Prentice Hall

EARTH SCIENCE

Tarbuck ◆ Lutgens

Chapter

11

Mountain Building

11.1 Rock Deformation

Factors Affecting Deformation

- Factors that influence the strength of a rock and how it will deform include temperature, confining pressure, rock type, and time.
  - **Deformation** is a general term that refers to all changes in the original shape and/or size of a rock body.
    - Most crustal deformation occurs along plate margins.
  - **Stress** is the force per unit area acting on a solid.
  - **Strain** is the change in shape or volume of a body of rock as a result of stress.

11.1 Rock Deformation

Factors Affecting Deformation

- Temperature and Pressure
  - Rocks deform permanently in two ways: brittle deformation and ductile deformation.
    - Brittle deformation is the fracturing of an object once its strength is exceeded.
    - Ductile deformation is a type of solid state flow that produces a change in the size and shape of an object without fracturing the object.

11.1 Rock Deformation

Factors Affecting Deformation

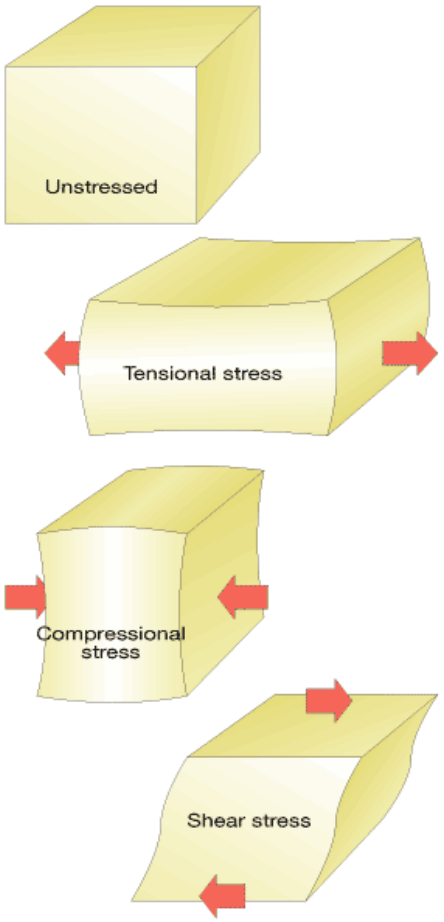
- Rock Type
  - Mineral composition and texture of a rock also greatly affect how it will deform.
- Time
  - Forces that are unable to deform rock when first applied may cause rock to flow if the force is maintained over a long period of time.

11.1 Rock Deformation

Types of Stress

- The three types of stresses that rocks commonly undergo are tensional stress, compressional stress, and shear stress.

