


## Chapter 5

### Volcanoes and Volcanism



## Introduction

- Volcanism is the eruption of magma, and associated gases at the surface.
- About 550 volcanoes have been active in historical times.
- About 12 or so erupt each year; most eruptions are small and go unnoticed.




## Introduction

Some magma erupts explosively as pyroclastic (fire-broken) rock and other erupts as lava flows.



## Introduction

- A fissure eruption along the East Rift of Kilauea. The fountain is 200 feet high!



## Introduction

- How can volcanism be both constructive and destructive?
- Volcanism may destroy houses and farmland and cause injuries and fatalities
- Volcanism is responsible for the origin of many oceanic islands and rich, fertile soils.

Pompeii and Mount Vesuvius


## Introduction

- Some Notable Volcanic Eruptions

Date	Deaths	Volcano	Deaths
Apr 10, 1815		Tambora, Indonesia	117,000 killed, including deaths from eruption, famine, and disease.
Oct 6, 1882		Galunggung, Java	Pyroclastic flows and mudflows killed 4,011.
Mar 2, 1886		Azu, Indonesia	2,806 died in pyroclastic flows.
Aug 27, 1883		Krakatau, Indonesia	More than 36,000 died, most killed by tsunamis.
June 7, 1892		Azu, Indonesia	1,532 died in pyroclastic flows.
May 8, 1902		Mount Pelée, Martinique	Noise ardente engulfed St. Pierre and killed 28,000.
Oct 24, 1902		Santa Maria, Guatemala	5,000 died during eruption.
May 19, 1919		Kelut, Java	Mudflows devastated 104 villages and killed 5,110.
Jan 21, 1951		Lamington, New Guinea	Pyroclastic flows killed 2,842.
Mar 17, 1963		Agung, Indonesia	1,148 perished during eruption.
May 18, 1980		Mount St. Helens, Washington	63 killed, 600 km <sup>2</sup> of forest devastated.
Mar 28, 1982		El Chichón, Mexico	Pyroclastic flows killed 1,877.
Nov 13, 1985		Nevaló del Ruiz, Colombia	Minor eruption triggered mudflows that killed 23,000.
Aug 21, 1986		Oku volcanic field, Cameroon	Cloud of CO <sub>2</sub> released from Lake Nyos killed 1,746.
June 15, 1991		Mount Pinatubo, Philippines	281 killed during eruption, 83 died in later mudflows, 358 died of illness.
July 1999		Soufrière Hills, Montserrat	19 killed, 12,000 evacuated.
Jan 17, 2002		Nyiragongo, Zaire	Lava flow killed 147 in Goma.
Aug 16, 2006		Tungurahua, Ecuador	Explosive eruption killed 71, continuously active since 1999, periodic evacuations and several villages destroyed.
Apr 2010		Eyafjallajökull, Iceland	No fatalities, but disrupted air traffic over the North Atlantic for several days.


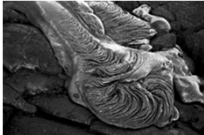
### Volcanism and Volcanoes

- Volcanic Gases
  - Primarily water vapor, with lesser amounts of carbon dioxide, sulfur dioxide, hydrogen sulfide and nitrogen gases.
  - Erupted sulfur can have long-term effects.




### Volcanism and Volcanoes

- Lava Flows
  - *Aa lava* is made up of angular blocks and fragments.
  - *Pahoehoe lava* has a smooth surface much like taffy.

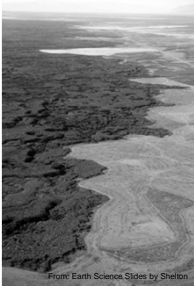
### Volcanism and Volcanoes

- Top 7" of fresh pahoehoe flow. The top of the flow is vesicular. Why?





### Volcanism and Volcanoes

- "Recent" Lava Flow, Snake River Plain, Idaho





### Volcanism and Volcanoes

- *Pressure ridges* and *spatter cones* are typical of many flows.

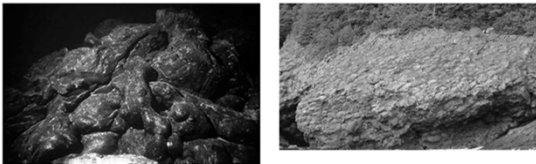
### Volcanism and Volcanoes

- *Columnar Joints* form in response to cooling and contraction of lava, form most commonly in basalt and andesite lava flow.

### Volcanism and Volcanoes

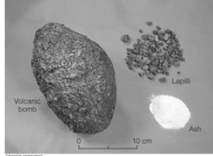

- **Pillow lavas** are bulbous, interconnecting masses that result from underwater eruption of basaltic lavas.



Click for Video!

### Volcanism and Volcanoes


- **Pyroclastic Materials**
  - Ash, lapilli, blocks, and bombs (tephra), that are explosively ejected by volcanoes.
  - Ash and jet engines.

