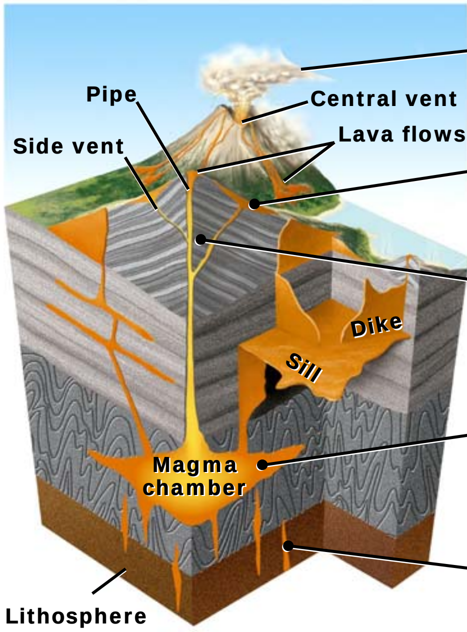
G-100
Lectures 8 & 9
Volcanoes

Volcanoes:

- Windows into Earth's interior
- Help us understand plate tectonic process and mantle convection
    - *At present, but also millions to billions of years in past using radioisotopic dating*
- Impact Earth's atmosphere and hydrosphere
- Pose hazards to millions of people

Volcanic geosystem



Gases injected into atmosphere (H_2O, CO_2, SO_4).

...accumulating on the surface to form a volcano.

Lavas erupt through a central vent and side vents,...

...rises through the lithosphere to form a crustal magma chamber.

Magma, which originates in the asthenosphere...

Lavas and other volcanic deposits

- Types of lava
  - Basaltic (1000-1200º C)

Figure 12-2
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Hawaii

Figure 12-3
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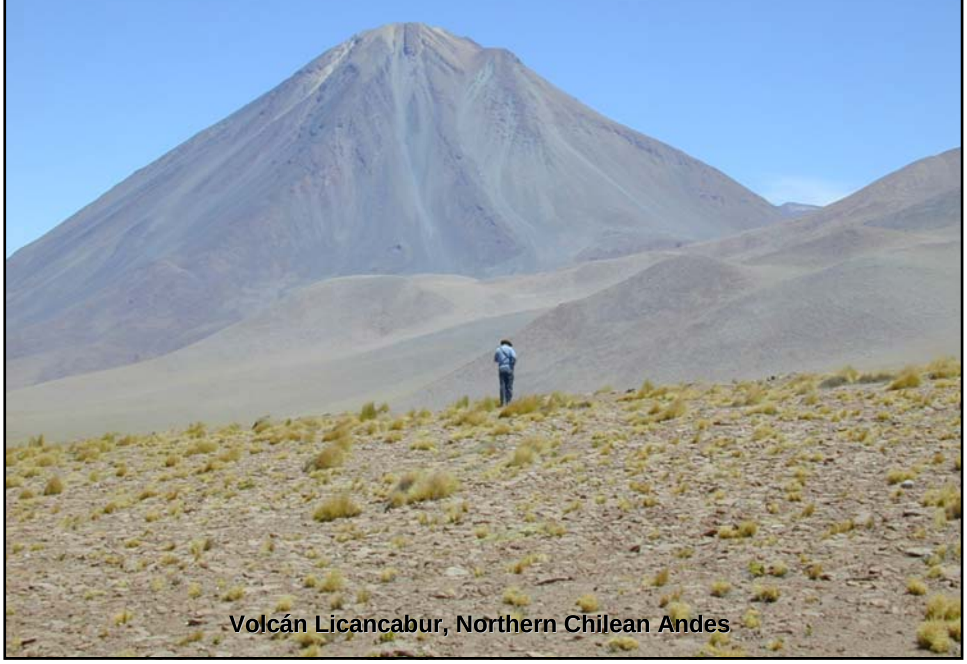
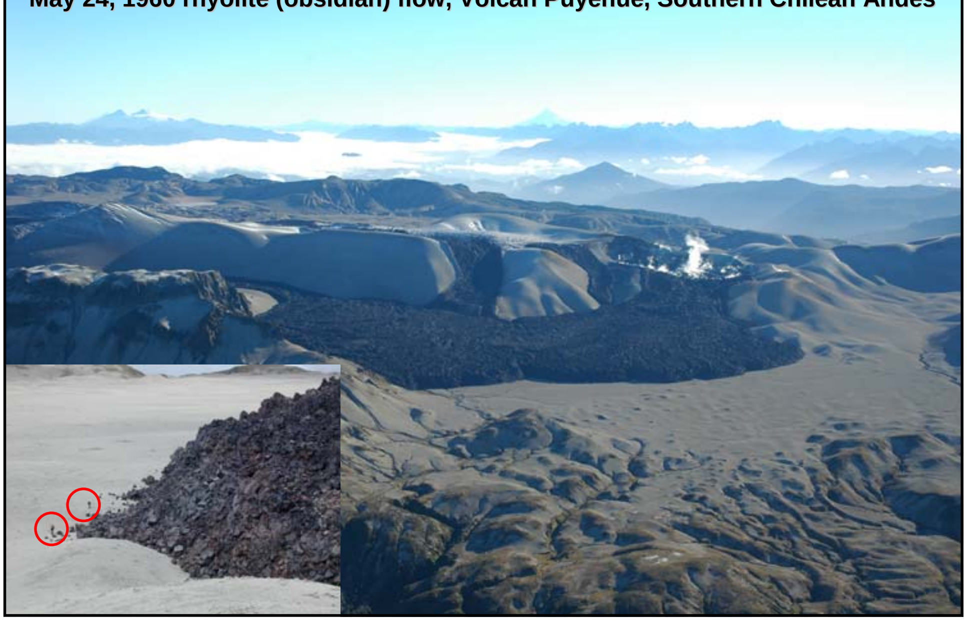
• Andesitic-dacitic (800-1000º C)



