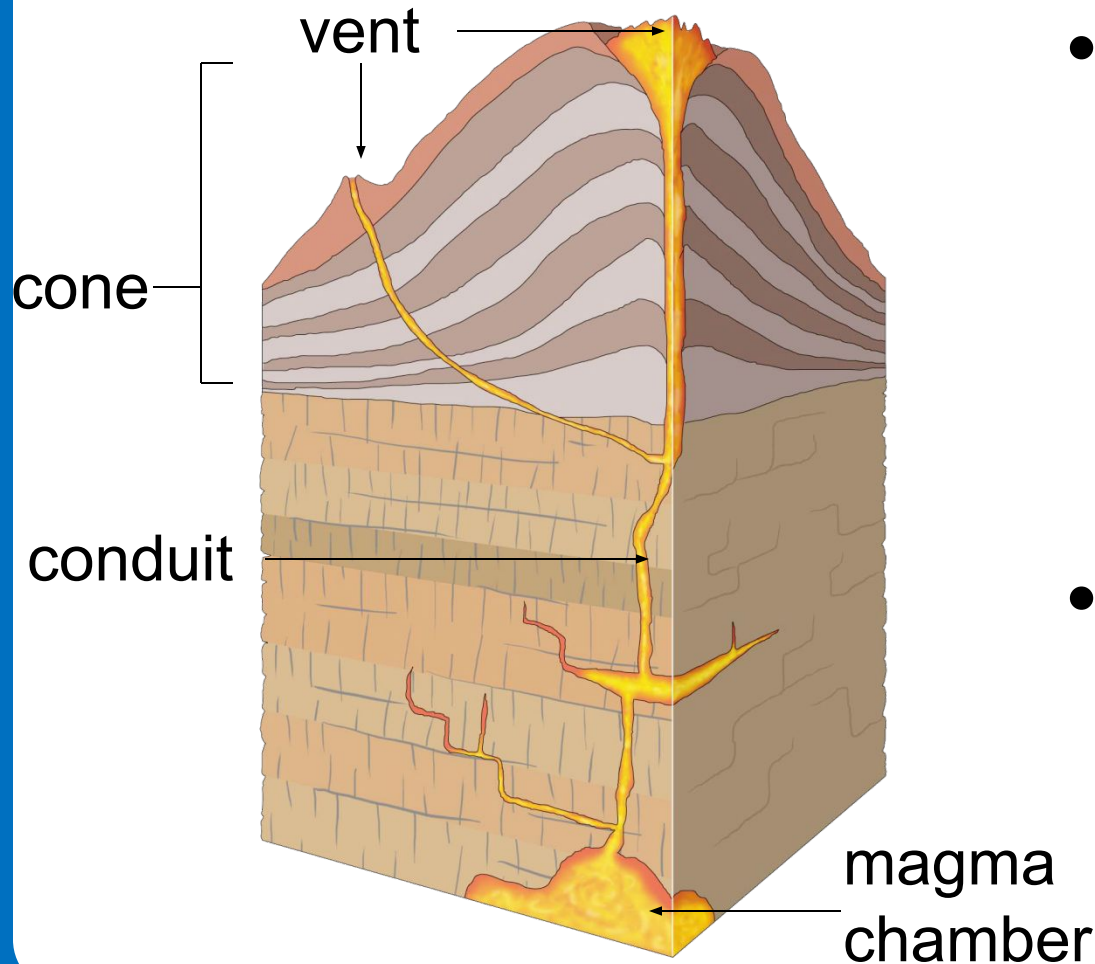


# Volcanoes: Eruptions and Hazards



# What is a volcano?

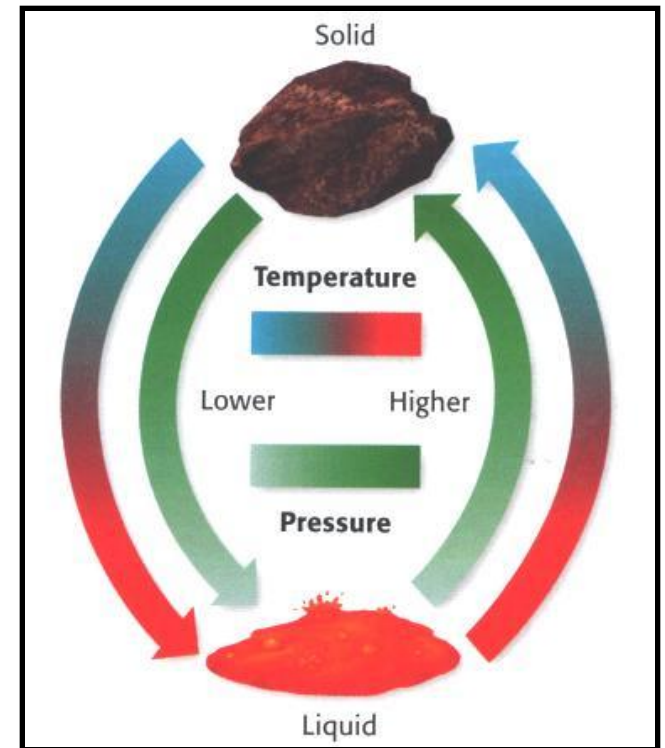
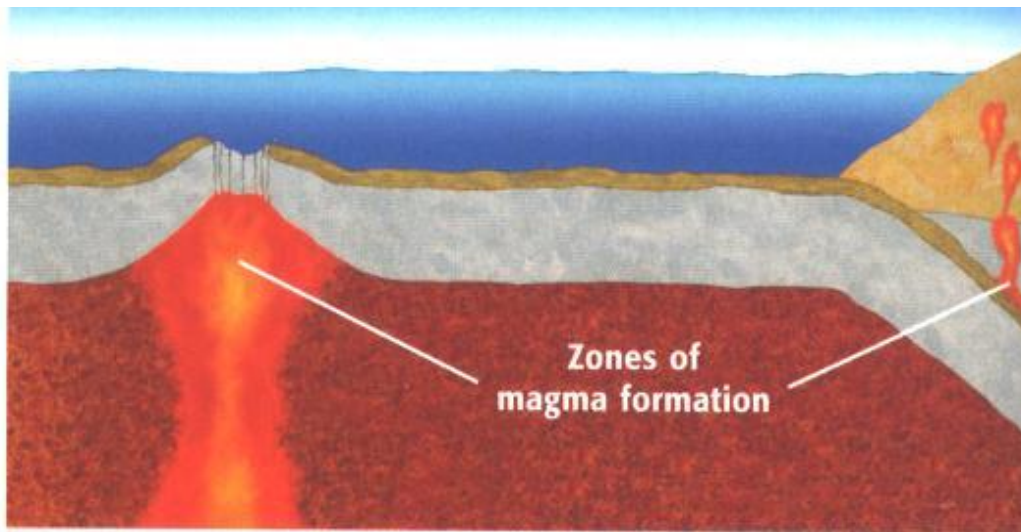