Eyjafjallajökull

### Volcanism and Volcanoes


#### Volcanic Ash and Lapilli, Hawaii



From: Earth Science Slides by Shelton

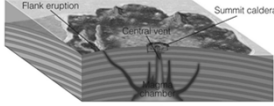

### What are the Types of Volcanoes?

- A volcano is a hill or mountain that forms around a vent, where lava, pyroclastic materials and gases erupt.



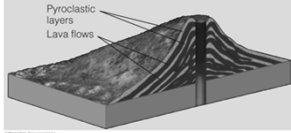

### What are the Types of Volcanoes?

- Shield Volcanoes have gentle slopes, rounded shapes and are composed largely of basaltic lava flows.

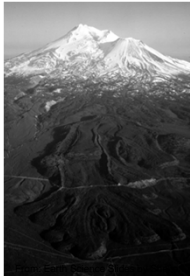
### What are the Types of Volcanoes?

- Composite Volcanoes (Stratovolcanoes) are composed of lava flows, pyroclastic debris and volcanic mud flows (lahars). They are explosive and are the most dangerous to humans.





What are the Types of Volcanoes?

- Mt. Shasta, California (a stratovolcano)




Stratification of lava and ash layers, near Mt. St. Helens




What are the Types of Volcanoes?

- Cinder Cones consist of tephra or cinder-like pyroclastic materials accumulated as relatively small, steep-sloped cones.



What are the Types of Volcanoes?


“SP Crater” near Flagstaff, Arizona



From: Earth Science Slides by Shelton


What are the Types of Volcanoes?

- Lava Domes are formed when viscous, generally felsic lavas form within the craters of certain volcanos. These volcanos can erupt explosively and commonly eject nuée ardentes.




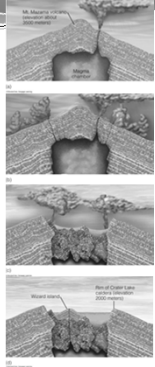
What are the Types of Volcanoes?

Nuee’ Ardentes (pyroclastic flow), Mayon Volcano, Philippines



### What are the Types of Volcanoes?

- Calderas are large oval to circular volcanic depressions that form when the summit of a volcano collapses into its magma chamber following very large eruptions.

### What are the Types of Volcanoes?

- Supervolcano Eruptions
  - None within recorded history
  - Three supervolcano eruptions have occurred in Yellowstone within the past 2 million years.
  - Huge eruptions with widespread blankets of ash and pumice in addition to felsic lava.



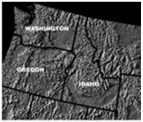



Figure 5.16, p. 124

### Other Volcanic Landforms

- Basalt plateaus form when fluid mafic lava erupts from long fissures (not vents), known as a fissure eruption. Basalt plateaus are made up of numerous overlapping basalt lava flows.

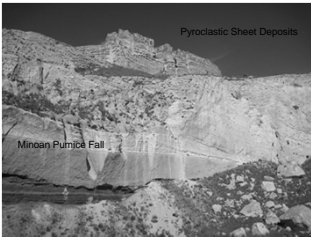
### Isla Encantada, west side of Gulf of California



From: Earth Science Slides by Shelton

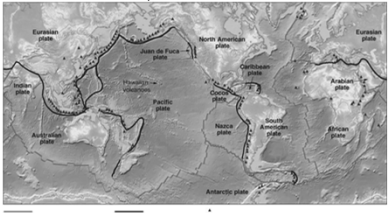
### Other Volcanic Landforms

- Pyroclastic Sheet Deposits are huge sheet-like eruptions of pyroclastic materials.



### Distribution of Volcanoes

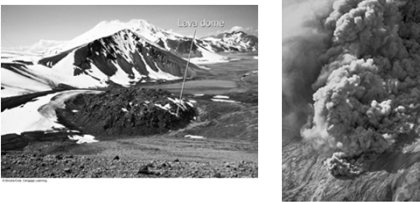
- Volcanoes are not randomly distributed, but occur in well-defined zones or belts (60% circum-Pacific belt, 20% Mediterranean belt, 20% are at or near mid-oceanic ridges).



Divergent plate boundary  
 Convergent boundary  
 Volcano


### North America's Active Volcanoes - Alaska

- Alaska's volcanoes stretch from the mainland of Alaska thru the Aleutian Island. Most are composite volcanoes, some with huge calderas. This volcanic arc is extremely active with many explosive eruptions.



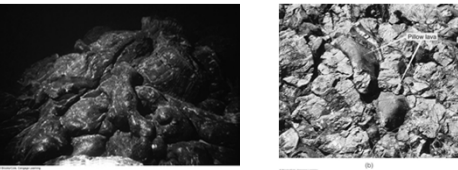
### North America's Active Volcanoes – The Cascades

- The Cascade Range stretches from Lassen Peak in California to British Columbia, Canada. Most of the large volcanoes in the range are composite volcanoes, but there are also two huge shield volcanoes and numerous cinder cones.



