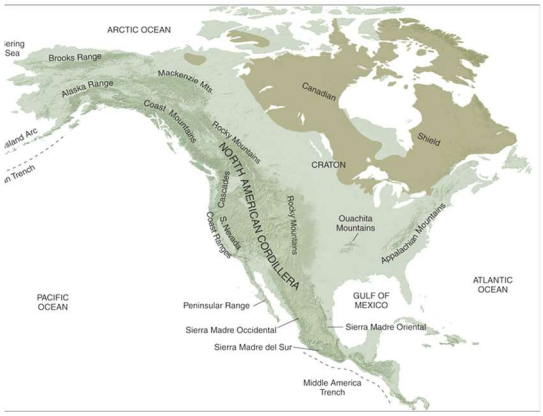
Grand Tetons in Wyoming

Chapter Outlines

NOTE: This is intended to help students 'organize' their understanding of each topic. It is <u>not</u> a comprehensive study guide for quizzes or midterms, i.e. <u>study your text!</u>

Mountain Belts

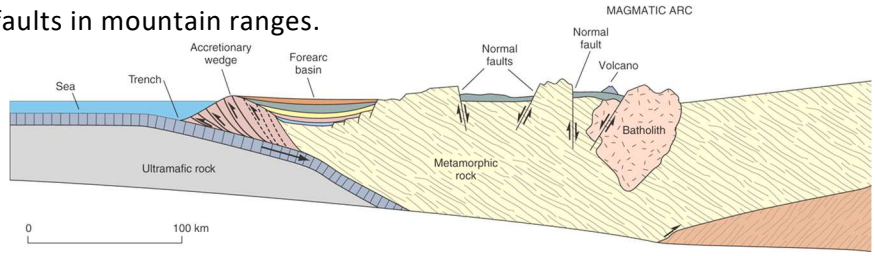
Mountains result from the application of tectonic forces to rocks, usually sedimentary or volcanic rocks. These may be changed to metamorphic rocks as mountain-building progresses. **Mountain-building** on continents is associated with intense deformation, folding, and faulting, usually along convergent plate boundaries. An **orogeny**, or **orogenesis**, is the overall process by which a mountain system is built.



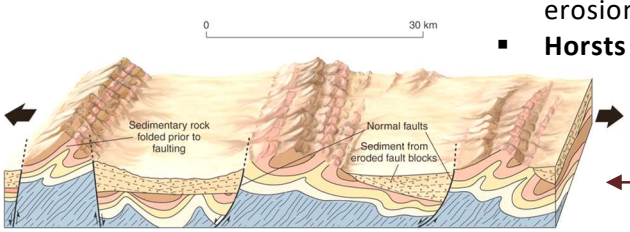
North American mountains

- Characteristics of mountain belts
  - Mountain belts are very long compared to their width. The North **American Cordillera** runs from southwestern Alaska to Panama.
  - Older mountain ranges *(Appalachians)* tend to be lower than younger ones *(Himalayas)* due to erosion.
    - Young mountain belts are tens of millions years old, whereas older ones may be hundreds of millions of years old.
  - Ancient mountain belts *(billions of years old)* have eroded nearly flat to form the stable cores ***(cratons)*** of the continents.
    - **Shields** – areas of cratons laid bare by erosion
  - Commonly located at or near the edges of continents
  - Form and grow by tectonic and volcanic activity over tens of millions of years
  - As mountains grow higher and steeper, erosion rates increase
  - Air *(atmosphere)* rising over mountain ranges results in precipitation and erosion
  - May also contain great thicknesses of volcanic rock
  - Earthquakes are common along faults in mountain ranges.

Typical sequence along an active margin

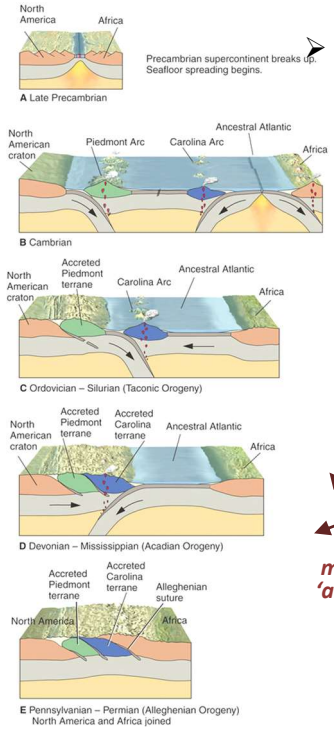


- **Rock patterns in mountain belts**
  - Mountain belts typically contain thick sequences of folded sedimentary rocks, often of marine origin.
  - Folds and thrust faults indicate crustal shortening produced by compression. This is common at convergent boundaries, along with regional metamorphism.
  - Erosion-resistant batholiths may be left behind as the 'backbone' of mountain ranges after long periods of erosion
    - Localized tension in uplifting mountain ranges after long periods of erosion can result in normal faulting
    - **Horsts** and **grabens** can produce mountains and valleys