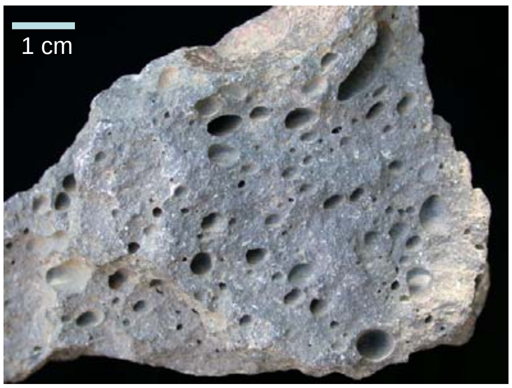
Volcán Licancabur, Northern Chilean Andes

• Rhyolitic (600-800º C)

May 24, 1960 rhyolite (obsidian) flow, Volcán Puyehue, Southern Chilean Andes



- Textures
  - Aphantic (glassy)-Porphyritic (few crystals)
  - Vesicular (bubbles)
  - Pyroclastic (fragmental)
    - Ash, lapilli, bombs (falls)
    - Pyroclastic flows (tuffs)



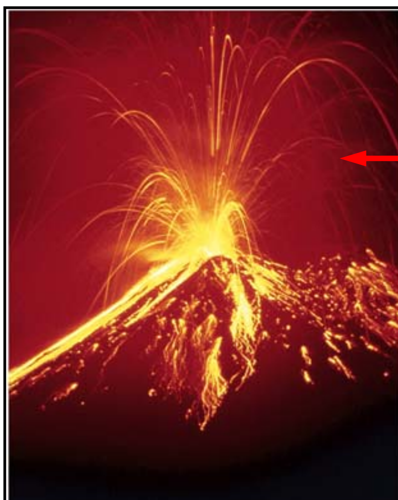


Figure 12-7 part 2
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Arenal, Costa Rica
Strombolian eruption
Basaltic bombs coalesce and flow

Why the constrast in explosivity?

Composition

Basalt

- **Isolated SiO_4**
- **High T (1100° C)**
- **Low viscosity**
- **Water diffuses out of melt**
- **thus weak explosivity**

Dacite

- **Framework SiO_4**
- **Low T (700° C)**
- **High viscosity**
- **Water trapped in melt**
- **Bubbles form, expand as magma rises, decompresses *until!***

Figure 12-10
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Mt. Unzen, Japan
Dacitic domec ollapse
pyroclastic ash flow

Pyroclastic Flows

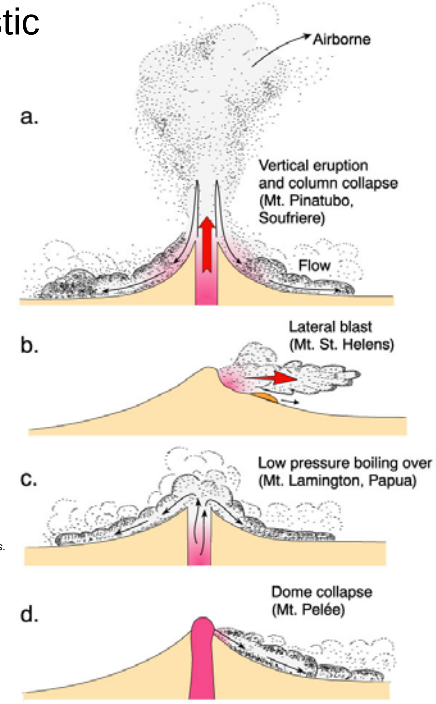


Figure 4-18. Types of pyroclastic flow deposits. After MacDonald (1972), *Volcanoes*. Prentice-Hall, Inc., Fisher and Schminke (1984), *Pyroclastic Rocks*. Springer-Verlag. Berlin.

a. Collapse of a vertical explosive or plinian column that falls back to earth, and continues to travel along the ground surface.

b. Lateral blast, such as occurred at Mt. St. Helens in 1980.

