









- 1  **Introduction to Environmental Geology, 5e**
Chapter 8
Volcanic Activity
- 2  **Volcanoes: summary in haiku form**
A volcano forms.
Magma comes to the surface -
explodes, if felsic.
- 3  **Case History: Mt. Unzen, 1991**
 - One of the 19 active volcanoes in Japan
 -
 - Erupted and killed approximately 15,000 people 200 years ago
 -
 - Erupted violently on June 3, 1991
 -
 - Thousands of ash flows by the end of 1993, getting the dubious honor of the king of the ash flow centers
 -
 - 44 people killed, including Harry Glicken, a U.S. volcanologist who escaped death in the May 18, 1980 eruption of Mount St. Helens
- 4  **Introduction (1)**
 - ~ 1,500 active volcanoes on Earth
 -
 - 400 erupted in the last century
 -
 - ~ 50 eruptions per year
 -
 - Most activity concentrated along major plate boundaries
 -
 - Impact risks depend on the types of volcanoes
- 5  Table 8.1
- 6  **Introduction to Volcanic Hazards**
 - ~ 500 million people living near volcanoes
 -
 - Almost 100,000 deaths during the last 125 years
 -
 - 23,000 lives lost in the last 20 years
 -
 - Densely populated countries in the volcanic zones
 -
 - Some major cities (< 350,000 people) located near volcanoes
- 7  **Volcanism (1)**
 - Volcanism: Volcanic activity, directly related to plate tectonics and most active volcanoes are located near plate boundaries
 -
 - Approximately two-thirds of the active volcanoes concentrated along the Pacific "*ring of fire*"
 -
 - In the United States: Alaska, Cascades, and Hawaii, experiencing two or three eruptions a year
- 8  **Global Volcanism (2)**


Figure 8.4

9  **How Magma Forms**

- Most magmas come from the asthenosphere
- Temperature: Increases with depth close to the temperature at which rocks melt, two additional factors:
 - Decompression melting: Occurs when the overlying pressure exerted on hot rock within the asthenosphere is decreased
 - Addition of volatiles: Lowers the melting temperature of rocks

10  **Volcanoes Types (1)**


- Volcanic eruption style
 - Depending on lava's viscosity and amount of dissolved gas content
 - *Viscosity*: Liquid's resistance to flow
 - Determined by silica content (lava composition) and lava temperature
 - Quiet flow (low viscous basalt flow) to violent explosion (high viscous lava eruption)

11  **Volcanoes Types (2)**

- Shield volcano: Built up almost entirely from numerous Basaltic lava flows, the slope of a shield volcano is very gentle near the top, but it increases on the flanks
- Composite volcanoes: Known for their beautiful cone shape, characterized by magma with an intermediate silica content, distinguished by a mixture of explosive activity and lava flows
- Volcanic domes: Characterized by viscous magma with a relatively high silica content, common rock type produced by this magma is *rhyolite*
- Cinder cones: Relatively small volcanoes formed from tephra, mostly volcanic ash and larger particles, volcanic bombs

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Table 8.2

13  **Volcanic Origin**

- The tectonic origins of different types of volcanoes helps explain the chemical differences in their rock types
- Volcanism occurring at mid-oceanic ridges produces basaltic rocks
- Shield volcanoes are formed above hot spots located below the lithospheric plates
- Composite volcanoes are associated with andesitic volcanic rocks and subduction zones
- Caldera-forming eruptions may be extremely explosive and violent, usually found inland of subduction zones


14  **Volcanic Origin**









Figure 8.11

15  **Volcanic Features**

- Craters and vent
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- Volcanic cones
-
- *Caldera*: Collapsed craters typically from explosive eruptions
-
- Hot springs and geysers
-
- *Fissure line*: Basaltic lava flow

16  **Volcanic Impact Risks (1)**

- *Lava flows*: From the vent of a crater or along a line of fissure
-
- Most common and abundant type: Basaltic lava low
-
- *Pahoehoe* lava: Less viscous, higher temp, with a smooth ropy surface texture