- A volcano is a vent or 'chimney' that connects molten rock (magma) from within the Earth's crust to the Earth's surface.
- The volcano includes the surrounding cone of erupted material.

# What causes volcanoes?

## The Formation of Magma

- Mantle rock melts when the temperature increases or the **pressure decreases**.

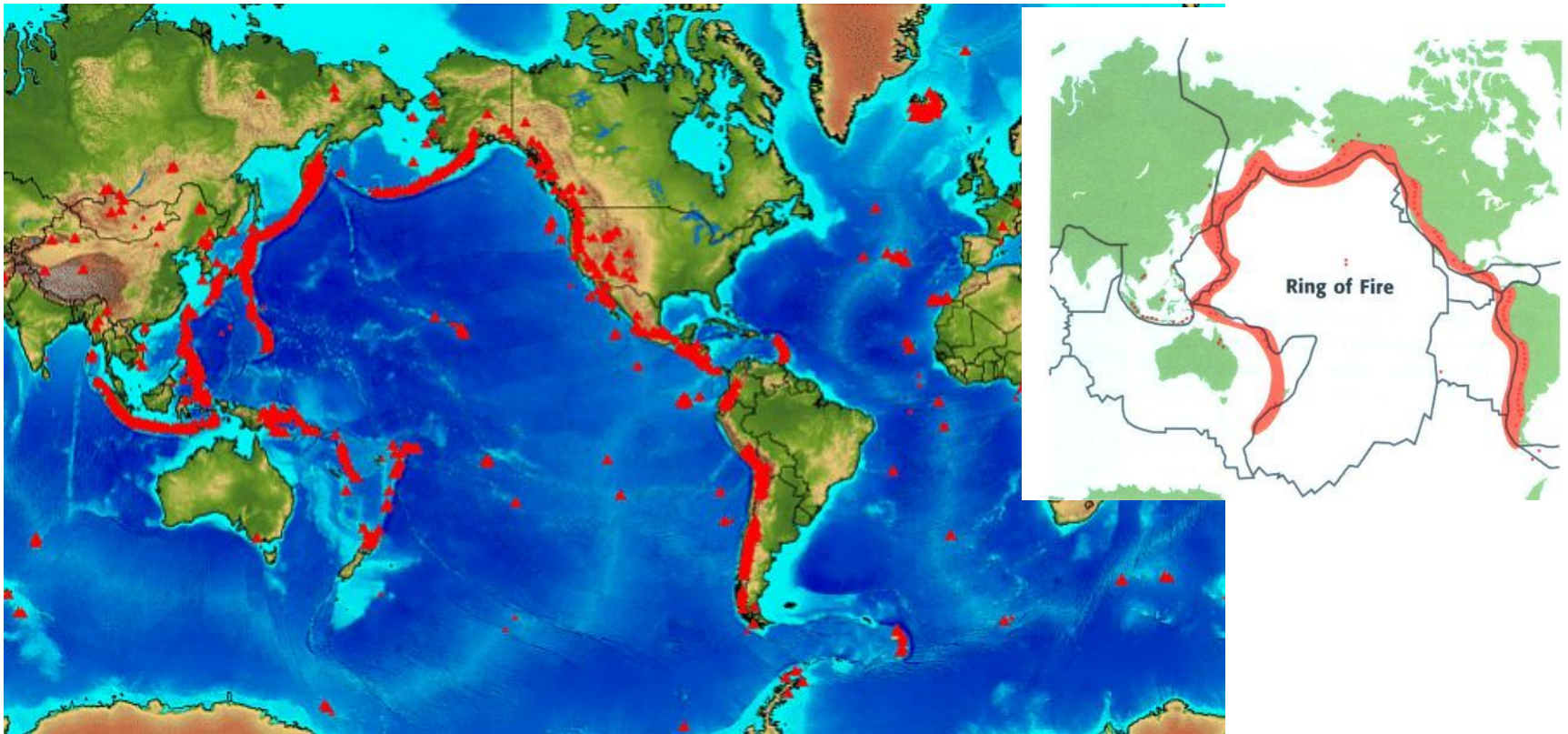




# What causes volcanoes?

## Where Volcanoes Form

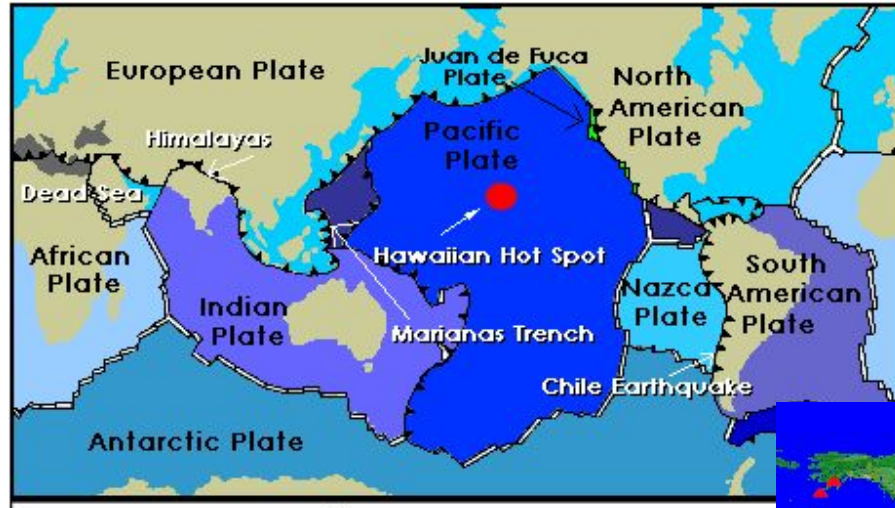
- Tectonic Plate Boundaries!!!