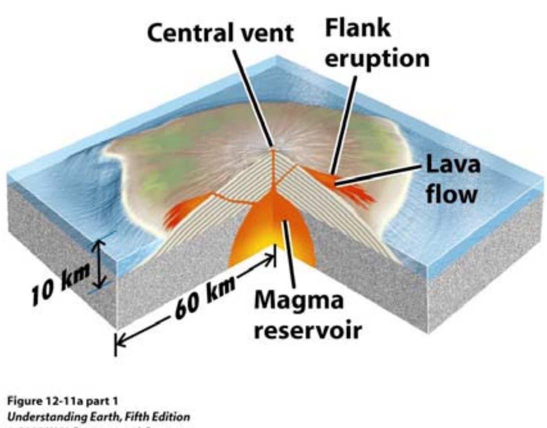
c. "Boiling-over" of a highly gas-charged magma from a vent.

d. Gravitational collapse of a hot dome.

from Winter (2001)

Eruptive styles and landforms

- shield volcanoes
- volcanic domes
- cinder-cone volcanoes
- stratovolcanoes
- volcanic craters (ash flow tuff)
- calderas (ash flow tuff)
- diatremes
- fissure eruptions (flood basalt)



Shield volcanoes are built up by the accumulation of thousands of thin basaltic flows that spread as gently sloping sheets. Each layer in the diagram represents many hundreds of thin flows. Magma can erupt on the flanks of a volcano as well as from the central vent.

Figure 12-11a part 1
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Figure 12-11a part 2
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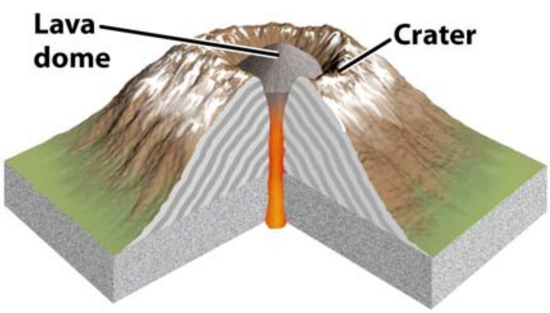

Volcanic domes are bulbous masses of felsic lava, which are so viscous that instead of flowing, they pile up over the vent. The photo shows a growing dome within the crater of Mount St. Helens after its 1980 eruption.

Figure 12-11b part 1
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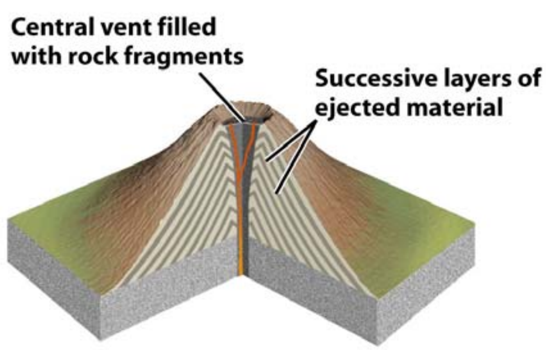

Figure 12-11c part 1
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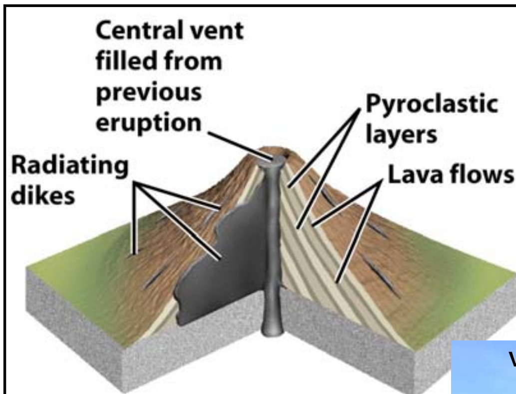
Cinder-cone volcanoes are formed when ejected material is deposited as layers that dip away from the crater at the summit. The vent beneath the crater is filled with fragmental debris. The photo is of Cerro Negro, shown erupting in 1968, a cinder cone built on an older terrain of lava flows.