Types of Stress

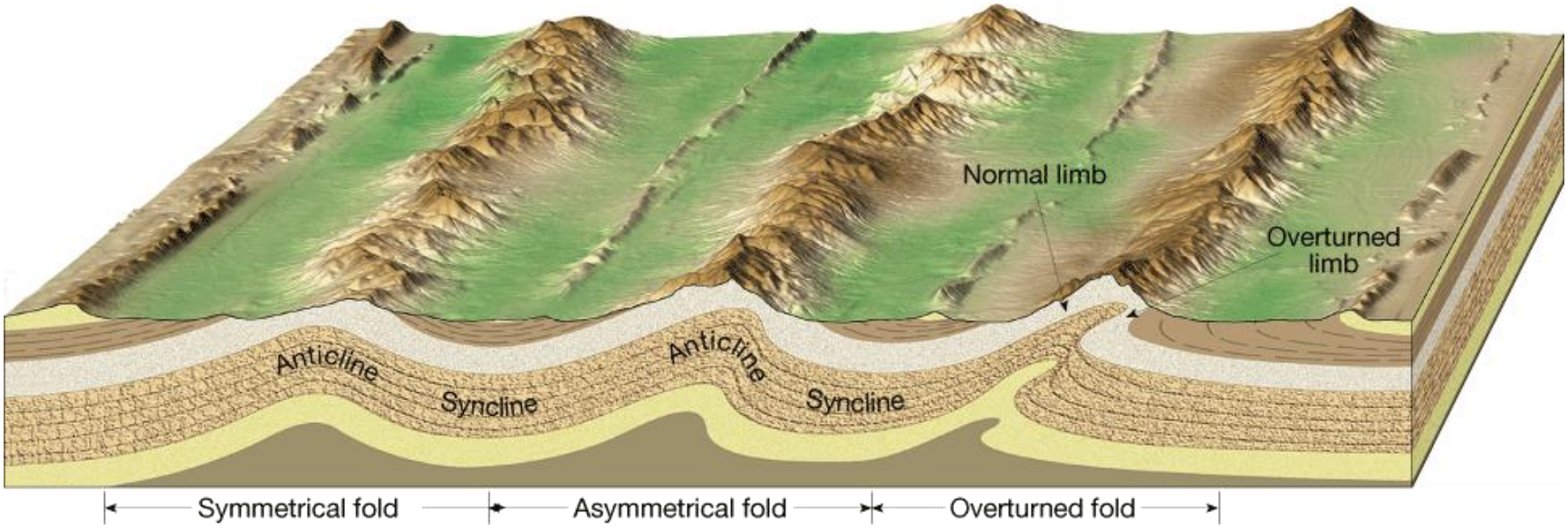


11.1 Rock Deformation

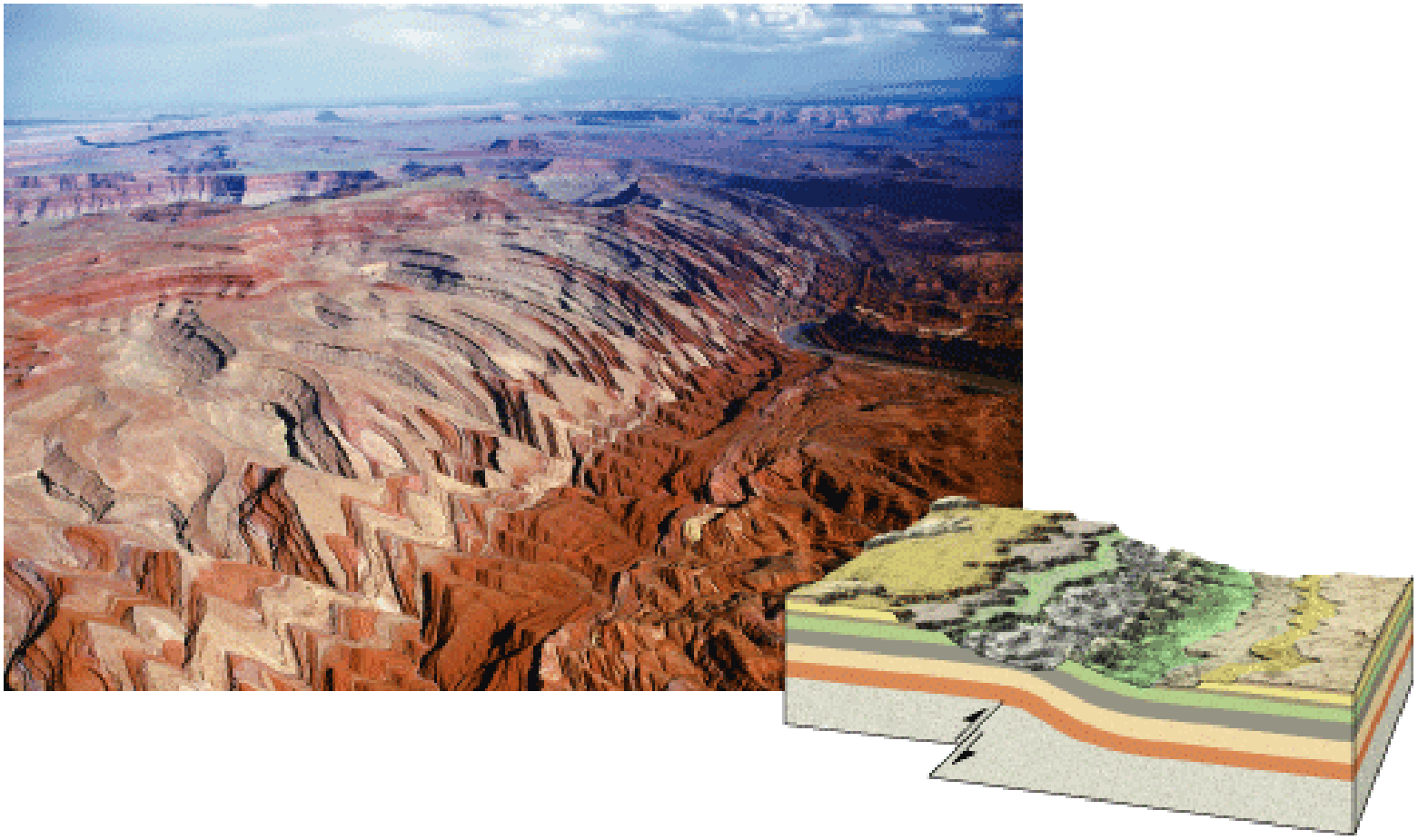
Folds

- Anticlines
  - **Anticlines** are most commonly formed by the upfolding, or arching, of rock layers.
- Synclines
  - **Synclines** are linear downfolds in sedimentary strata.
  - Synclines are often found in association with anticlines.
- Monoclines
  - **Monoclines** are large step-like folds in otherwise horizontal sedimentary strata.

Anticlines and Synclines



Monoclines



11.1 Rock Deformation

Faults

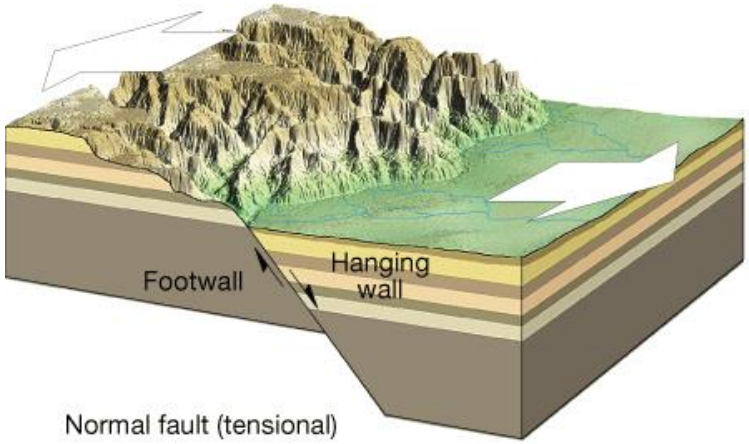
- Normal Faults
  - **Normal faults** occur when the hanging wall block moves down relative to the footwall block.
- Reverse Faults and Thrust Faults
  - **Reverse faults** are faults in which the hanging wall block moves up relative to the footwall block.
  - **Thrust faults** are reverse faults with dips less than 45^{o}.