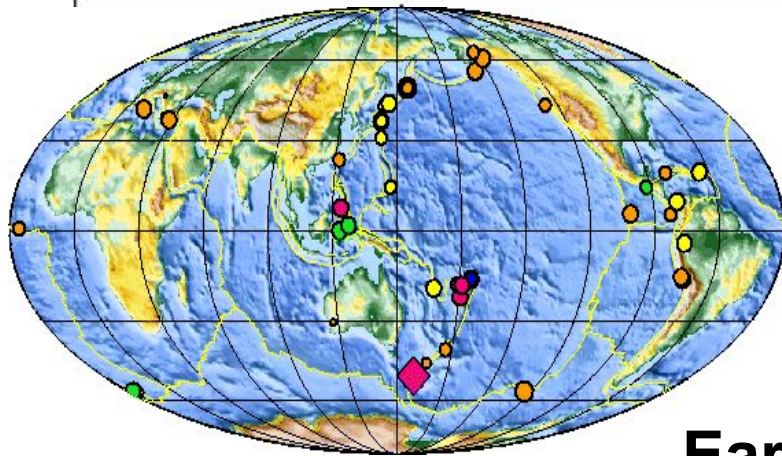
~75% world's active volcanoes in Ring of Fire



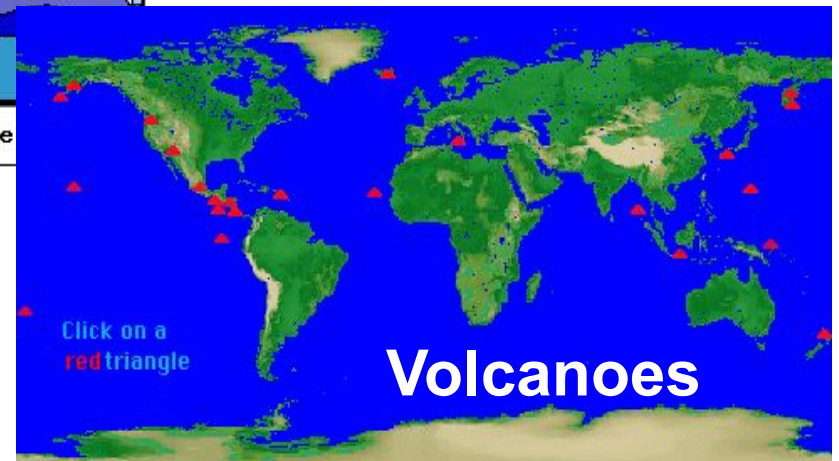
# Volcanoes and Earthquakes are found on places where plates meet