February 25, 1943. Day 5 of Parícutin Volcano's first lava flow. Note eruption of scoria from atop 200 m high cinder cone



Stratovolcanoes are built from alternating layers of pyroclastic material and lava flows. Lava that has solidified in fissures forms riblike dikes that strengthen the cone.

Figure 12-11d part 1
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Craters are found at the summits of most volcanoes. After an eruption, lava often sinks back into the vent and solidifies, to be blasted out by a later pyroclastic explosion.

Figure 12-11e
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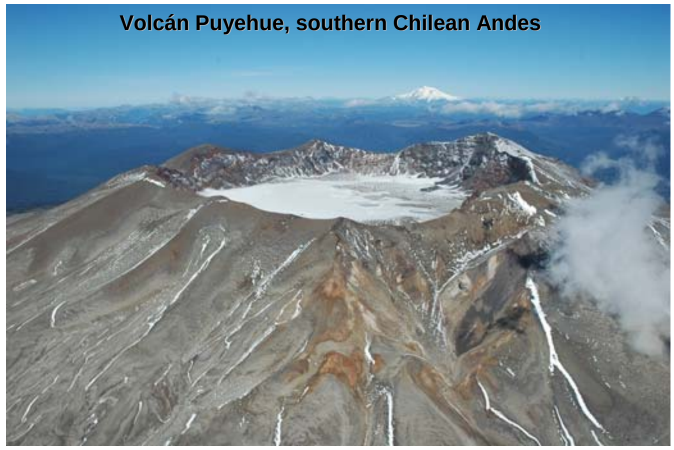
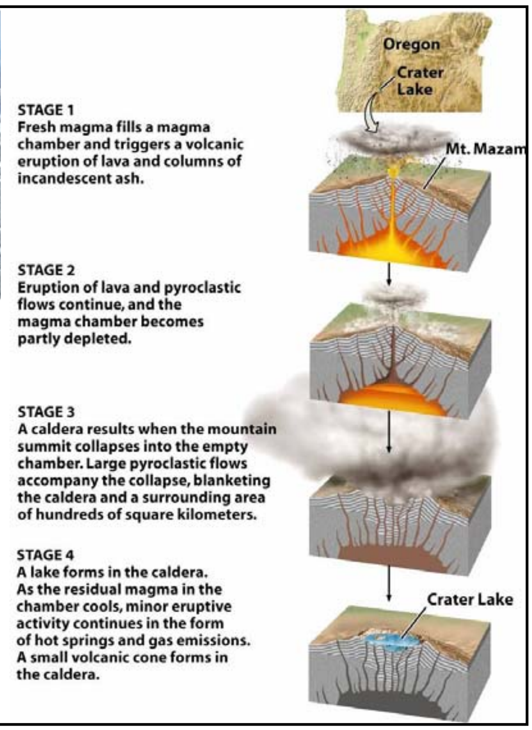
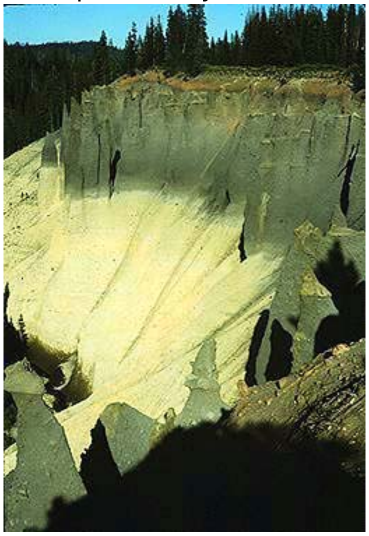


Caldera formation



- Crater Lake Caldera
- Mt. Mazama ash
  - 50 km^3
  - Erupted 6950 yrBP



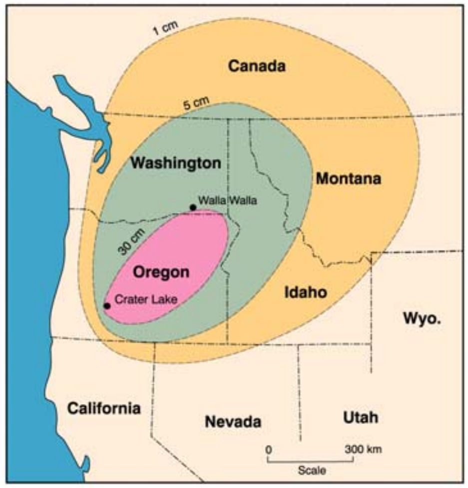
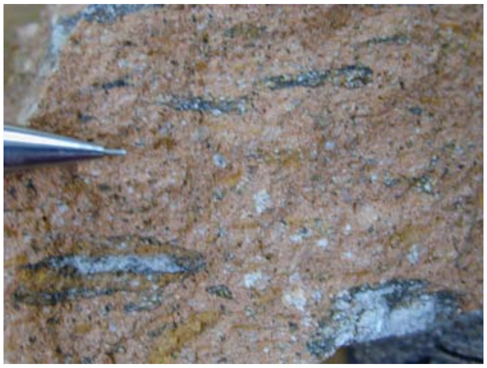


