Chap. 9 Tectonics, Earthquakes, and Volcanoes

Mount Everest.

Bam, Iran
>30k dead
2003 6.9M

Mount Everest from the Space Shuttle; loc map
Trans AK pipeline knocked off supports 7.9 M Denali eq in 2003 [http://pubs.usgs.gov/fs/2003/fs014-03/]. ~700 died or 4x?

2005 Muzaffarabad Pakistan-Kashmir M 7.6 70k died

M 7.9 eq in Chengdu China 2008; 83k died.

Hypsographic curve - distrib of land by area and elev

Topographic regions

Continental shields--cratons exposed at Earth’s surface.
Shield showing glacial striations

Crustal formation: sea floor spreading forms new ocean crust. Subduction of oceanic lithosphere creates volcanic arcs atop the subduction zone. Ex. Cascadia!

Accreted terranes--the great tectonic breakthrough of 1980s. Ex is Wrangell mtns

Fault types

Crustal deformation - folding and faulting
Anticlines - convex upward
Synclines - concave upward
Figure 09.08

Syncline, Maryland

Roadcut near the San Andreas Fault

Folding in the Zagros crush zone, Iran

Dome

Basin

38 km (24 mi)
Black Hills of ND shaded relief—makes it easier to tell it’s a dome.

Normal fault (tension) and Wasatch Front in Utah

Reverse or thrust fault (compression); ex from BC

Strike slip (shearing) ex: San Andreas
Four quakes in southern CA

Horst and graben landscape
The Alps

Ocean-continent subduction

Ocean-ocean subduction

Collision of two continental tectonic plates

The Appalachians
Mount Hood, a composite volcano in the Cascade Range is composed largely of dacite and andesite.

Basalt of the Miocene Columbia River Basalt Group in the Columbia River Gorge.

Effusive basalt is low silica and thus low viscosity, so it flows more easily than more sticky lavas.
White Island off New Zealand, a composite volcano

Mount St. Helens prior to the 1980 eruption, and Spirit Lake.

Mount St. Helens, 1980

Debris avalanche deposit and North Fork Toutle River after the eruption. View to the east; Mount St. Helens in the distance.

(b) An eruption that changed volcanology, and us!

The Mount St. Helens eruptive sequence 5/18/1980, shown with photos (from Keith Ronnholm) and diagrams.

A dacite (higher silica) volcanic bomb from Mount St. Helens (left) compared to basalt (lower silica) lava from Kilauea. More sticky dacite is explosive; basalt is effusive (flows more readily).
Lava flowing into the ocean from Kilauea volcano.

Puʻu Oʻo vent on the east flank of Kilauea has changed many times since formed.

Mount Rainier (composite volcano) compared with Mauna Loa (shield volcano). Mauna Loa is Earth’s largest volcano.

Diagrammatic view of a typical composite or "stratovolcano". This type of volcano is commonly associated with subduction zones.

Long Valley is a “restless caldera” in California. Several ski patrol members died there a few years ago when they fell into a pit filled with carbon dioxide gas from the volcano. Calderas are much more challenging to monitor than smaller volcanic systems such as composite volcanoes.
### Table 8.1: Magnitude, Intensity, and Frequency of Earthquakes

<table>
<thead>
<tr>
<th>Description</th>
<th>Effects on Populated Areas</th>
<th>Moment Magnitude Scale</th>
<th>Modified Mercalli Scale</th>
<th>Number per Year*</th>
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</thead>
<tbody>
<tr>
<td>Great</td>
<td>Damage mostly local</td>
<td>8.0-9.0</td>
<td>VII</td>
<td>1</td>
</tr>
<tr>
<td>Major</td>
<td>Great damage</td>
<td>7.0-8.0</td>
<td>VI-IX</td>
<td>10</td>
</tr>
<tr>
<td>Severe</td>
<td>Great damage, some minor</td>
<td>6.0-7.0</td>
<td>V-VI</td>
<td>100</td>
</tr>
<tr>
<td>Light</td>
<td>Minor damage, some minor</td>
<td>5.0-6.0</td>
<td>IV-V</td>
<td>1,000</td>
</tr>
<tr>
<td>Very Light</td>
<td>Mostly minor</td>
<td>4.0-5.0</td>
<td>III</td>
<td>10,000</td>
</tr>
</tbody>
</table>

*Based on descriptions since 1900.

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### Table 8.2: A Sampling of Significant Earthquakes

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Number of Deaths</th>
<th>Magnitude (moment magnitude)</th>
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</thead>
<tbody>
<tr>
<td>1906/04/12</td>
<td>San Francisco, California</td>
<td>3,000</td>
<td>7.9</td>
</tr>
<tr>
<td>1923/01/16</td>
<td>Long Beach, California</td>
<td>100</td>
<td>7.1</td>
</tr>
<tr>
<td>1925/01/17</td>
<td>Oklahoma City, Oklahoma</td>
<td>68</td>
<td>7.0</td>
</tr>
<tr>
<td>1940/02/09</td>
<td>Mexico City, Mexico</td>
<td>100</td>
<td>8.1</td>
</tr>
<tr>
<td>1964/01/01</td>
<td>Anchorage, Alaska</td>
<td>100</td>
<td>7.9</td>
</tr>
<tr>
<td>1971/06/28</td>
<td>La Paz, Bolivia</td>
<td>1,000</td>
<td>7.8</td>
</tr>
<tr>
<td>1985/01/01</td>
<td>Kobe, Japan</td>
<td>6,000</td>
<td>7.2</td>
</tr>
<tr>
<td>2004/05/23</td>
<td>Marseilles, France</td>
<td>10</td>
<td>5.5</td>
</tr>
</tbody>
</table>

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### Table 8.3: Sample of Notable Composite Volcano Eruptions

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Number of Deaths</th>
<th>Amount Erupted (m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980/01/17</td>
<td>Mount St. Helens, Washington</td>
<td>58</td>
<td>290,000</td>
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<tr>
<td>1991/05/18</td>
<td>Mount St. Helens, Washington</td>
<td>5</td>
<td>50,000</td>
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<tr>
<td>1991/10/01</td>
<td>Mount Pinatubo, Philippines</td>
<td>515</td>
<td>2.5</td>
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<tr>
<td>1994/09/18</td>
<td>Mount St. Helens, Washington</td>
<td>5</td>
<td>50,000</td>
</tr>
<tr>
<td>1996/03/01</td>
<td>Mount St. Helens, Washington</td>
<td>5</td>
<td>50,000</td>
</tr>
</tbody>
</table>

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