11.1 Rock Deformation

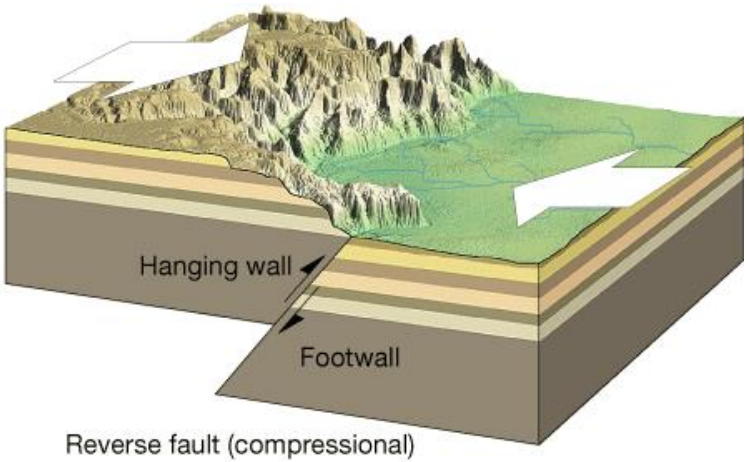
Folds

- Strike-Slip Fault
  - **Strike-slip faults** are faults in which the movement is horizontal and parallel to the trend, or strike, of the fault surface.
- Joints
  - Joints are fractures along which no appreciable movement has occurred.

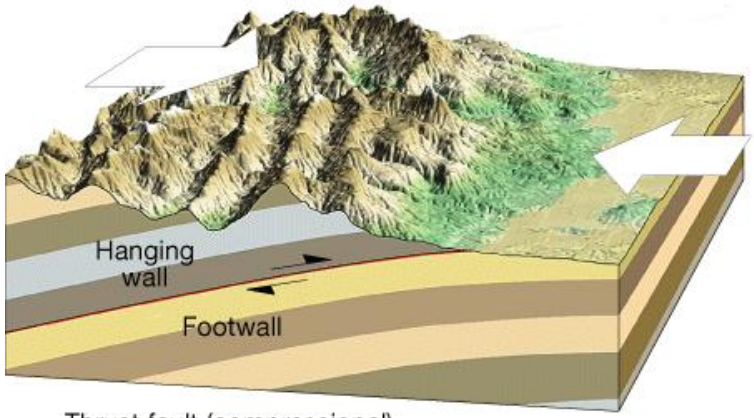
Four Types of Faults



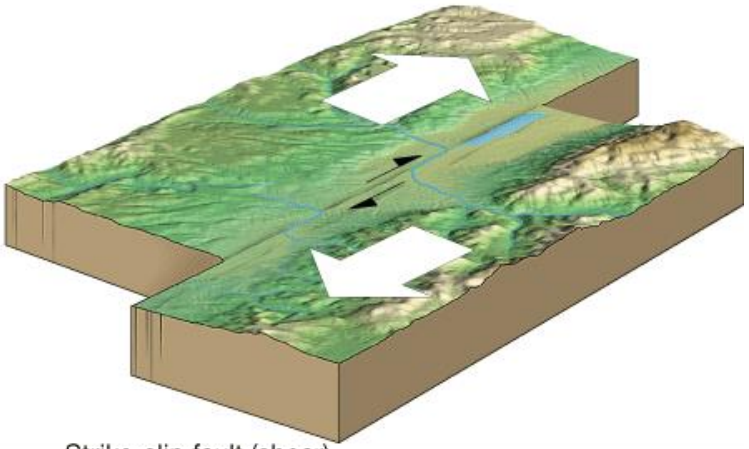
Normal fault (tensional)



Reverse fault (compressional)



Thrust fault (compressional)



Strike-slip fault (shear)

Joints

11.2 Types of Mountains

Folded Mountains

- Mountains are classified by the dominant processes that have formed them.
  - **Orogenesis** is the collection of processes that result in the forming of mountains.
- Folded Mountains
  - Mountains that are formed primarily by folding are called **folded mountains**.

