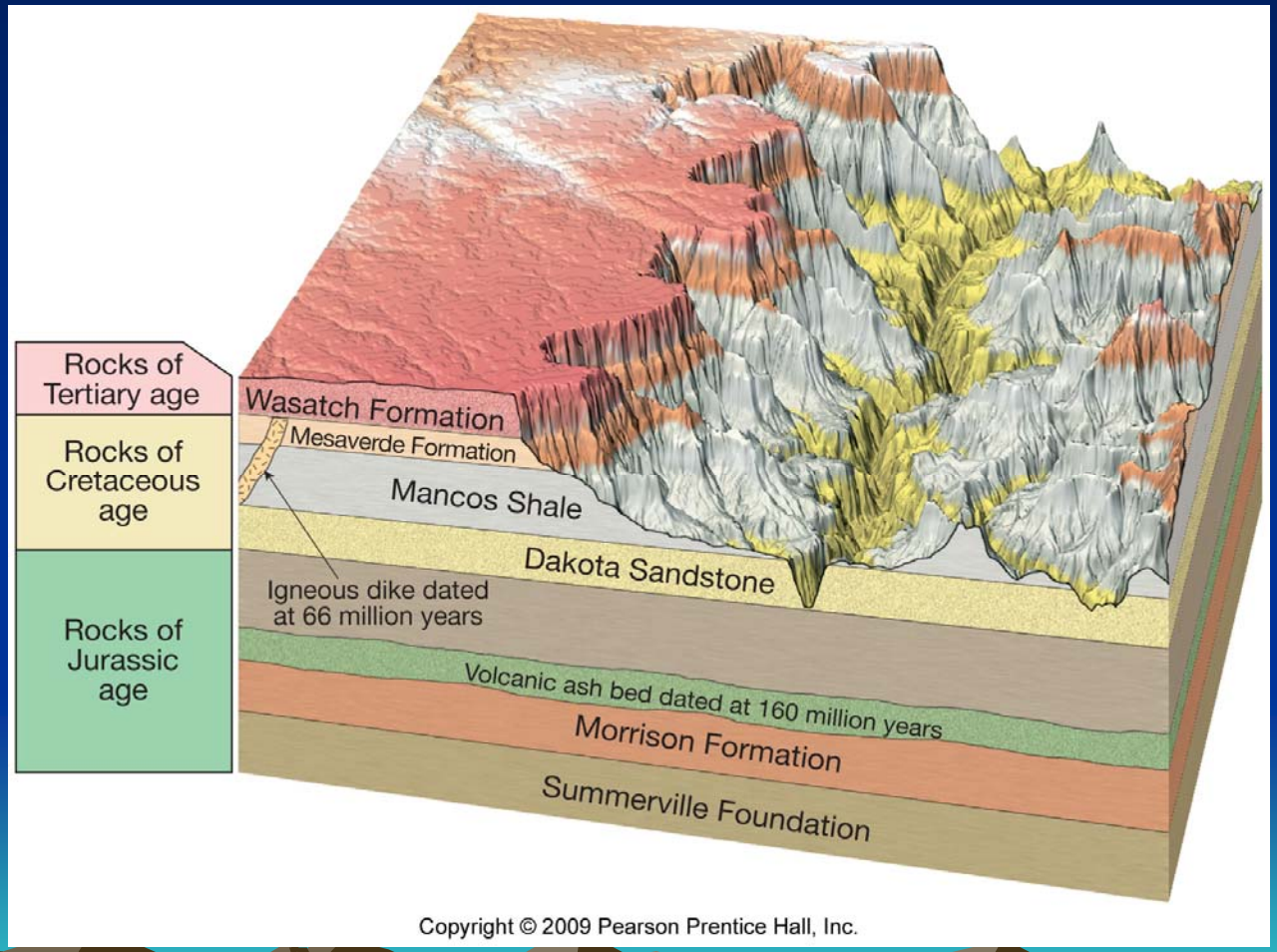


Figure 11.21

Radioactivity and radiometric dating

- Carbon-14 dating
  - Half-life of only 5,730 years
  - Used to date very recent events
  - Carbon-14 produced in upper atmosphere
    - Incorporated into carbon dioxide
    - Absorbed by living matter
  - Useful tool for anthropologists, archaeologists, historians, and geologists who study very recent Earth history

Geologic time scale

- Divides geologic history into units
- Originally created using relative dates
- Subdivisions
  - Eon
    - Greatest expanse of time
    - Four eons
      - Phanerozoic (“visible life”) – the most recent eon
      - Proterozoic

