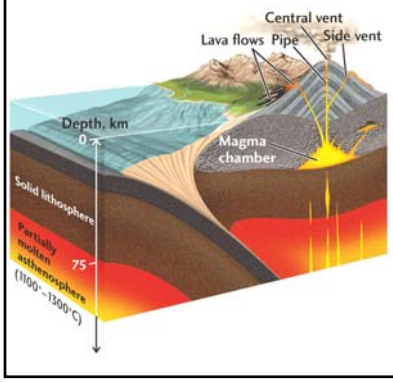
Volcanoes: Big Ideas

- Humans cannot eliminate natural hazards, such as volcanic eruptions, but can engage in activities that reduce their impacts by identifying high-risk locations, improving construction methods, and developing warning systems
- Water's unique physical and chemical properties are essential to the dynamics of all of Earth's systems
- Understanding geologic processes active in the modern world is crucial to interpreting Earth's past
- Over Earth's vast history, both gradual and catastrophic processes have produced enormous changes
- Earth scientists do reproducible experiments and collect multiple lines of evidence.

Why are volcanoes hazards?



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

3. Lavas erupt from the magma chamber through central and side vents…

2. …rises through the lithosphere to form a magma chamber

1. Magma, which originates in the partially melted asthenosphere…

Types of Lavas

- **Basaltic lavas**: low-viscosity mafic lavas, typically erupted at 1000º to 1200º C; cool to form basalt.
- **Rhyolitic lavas**: high-viscosity felsic lavas, typically erupted at 800º to 1200º C; cool to form rhyolite.
- **Andesitic lavas**: intermediate in composition and viscosity between mafic and felsic magmas; cool to form andesite.

Fig. 12.16

Flood Basalts of the Columbia Plateau

Fig. 12.16

Fig. 12.3

Vesicular Basalt:

trapped gases form bubbles (vesicles)

Fig. 12.6

Fig. 12.7

Pyroclastic Material:

Fragmentary volcanic rocks ejected into the air

Fig. 12.7

Volcanic Bomb

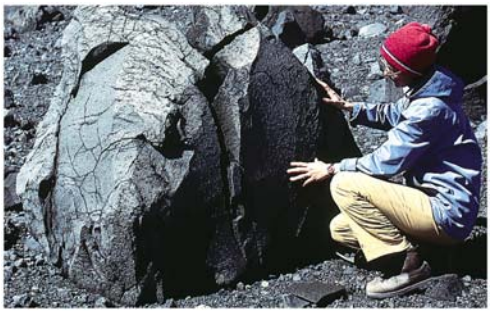


Fig. 12.8

Volcanic Breccia

Fig. 12.9

Welded Tuff Formed from Pyroclastic-Flow Deposit

Fig. 12.9

Eruptive Styles & Landforms

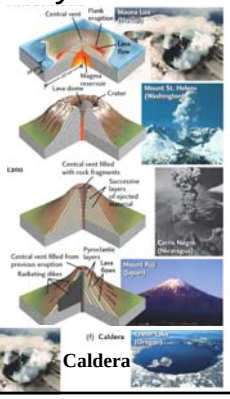


Fig. 12.11

Fig.12.11.a

Shield Volcano

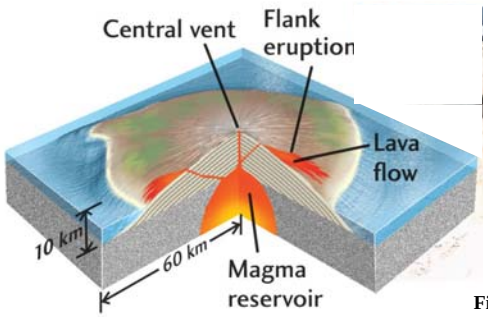


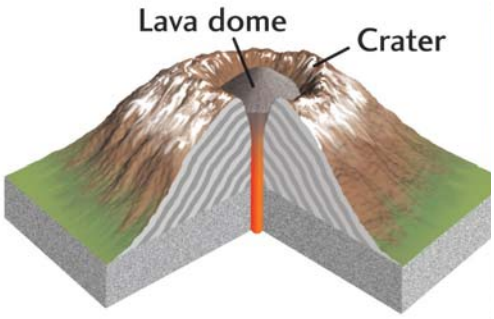
Fig.12.11.a

Shield Volcanoes

- Formed mainly of basaltic lavas
- Gentle sides: ~2-10 degrees
- Can be huge: up to 120 km wide!
- Long duration of activity:10,000's yrs
- Eruptions usually non-violent