Figure 4-16. Approximate aerial extent and thickness of Mt. Mazama (Crater Lake) ash fall, erupted 6950 years ago. After Young (1990), Unpubl. Ph.D. thesis, University of Lancaster. UK.

from Winter (2001)

Long Valley Caldera,California
- Bishop Tuff (>100 m thick)
- non-welded base
- welded interior



welding and compaction in ash flow tuff = flattened pumice lapilli

Laki fissure eruption Iceland

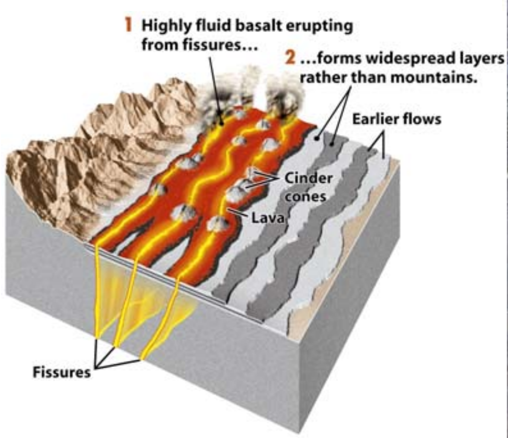


Figure 12-15 part 1
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Figure 12-15 part 2
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Flood basalt, Columbia Plateau,Washington

Figure 12-16 part 1
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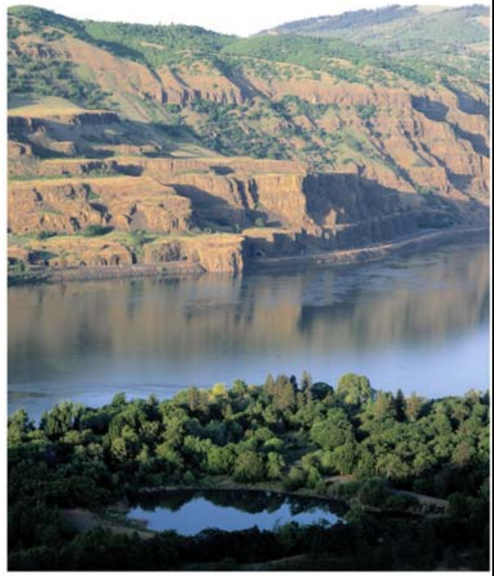

Figure 12-16 part 2
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Impacts of volcanism

- **hydrosphere**
- **atmosphere**

Old Faithful geyser, Yellowstone

Figure 12-18
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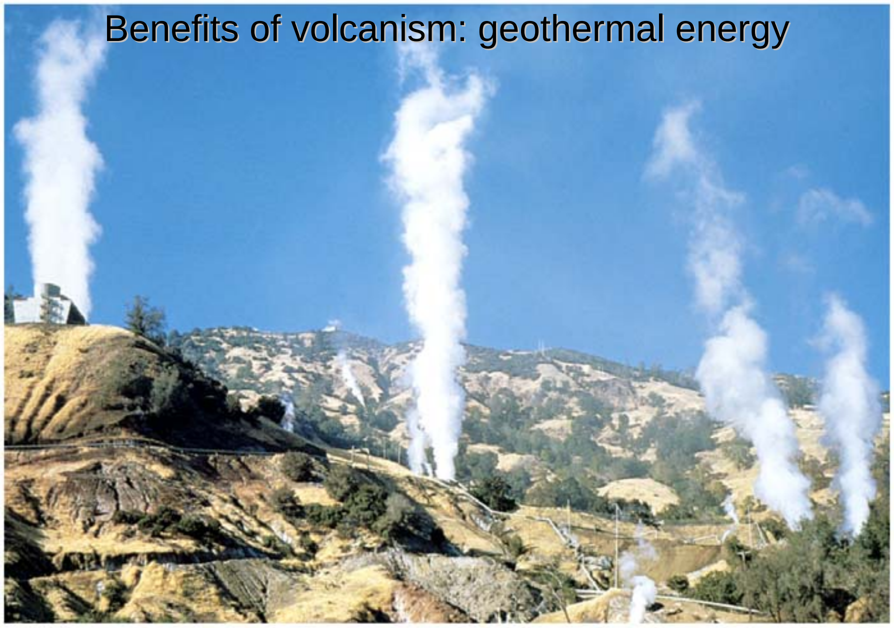
Fumaroles, Santiaguito dome Guatemala