Plates



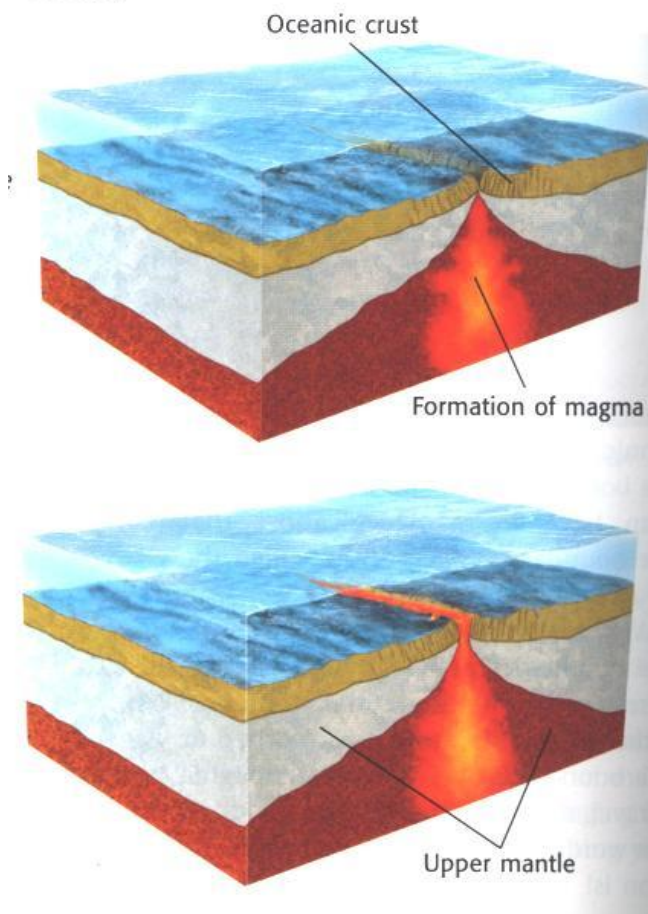
Earthquakes



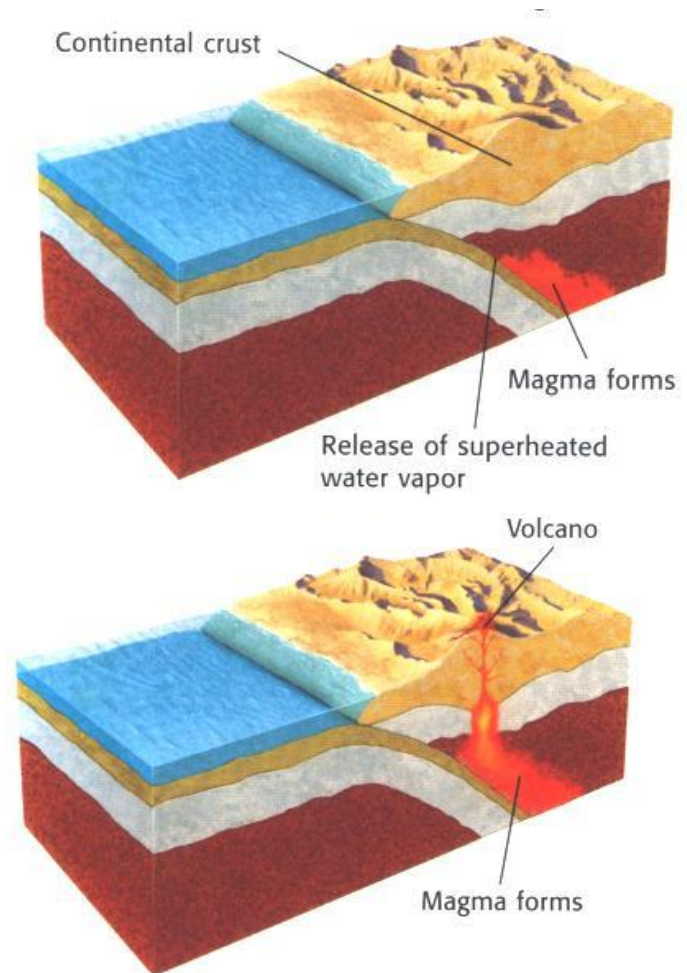
Volcanoes

# What causes volcanoes?

Boundary

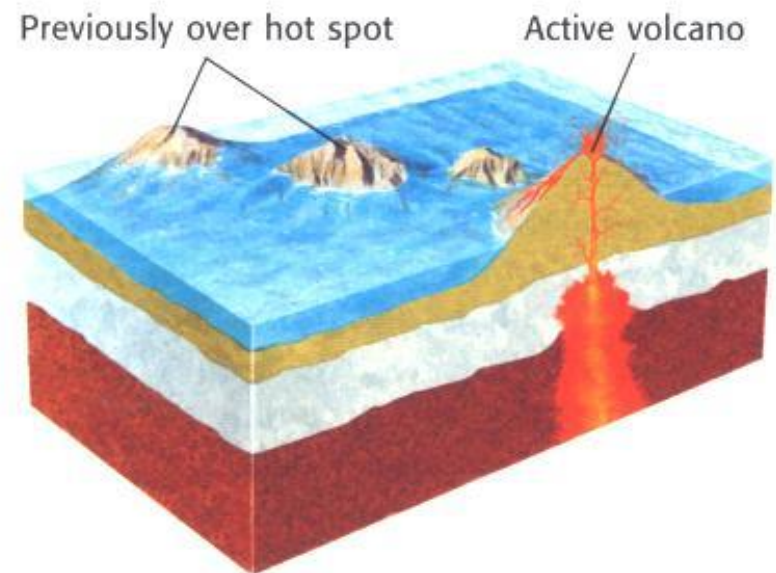
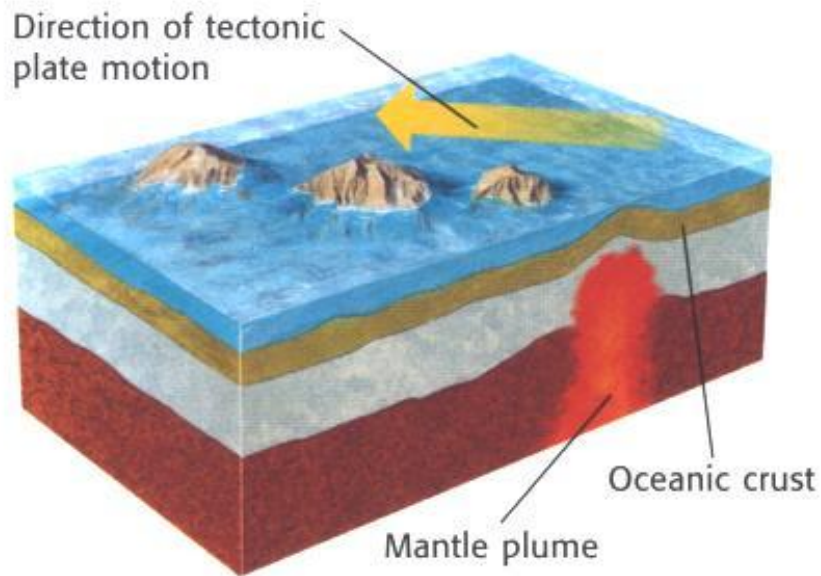


Continental crust



# What causes volcanoes?

## Hot Spots





# How and why do volcanoes erupt?

- **Hot, molten rock (magma) is buoyant (has a lower density than the surrounding rocks) and will rise up through the crust to erupt on the surface.**
  - **Same principle as hot air rising, e.g. how a hot air balloon works**
- **When magma reaches the surface it depends on how easily it flows (viscosity) and the amount of gas ( $\text{H}_2\text{O}$ ,  $\text{CO}_2$ , S) it has in it as to how it erupts.**

# How and why do volcanoes erupt?

✓ **Large amounts of gas and a high viscosity (sticky) magma will form an explosive eruption!**

Think about shaking a carbonated drink and then releasing the cap.

✓ **Small amounts of gas and (or) low viscosity (runny) magma will form an effusive eruption**

Where the magma just trickles out of the volcano (lava flow).

