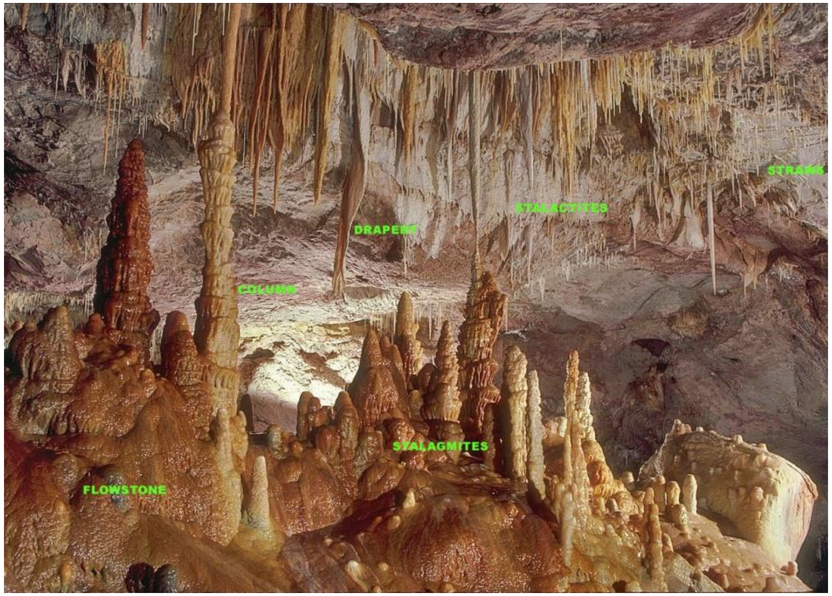
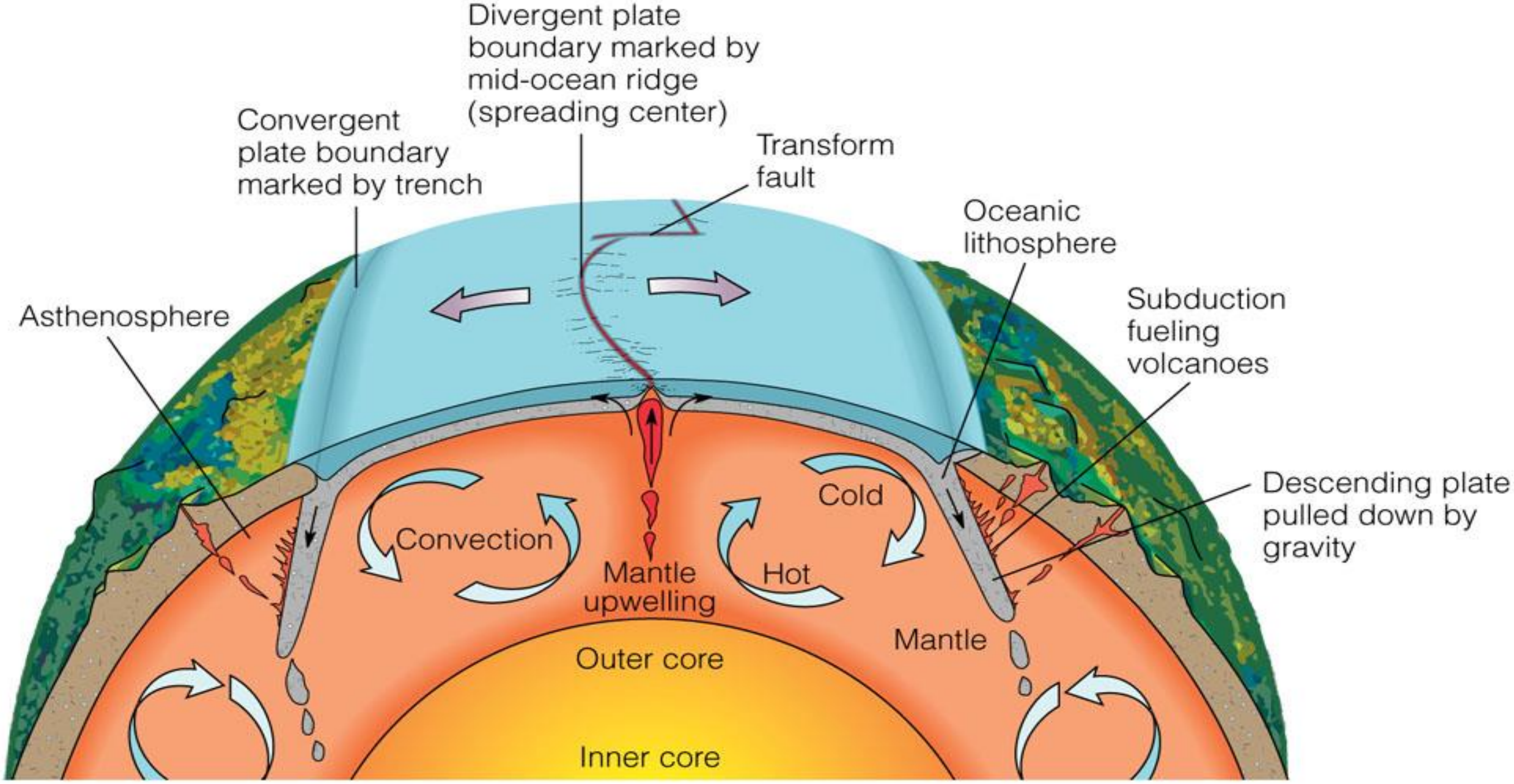
IDC 203: INTRODUCTION TO EARTH SCIENCES



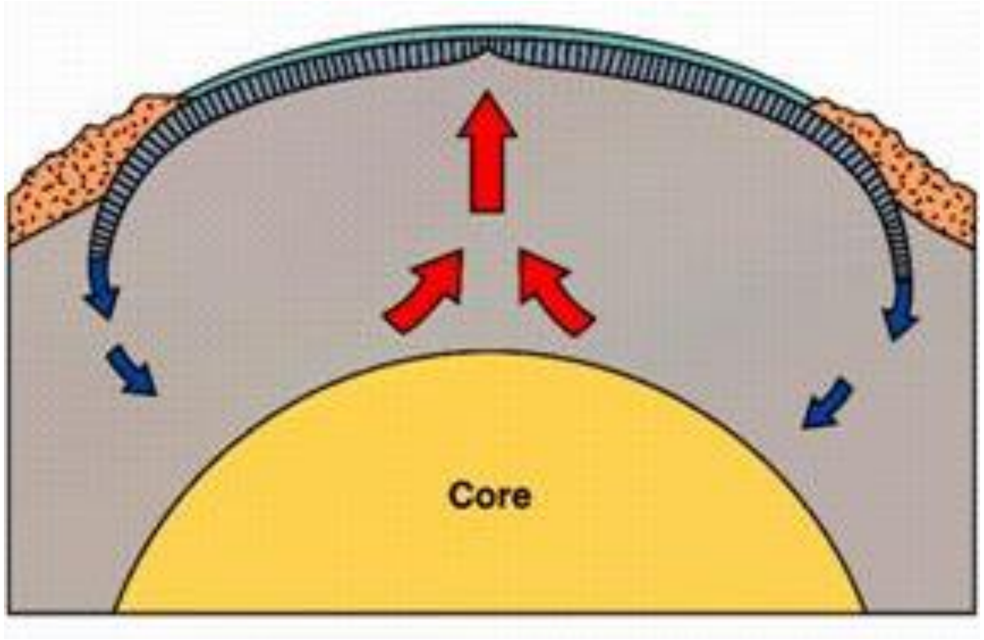
Convection currents

In 1960`s convection currents has been proposed as driving force to move continents



