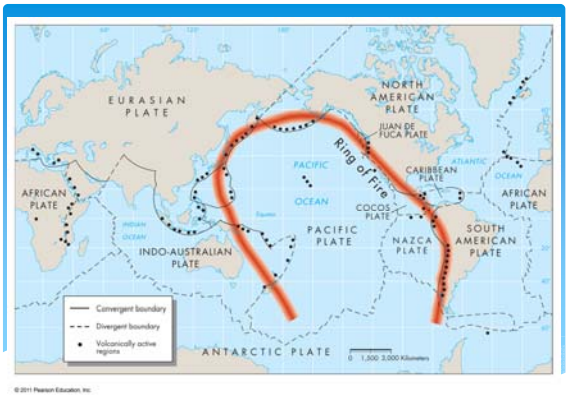
Environmental Geology
Chapter 9
Volcanic Activity

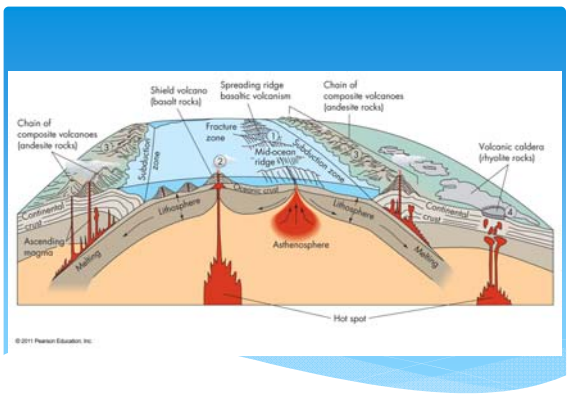
Fall 2015

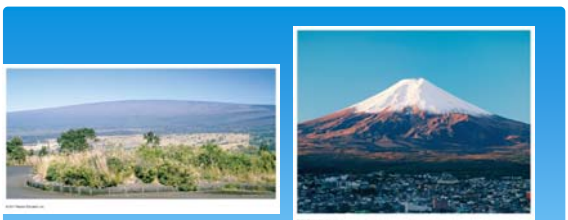
TABLE 9.1 Selected historic volcanic events

Volcano or City	Year	Effect
Vesuvius, Italy	A.D. 79	Destroyed Pompeii and killed 16,000 people. City was buried by volcanic activity and rediscovered in 1595.
Skaptar Jokull, Iceland	1783	Killed 10,000 people (many died from famine) and most of the island's livestock. Also killed some crops as far away as Scotland.
Tambora, Indonesia	1815	Global cooling; produced "year without a summer."
Krakatoa, Indonesia	1883	Tremendous explosion; 36,000 deaths from tsunami.
Mount Pelée, Martinique	1902	Ash flow killed 30,000 people in a matter of minutes.
La Soufrière, St. Vincent	1902	Killed 2000 people, and caused the extinction of the Carib Indians.
Mount Lamington, Papua New Guinea	1951	Killed 6000 people.
Villarica, Chile	1963–64	Forced 30,000 people to evacuate their homes.
Mount Helgafell, Heimaey Island, Iceland	1973	Forced 5200 people to evacuate their homes.
Mount St. Helens, Washington, USA	1980	Debris avalanche, lateral blast, and mudflows killed 54 people, destroyed more than 100 homes.
Nevado del Ruiz, Colombia	1985	Eruption generated mudflows that killed at least 22,000 people.
Mount Unzen, Japan	1991	Ash flows and other activity killed 41 people and burned more than 125 homes. More than 10,000 people evacuated.
Mount Pinatubo, Philippines	1991	Tremendous explosions, ash flows, and mudflows, combined with a typhoon, killed more than 300 people; several thousand people evacuated.
Montserrat, Caribbean	1995	Explosive eruptions, pyroclastic flows; south side of island evacuated, including capital city of Plymouth; several hundred homes destroyed.
Mount Nyiragongo, Congo, Africa	2002	Lava flows through 14 villages and part of the city of Goma; several hundred thousand people evacuated, about 5000 homes destroyed, about 45 people killed.

Source: Data partially derived from Ollier, C. 1969, Volcanoes, Cambridge, MA: MIT Press.