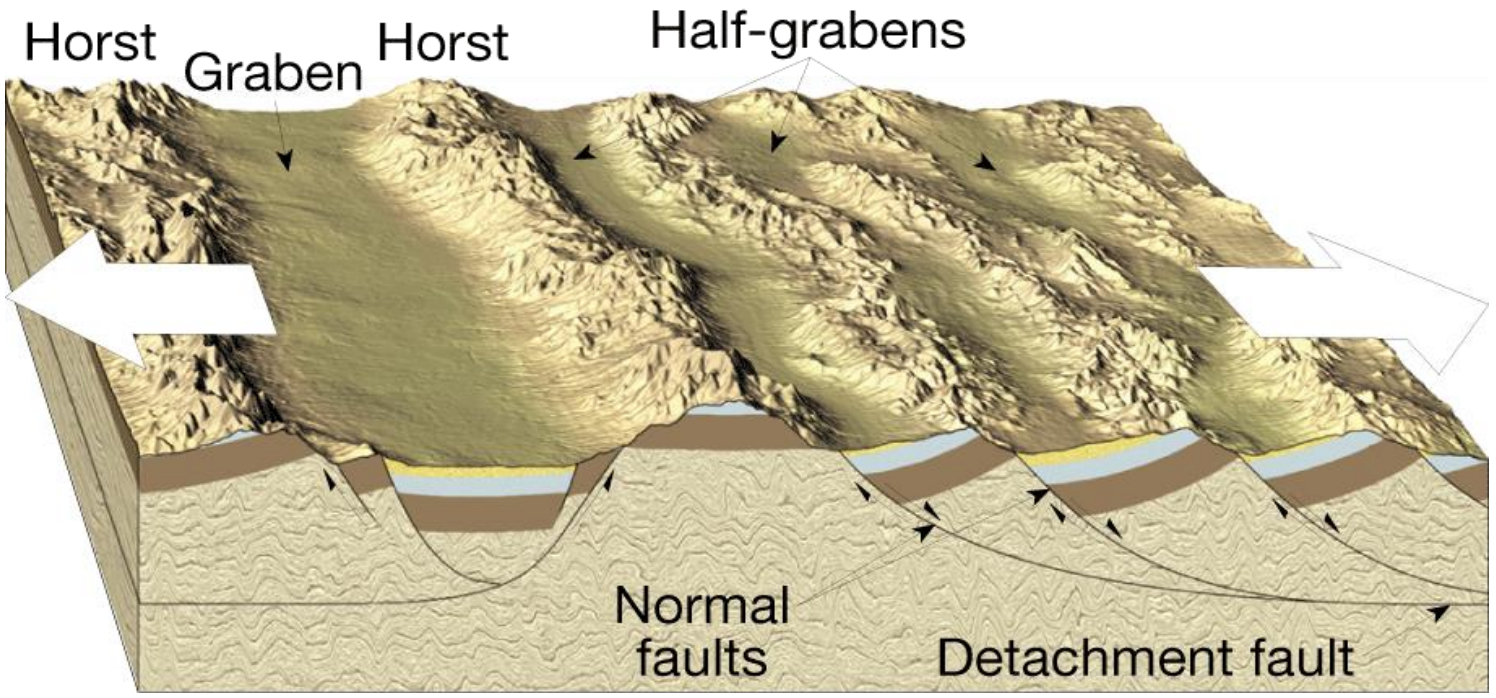
Folded Mountains

11.2 Types of Mountains

Fault-Block Mountains

- Large-scale normal faults are associated with structures called fault-block mountains.
  - **Fault-block mountains** are formed as large blocks of crust are uplifted and tilted along normal faults.
  - **Grabens** are formed by the downward displacement of fault-bounded blocks.
  - **Horsts** are elongated, uplifted blocks of crust bounded by faults**.**

Fault-Block Mountains

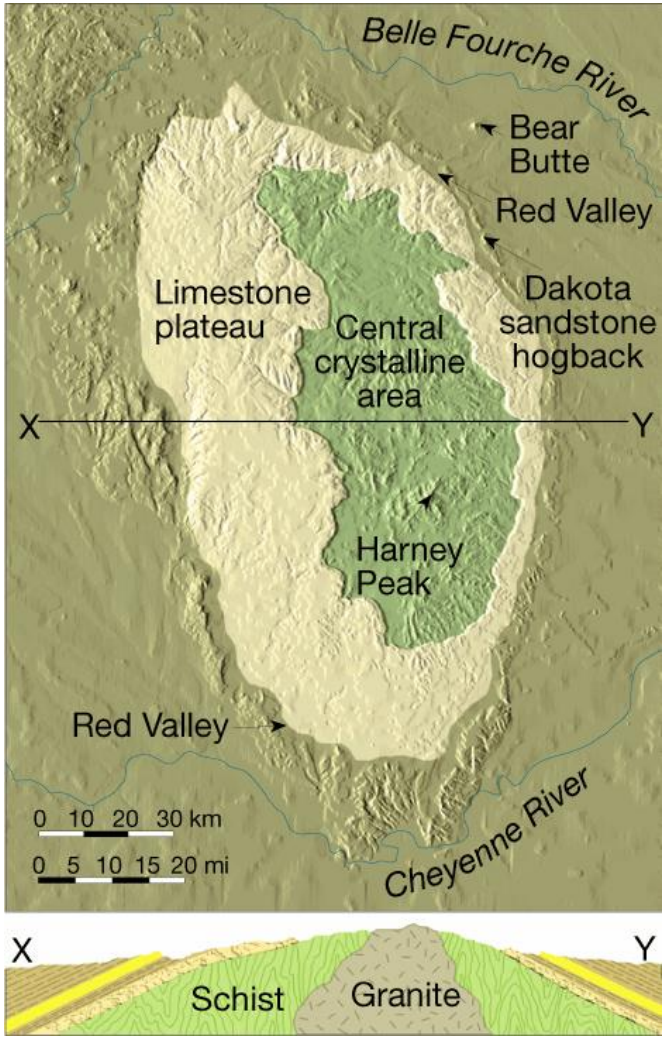


11.2 Types of Mountains

Domes and Basins

- When upwarping produces a circular or elongated structure, the feature is called a dome.
  - **Uplifted mountains** are circular or elongated structures formed by uplifting of the underlying basement rock.