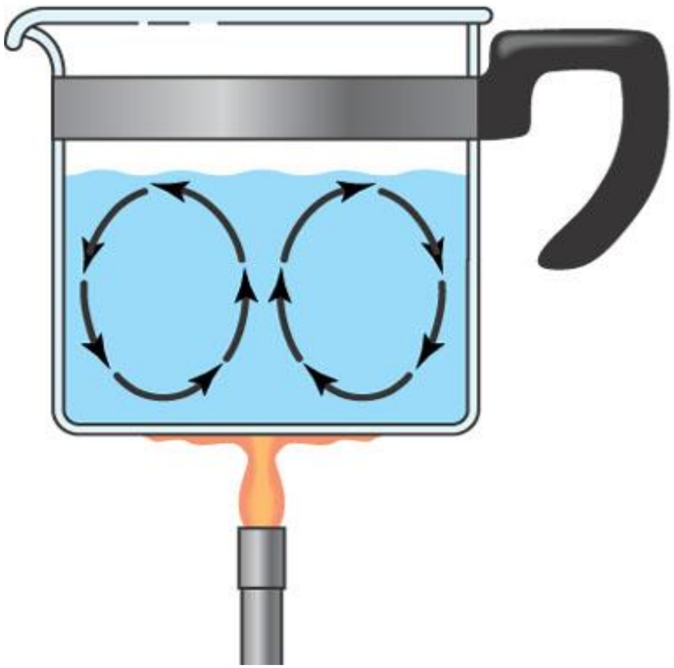
Convection currents

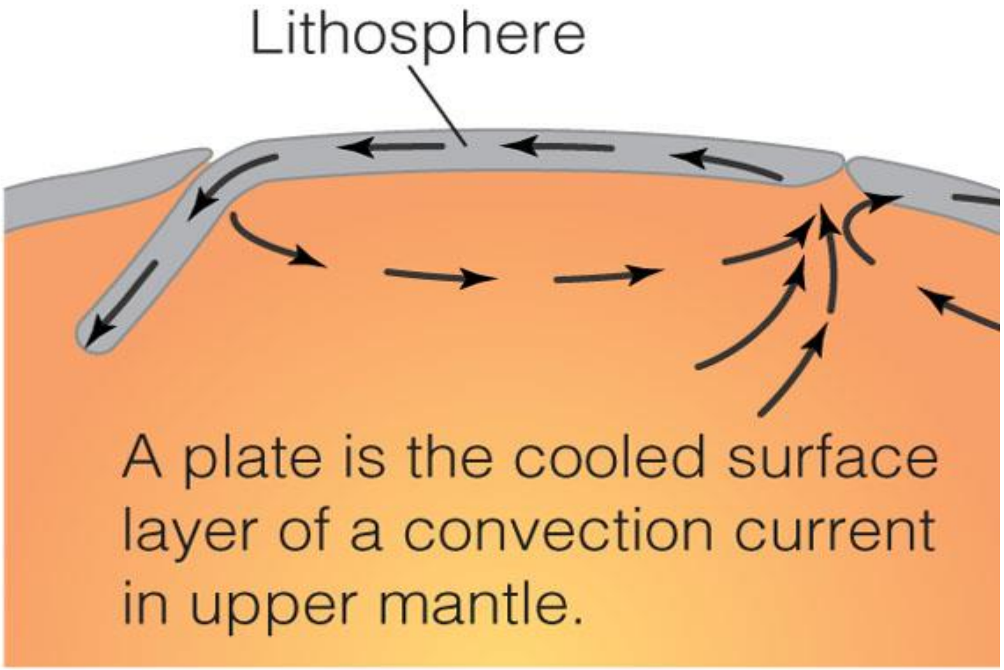
Driving force for convection?



Movement of matter is driven by Earth's internal and external sources of energy

Convection currents





How deep does the convection occurs?

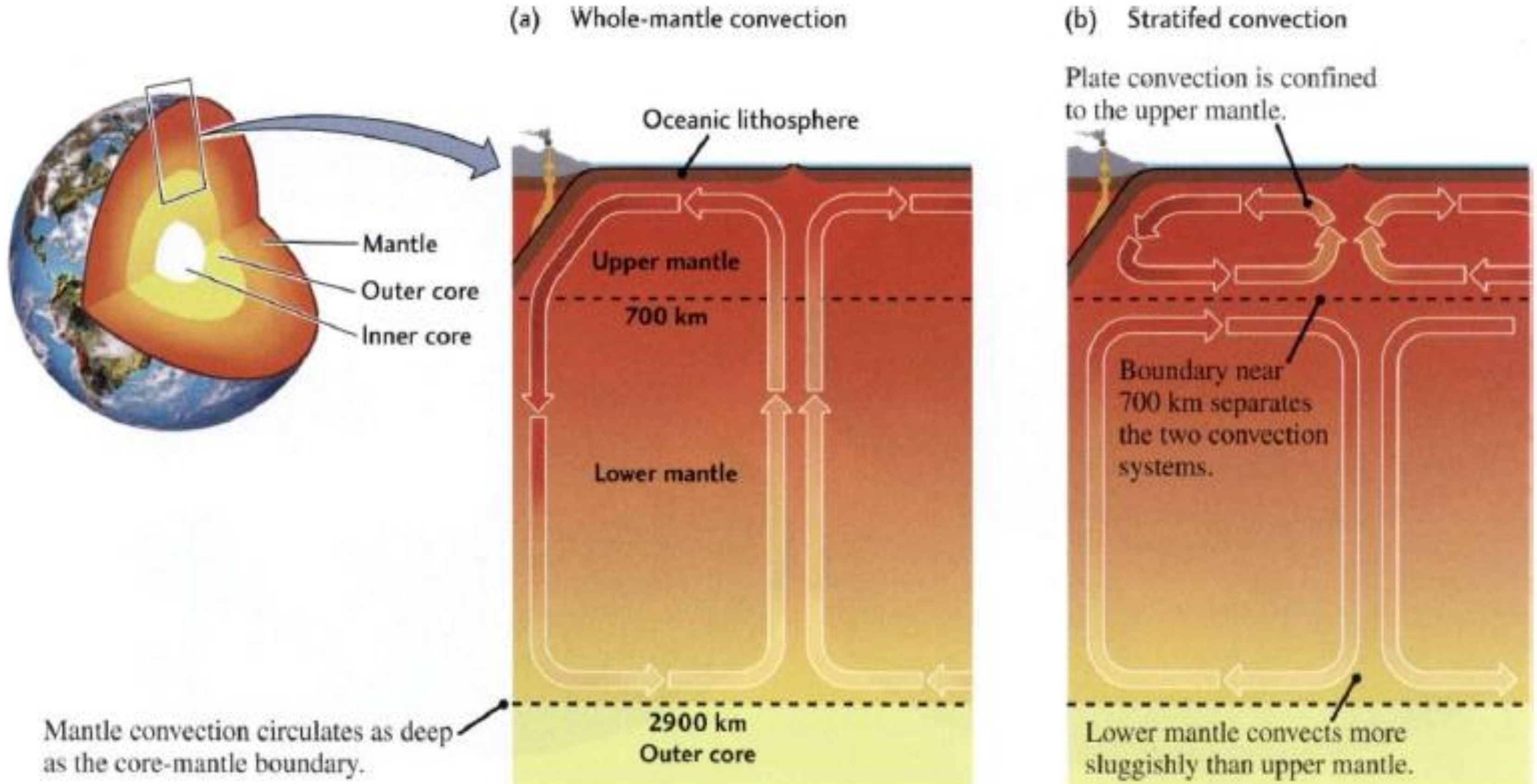


Figure 2.14 Two competing hypotheses for the mantle convection system.

Two competing hypotheses for the mantle convection system

Rates and History of plate movements

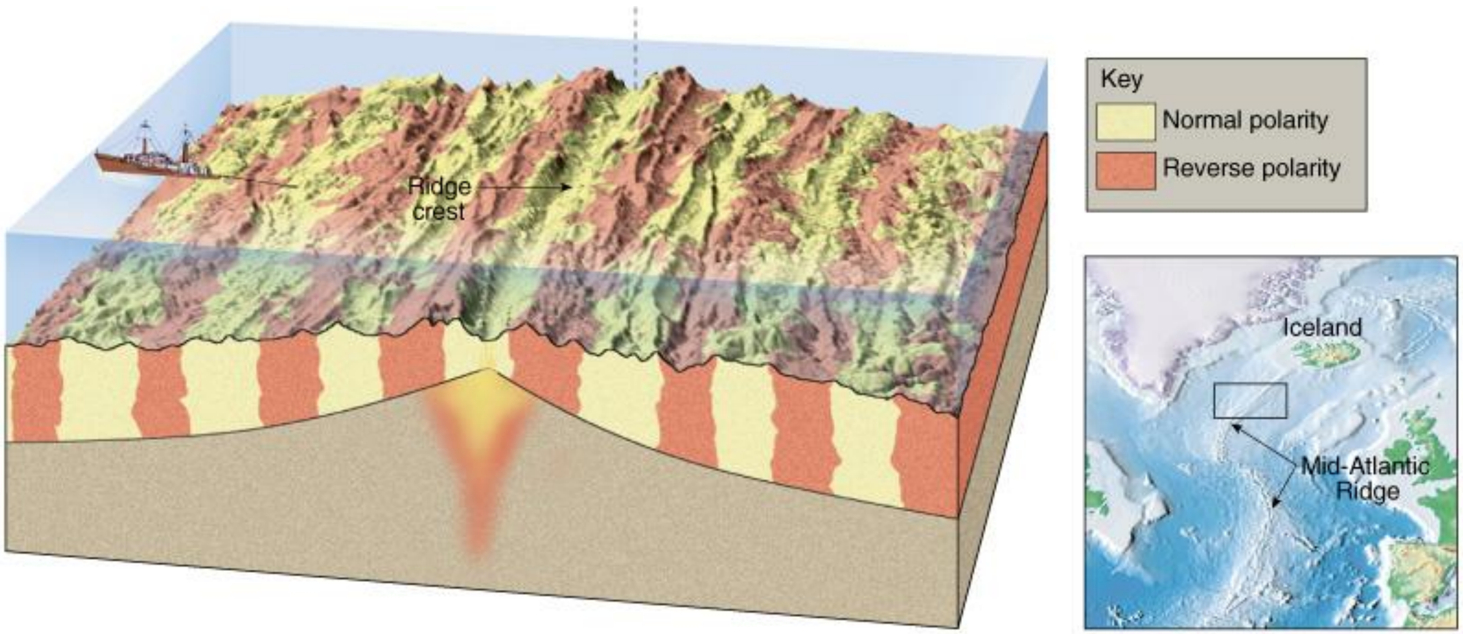
How fast do plates move?

Do some plates move faster than others, and if so, why?

Is the velocity of plate movements today the same as it was in the Geologic past?

