Evolution of Continents
Chapter 20

Does not contain complete lecture notes.

Mountain belts

- **Orogenesis – the processes that collectively produce a mountain belt**
  - **Includes folding, thrust faulting, metamorphism, and igneous activity**
- **Mountain building has occurred during the recent geologic past**
  - **Alpine-Himalayan chain**

Mountain belts

- **Mountain building has occurred during the recent geologic past**
  - **American Cordillera – the western margin of the Americas from Cape Horn to Alaska which includes the Andes and Rocky Mountains**
  - **Mountainous terrains of the western Pacific**

Mountain belts

- Older Paleozoic- and Precambrian-age mountains
  - Appalachians
  - Urals in Russia
- Several hypotheses have been proposed for the formations of Earth's mountain belts

Mountain building building at convergent boundaries

- Plate tectonics provides a model for orogenesis
  - Mountain building occurs at convergent plate boundaries
  - Of particular interest are active subduction zones
    - Volcanic arcs are typified by the Aleutian Islands and the Andean arc of western South America

Mountain building building at convergent boundaries

- Aleutian-type mountain building
  - Where two ocean plates converge and one is subducted beneath the other
  - Volcanic island arcs result from the steady subduction of oceanic lithosphere
    - Most are found in the Pacific
    - Continued development can result in the formation of mountainous topography consisting of igneous and metamorphic rocks

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Mountain building along continental margins
    - Involves the convergence of an oceanic plate and a plate whose leading edge contains continental crust
    - Exemplified by the Andes Mountains

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Stages of development - passive margin
    - Continental margin is part of the same plate as the adjoining oceanic crust
    - Deposition of sediment on the continental shelf is producing a thick wedge of shallow-water sediments

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Stages of development – active continental margins
    - Subduction zone forms
    - Deformation process begins
    - Convergence of the continental block and the subducting oceanic plate leads to deformation and metamorphism of the continental margin
    - Continental volcanic arc develops

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Stages of development – active continental margins
    - – Accretionary wedge may form
      - – Chaotic accumulation of sedimentary rocks and metamorphic rocks with occasional scraps of ocean crust

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Composed of roughly two parallel zones
    - – Volcanic arc
      - – Develops on the continental block
      - – Consists of large intrusive bodies intermixed with high-temperature metamorphic rocks

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Composed of roughly two parallel zones
    - – Accretionary wedge
      - – Seaward segment
      - – Consists of folded, faulted, and metamorphosed sediments and volcanic debris

Mountain building building at convergent boundaries

- Andean-type mountain building
  - Sierra Nevada and Coast Ranges
    - One of the best examples of an active Andean-type orogenic belt
    - Subduction of the Pacific Basin under the western edge of the North American plate
    - Sierra Nevada batholith is a remnant of a portion of the continental volcanic arc

Mountain building building at convergent boundaries

- Continental collisions
  - Two lithospheric plates, both carrying continental crust
  - The Himalayan Mountains are a youthful mountain range formed from the collision of India with the Eurasian plate about 45 million years ago

Mountain building building at convergent boundaries

- Continental collisions
  - The Appalachian Mountains formed about 250 million to 300 million years ago resulting from collision of North America, Europe, and Africa
  - Orogenesis here is complex including subduction, igneous activity, collision of continental blocks, folding, and uplift of the crust

Mountain building building at convergent boundaries

- **Continental accretion and mountain building**
  - A third mechanism of orogenesis
  - Small crustal fragments collide and merge with continental margins
  - Responsible for many of the mountainous regions rimming the Pacific
  - Accreted crustal blocks are called terranes

Vertical movements of the crust

- **Isostatic adjustment**
  - Less dense crust floats on top of the denser and deformable rocks of the mantle
  - Concept of floating crust in gravitational balance is called isostasy

Vertical movements of the crust

- **Vertical motions and mantle convection**
  - Buoyancy of hot rising mantle material accounts for broad upwarping in the overlying lithosphere
  - Examples
    - Uplifting in Southern Africa

Vertical movements of the crust

- Vertical motions and mantle convection
  - Examples
    - Downward crustal displacements
      - Regions once covered by ice during the last Ice Age
      - Continental margins where sediments are being deposited, such as the mouth of the Mississippi River
      - Circular basins found in the interiors of some continents (Illinois and Michigan basins)

Vertical movements of the crust

- Possible mechanism for crustal subsidence
  - May be linked to subduction of oceanic lithosphere
    - A subducting, detached lithospheric plate creates a downward flow in its wake that tugs on the base of the overriding continent
  - More observational data is needed to test the hypothesis

Mountain building away from plate margins

- Example: the American West, extending from the Front Range of the southern Rocky Mountains across the Colorado Plateau and through the Basin and Range province

Mountain building away from plate margins

- Crustal thickness suggests that the elevation difference where the Great Plaines meet the Rockies must somehow be the result of mantle flow
  - Hot mantle may have provided the buoyancy to raise the southern Rockies, as well as the Colorado Plateau and the Basin and Range province

Mountain building away from plate margins

- Upwelling associated with the Basin and Range province started about 50 million years ago and remains active today
- Not all geologists studying the region agree with the model
- Another hypothesis suggests that the addition of terranes to North America produced the observed uplift in the American West

The origin and evolution of continental crust

- There is a lack of agreement among geologists as to the origin and evolution of continents
- Early evolution of the continents model
  - One proposal is that continental crust formed early in Earth's history

The origin and evolution of continental crust

- Early evolution of the continents model
  - Total volume of continental crust has not changed appreciably since its origin
- Gradual evolution of the continents model
  - Continents have grown larger through geologic time by the gradual accretion of material derived from the upper mantle

The origin and evolution of continental crust

- Gradual evolution of the continents model
  - Earliest continental rocks came into existence at a few isolated island arcs
  - Evidence supporting the gradual evolution of the continents comes from research in regions of plate subduction, such as Japan and the western flanks of the Americas

The origin and evolution of continental crust

- Explanations describing the origin and evolution of the continents are highly speculative