Domed Mountains



11.3 Mountain Formation

Mountain Building at Convergent Boundaries

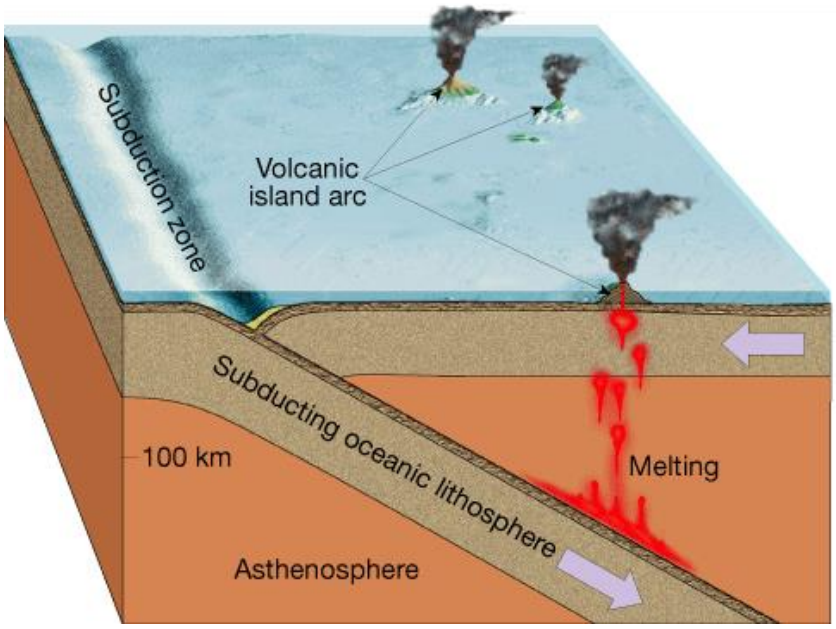
- Most mountain building occurs at convergent plate boundaries. Colliding plates provide the compressional forces that fold, fault, and metamorphose the thick layers of sediments deposited at the edges of landmasses.

