Phanerozoic (last 0.54 by)

• Tectonics
• Climate
• Life
Tools for Locating Past Continent Positions

• Fossils depending on climate
• Alignment of geological features
• Geometrical fit of continental margins
• Similarity of fossil record in distant lands
• Deposits depending on climate (coal, bauxite, evaporites, glacial tills and dropstones)
• Paleomagnetism: magnetic anomalies and polar wander (declination = rotation, inclination = latitude)
Color defines positive and negative anomalies
Wilson Cycle
Rift
Subduct
Collide
Insulate
Rift
etc.

Press et al. (2003)
Continents Grow Larger through Collisions

Press et al. (2003)
Accretion of a buoyant fragment to a continent

TIME 1
A buoyant oceanic or continental fragment is carried into a plate collision zone.

TIME 2
The fragment is more buoyant than the subducting lithosphere, and is not subducted.

TIME 3
The fragment becomes welded to the overriding plate.

Accretion of Terranes

Press et al. (2003)
Ages of Continental Cratons

Younger Rocks on Margins
NA basement ages

Appalachians 0.3-0.4 by

Coast ranges
Cascades <0.2 by

Sierras

Appalachians 0.3-0.4 by
Key Tectonic Events of Phanerozoic (1)

**Paleozoic:** Wilson cycle builds continents:  
3 orogenies in North America

- **Pangea assembled as arcs and continents hit Eastern NA, adding new terranes.**
  - Ordovician = Taconic (Eastern NY, Vermont and Massachusetts)
  - Devonian = Acadian (central CT through Maine; Scotland)
  - Carboniferous = Alleghanian/Hercynian (PA to Georgia)
Appalachians
Reemanent
of an
orogenic
collision

Press et al.
Key Tectonic Events of Phanerozoic (2)

**Mesozoic**: Wilson cycle splinters continents

- **Pangea rifts**: N. Atlantic opens about 200 my (late Triassic), South Atlantic a bit later (Cretaceous)

**Mesozoic/Cenozoic**

- **Orogenies on the margins**:
  - Cretaceous/Tertiary (80-40 my) = Laramide Rocky Mts
  - late Mesozoic/Cenozoic = Alpine and Himalayan orogenies
  - Mideast = compressional tectonics; many deep coastal basins
Pangea about 240 my ago
India and Asia Collide

Press et al. (2003)
Himalayas Grow

Press et al. (2003)
<table>
<thead>
<tr>
<th>Orogeny</th>
<th>Time</th>
<th>Event</th>
<th>Location</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grenville</td>
<td>1-1.2 by</td>
<td>E. North Am.</td>
<td>Rodinia assembled</td>
<td></td>
</tr>
<tr>
<td>Acadian</td>
<td>0.4 by</td>
<td>Arc hits NE US</td>
<td>Northern Appalachians</td>
<td></td>
</tr>
<tr>
<td>Taconic</td>
<td>0.4 by</td>
<td>Arc hits NE US</td>
<td>Northern Appalachians</td>
<td></td>
</tr>
<tr>
<td>Appalachian</td>
<td>0.3 by</td>
<td>Africa hits N.A.</td>
<td>Southern Appalachians</td>
<td></td>
</tr>
<tr>
<td>Laramide</td>
<td>40-80 my</td>
<td>Farallon subducts fast</td>
<td>Push up Rockies</td>
<td></td>
</tr>
<tr>
<td>Himalayan</td>
<td>0-40 my</td>
<td>India hits Asia</td>
<td>Himalayas form</td>
<td></td>
</tr>
<tr>
<td>Alpine</td>
<td>0-100 my</td>
<td>Africa hits Europe</td>
<td>Alps form</td>
<td></td>
</tr>
</tbody>
</table>
What makes global sea level change?

Parts of the continents are sometimes flooded, especially during Early Paleozoic and Cretaceous (Western Interior Seaway) due to:

**Tectonics**
- Continents thicken during big orogenies = low sea level
- Continents thin during major rifting = high level
- Sea level may change by several hundred meters

**Growth or melting of ice sheets**
- High sea level in warm periods
- Low sea level during cold periods
- Pleistocene oscillations about 100 m
Continent thickness determines how much is exposed

<table>
<thead>
<tr>
<th></th>
<th>Continent</th>
<th>Ocean crust</th>
<th>Upper mantle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>2.7</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Other Events of Phanerozoic

Life (5 major mass extinctions observed, 2 really big)
• Fossils become abundant (hard parts synthesized)
• Vertebrates develop
• Plants come ashore
• Amphibians come ashore
• Reptiles develop and dominate life
• Mammals develop

Atmosphere
• O2 abundant. Maybe higher than present during Carboniferous
• O2 drops in late Permian (cause of Permo-Triassic extinction?)
• Likely changes in CO2 (affects climate)

Climate
• Glaciations during Ordovician, Devonian (extinction causes?)
  also Permian, late Cenozoic (Pleistocene)
• All times when supercontinents or large land masses were present.
Paleozoic: Age of invertebrates
Mold & Cast: Devonian Brachiopod
Silica Shale, Ohio
Plants on land in late Silurian
Very abundant in Carboniferous
(Pennsylvanian fern;
Coal Measures, Germany)
Carboniferous Coal Seam

Blue Mts near Sydney, Australia
Cretaceous: Large inland sea in N. America
(Ammonite floated in ocean)
K-T boundary: How did this guy disappear from the food chain?
Genera vs. time:

- Ice ages
- Anoxia
- Meteorite impact
- Cause?
end
Divergent Boundary
(Press et al.)

Melt dry mantle -> 1200°C -> Basalt
Uses of Paleomagnetism

• Polar Wander (on continents) = apparent motion of North Pole
  Rocks record magnetic vector aligned with field
  Declination relative to North Pole = rotation
  Inclination relative to level surface = latitude

• Magnetic Anomalies of Earth Field
  Magnetic Field flip flops every 1-2 my
  Ocean crust records field orientation when it cools
  Positive anomaly = rocks formed in ‘normal times’
  Negative anomaly = rocks formed in ‘reversed times’
  Transitions = rocks formed when field flipped