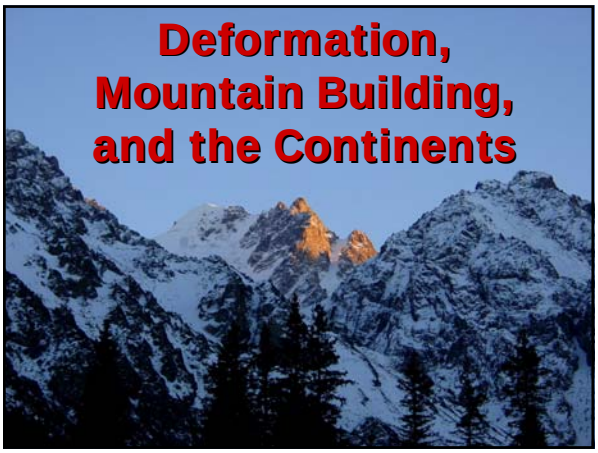
Essentials of Geology

David Sallee

Chapter 17

Deformation, Mountain Building, and the Continents

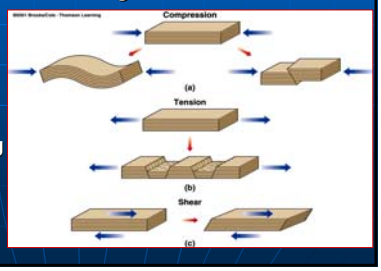


Introduction

- Rock deformation results from several forces and is characterized in different ways
- Dynamic forces at plate boundaries cause fracturing, folding, metamorphism, and igneous activity
- Rock deformation and mountain building are closely related

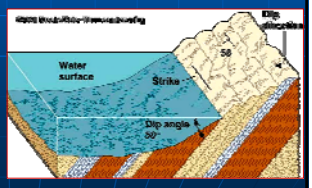
Rock Deformation

- Stress is the force applied to a body of rock or crust; strain is the resulting deformation
- Three main types are recognized:
  - compressive
    - folds, faults
  - tensional
    - faults
  - shear
    - faulting along planes



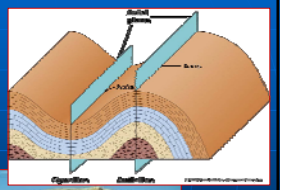
Strike and Dip

- The orientation of rock layers
  - Strike is the compass direction of a line formed by the intersection of an inclined plane with a horizontal line
  - Dip is the measure of an inclined plane's maximum inclination from horizontal and is measured at right angles to the strike direction



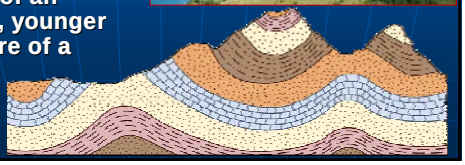
Deformation and Geologic Structures

- Folded rock layers
  - Monoclines
    - bends or flexures
  - Anticlines
    - up-arched folds
  - Synclines
    - down-arched folds



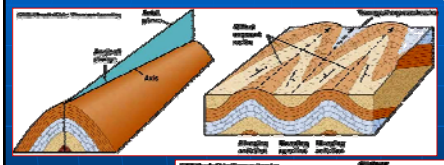
Deformation and Geologic Structures

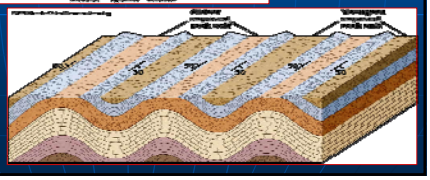
- Rock layers dip toward one another in a syncline and away in an anticline
- Older rocks are in the core of an anticline, younger in the core of a syncline



Deformation and Geologic Structures

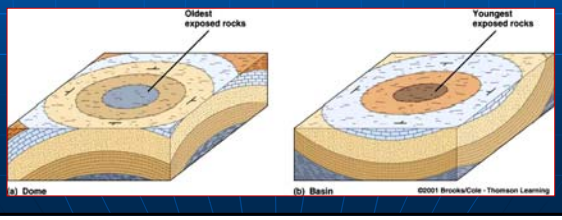
- Plunging and non-plunging folds





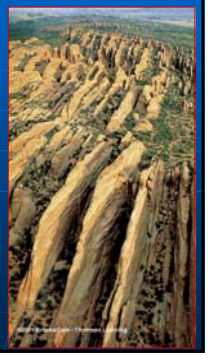
Deformation and Geologic Structures

- Domes
  - Rock layers dip away from the center
- Basins
  - Rock layers dip toward the center



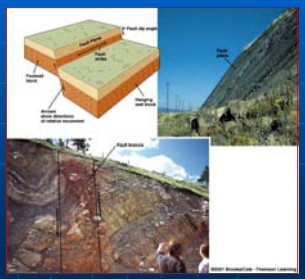
Deformation and Geologic Structures

- Joints
  - fractures with no displacement
  - often associated with folding



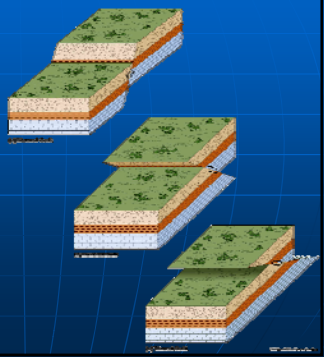
Deformation and Geologic Structures

- Faults
  - Fractures along which movement has taken place
  - Footwall lies below the fault plane
  - Hanging wall is above the fault plane
  - Relative motion of hanging and footwall names the fault