Horsts and grabens

A result of tensional forces

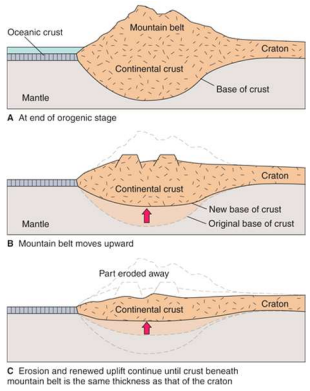


Evolution of Mountain Belts

- **Accumulation stage**
  - Typically occurs in marine environment at opening ocean basins *(divergence).* An ocean basin opens, collects sediment from adjacent land areas, then closes, collecting sediment during the entire course *(a very long tectonic process).*

- **Orogenic stage** – closing of an ocean basin, subduction complex, and subsequent uplifting of mountains.
  - Results of ocean-continent, arc-continent, or continent-continent convergence
  - Subsequent gravitational collapse *(of the newly built mountains)* and spreading may bring deep-seated rock to the surface

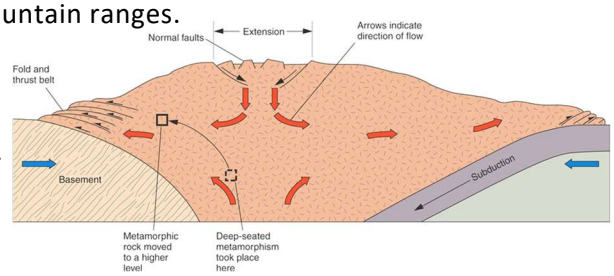
Long-term stages in mountain building in the 'ancestral' Atlantic Ocean basin

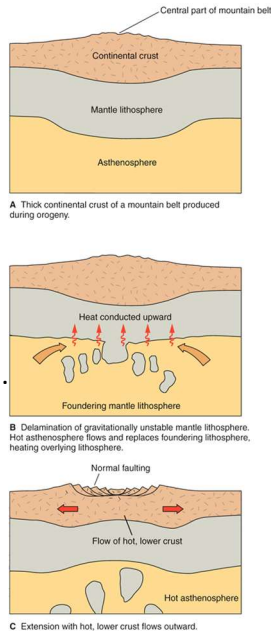


- **Block-faulting** – After convergence stops, a long period of erosion, uplift and block-faulting occurs.
- As erosion removes overlying rock, the crustal root of a mountain range rises by isostatic adjustment.
- Tension in uplifting and spreading crust results in normal faulting and fault-block mountain ranges.

Erosion, isostatic adjustment, block-faulting, etc

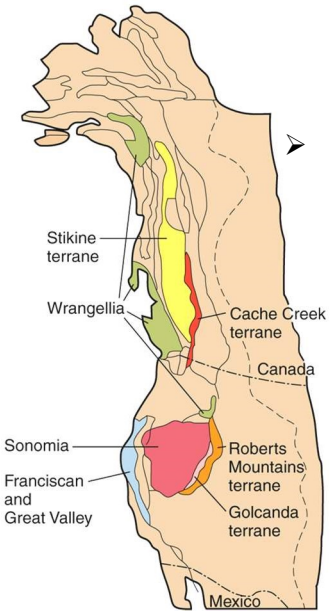
Gravitational Spreading– a result of 'over-heightened' mountains





- **Basin-and-Range province**
  - There is evidence that the bottom side of thickened lithosphere will occasionally break away from the crust and sink into the asthenosphere.
  - This can lead to an inflow of hot asthenosphere, stretching and thinning of the crust, normal faulting, and increased volcanic activity.
  - The Basin and Range province of Nevada is thought to have this origin.

Crustal delamination



Growth of a continent

- Continents grow larger as a result of the building of mountain belts, i.e. accumulated sediments and igneous activity add continental crust.
- **Accreted terranes** add to a continent with each episode of convergence.
  - Western America *(especially Alaska)* contains many such terranes.
  - Numerous terranes, of gradually decreasing age, surround older cratons that form the cores of continents.

Accreted terranes on the west coast of North America