Benefits of volcanism: geothermal energy



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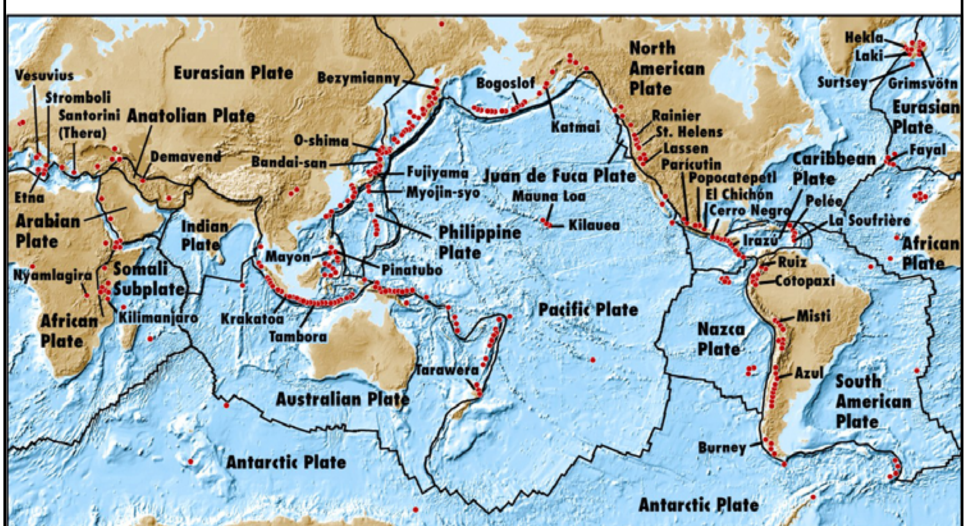
Global pattern of volcanism



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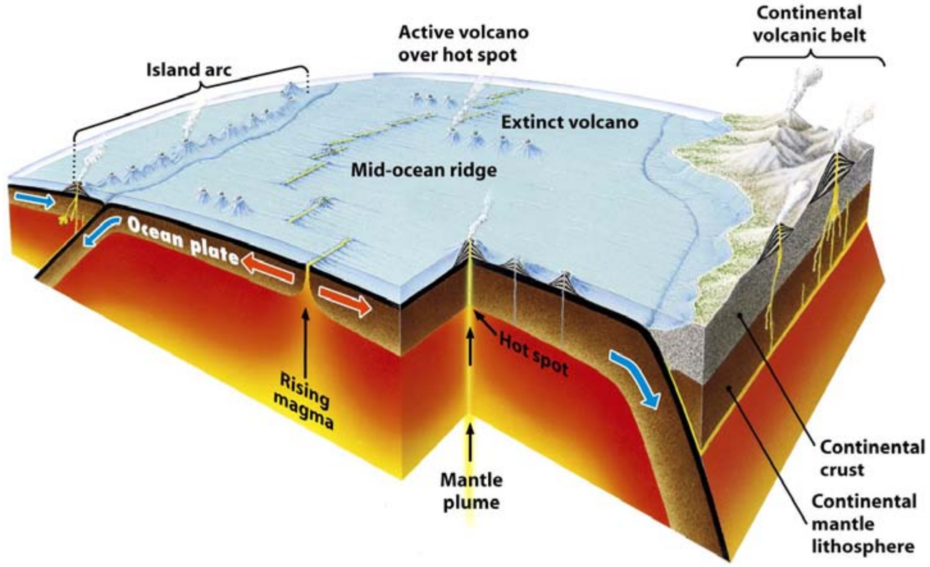
Global pattern of volcanism



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Hot spots & Mantle plumes

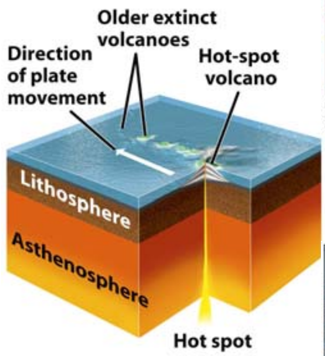

Figure 12-21a part 1
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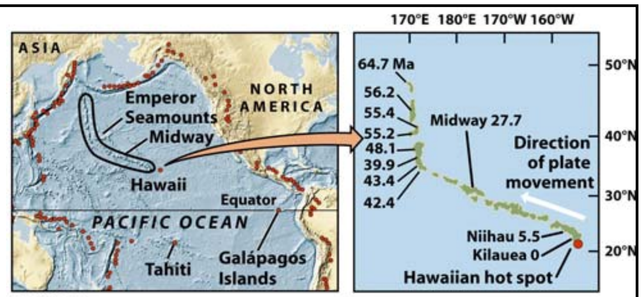