# The Composition of Magma Determines whether it is explosive or not!

- High **water** content
  - More likely to be **EXPLOSIVE**!!!
- High **silica** content
  - More likely to be **EXPLOSIVE**!!!
  - **Why?**
    - Silica has a thick, stiff consistency
      - Flows slowly
      - Tends to Harden in the volcano's vent



# What Erupts from a Volcano?

## Pyroclastic material

- Rock fragments created by **EXPLOSIVE** eruptions
  - magma explodes from volcano and solidifies in the air
  - existing rock is shattered by powerful eruptions



Volcanic blocks



Volcanic bombs



Lapilli



Volcanic ash

# What Erupts from a Volcano?

**Lava can be  
thick or thin.**

Pahoehoe



Aa



Blocky lava



Pillow lava



# How do volcanoes affect the Earth?

## Flows and Fallouts

- hot ash can flow really quickly
  - Knock down buildings
  - Dam rivers (flooding/drought)
  - Kill crops and livestock

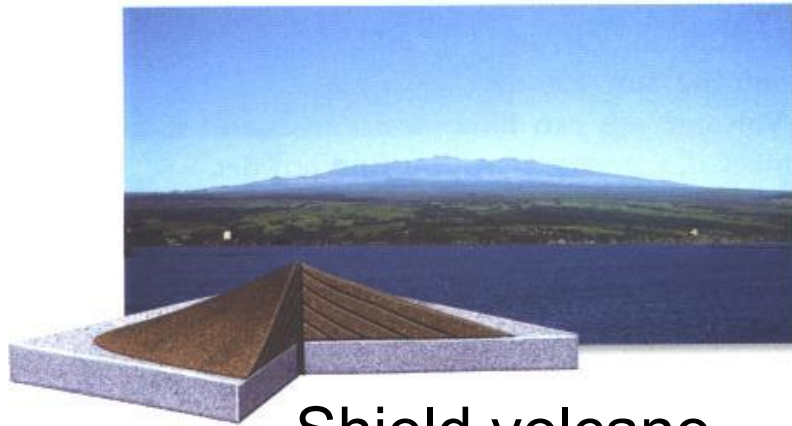
## Climatic Changes

- Ash & Gases can block sunlight
  - Drop average global temperature noticeably



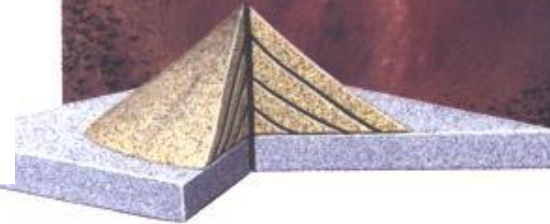
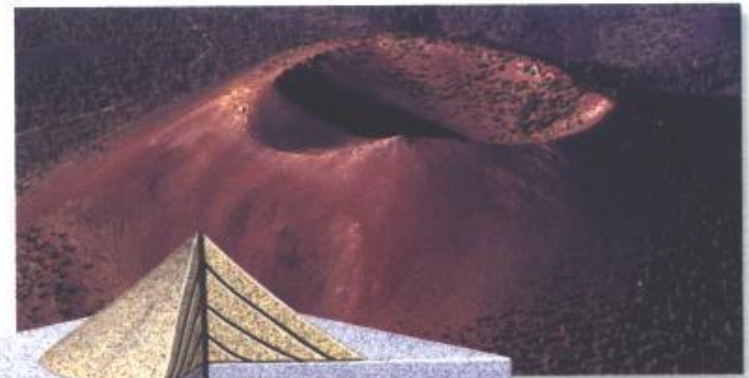


# Types of Volcanoes



Shield volcano

Cinder cone volcano



Composite volcano

# Craters, Calderas, and Lava Plateau

## Crater

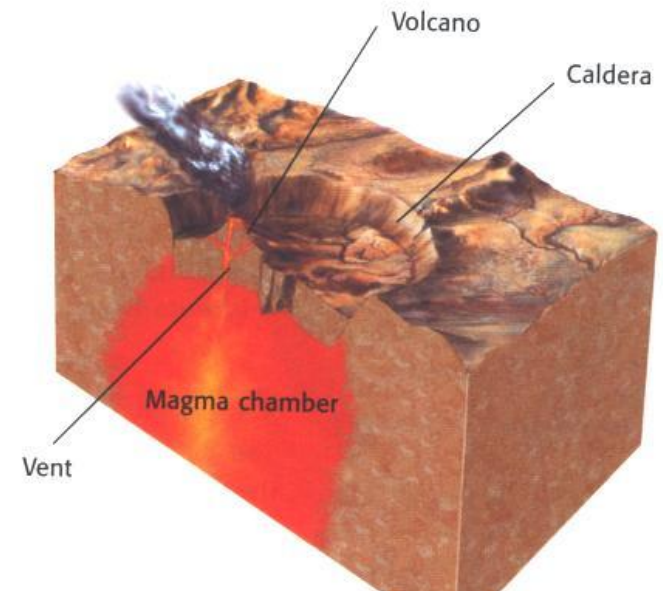
- From explosions of material out of the vent and the collapse of material back into vent

## Caldera

- Much larger depression that forms when magma chamber empties and its roof collapses

## Lava Plateau

- Forms when lava erupts from long cracks, or fissures, and spreads out evenly (thousands of km)



# Explosive Eruptions

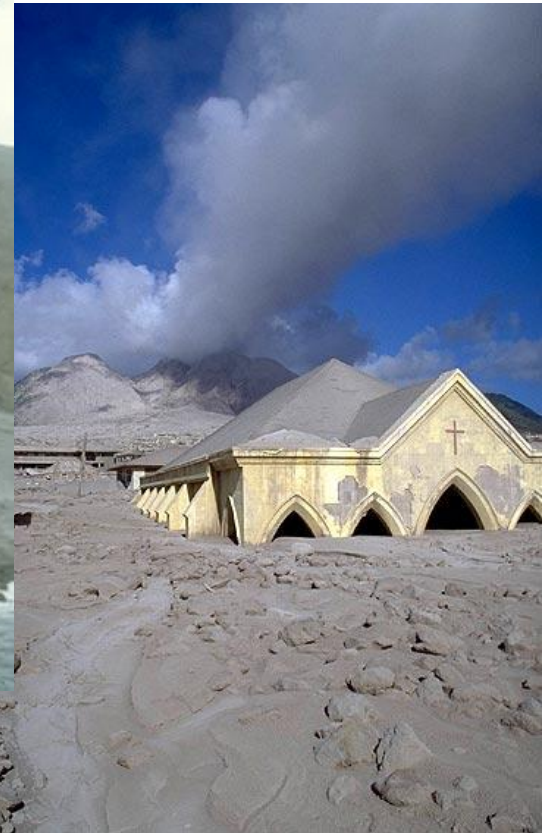
- Explosive volcanic eruptions can be catastrophic
- Erupt 10's-1000's km<sup>3</sup> of magma
- Send ash clouds >25 km into the stratosphere
- Have severe environmental and climatic effects
- Hazardous!!!