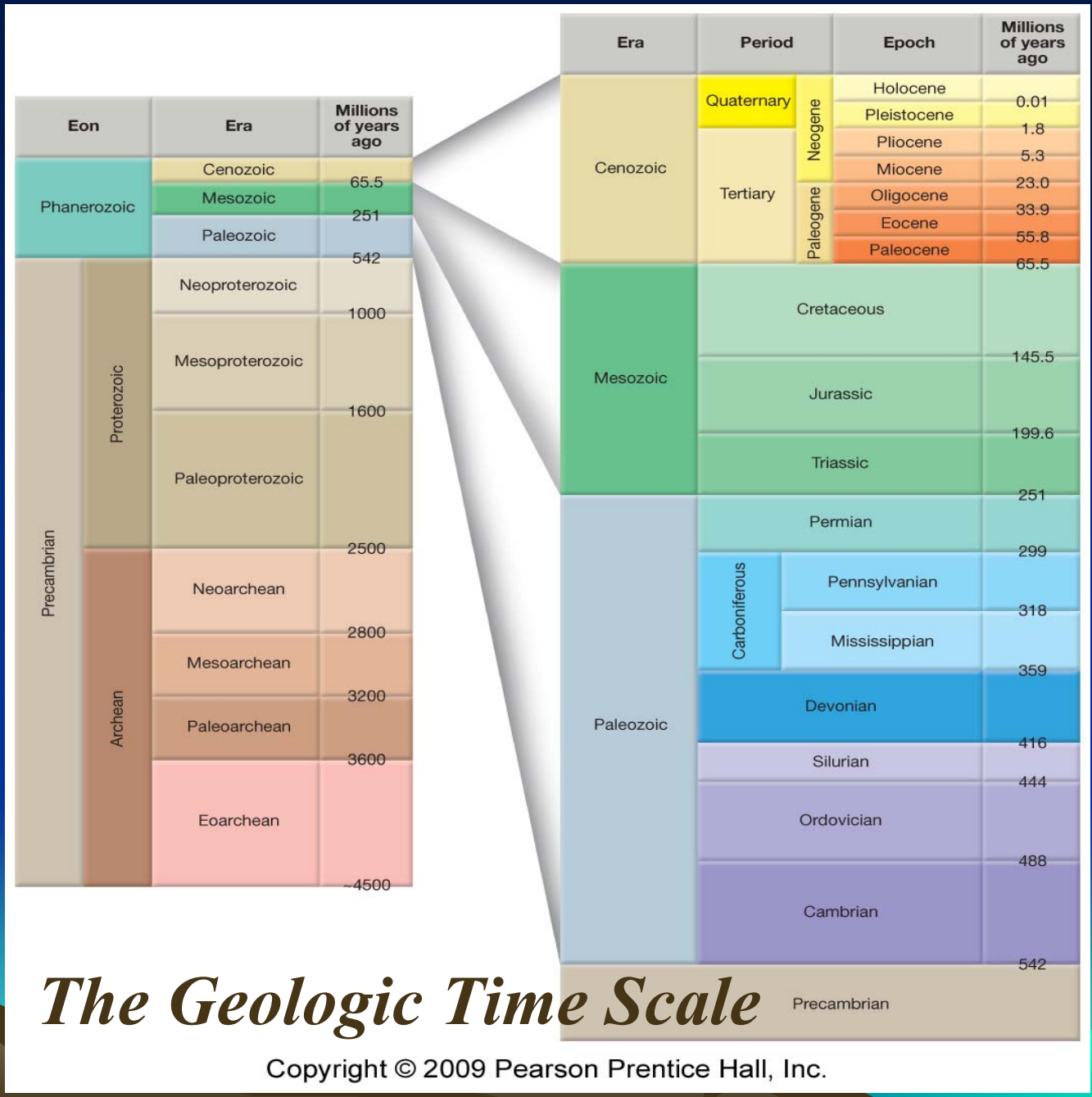
Geologic time scale

- Subdivisions
  - Eon
    - Four eons
      - Archean
      - Hadean – the oldest eon
  - Era
    - Subdivision of an eon

Geologic time scale

- Subdivisions
  - Era
    - Eras of the Phanerozoic eon
      - Cenozoic (“recent life”)
      - Mesozoic (“middle life”)
      - Paleozoic (“ancient life”)
  - Eras are subdivided into periods
  - Periods are subdivided into epochs

Figure 11.19


Eon
Era
Millions of years ago
Phanerozoic
Cenozoic
65.5
Mesozoic
251
Paleozoic
542
Precambrian
Proterozoic
Neoproterozoic
1000
Mesoproterozoic
1600
Paleoproterozoic
2500
Archean
Neoarchean
2800
Mesoarchean
3200
Paleoarchean
3600
Eoarchean
~4500
Era
Period
Epoch
Millions of years ago
Cenozoic
Quaternary
Neogene
Holocene
0.01
Pleistocene
1.8
Tertiary
Pliocene
5.3
Miocene
23.0
Paleogene
Oligocene
33.9
Eocene
55.8
Paleocene
65.5
Mesozoic
Cretaceous
145.5
Jurassic
199.6
Triassic
251
Paleozoic
Permian
299
Carboniferous
Pennsylvanian
318
Mississippian
359
Devonian
416
Silurian
444
Ordovician
488
Cambrian
542
Precambrian
The Geologic Time Scale
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Geologic time scale

- Difficulties in dating the time scale
  - Not all rocks are datable (sedimentary ages are rarely reliable)
  - Materials are often used to bracket events and arrive at ages

End of Chapter 11