Figure 12-21a part 2
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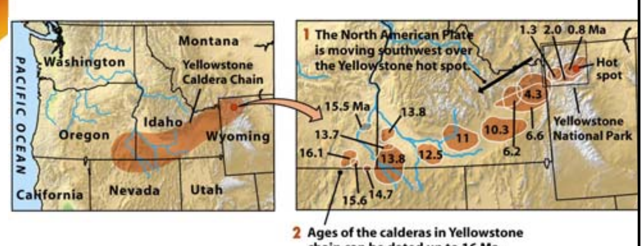

Figure 12-21b
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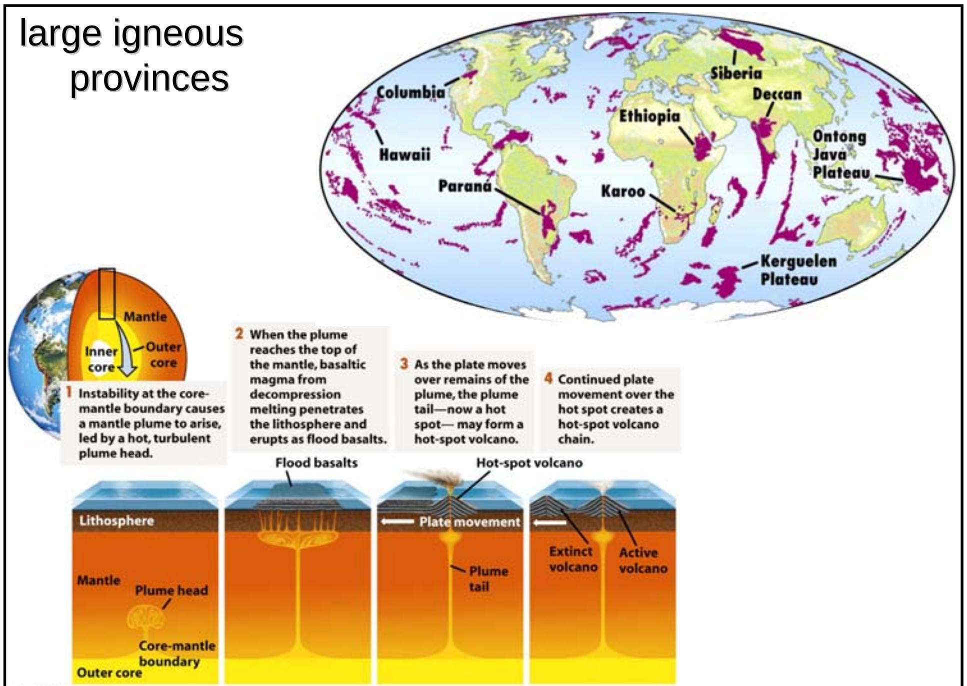
large igneous provinces



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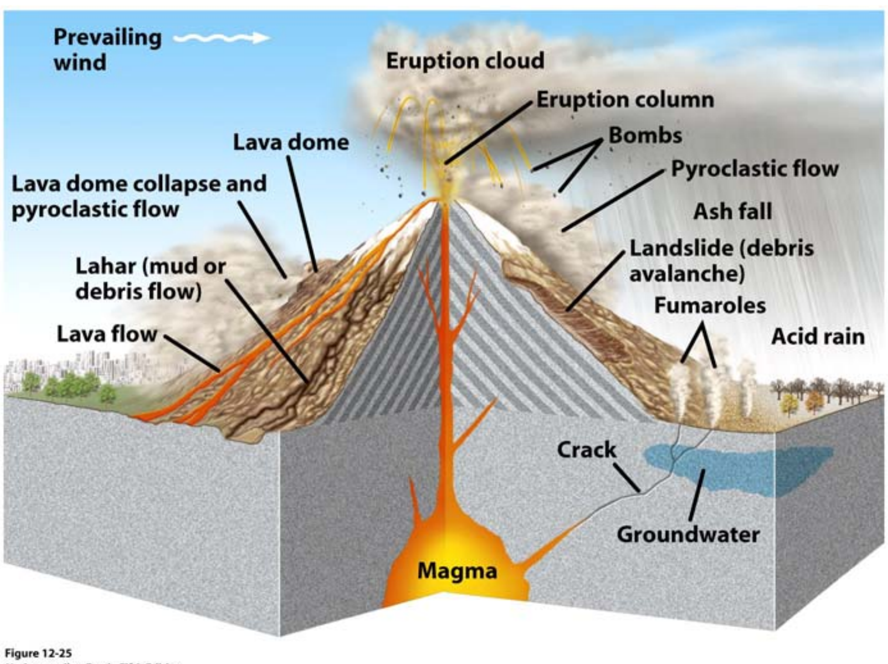