Mauna Loa, a shield volcano

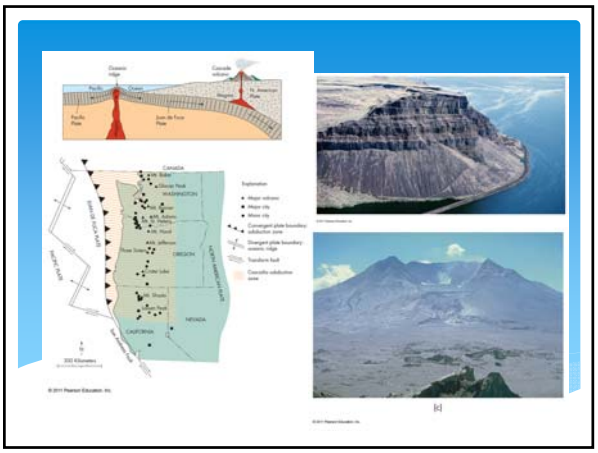
Mt. Fuji, a composite volcano

Lava dome in Mt. St. Helens

A cinder cone in Arizona

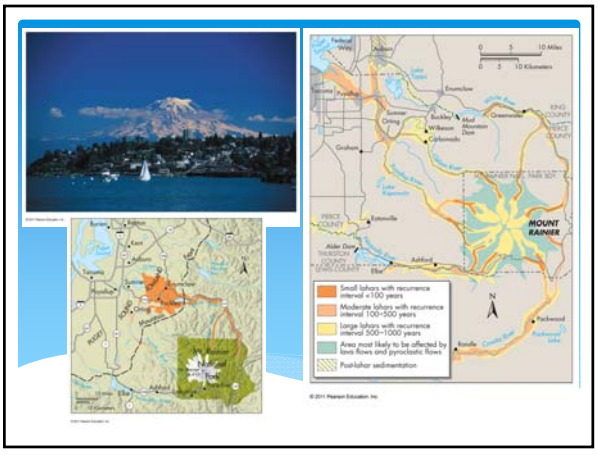
TABLE 9.2 Types of volcanoes

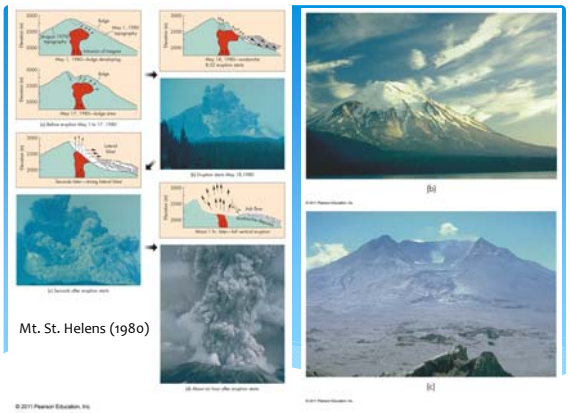
Volcano Type	Shape	Silica Content of Magma	Viscosity	Rock Type Formed	Eruption Type	Example
Shield volcano	Gentle arch, or shield shape, with shallow slopes; built up of many lava flows	Low	Low	Basalt	Lava flows, tephra ejections	Mauna Loa, Hawaii Figure 9.3
Composite volcano, or stratovolcano	Cone-shaped; steep sides; built up of alternating layers of lava flows and pyroclastic deposits	Intermediate	Intermediate	Andesite	Combination of lava flows and explosive activity	Mt. Fuji, Japan Figure 9.5
Volcanic dome	Dome shaped	High	High	Rhyolite	Highly explosive	Mt. Lassen, CA Figure 9.6
Cinder cone	Cone shaped; steep sides; often with summit crater	Low	Low	Basalt	Tephra (mostly ash) ejection	Springerville, AZ Figure 9.7



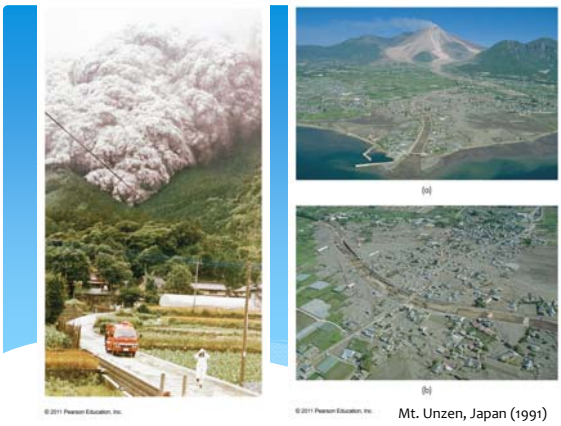
Heimaey, Iceland

Lake Nyos, Camaroon



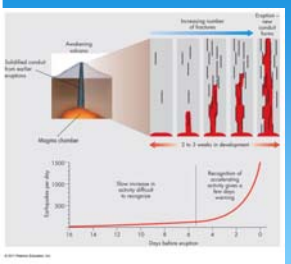


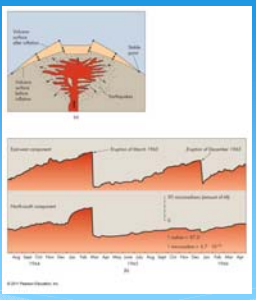
Mt. St. Helens (1980)



