Ch. 11 Mountain Building

Our Appalachians (eastern US)
Mountains - large masses of rock that rise great distances above its base.
Mountains Form at:

- Convergent boundaries – collision boundaries, 2 continents colliding together.
  - Along Active **Continental Margins**: the underwater part of continental crust (continental shelf & continental slope)
2 types of Continental Margins: Active continental margin and Passive continental margin

• **Active Continental Margin** – occur along plate boundaries (where plates are actively moving)
  - This is where mountain building takes place!!
  - Ex.) Nazca Plate (oceanic crust) subducting beneath South American Plate (causing mountains to form, earthquake and volcanic activity. (Andes Mountains)

• **Passive Continental Margin** – do not occur along plate boundaries
  - These are stable margins and accumulate large amounts of sediments (from mountains/continent weathering and eroding away and from shells of marine organisms
  - Provide the material from mountains to form in the future.

• Ex.) East coast of North America (where we live). A wedge of sediment 250 km wide and 10 km thick has accumulated there.
Label the diagrams below as passive or active continental margins:
How Mountains Form
(rocks have been permanently deformed under stress = this makes metamorphic rocks):

- Stress
- Folds
- Faults
- Joints

(see ES1102)
## Stress – 3 types

<table>
<thead>
<tr>
<th>Types of Stress</th>
<th>Compression</th>
<th>Tension</th>
<th>Shear Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction</strong></td>
<td>Rock layers are being squeezed inward</td>
<td>Rock layers are being pulled and stretched apart</td>
<td>Rock layers are being pushed in 2 different way (opposite each other)</td>
</tr>
<tr>
<td>rocks are moving</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>What’s happening to rocks</strong></td>
<td>Rocks layers are becoming thicker and shorter</td>
<td>Rocks become thinner and longer and some are fractured</td>
<td>Shape of rocks are distorted</td>
</tr>
<tr>
<td><img src="image4.png" alt="Diagram" /></td>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
<td><img src="image7.png" alt="Diagram" /></td>
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</table>
Stress

Compression

Tension

Shear
How Mountains Form
(rocks have been permanently deformed under stress = this makes metamorphic rocks):

• Stress
• Folds
• Faults
• Joints

(see ES1102)
**Folds** — occurs deep beneath Earth’s surface. During plate collision stress can cause rock layers along continental margins to crumple/fold.

**Example of folded mountains:** Valley and Ridge Province of the Appalachian Mountains – extends from New York to Alabama (in VA: Shenandoah Valley/Shenandoah National Park, Winchester area)
Folds

- **Syncline** – downward fold (valley of mountain)
- **Anticline** – upward fold (top of mountain)
How Mountains Form

(rocks have been permanently deformed under stress = this makes metamorphic rocks):

• Stress
• Folds
• Faults
• Joints

(see ES1102)
Faults – a break in the lithosphere where movement occurs. (cause of earthquakes and important in mountain building)

- 4 Types:
  - Normal Fault
  - Reverse Fault
  - Thrust Fault
  - Strike-Slip Fault
# Faults

## Types of Faults

<table>
<thead>
<tr>
<th>Direction rocks are moving</th>
<th>Normal Fault</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanging wall moves down in relation to footwall (like what would <em>normally</em> happen with gravity)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of stress applied to rocks</th>
<th>Tension (pulling crust apart)</th>
</tr>
</thead>
</table>

![Diagram of Normal Fault](image-url)
Normal Fault

Hanging Wall

Foot Wall
Tension

Action of coincident oppositely directed forces acting away from each other
Rift Valley Formed by Extension
## Faults

<table>
<thead>
<tr>
<th>Types of Faults</th>
<th>Reverse Fault</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction rocks are moving</strong></td>
<td>Hanging wall moves up in relation to footwall</td>
</tr>
<tr>
<td><strong>Type of stress applied to rocks</strong></td>
<td>Compression (thickens and shortens the rocks)</td>
</tr>
</tbody>
</table>
Reverse Fault
Compression

Action of coincident oppositely directed forces acting towards each other

Reverse Fault

Dip-slip fault (reverse)

Shortening
# Faults

<table>
<thead>
<tr>
<th>Types of Faults</th>
<th>Thrust Fault</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction rocks are moving</strong></td>
<td>Hanging wall is thrust over the footwall Fault plane dips 45° or less</td>
</tr>
</tbody>
</table>

**Thrust Fault**

Type of stress applied to rocks

Compression
Thrust Fault
Thrust Fault
Thrust Fault
# Faults

<table>
<thead>
<tr>
<th>Types of Faults</th>
<th>Strike-Slip Fault</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction rocks are moving</strong></td>
<td>Rocks on either side of fault are moving horizontally past each other</td>
</tr>
<tr>
<td><strong>Type of stress applied to rocks</strong></td>
<td>Shear stress</td>
</tr>
</tbody>
</table>
Strike-Slip Faults
Shear

Action of coincident oppositely directed forces acting parallel to each other across a surface in a couple

Strike-slip fault
How Mountains Form

(rocks have been permanently deformed under stress = this makes metamorphic rocks):

• Stress
• Folds
• Faults
• Joints

(see ES1102)
**Joints** – breaks in bedrock, but **NO** movement has occurred here

Provide channels through the crust where fluids can enter and move through bedrock.

Caverns form in limestone from water dissolving limestone along joint planes. Quartz or calcite veins can fill joints (as hot fluids rise up through the crust).
Types of Mountains:

• Folded Mountains
• Dome Mountains
• Volcanic Mountains
• Fault-block Mountains
• Horsts and Grabens
Folded Mountains
- formed when 2 continental plates collide and rocks are folded and crumpled, (compressional stress)
  - Examples: Appalachian, Alps, northern Rocky Mountains, Urals, Himalayas
Folds

- **Syncline** – downward fold (valley of mountain)
- **Anticline** – upward fold (top of mountain)
Sidling Hill, Maryland
(on the way to Cumberland, MD or Frostburg, MD)
Overturned folds
Overturned Folds
Folding creates non-volcanic mountains
Dome Mountains

- nearly circular folded mountain (not found in mountain belts), they are found alone in areas of essentially flat-lying sedimentary rocks
Dome Mountains

Two Types:

– Plutonic dome mountain – overlying crustal rocks pushed up by an igneous intrusion (like a laccolith)
  • Example: mountains along the Colorado Plateau and the Rocky Mountains

– Tectonic dome mountain – uplifting forces arch rock layers upward.
  • Example: Adirondack Mountains of NY, Black Hills of South Dakota
Adirondack Mountains, NY

Black Hills, SD
Volcanic Mountains

– tend to form on continental crust near a subduction boundary
  Example: Cascade mountains (northwestern US)
Fault-Block Mountains

- formed by tension stress, crust is uplifted which causes the crust to stretch and crack and form normal faults. Whole blocks of crust are pushed up during these normal faults.

Example: Sierra Nevada in CA, Wasatch Range of Utah, Teton Range of Wyoming
Horsts and Grabens – formed by tensional stress and normal faulting

**Horsts** – a block or crust thrust upward between 2 normal faults

**Grabens** – a block of crust that has dropped between 2 normal faults

Example: Great Rift Valley in East Africa

Example: Basin and Range Province of Nevada
Horsts and Grabens – formed by tensional stress and normal faulting
Example: Great Rift Valley in East Africa – rising magma is forcing crust upward, tensional stress causes the crust to stretch. Normal faults have formed on either side of the rift valley and in between large blocks of rocks have dropped (grabens).
Wildrose Graben, Southern California