Above: Large eruption column and ash cloud from an explosive eruption at Mt Redoubt, Alaska

# Explosive Eruptions

- Three products from an explosive eruption
  - Ash fall
  - Pyroclastic flow
  - Pyroclastic surge



Pyroclastic flows on Montserrat, buried the capital city.





Direct measurements of pyroclastic flows are extremely dangerous!!!



# Effusive Eruptions



Hawaii

- Effusive eruptions are characterised by outpourings of lava on to the ground.



Courtesy of [www.swisseduc.ch](http://www.swisseduc.ch)

# Volcanic Hazards

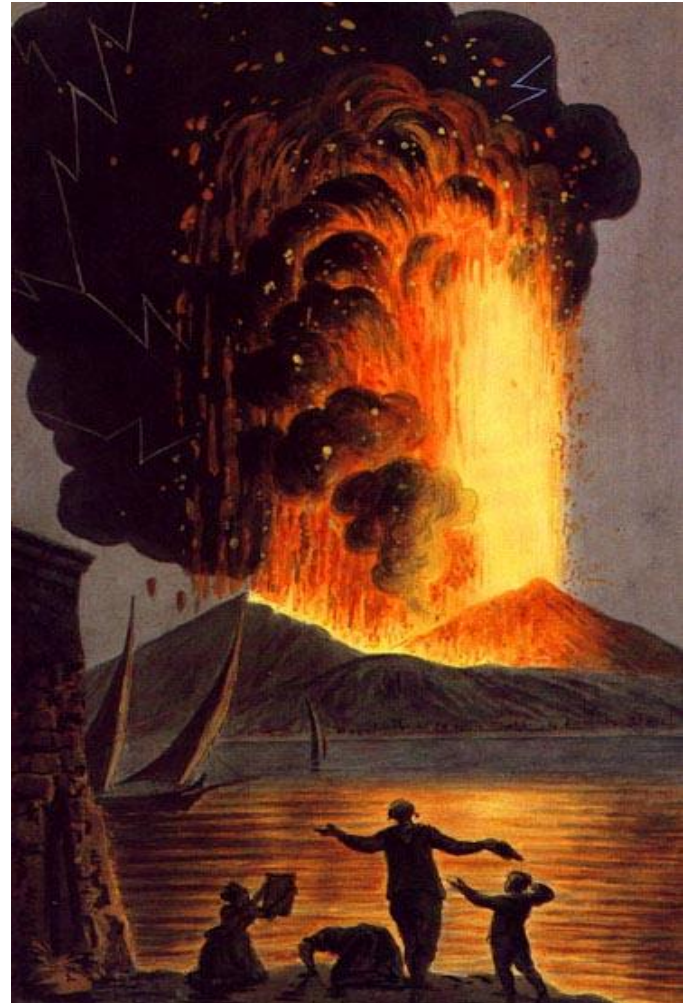


- Pyroclastic flow
- Lahars/Mud flows
- Pyroclastic fall
- Lava flow
- Noxious Gas
- Earthquakes