Rates and History of plate movements

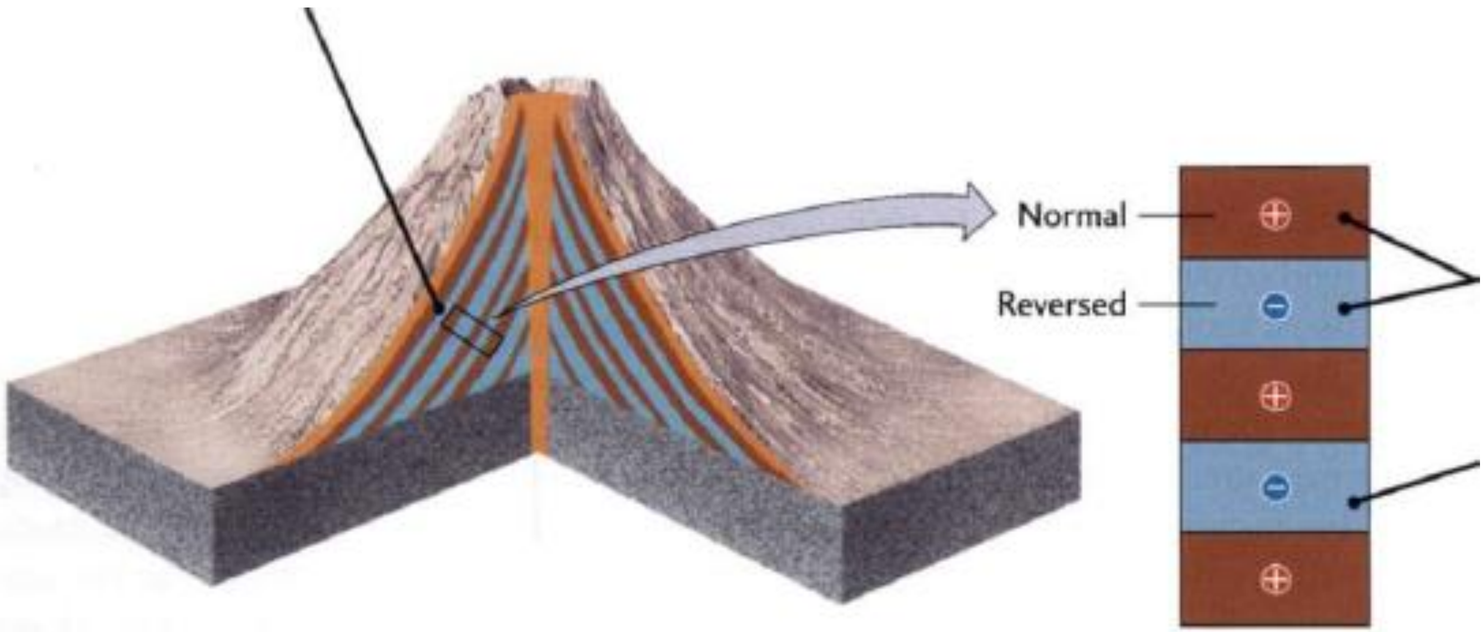
Paleomagnetism



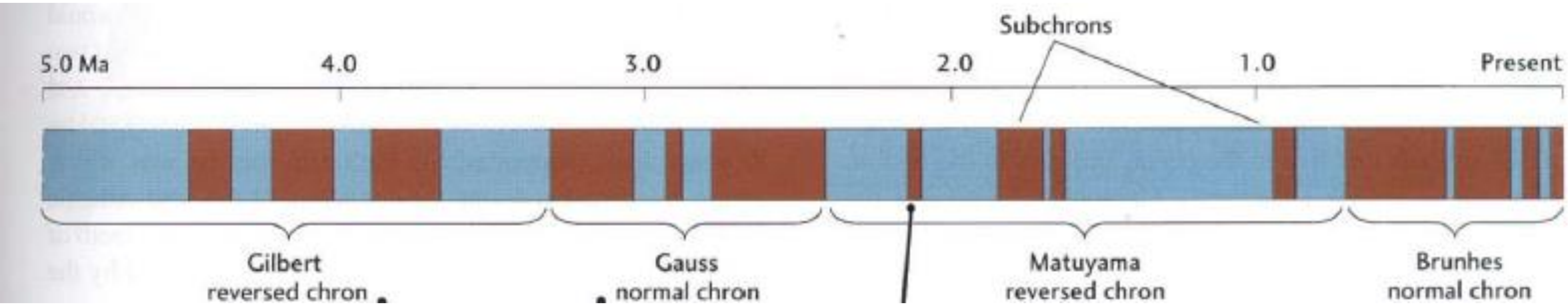
B. Research vessel towing magnetometer across ridge crest