Mt. Unzen, Japan (1991)

Volcano Monitoring





Seismology
"A" and "B" signals

Shape Change

Volcano Monitoring

Gas Emissions

Geologic History

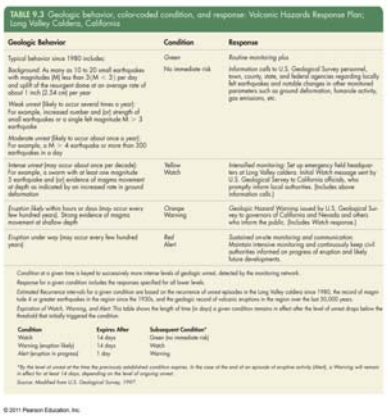


TABLE 9.3 Geologic behavior, color-coded condition, and response: Volcanic Hazards Response Plan; Long Valley Caldera, California

Geologic Behavior	Condition	Response
Typical behavior since 1980 includes:	Green	Routine monitoring plus
Background: As many as 10 to 20 small earthquakes with magnitudes (M) less than 3.0 (M < 3) per day and uplift of the resurgent dome at an average rate of about 1 inch (2.54 cm) per year	No immediate risk	Information calls to U.S. Geological Survey personnel, town, county, state, and federal agencies regarding locally felt earthquakes and notable changes in other monitored parameters such as ground deformation, fumarole activity, gas emissions, etc.
Weak unrest (likely to occur several times a year): For example, increased number and (or) strength of small earthquakes or a single felt magnitude M = 3 earthquake		
Moderate unrest (likely to occur about once a year): For example, a M = 4 earthquake or more than 300 earthquakes in a day		
Intense unrest (may occur about once per decade): For example, a swarm with at least one magnitude 5 earthquake and (or) evidence of magma movement at depth as indicated by an increased rate in ground deformation	Yellow Watch	Intensified monitoring: Set up emergency field headquarters at Long Valley caldera. Initial Watch message sent by U.S. Geological Survey to California officials, who promptly inform local authorities. [Includes above information calls.]
Eruption likely within hours or days (may occur every few hundred years). Strong evidence of magma movement at shallow depth	Orange Warning	Geologic Hazard Warning issued by U.S. Geological Survey to governors of California and Nevada and others who inform the public. [Includes Watch response.]
Eruption under way (may occur every few hundred years)	Red Alert	Sustained onsite monitoring and communication. Maintain intensive monitoring and continuously keep civil authorities informed on progress of eruption and likely future developments.

Condition at a given time is keyed to successively more intense levels of geologic unrest, detected by the monitoring network.

Response for a given condition includes the responses specified for all lower levels.

Estimated Recurrence intervals for a given condition are based on the recurrence of unrest episodes in the Long Valley caldera since 1980, the record of magnitude 6 or greater earthquakes in the region since the 1930s, and the geologic record of volcanic eruptions in the region over the last 50,000 years.

Expiration of Watch, Warning, and Alert: This table shows the length of time (in days) a given condition remains in effect after the level of unrest drops below the threshold that initially triggered the condition.

Condition	Expires After	Subsequent Condition*
Watch	14 days	Green (no immediate risk)
Warning (eruption likely)	14 days	Watch
Alert (eruption in progress)	1 day	Warning

*To the level of unrest at the time the previously established condition expires. In the case of the end of an episode of eruptive activity (Alert), a Warning will remain in effect for at least 14 days, depending on the level of ongoing unrest.

Source: Modified from U.S. Geological Survey, 1997.

Why Do People Live Near Volcanoes?

- They were born there
- Fertile land for raising crops
- An eruption is perceived as unlikely
- They have no choice

Given the good science that is now available, loss of life should not occur if the danger is effectively communicated to the public with the goal of preventing a disaster of catastrophe.