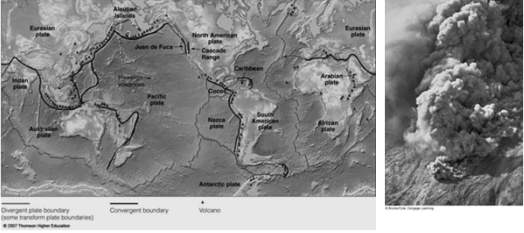
### Plate Tectonics, Volcanoes, and Plutons

- Volcanic activity at or near mid-oceanic ridges (divergent plate boundaries) is mainly submarine, but in a few places such as Iceland, it occurs above sea level. The volcanoes that form are mostly mafic shield volcanoes



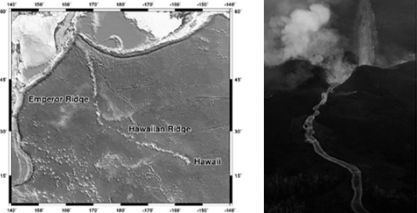
### Plate Tectonics, Volcanoes, and Plutons

- At convergent plate boundaries, intermediate and felsic magmas produced by the partial melting of the subducted plates.



### Plate Tectonics, Volcanoes, and Plutons

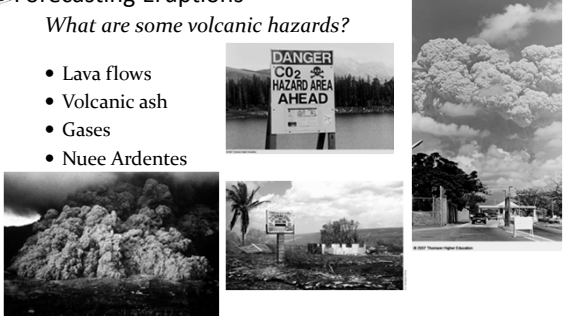
- Intraplate Volcanism, is often produced by hot spot activity. The Hawaiian Islands formed as a series of volcanoes originating from a stationary mantle plume as the Pacific Plate moved over it.



### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

What are some volcanic hazards?

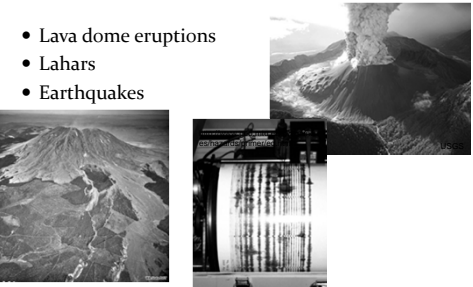
- Lava flows
- Volcanic ash
- Gases
- Nuee Ardentes



### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

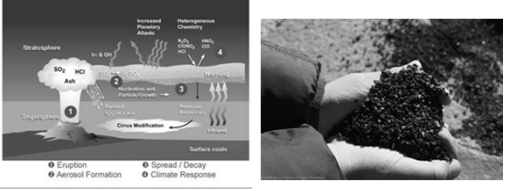
What are some volcanic hazards (cont.)?

- Lava dome eruptions
- Lahars
- Earthquakes



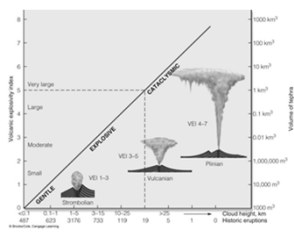
### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

- Potential Long-Term Effects
- Climate
- Soils




### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

- How Large Is an Eruption, and How Long Do Eruptions Last?
- VEI - the most widely used indication of the size of a volcanic eruption is the volcanic explosivity index.



### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

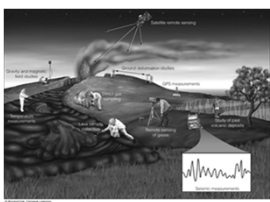
- Is It Possible to Forecast Eruptions?



- Geologic Investigations can tell us about:
- The type of past eruptions
- The size of past eruptions
- The frequency of past eruptions

### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

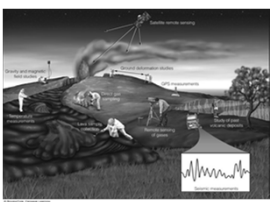
- Is It Possible to Forecast Eruptions?



- Monitoring volcanoes helps geologists to forecast imminent eruptions
- Involves recording and analyzing both physical and chemical changes at volcanoes.

### Volcanic Hazards, Volcano Monitoring, and Forecasting Eruptions

- Is It Possible to Forecast Eruptions?



- Tiltmeters and GPS to detect changes in slope, elevation, and shape
- Seismometers to detect harmonic tremors and long-period events.
- Gas emissions and well water are also measured (content and temperature).