C. Location map

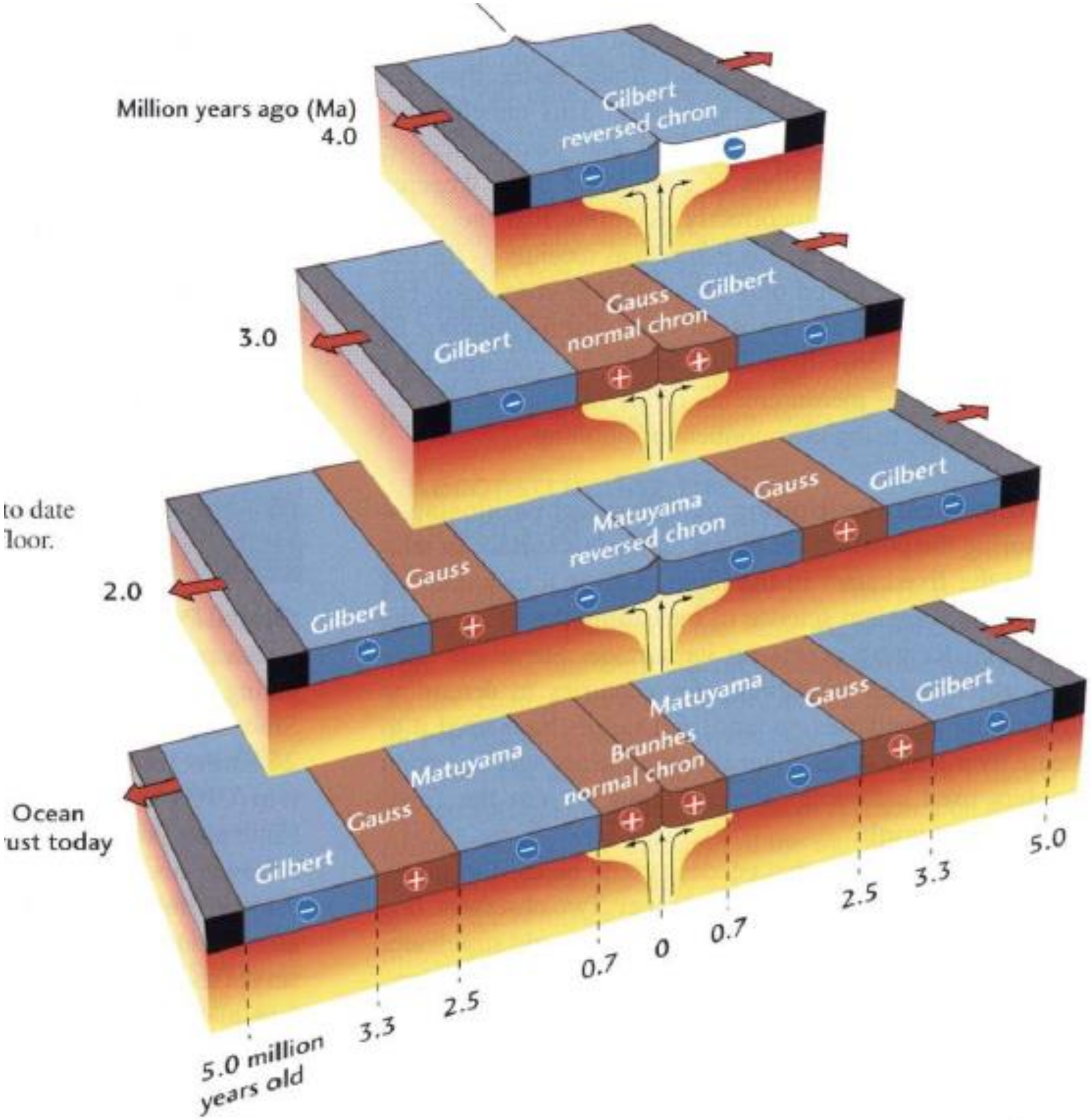
Paleomagnetism

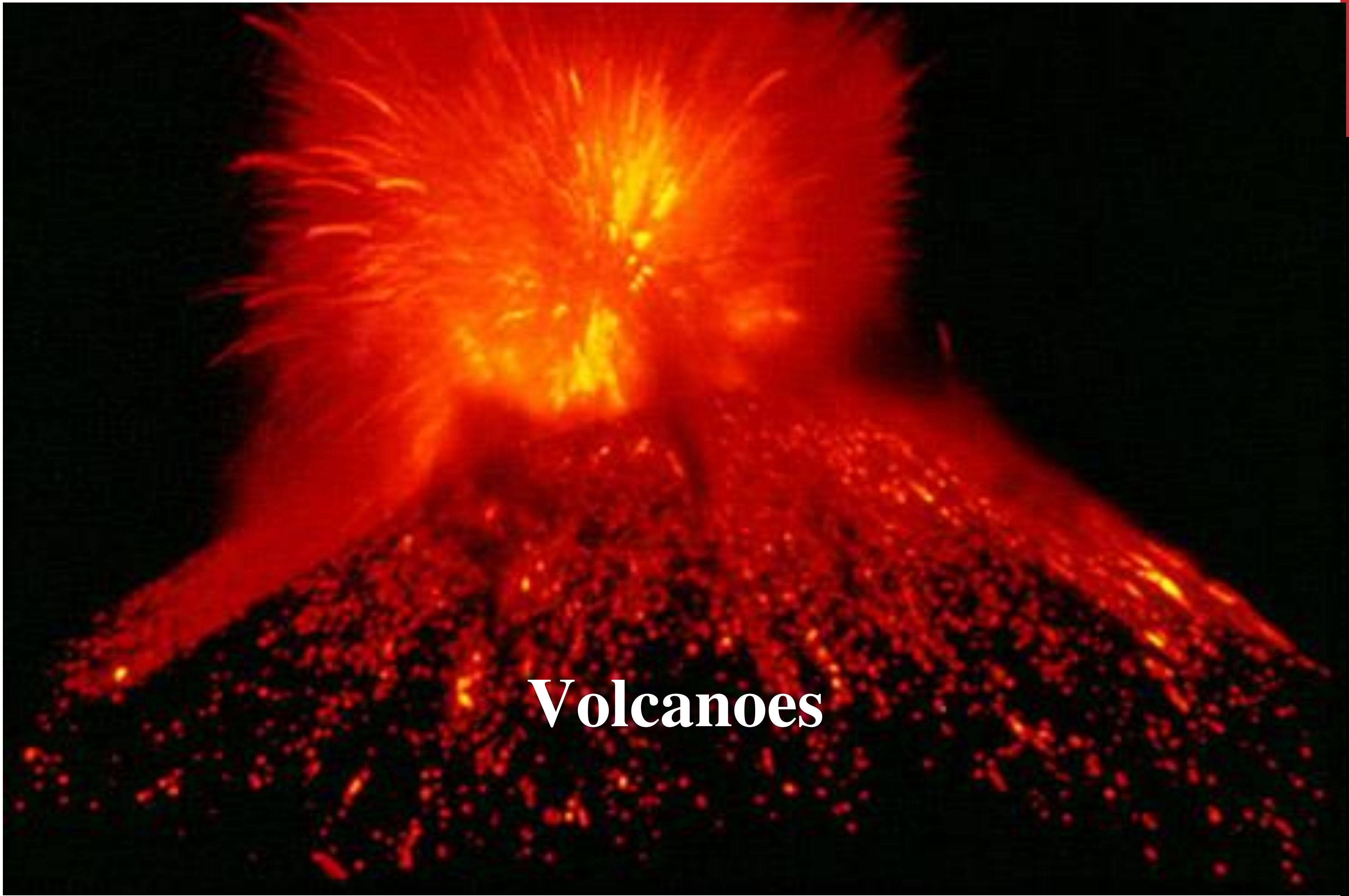


Paleomagnetism



Paleomagnetism

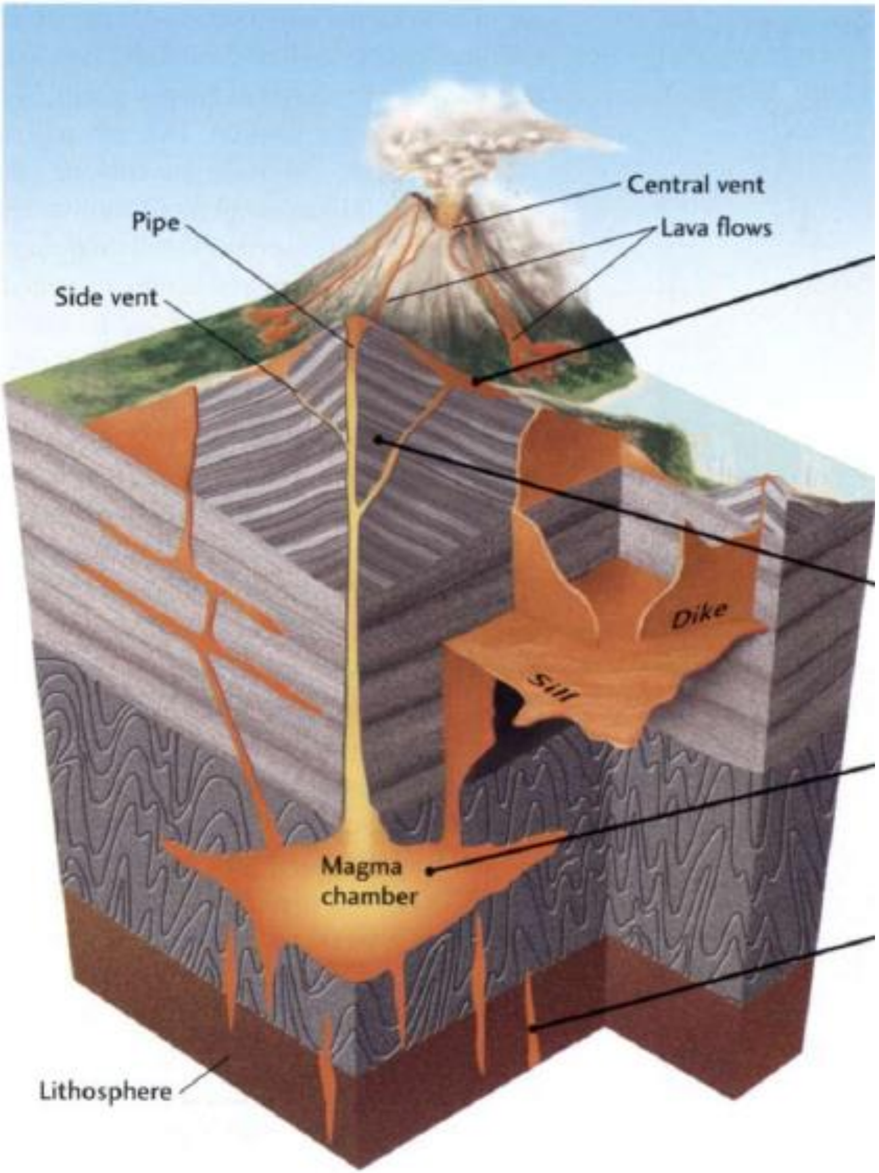



Volcanoes

Eruption at Pompeii

MAY 1990 ERUPTION OF KILAUEA, HAWAII

Plumbing System of a Volcano



Lava accumulates on the surface to form volcano

Lava erupts through a Central and side vents

Rise through the lithosphere

Originates from the Asthenosphere

Types of Lavas

- Basaltic Lavas
- Andesitic Lavas
- Rhyolitic Lavas

Basaltic Lavas

•Mid oceanic ridges

•Mafic in composition

•Higher temperature

•Rarely explosive

A central vent eruption from Kilauea, Hawaii produces fast flowing Basaltic lavas

Type of Basaltic Lavas

Pillow Lava

Andesitic Lavas

- Intermediate SiO_2
- Flow relatively slow
- Temperature lower
- Subduction settings
- Phreatic explosions

Mount St Helens, a andesitic volcano in south-western Washington state

Phreatic explosions

Rhyolitic Lavas

- High silica (~68%)
- Temperature lower (600-800)
- Thick bulbous deposits
- Gases are easily trapped with in ryholitic lavas

Viscous rhyolite lava flow. Wilson Butte dome, Long Valley, California

Types of magma

Magma Type	Solidified Rock	Chemical Composition	Temperature	Viscosity	Gas Content
Basaltic	Basalt	45-55 SiO_2 %, high in Fe, Mg, Ca, low in K, Na	1000 - 1200°C	Low	Low
Andesitic	Andesite	55-65 SiO_2 %, intermediate in Fe, Mg, Ca, Na, K	800 - 1000°C	Intermediate	Intermediate
Rhyolitic	Rhyolite	65-75 SiO_2 %, low in Fe, Mg, Ca, high in K, Na	650 - 800°C	High	High