Fig. 12.11b

Volcanic Dome

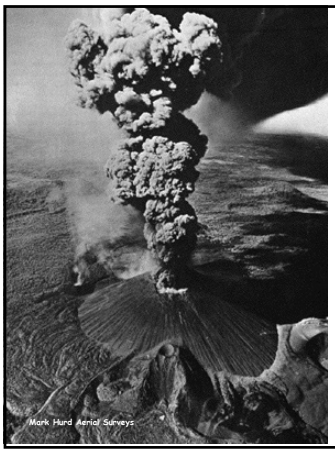


12.11b

Volcanic Domes

- Form of viscous felsic lavas
- Steep-sided and small:~100's m wide
- Grow slowly

Paricutin Volcano, Mexico (1943-1952)



Cerro Negro Cinder Cone, near Managua, Nicaragua in 1968

Fig. 12.11c

Cinder Cone

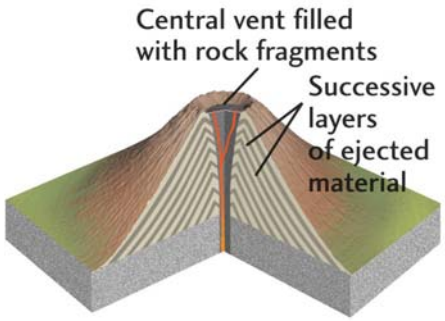


Fig. 12.11c

Cinder Cones

- Formed mainly of basaltic pyroclastic material
- Steep sides: ~30 degrees
- Relatively small: ~ 1 km wide
- Short-lived: typically a single event

Mt Fujiyama, Japan

Fig. 12.11d

Composite Volcano

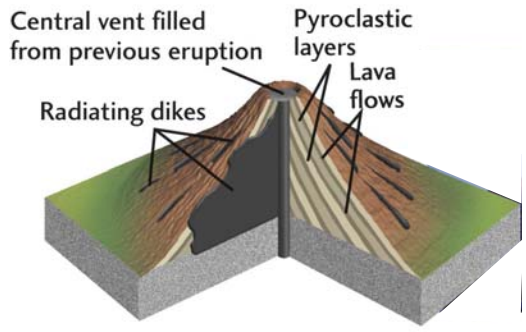


Fig. 12.11d

Composite Volcano

- Mainly alternating pyroclastic deposits and andesitic lava flows
- Slopes are intermediate in steepness
- Relatively large: ~10-15 km wide
- Intermittent eruptions over long time span: 1,000's of yrs
- Eruptions often highly explosive

Caldera

Fig. 12.11e

Caldera

- A large depression (typically several km wide) formed by collapse of a volcano into a partially drained magma chamber
- May have younger domes within it

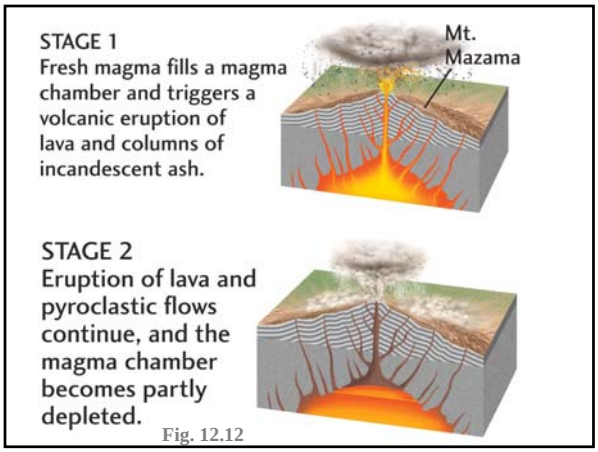
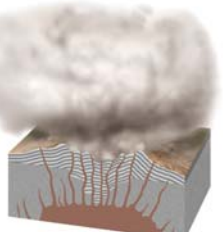


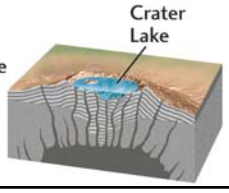
Fig. 12.12

Fig. 12.12

STAGE 3
A caldera results when the mountain summit collapses into the empty chamber. Large pyroclastic flows accompany the collapse, blanketing the caldera and a surrounding area of hundreds of square kilometers.