# Pyroclastic Flow

- For example, eruption of Vesuvius in 79 AD destroyed the city of Pompeii





# Pompeii (79AD)

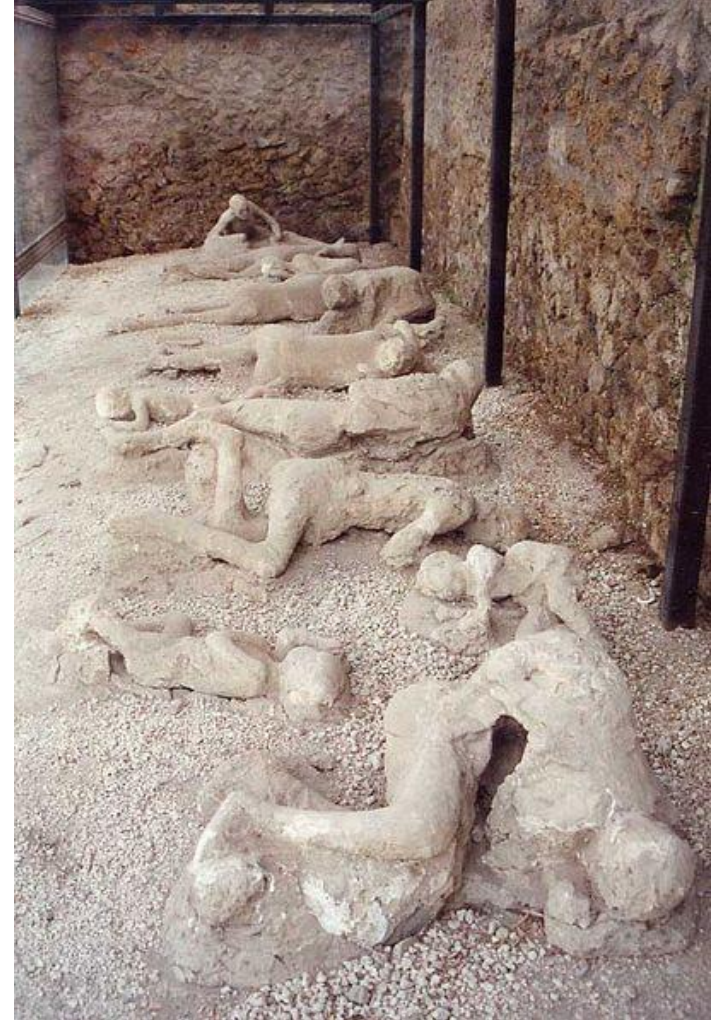
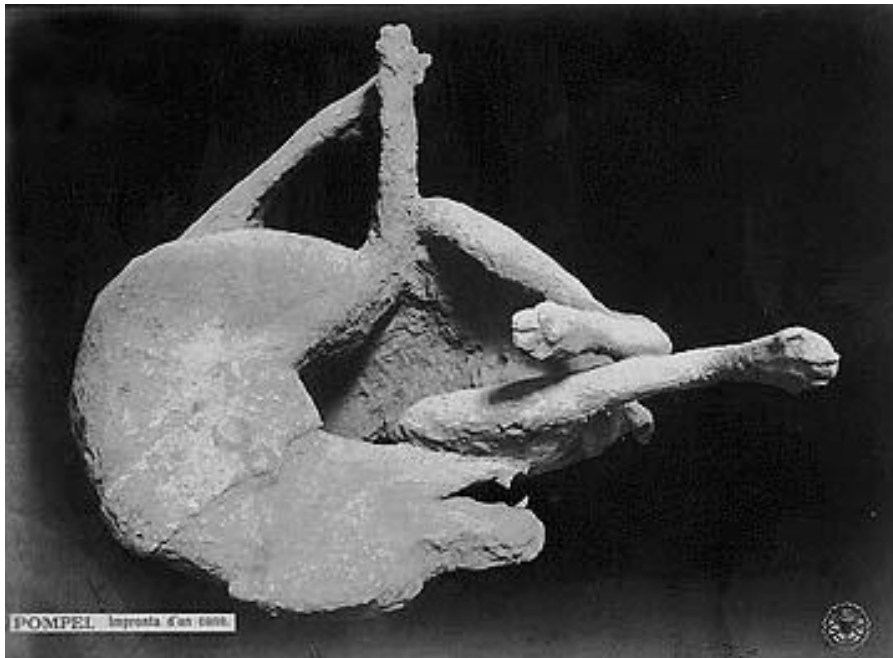


On August 24, 79AD Mount Vesuvius literally blew its top, erupting tonnes of molten ash, pumice and sulfuric gas miles into the atmosphere. Pyroclastic flows flowed over the city of Pompeii and surrounding areas.



# Pompeii (79AD)

**Pyroclastic flows of poisonous gas and hot volcanic debris engulfed the cities of Pompeii, Herculaneum and Stabiae suffocating the inhabitants and burying the buildings.**



# Pompeii (79AD)



**The cities remained buried and undiscovered for almost 1700 years until excavation began in 1748. These excavations continue today and provide insight into life during the Roman Empire.**

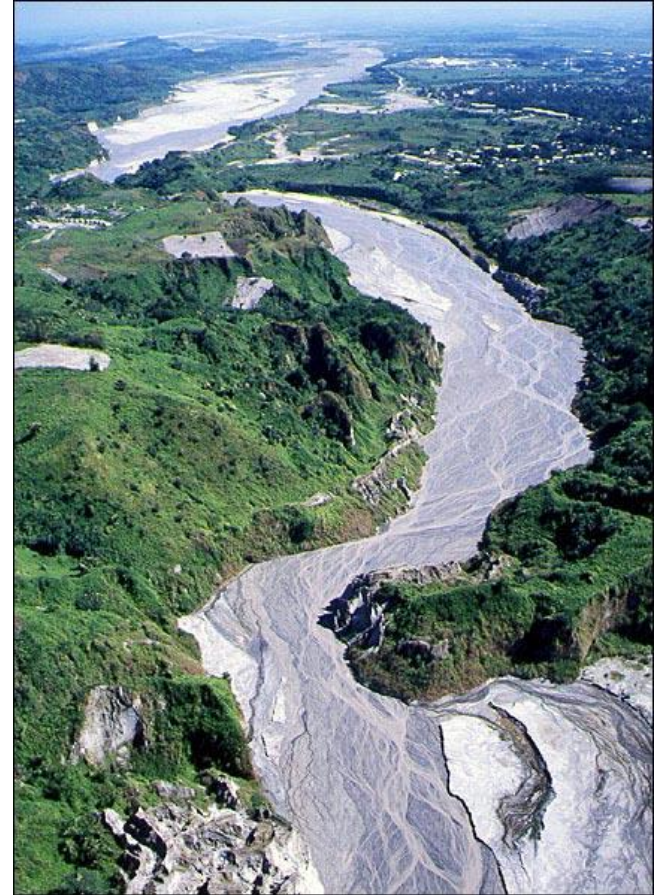


How do pyroclastic flows cause devastation?



# Pyroclastic Flow - lahars

- Hot volcanic activity can melt snow and ice
- Melt water picks up rock and debris
- Forms fast flowing, high energy torrents
- Destroys all in its path