Textures of Volcanic rocks

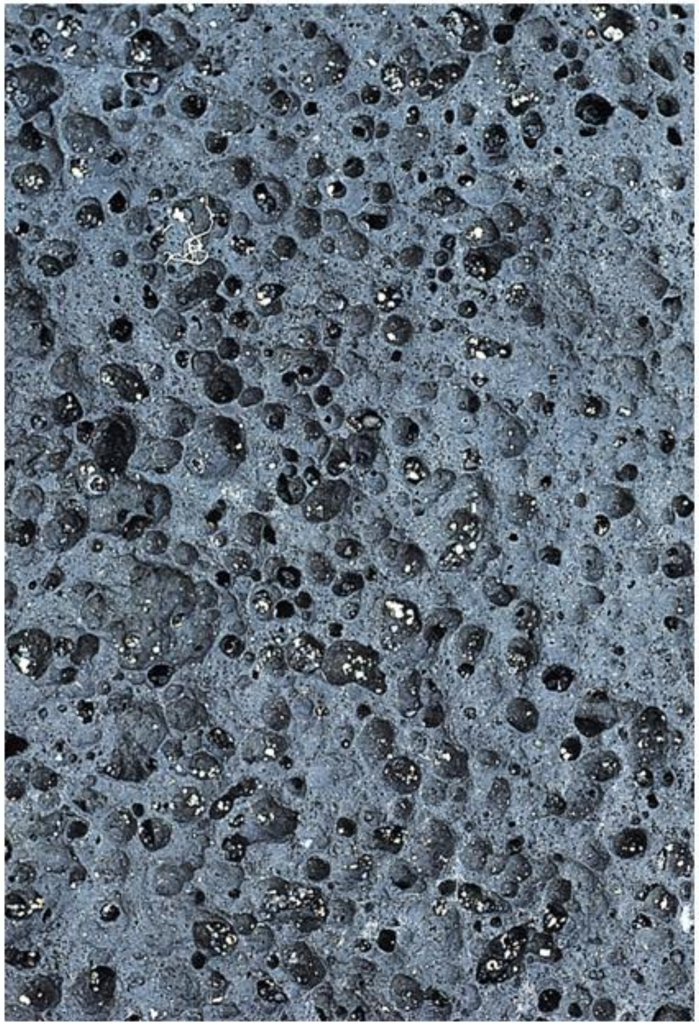
Obsidian

Vesicular

Obsidian

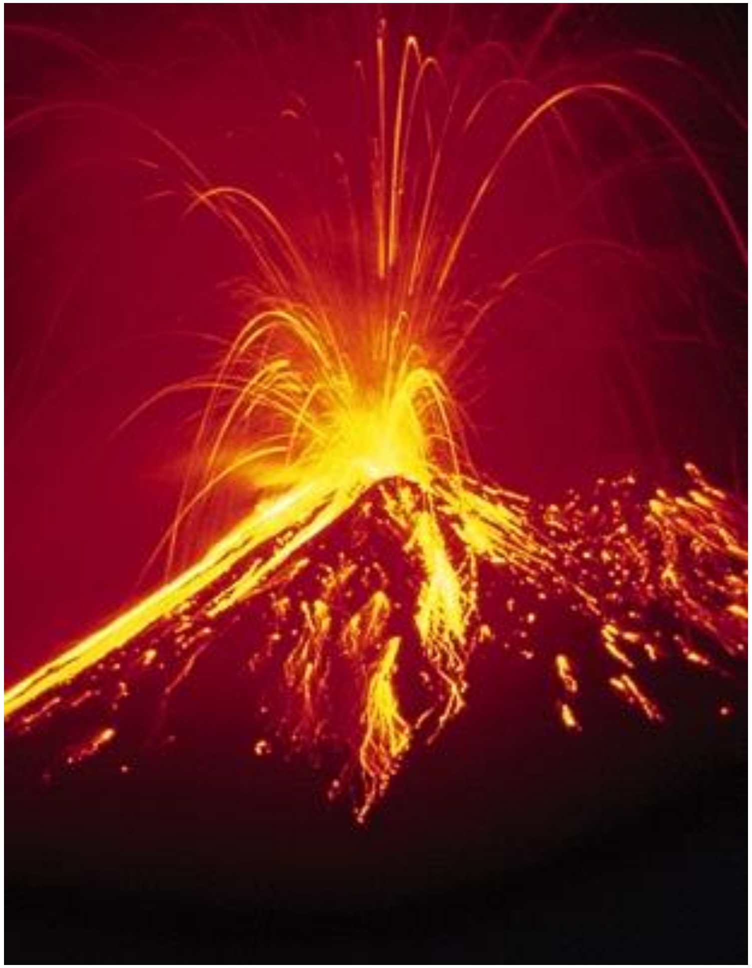
Silica rich rapidly cooled lavas form obsidian

Vesicular Basalt



Pumice floating in water

Pyroclastic deposits



Explosive eruption at Arenal Volcano,
Costa Rica

Volcanic ejecta

Pyroclastic flows

Pyroclastic deposits

- Volcanic ash – less than 2mm in diameter
- Volcanic Bombs- large fragments

Volcanic ash

Volcanic Bombs

Pyroclastic deposits

(a)

Tuff

(b)

Volcanic breccia

Pyroclastic flow

Pyroclastic flow plunged down the slopes of Mount Unzen, Japan

Eruptive styles and landforms

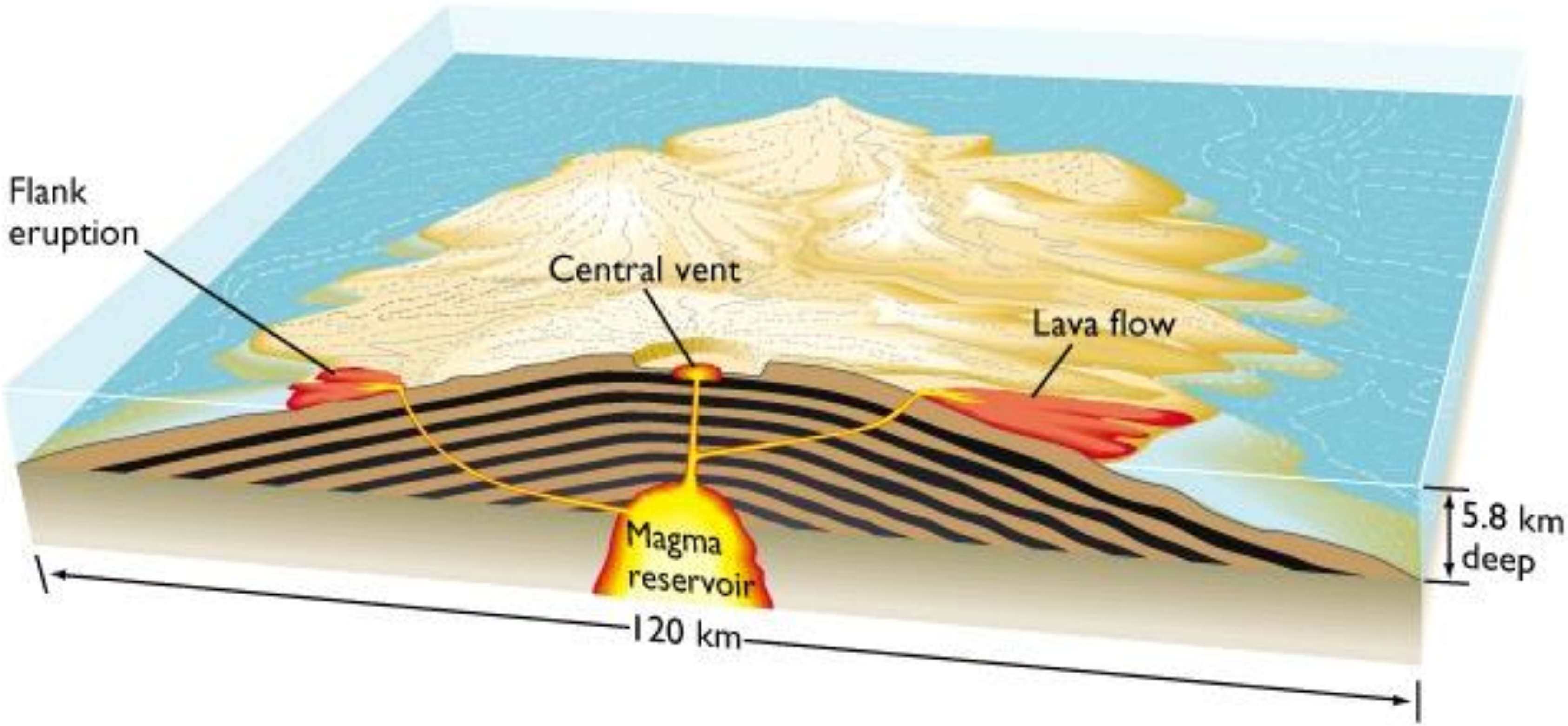
- Composition of magma
  - gas content
  - chemical compostion
- Type of material erupted (lava versus pyroclasts)
- Environmental condition in which it erupts
  (submarine vs. continental)

Central Eruptions

Shield Volcanoes

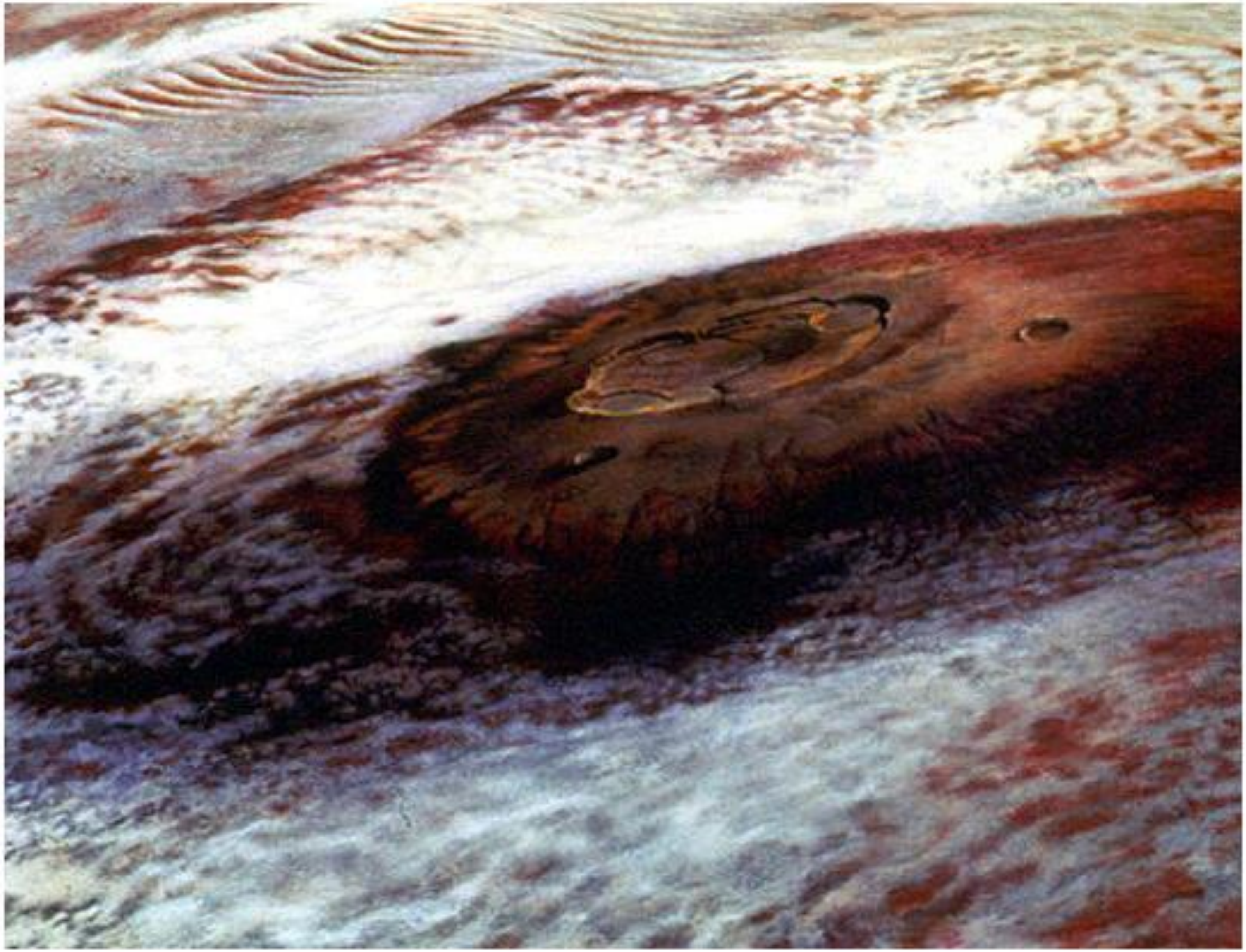
- **Low-viscosity lava flows (Mafic)**
- **Gently sloping flanks — between 2 and 10 degrees**