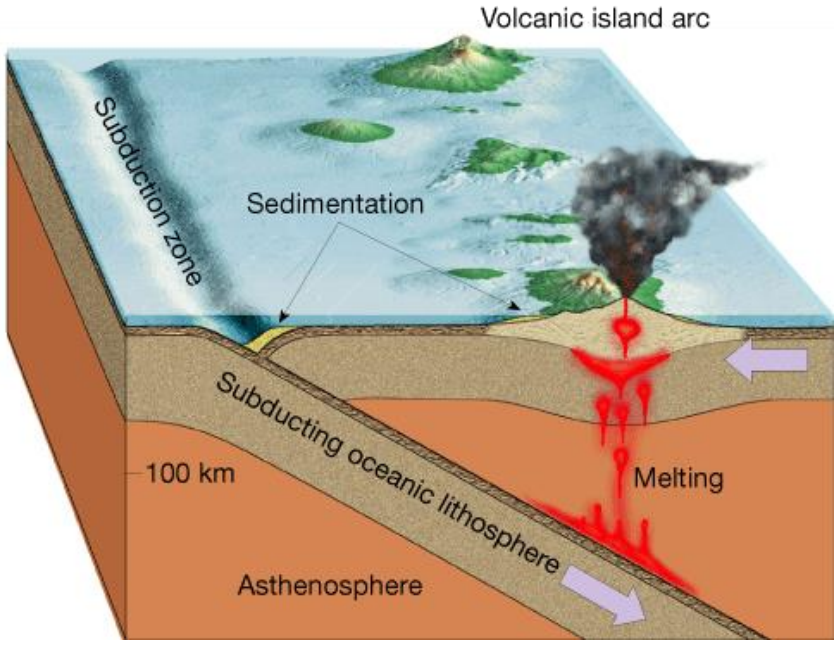
11.3 Mountain Formation

Mountain Building at Convergent Boundaries

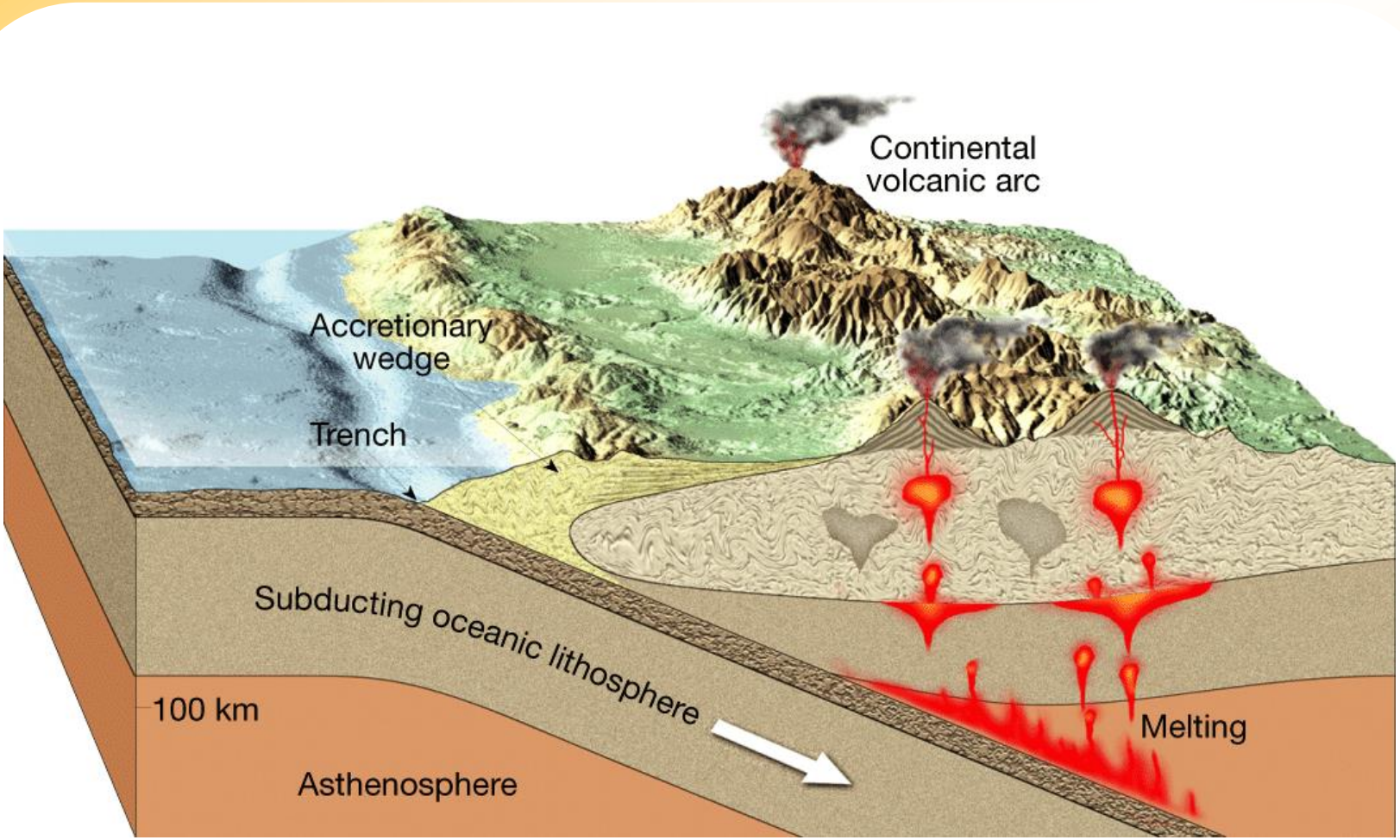
- Ocean-Ocean Convergence
  - Ocean-ocean convergence mainly produces volcanic mountains.
- Ocean-Continental Convergence
  - The types of mountains formed by ocean-continental convergence are volcanic mountains and folded mountains.
  - An **accretionary wedge** is the accumulation of different sedimentary and metamorphic rocks with some scraps of ocean crust.