STAGE 4
A lake forms in the caldera. As the residual magma in the chamber cools, minor eruptive activity continues in the form of hot springs and gas emissions. A small volcanic cone forms in the caldera.



Phreatic Explosion:

caused by magma mixing with water

Fig. 12.5

Formation of a Diatreme

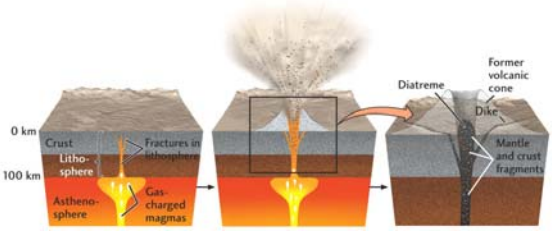


Fig. 12.13

Almost 5 carat yellow diamond found in Crater of Diamonds, AK Three years ago

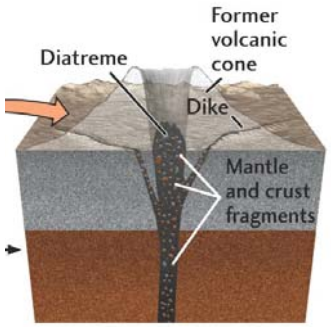


Fig. 12.13

Fissure Eruptions: A volcanic eruption originating along an elongate fissure rather than a central vent

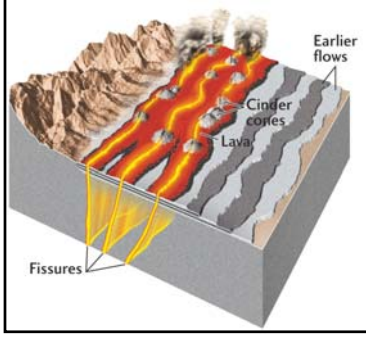


Fig. 12.15

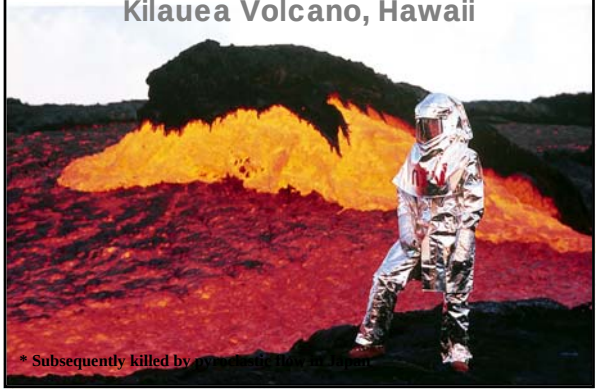
Volcanoes along the Laki Fissure (Iceland) formed in 1783, resulting in the largest lava flow in recorded history

Fig. 12.15

Volcanic Hazards

Volcanologist* studying lava flow.

Kilauea Volcano, Hawaii



* Subsequently killed by pyroclastic flow in Japan

Mt. St. Helens: Before

Mt. St. Helens: During

Mt. St. Helens: After

Active Subaerial Volcanoes of the World
(80% at convergent plate boundaries)