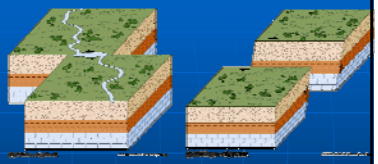
Deformation and Geologic Structures

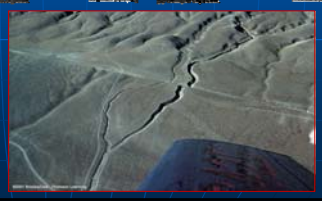
- Dip-Slip faults
  - formed by tensional or compressive stress
  - Normal fault
    - hanging wall moves down
  - Reverse fault
    - hanging wall moves up
  - Thrust
    - low-angle reverse fault



Deformation and Geologic Structures

- Strike-Slip faults
  - formed by shear forces
  - are right lateral or left lateral
- Oblique-Slip faults
  - both dip and strike movement





Deformation and the Origin of Mountains

- While mountains are large from a human perspective, they are just the surface expression of much larger forces
- Types of mountains
  - Differential weathering, volcanic, oceanic ridges, intrusion and uplift, block-faulting, convergent boundaries

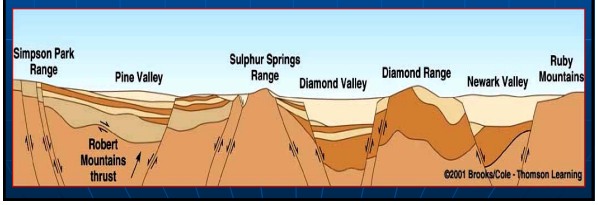
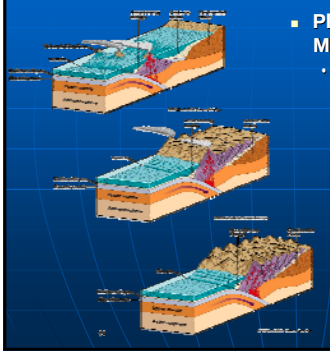


Plate Tectonics and the Origin of Mountains



- Plate Boundaries and Mountain Building
  - Oceanic-oceanic boundaries
    - Orogenies occur where oceanic crust is subducted beneath another oceanic plate
    - Characterized by volcanic island arcs and subduction complexes (accretionary wedge)
    - Emplacement of plutons
    - Back-arc basin receives volcanic and continental sediments, which are faulted and fused to the continent

Plate Tectonics and the Origin of Mountains

- Oceanic-continental boundaries
  - Oceanic crust is subducted beneath continental crust
  - Partial melting results in a chain of andesitic volcanoes
  - Deformed accretionary wedge rocks found seaward
  - Folded and faulted sedimentary rocks found landward
  - Volcanism and seismicity are common

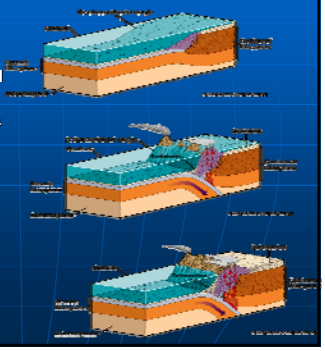
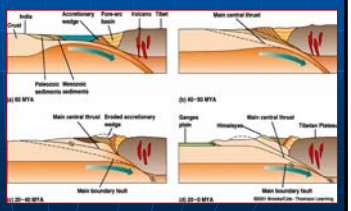


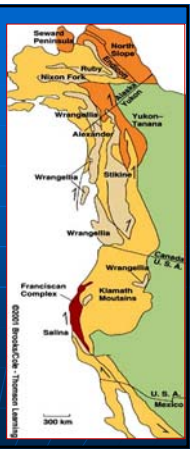
Plate Tectonics and the Origin of Mountains

- Continental-continental boundaries
  - Himalayas are the best example
  - Oceanic crust is consumed in an oceanic-continental boundary until the two continents meet
  - Crustal thickening, uplift, and thrusting occurs as movement slows and subduction ceases
  - Marine sediments are thrust upward onto the new continent

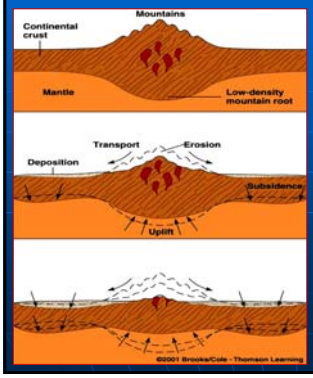


Terranes and the Origins of Mountains

- Terranes differ completely in their fossil content, structural trends, and paleomagnetic properties from rocks of the surrounding mountain system
- The Pacific coast consists of accreted terranes or igneous intrusions
  - composed of volcanic island arcs, oceanic ridges, seamounts, and fragments of continents scraped off by the continent's margin



Earth's Continental Crust



- Principle of Isostasy
- Crust is floating in equilibrium on the denser mantle below
- Crust is similar to an iceberg, in that it sinks into the mantle to its equilibrium level
- Isostatic rebound occurs when loading or unloading of the crust occurs through sedimentation, glacial activity, or erosion