Ocean-Ocean Convergence





Ocean-Continental Convergence

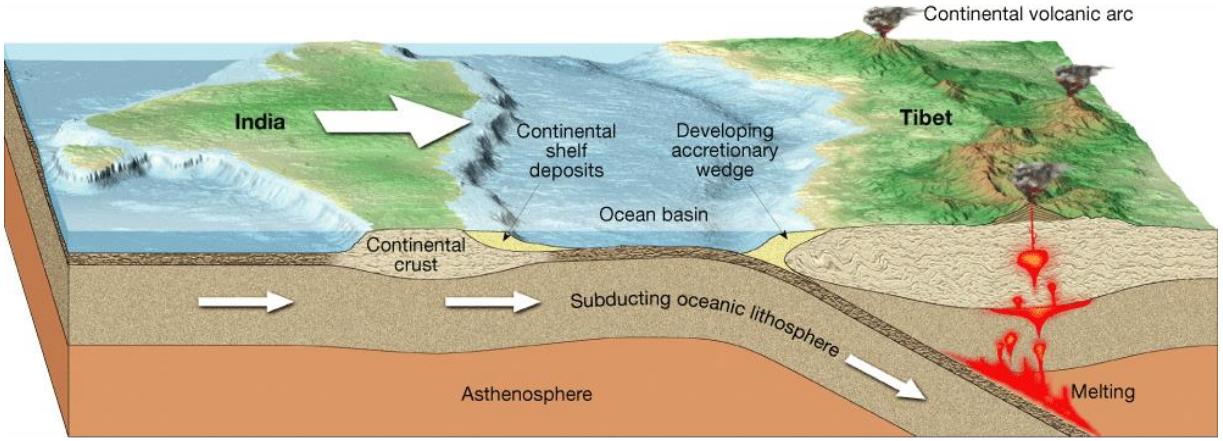


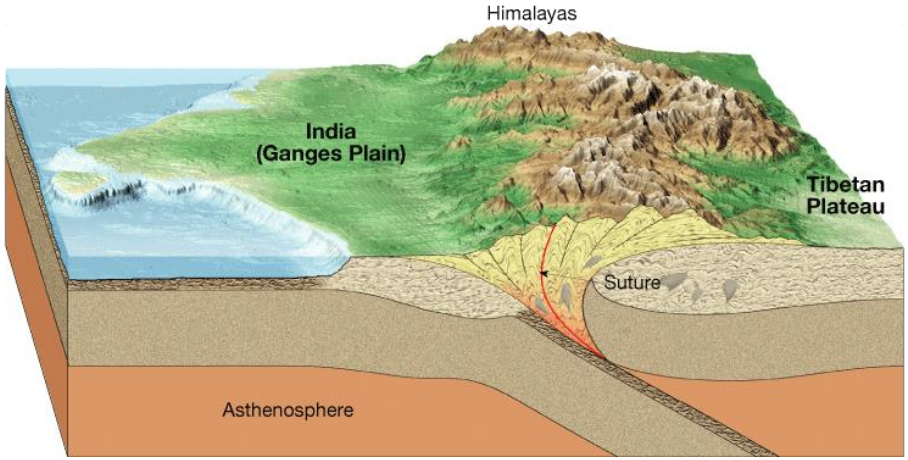
11.3 Mountain Formation

Mountain Building at Convergent Boundaries

- Continental-Continental Convergence
  - At a convergent boundary between two plates carrying continental crust, a collision between the continental fragments will result and form folded mountains.

Continental-Continental Convergence



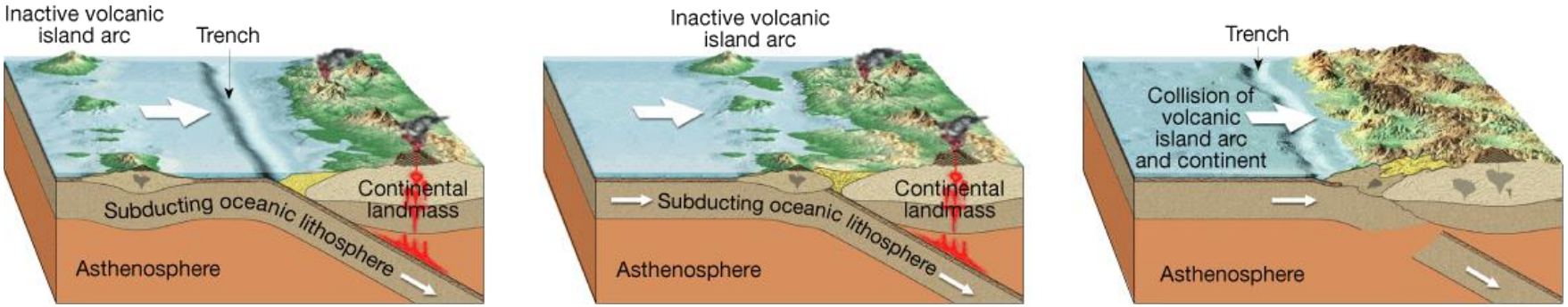


11.3 Mountain Formation

Mountain Building at Divergent Boundaries

- The mountains that form along ocean ridges at divergent plate boundaries are fault-block type mountains.

Mountain Building by Continental Accretion



11.3 Mountain Formation

Non-Boundary Mountains

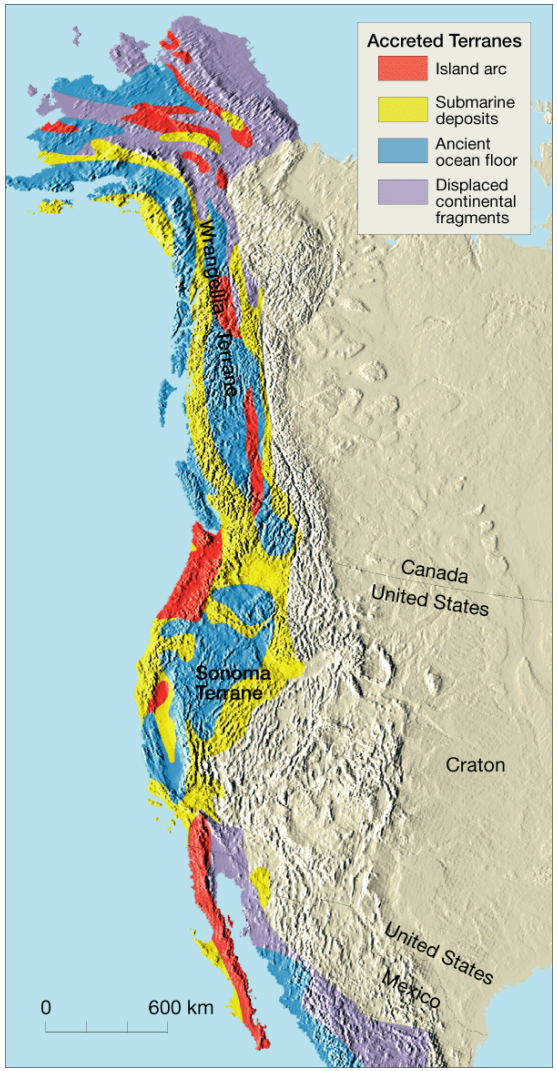
- Not all mountains are formed by plate boundaries. Some are formed by hot spots or regional extension or stretching.