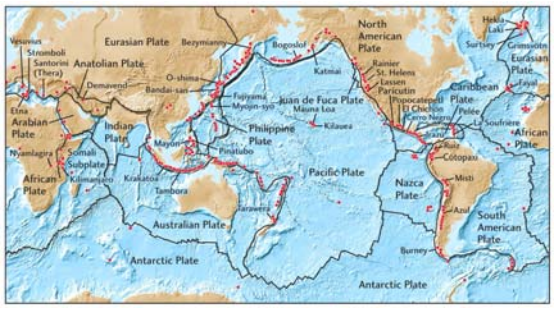


Fig. 12.19

Volcanism Associated with Plate Tectonics

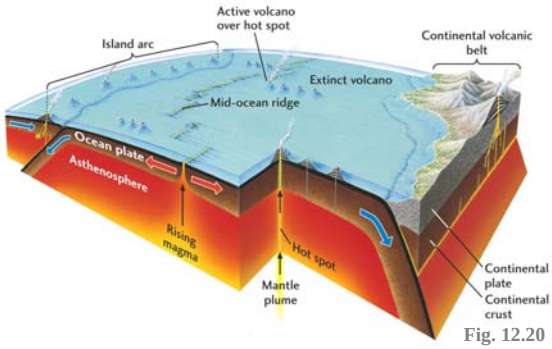


Fig. 12.20

Hot Spot Tracks

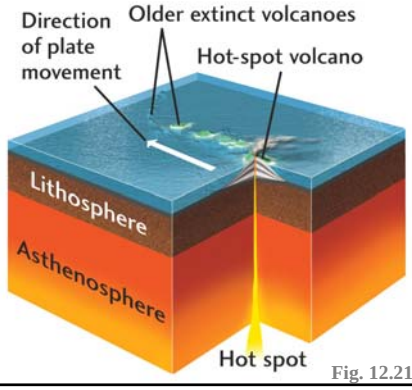


Fig. 12.21

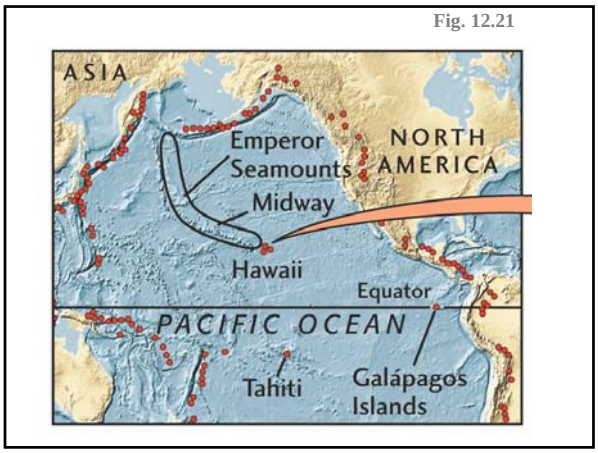
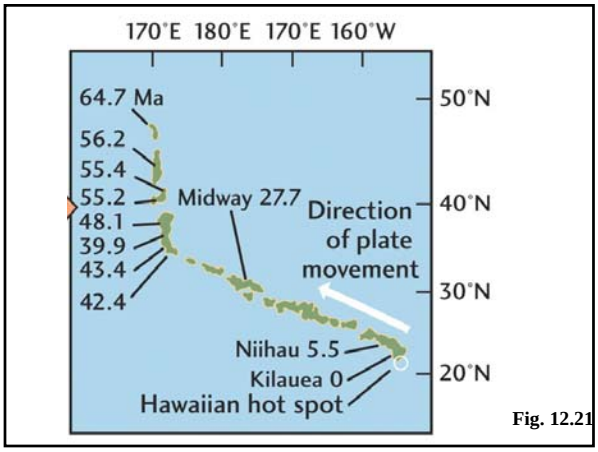
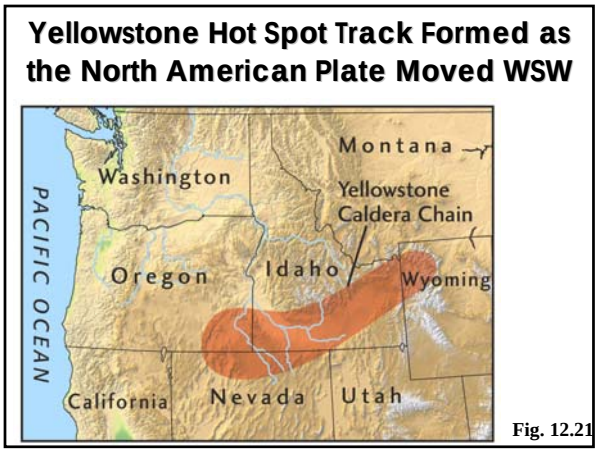


Fig. 12.21
ASIA
Emperor
Seamounts
NORTH
AMERICA
Midway
Hawaii
Equator
PACIFIC OCEAN
Tahiti
Galápagos
Islands