-
- *Aa* lava: More viscous and slow moving, lower temp, with a blocky surface texture
- 17  **Volcanic Impact Risks (2)**
 - *Pyroclastic* flow
 - Enormous amount of rock fragments, volcanic glass fragments, and volcanic bombs
 - Associated with explosive volcanic eruptions
 - Ash fall, from a more vertical ash eruption
 - More deadly if lateral blast
 - Pyroclastic hot avalanches, *nueé ardentes*, French for “glowing cloud”
 - Hot temperature and fire hazards
- 18  **Volcanic Impact Risks (3)**
 - More on ash fall and ash flow
 - Covering large area, 100s or 1,000s of km²
 - Wider impact if ash flows reach upper atmosphere
 - Hot temp (*nueé ardentes*) ash and moving at rapid speed (100 km/h)
 - Harm to human health and structures
 - Blocking away solar radiation
 - Hazardous for air traffic
- 19  **Volcanic Impact Risks (4)**
 - Poisonous Gases
 - Volcanic gases: H₂O, CO₂, CO, SO₂, H₂S
 - Floating in air
 - Dissolved in water
 - Dangerous for health, plants, and animals
 - Producing smog air (*vog*), acid rain, and toxic soil
 - Health effects of *vog*: breathing problems, headaches, sore throats, watery eyes
 - Can release from a dormant volcano
- 20  **Poisonous Gases**
Figure 8.22a and b
- 21  **Volcanic Impact Risks (5)**
 - Debris Flows and Mudflows
 - The most secondary volcanic hazard
 - Collectively known as *lahar*, an Indonesian term
 - From the collapse of volcano slopes
 - Sudden melting of snow caps and glaciers at the top of a volcano
 - Rapid downslope flow at the speed of 50 km/h
 - Long flowing distance: Tens of miles from the volcano
 - Trigger submarine avalanches and tsunamis
- 22  **Case Study (1)**
Mount Pinatubo
 - June 15–16, 1991
 - Killed 350 people and destroyed a U.S. military base
 - Nearly 1-ft depth of ash covered buildings over a 40-km radius
 - Huge cloud of ash 400 km wide into nearly 40-km elevation
 - Affected global climate (cooler summer the next year; global temp differences –0.5°C, ~1°F)
- 23  **Mount Pinatubo**
Figure 8.26
- 24  **Case Study (2)**
Mount St. Helens

- May 18, 1980, erupted after a 120-year dormancy
- Earthquake (4–5 magnitude) precursor, triggered massive landslide displacing water in Spirit Lake and traveling an 18-km distance down the Toutle River
- Lateral blast impacted 19 miles at 1000 km/h
- Mudflows reached nearly 100 km (60 mi) away Cowlitz and Columbia Rivers

25 **Case Study (2)**

Mount St. Helens (continued)

- Ash/tephra materials spread over WA, ID, and west MT
-
- Its maximum altitude (peak) reduced by 450 meters (over 1476 ft)
-
- Killed 54 people, damaged 100 homes, 800 million feet of timber: Total cost \$3 billion

26 **Mount St. Helens (1)**

Figure 8.28

27 **Forecasting Volcanic Activity**

- Seismic Activities: Earthquakes as precursors
-
- Thermal, magnetic, and hydrologic conditions
-
- Amount of volcanic gas emission, both rate and composition
-
- Topographic monitoring: Tilting and special bulging
-
- Remote sensing: Radar 3-D interferometry
-
- Geologic history of a volcano

28 **Volcanic Alert or Warning**

Table 8.3

29 **Public Perception and Adjustment**

- Perception of the volcanic hazards
 - Age and residence time affecting one's perception
 - No other choices as where to live
 - Optimistic and accepting risks
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- Adjustment
 - Public awareness and education
 - Improvement in education
 - Better scientific info dissemination
 - Timely and orderly evacuation





















































30 **Applied and Critical-Thinking Topics**




































- What are the possible reasons why people live near a volcano?
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- Is your area vulnerable to the impact risks of volcanic activities?
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- How do political and economic factors influence people's attitude toward the volcanic hazard?
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- How to develop a public relations program that could alert people to a potential volcanic hazard?

31 **Figures Follow:**

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120	 End of the Road (and Chapter)