11.3 Mountain Formation

Continental Accretion

- **Accretion** is a process that occurs when crustal fragments collide with and stay connected to a continental plate.
- Terranes
  - **Terranes** are any crustal fragments that have a geologic history distinct from that of the adjoining fragments.
  - Terranes occur along the Pacific Coast.

Accretion in Western North America

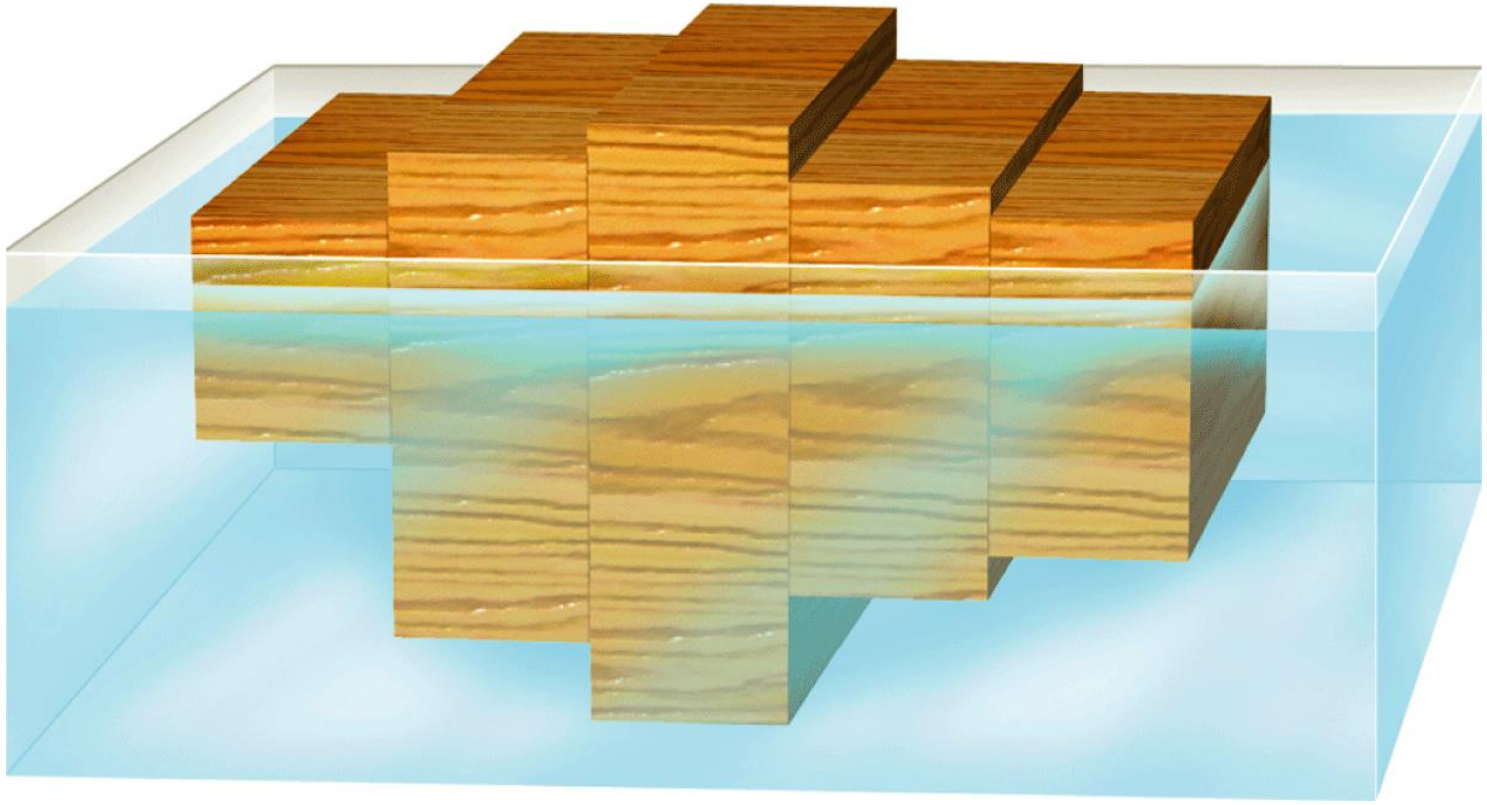


11.3 Mountain Formation

Principles of Isostasy

- Isostatic Adjustment for Mountains
  - **Isostasy** is the concept that Earth's crust is floating in gravitational balance upon the material of the mantle.
  - Because of isostasy, deformed and thickened crust will undergo regional uplift both during mountain building and for a long period afterward.
  - **Isostatic adjustment** is the process of establishing a new level of gravitational equilibrium.

Isostatic Adjustment



Isostatic Adjustment in Mountains