170°E 180°E 170°E 160°W
64.7 Ma
56.2
55.4
55.2
48.1
39.9
43.4
42.4
Midway 27.7
Direction
of plate
movement
50°N
40°N
30°N
20°N
Niihau 5.5
Kilauea 0
Hawaiian hot spot
Fig. 12.21


Yellowstone Hot Spot Track Formed as the North American Plate Moved WSW
Montana
Washington
Yellowstone
Caldera Chain
PACIFIC OCEAN
Oregon
Idaho
Wyoming
California
Nevada
Utah
Fig. 12.21

Age of Yellowstone Calderas Track Movement of Plate Over the Hot Spot

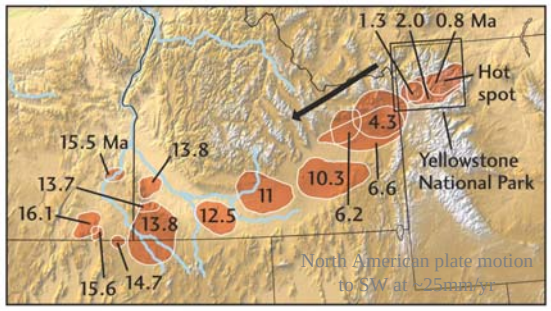


Fig. 12.21

Types of Volcanic Hazards

- **Lava Flows**:
  - e.g. Hawaii, 1998
- **Gas**:
  - e.g. Lake Nyos (Cameroon), 1984 -1700 people killed
- **Ash fall:**
  - e.g. Mt Pinatubo, 1991

Lava Flow, Hawaii

Tree-kill area from Carbon Dioxide

Ash from Mt. Pinatubo

Types of Volcanic Hazards

- **Pyroclastic flows**:
  - e.g. Mt Pelee, 1902 - 28,000 killed
- **Lahars** (mudflows):
  - e.g. Nevado del Ruiz, 1985 - 23,000 killed
- **Tsunami**:
  - e.g. Krakatoa, 1883 - 36,417 killed

Pyroclastic Flows:

A density flow consisting of a hot (up to 800° C), poisonous mixture of gas and pyroclastic material moving downslope at speed in excess of 200 km/hr!

Fig. 12.10

Lahars (Volcanic mudflows)

- Formed by the sudden mixing of large volumes of pyroclastic material with water (e.g. heavy rain, draining of crater lake, melting of glacier)
- Lahars can move 100+ km/hr, and can cover large areas (1,000's of km^2), and can kill large numbers of people (~25,000 in one event)

Cumulative Deaths Due to Volcanic Eruptions Over the Last 2,000 Years

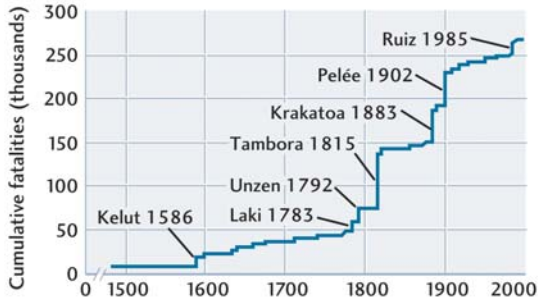
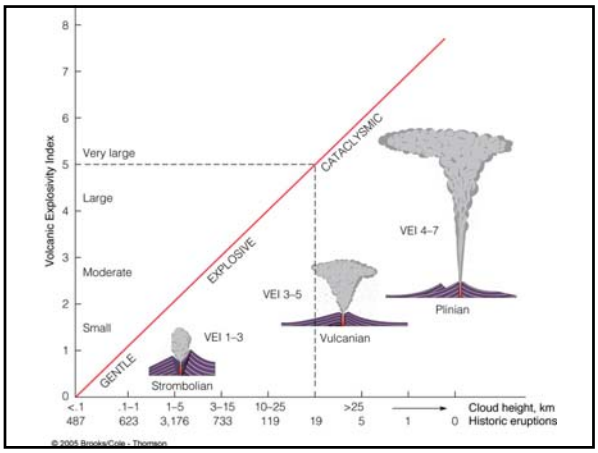
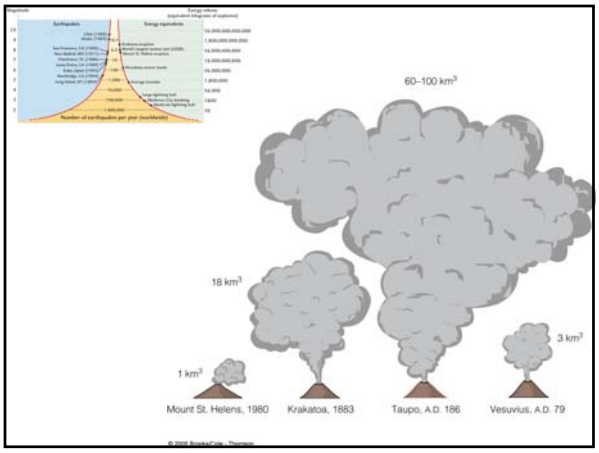