Shield Volcanoes



Shield Volcanoes

Olympus Mons Shield Volcano

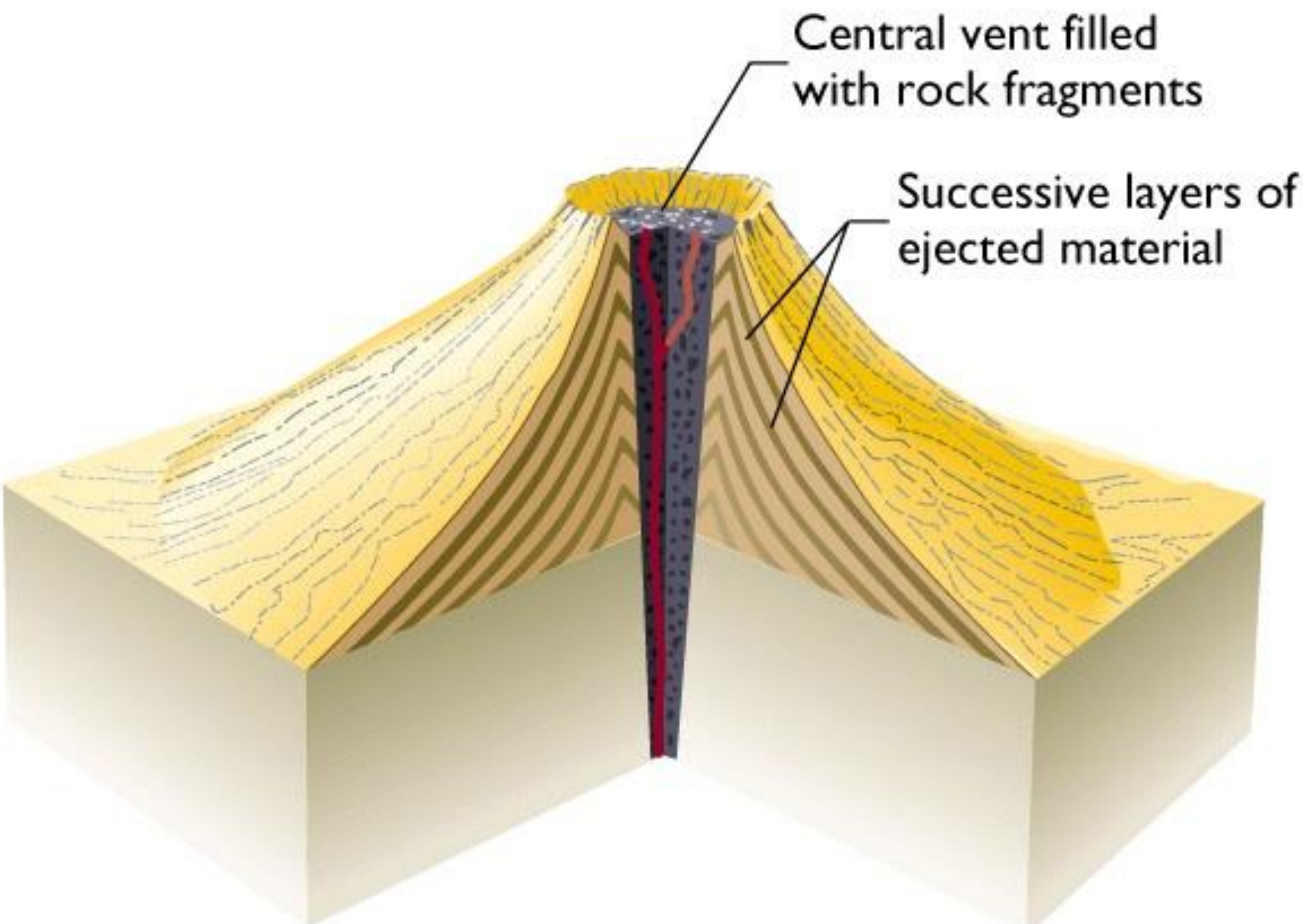


Central Eruptions

Cinder Cones

- **Formed of pyroclastics only**
- **Steep sides — ~30 degrees**
- **Short duration of activity**
- **Larger fragments near to vent form steep slopes**

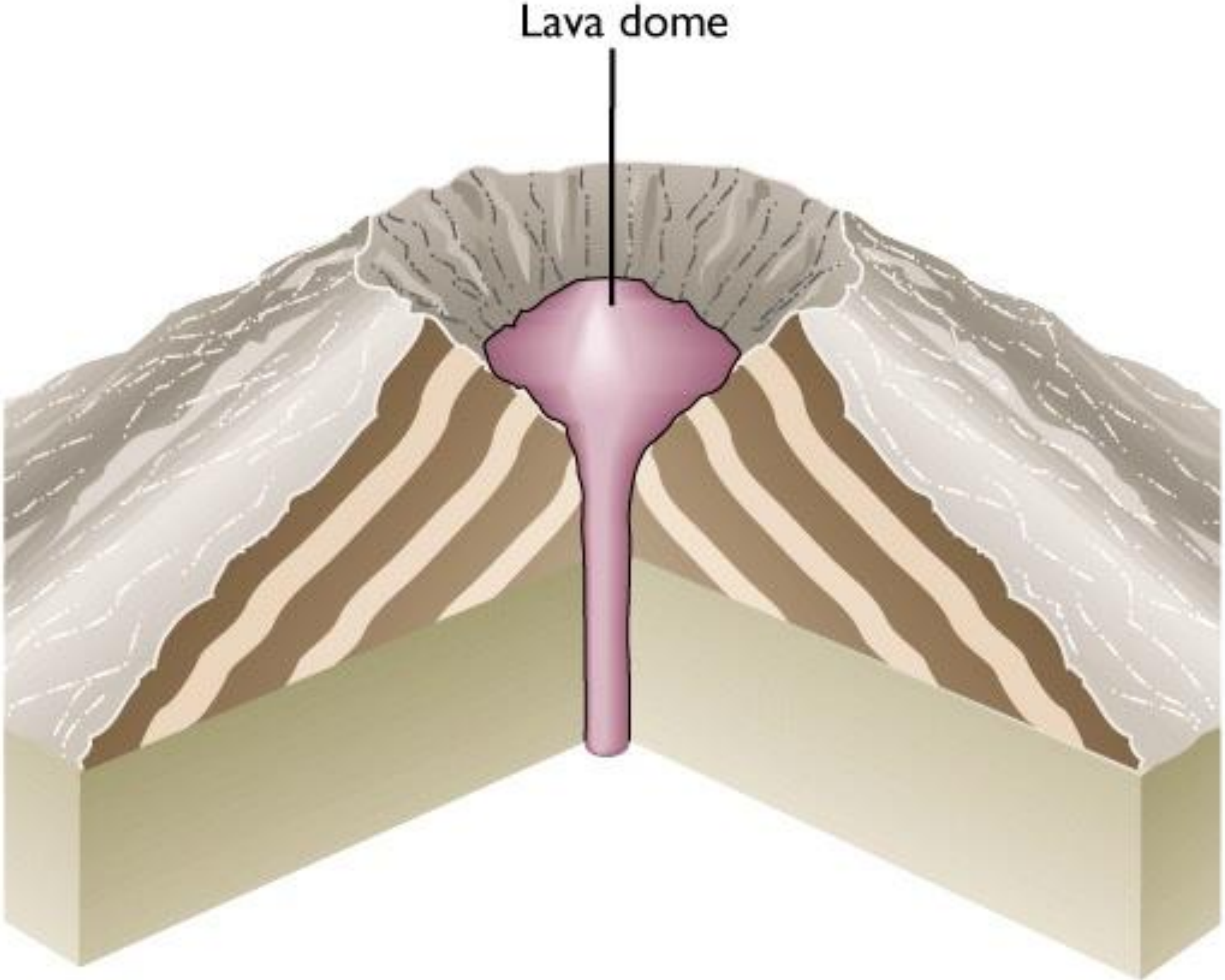
Cinder Cones



Cerro Negro Cinder Cone near Managua Nicaragua in 1968

Volcanic domes

- **Forms above a volcanic vent, a bulbous step sided mass of rock**
- **Viscous lava — usually silica-rich (or cooler magma)**
- **Associated with violent eruptions**