Figure 12-25
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Volcanism and human affairs

Hazards
- lahars
- flank collapse
- caldera collapse
- eruption clouds

Resources
- volcanic soils
- industrial materials
- ore formation
- geothermal energy

Volcanism and human affairs

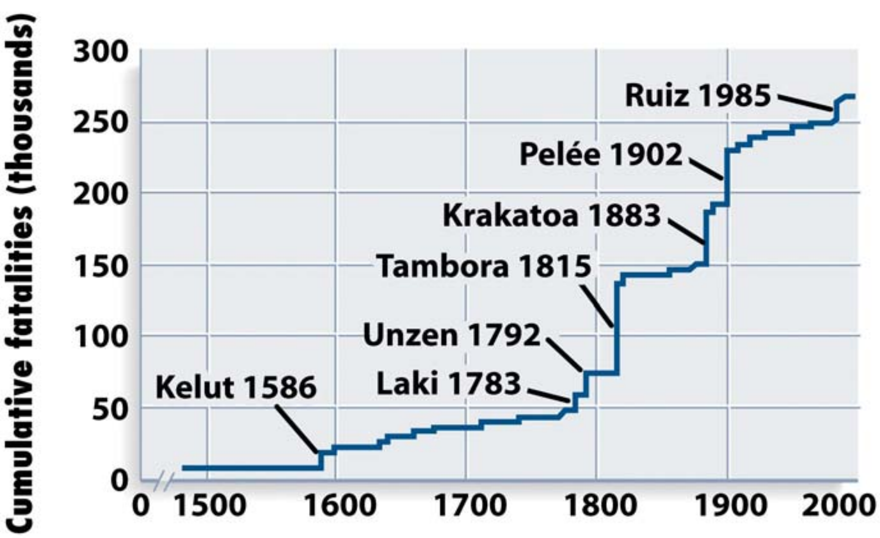

Figure 12-24a
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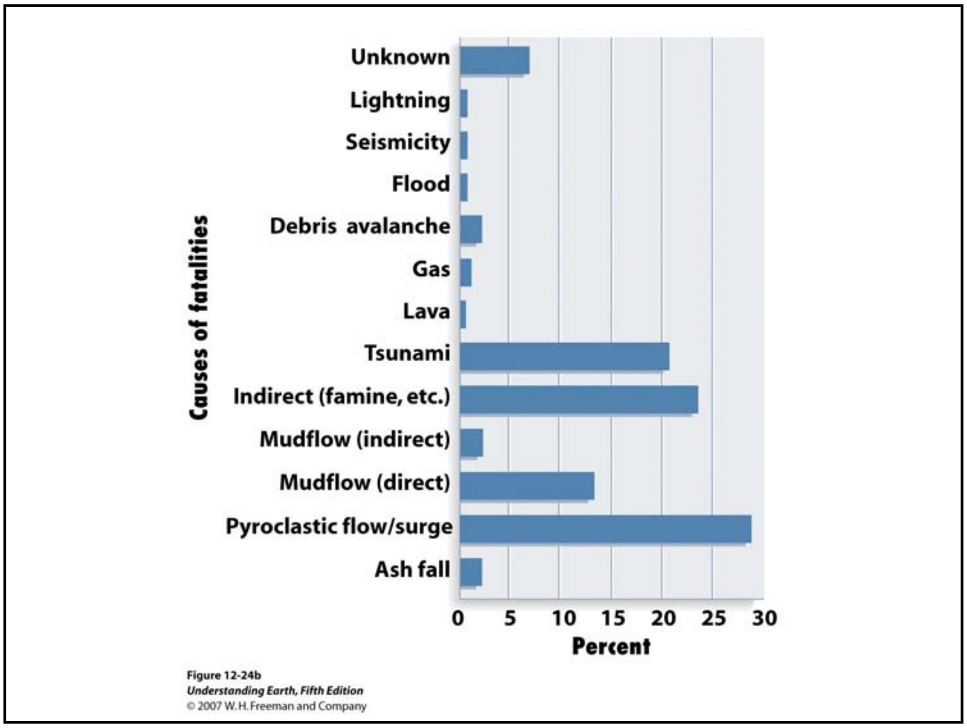
Unknown
Lightning
Seismicity
Flood
Debris avalanche
Gas
Lava
Tsunami
Indirect (famine, etc.)
Mudflow (indirect)
Mudflow (direct)
Pyroclastic flow/surge
Ash fall
Causes of fatalities
0 5 10 15 20 25 30
Percent
Figure 12-24b
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