Fig. 12.24



Plinian ash cloud, Mt. Pinatubo



Location of Potentially Hazardous Volcanoes in Alaska & Hawaii

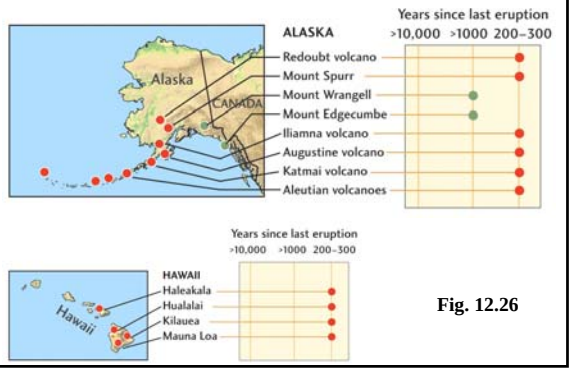


Fig. 12.26

Redoubt Volcano, Alaska 1989

Continental U.S. Volcanic Hazards

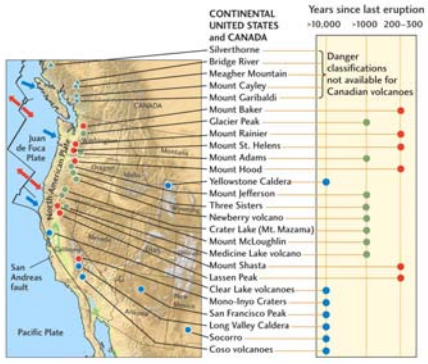
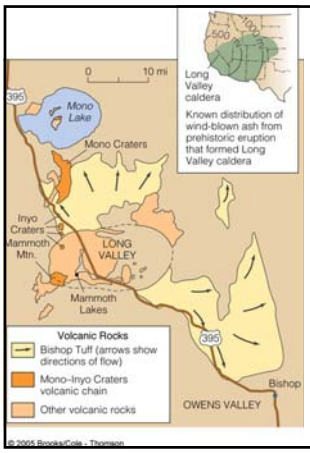
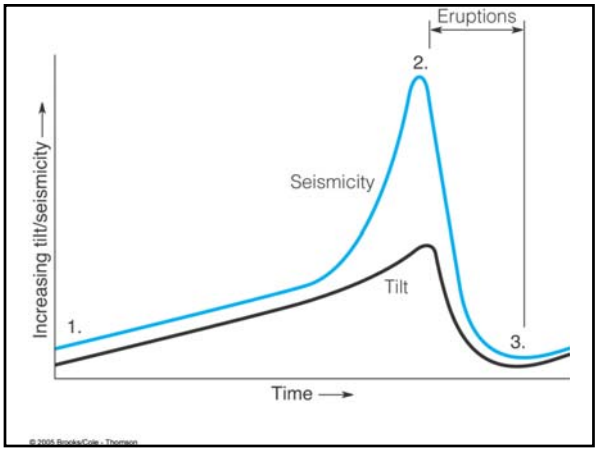


Fig. 12.26



Supervolcanoes: Yellowstone And Long Valley

Long Valley Caldera



Volcano Videos

- http://www.metacafe.com/watch/119241/big_in_japan/
- http://www.metacafe.com/watch/738148/volcanic_eruption/
- http://www.metacafe.com/watch/yt-_8fpvgLTJhg/underwater_volcanic_eruption/
- http://www.metacafe.com/watch/yt-BbTFkPxwhTM/eruption_of_etna_volcano_december_2006/