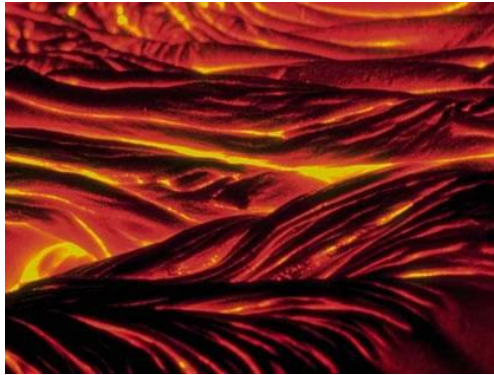
# Pyroclastic Fall

## Ash load

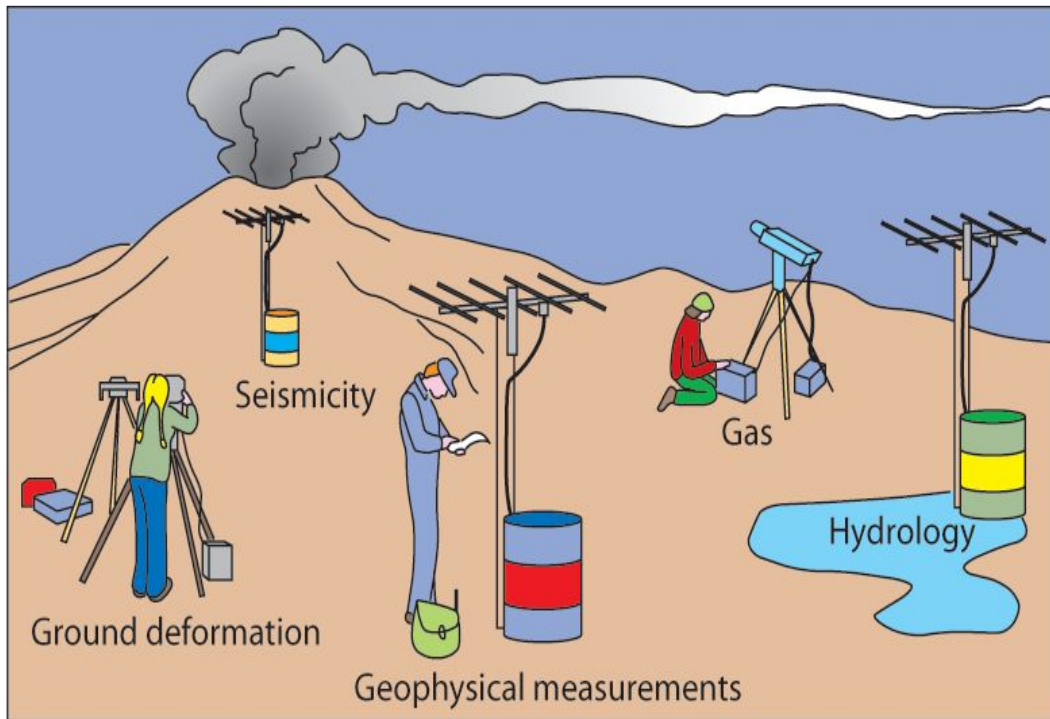
- Collapses roofs
- Brings down power lines
- Kills plants
- Contaminates water supplies
- Respiratory hazard for humans and animals

# Lava Flow

- It is not just explosive volcanic activity that can be hazardous. Effusive (lava) activity is also dangerous.

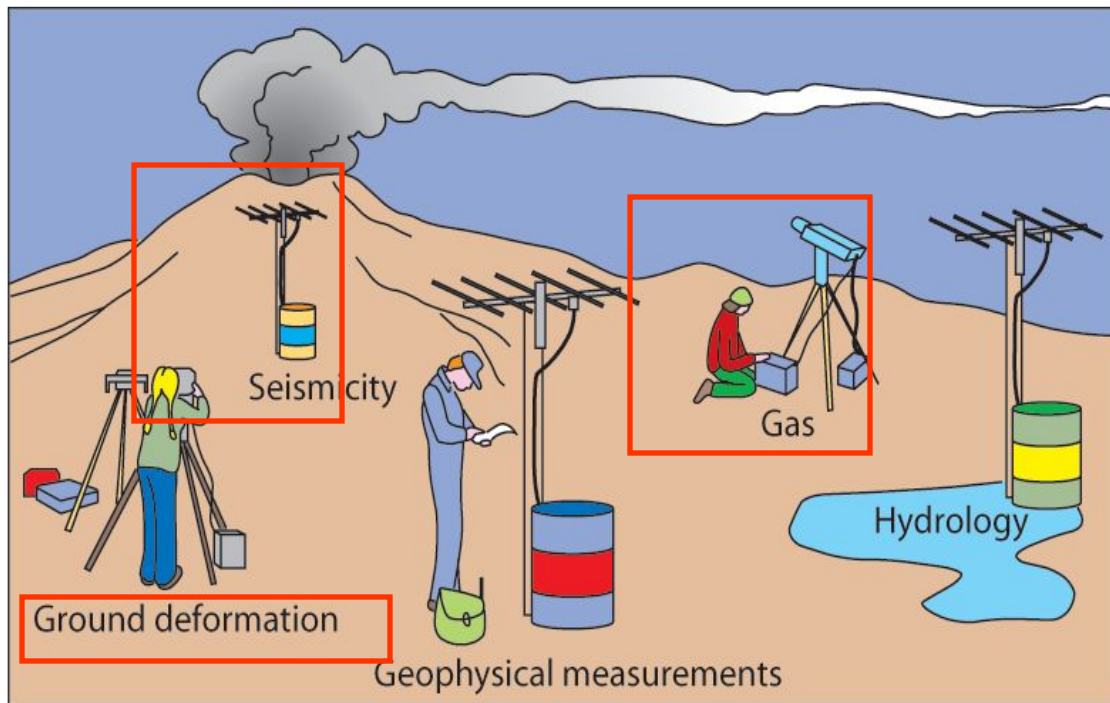


# Volcano Monitoring



**Volcano Observatories are set up on all active volcanoes that threaten the human population. These are designed to monitor and potentially to predict the eruptive behaviour of the volcano in question.**

# Volcano Monitoring



- Seismicity
- Deformation
- Gas Output
  - (on volcano and remote sensing techniques)

These three things are the most important precursors to an eruption.



# Gas Monitoring

- Gas samples are collected from fumaroles and active vents.



- Gas levels may also be monitored by remote sensing techniques



# In Summary..

- Volcanoes are extremely hazardous.
- However, the volcano can be studied, monitored and understood.
- Each volcano is different, and offers a unique set of dangers
- Plans may be emplaced to help control potential damage.