Lava dome

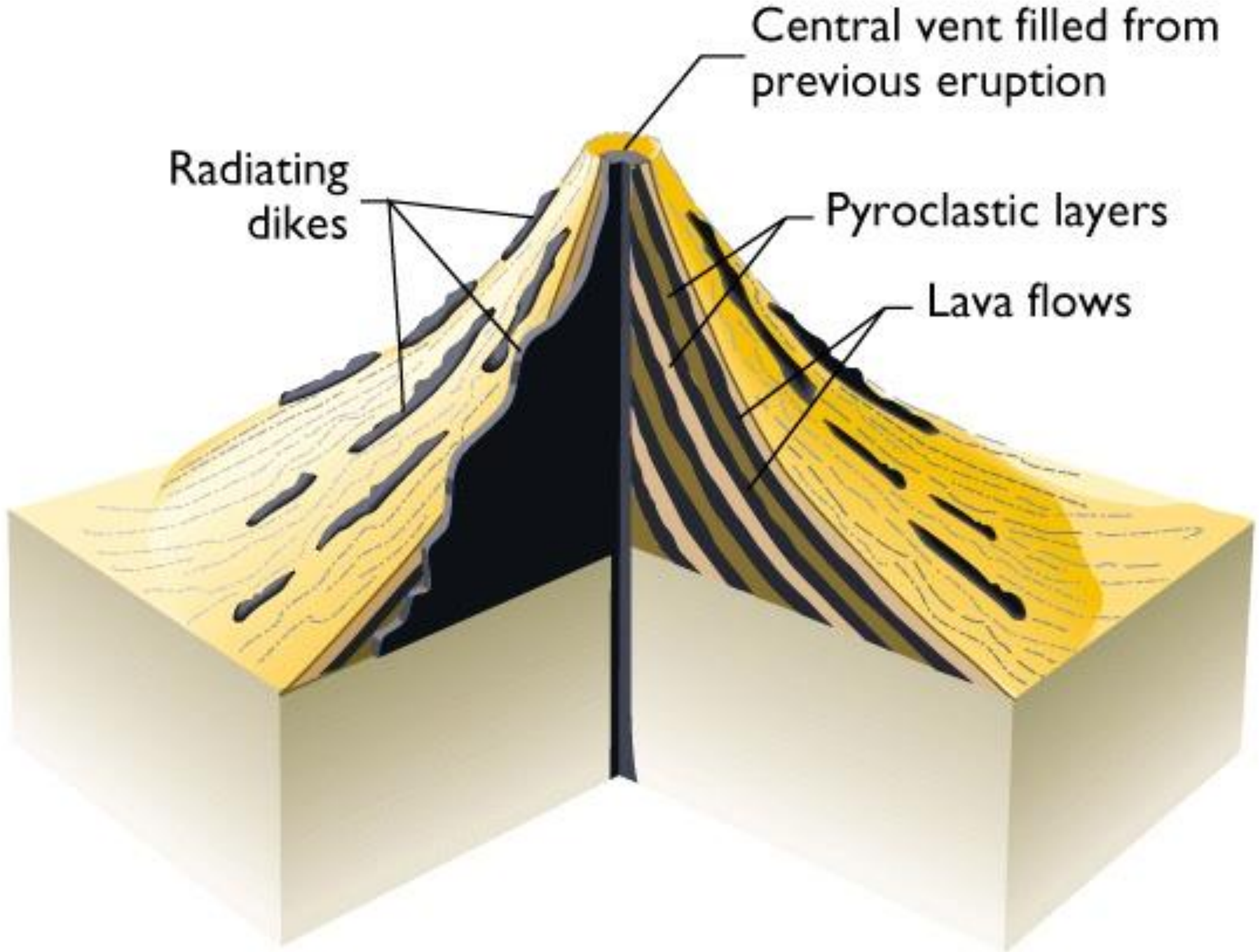
Lava Dome

INYO OBSIDIAN DOMES-CALIFORNIA

Composite/strato Volcano

- **Alternating pyroclastic layers and lava flows**
- **Slopes intermediate in steepness**
- **Intermittent eruptions over long time span**
- **Mostly *Andesite***
- **Distribution**
  - Circum-Pacific Belt (“Ring of Fire”)
  - Mediterranean Belt

Composite Volcano



MT FUJIYAMA, JAPAN

Fig. 5.15

Crater

• Bowl shape pit found at the summit of volcanic mountains

Xico volcanic crater, Mexico city

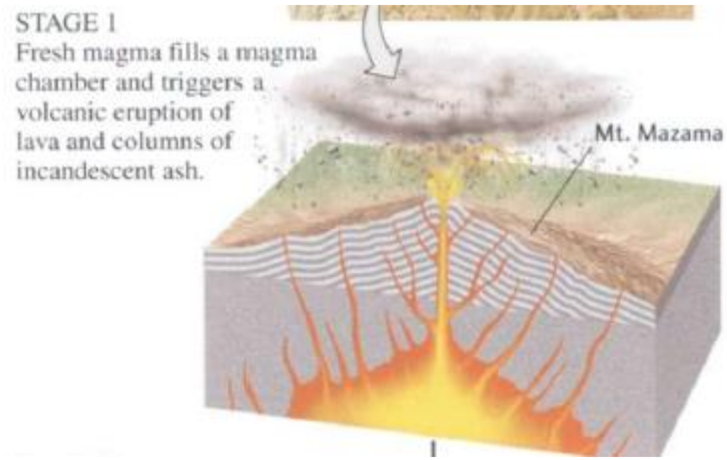
Calderas

- **Depression at top of volcano produced during an eruption**

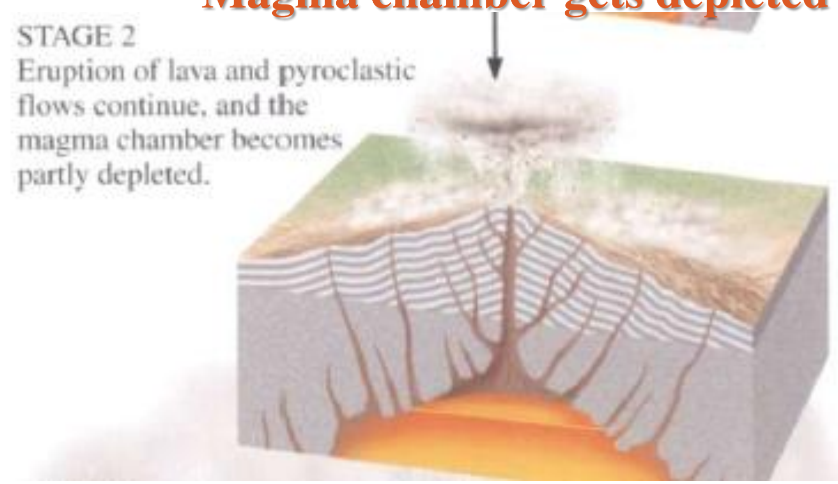
- **Great volume of magma are discharged rapidly from a large magma chamber, the chamber can no longer support it**

Calderas

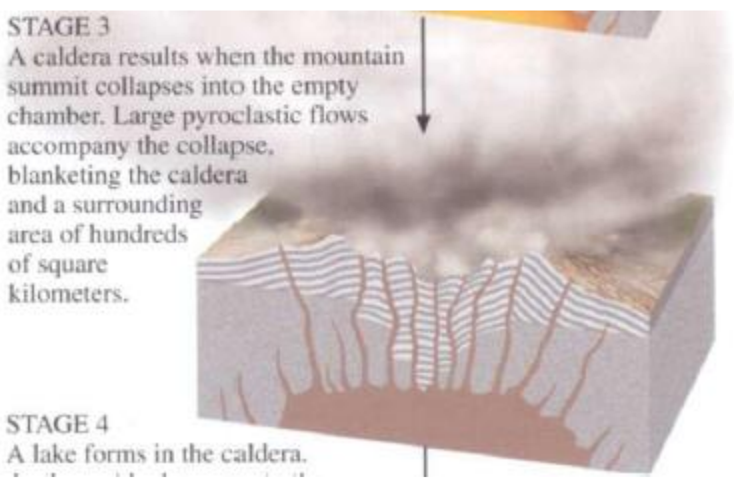
Volcanic eruption

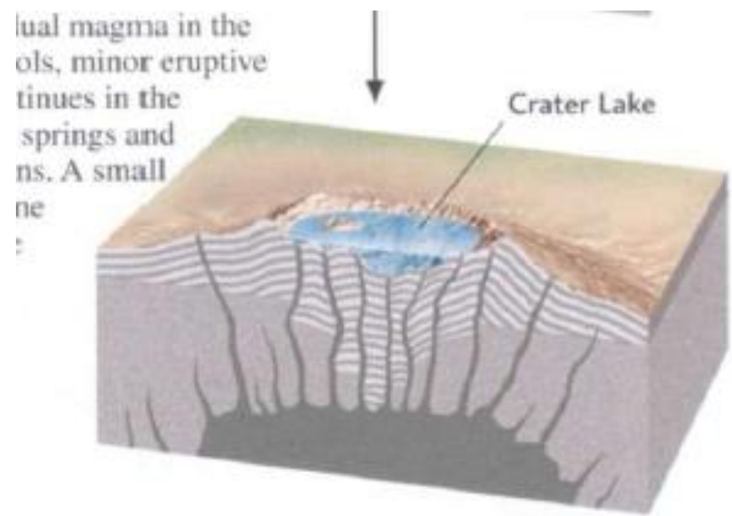


Magma chamber gets depleted



Collapse of mountain summit into empty chamber

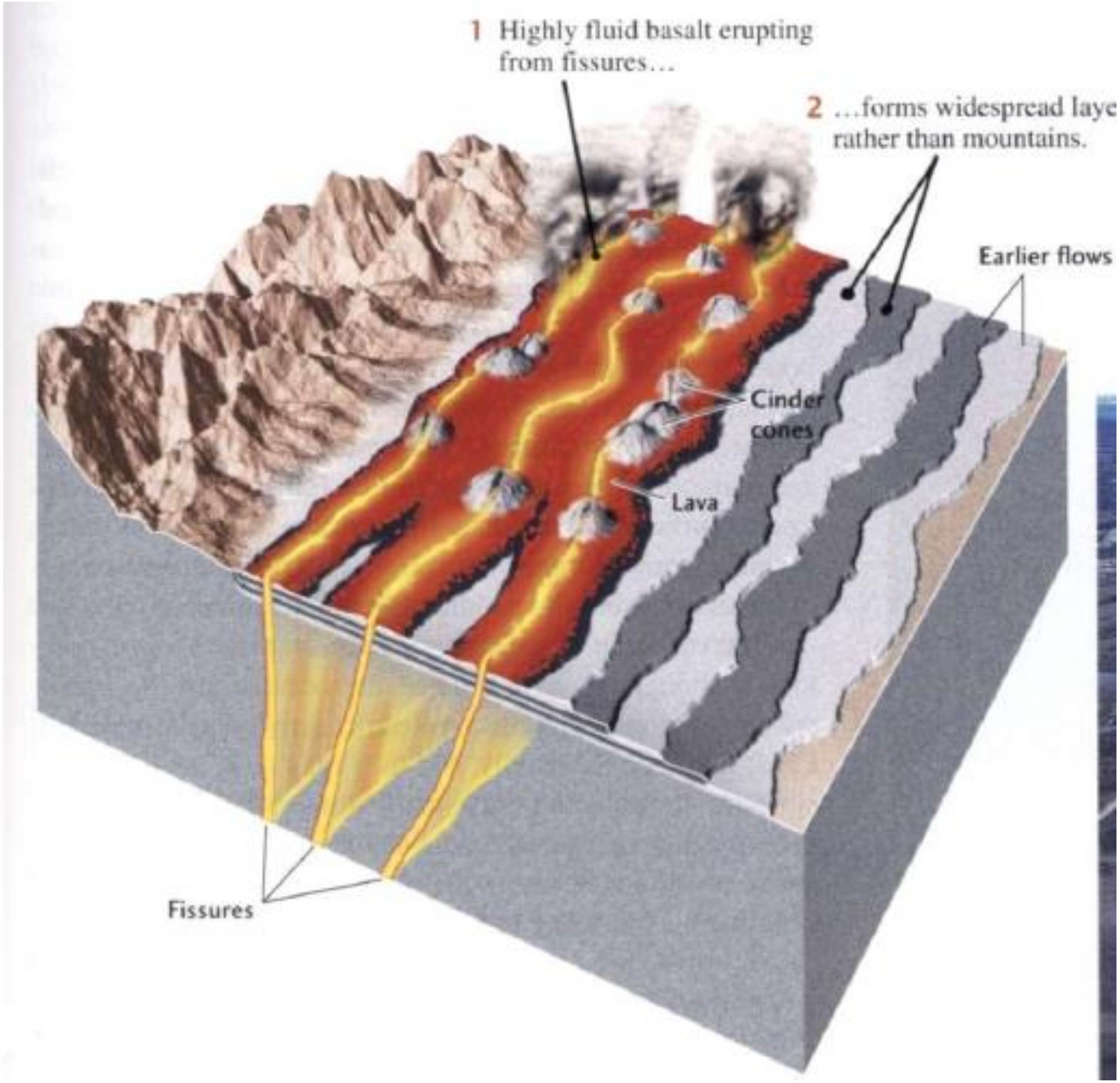




Mt Fujiyama, Japan **Before May, 1980**


After May, 1980
David Weintraub/Photo Researchers

Fissure type eruption



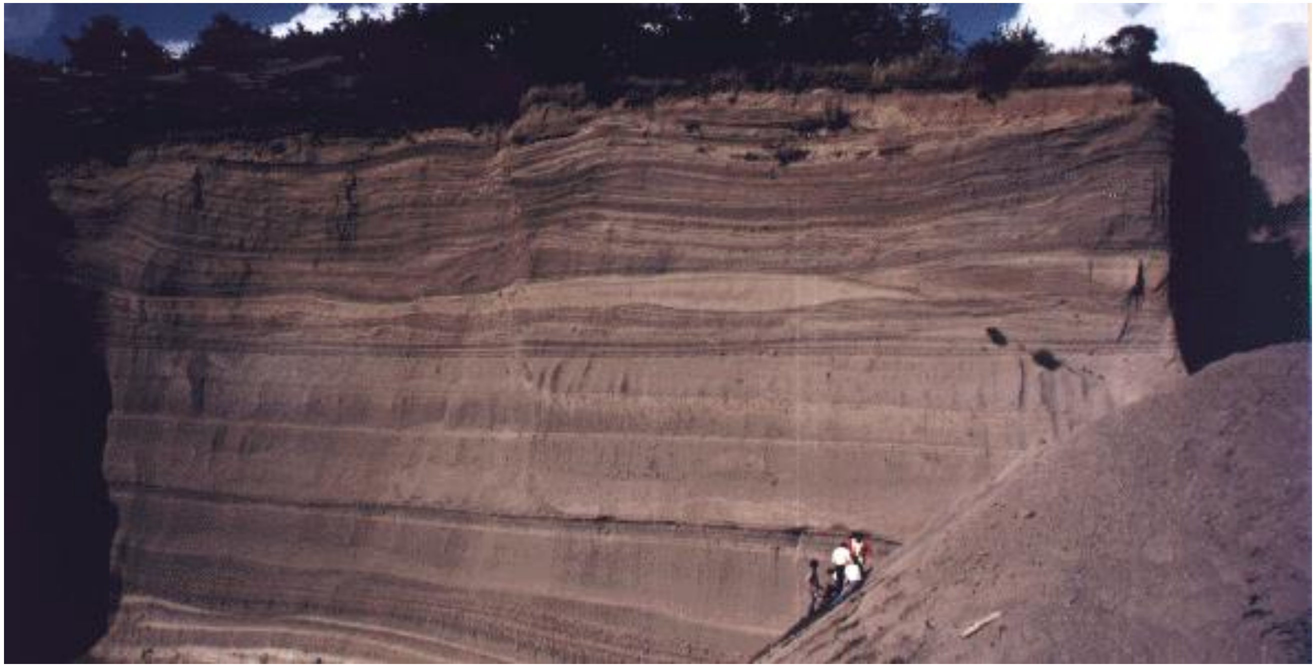
Fissure type eruption

Flood basalts

Deccan basalts

Fissure type eruption

Ash flow deposits



Quarry within pyroclastic deposits of Laacher See volcano, Germany

Materials ejected from Volcanoes

Volatile material

- **Steam (H_2O)**
- **Carbon dioxide (CO_2)**
- **Hydrogen sulfide (H_2S)**
- **Many other constituents (N, Ar, He etc)**

Sulfur-encrusted fumerole: Galapagos Islands

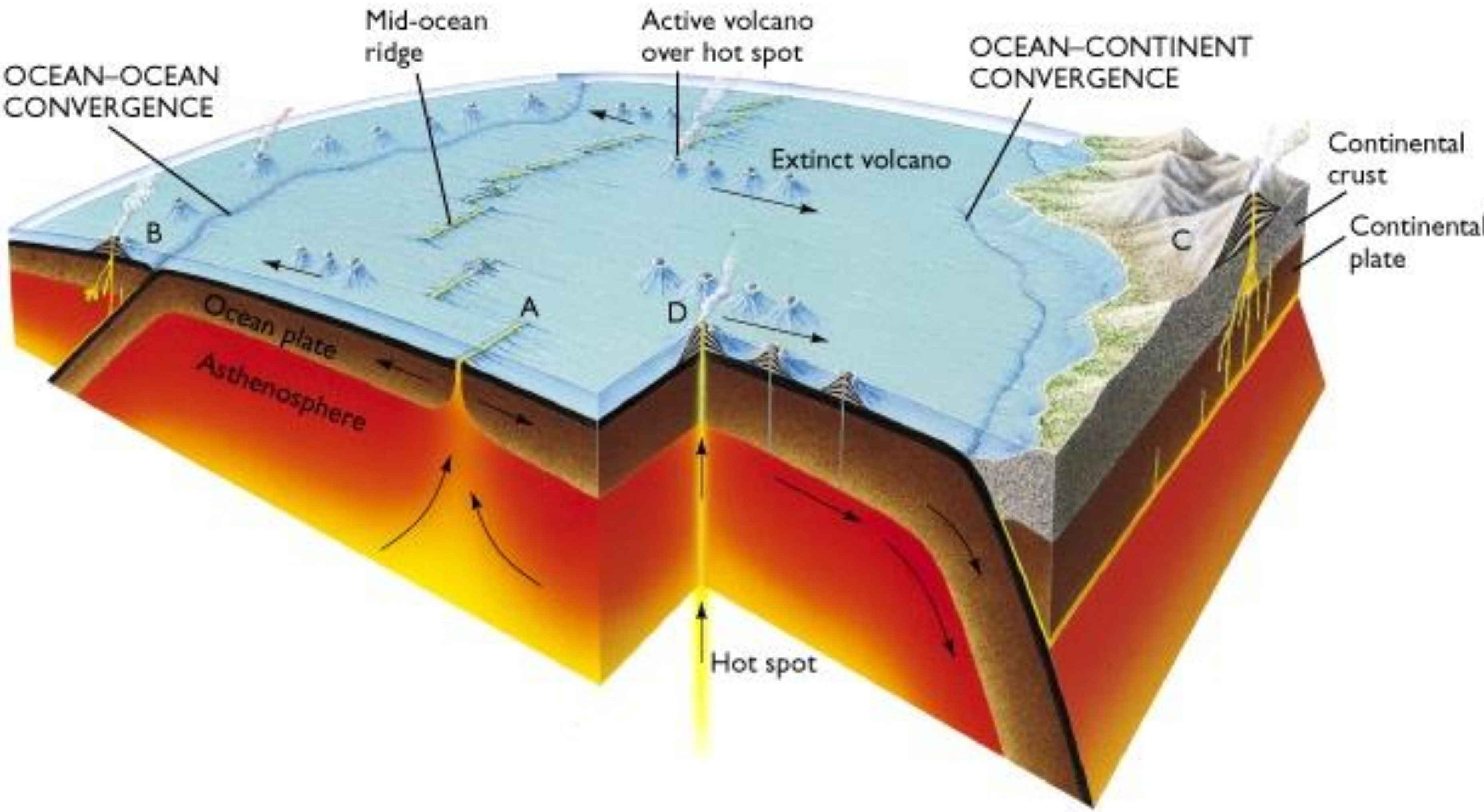
The tectonic setting of Volcanoes

- Convergent plate boundaries

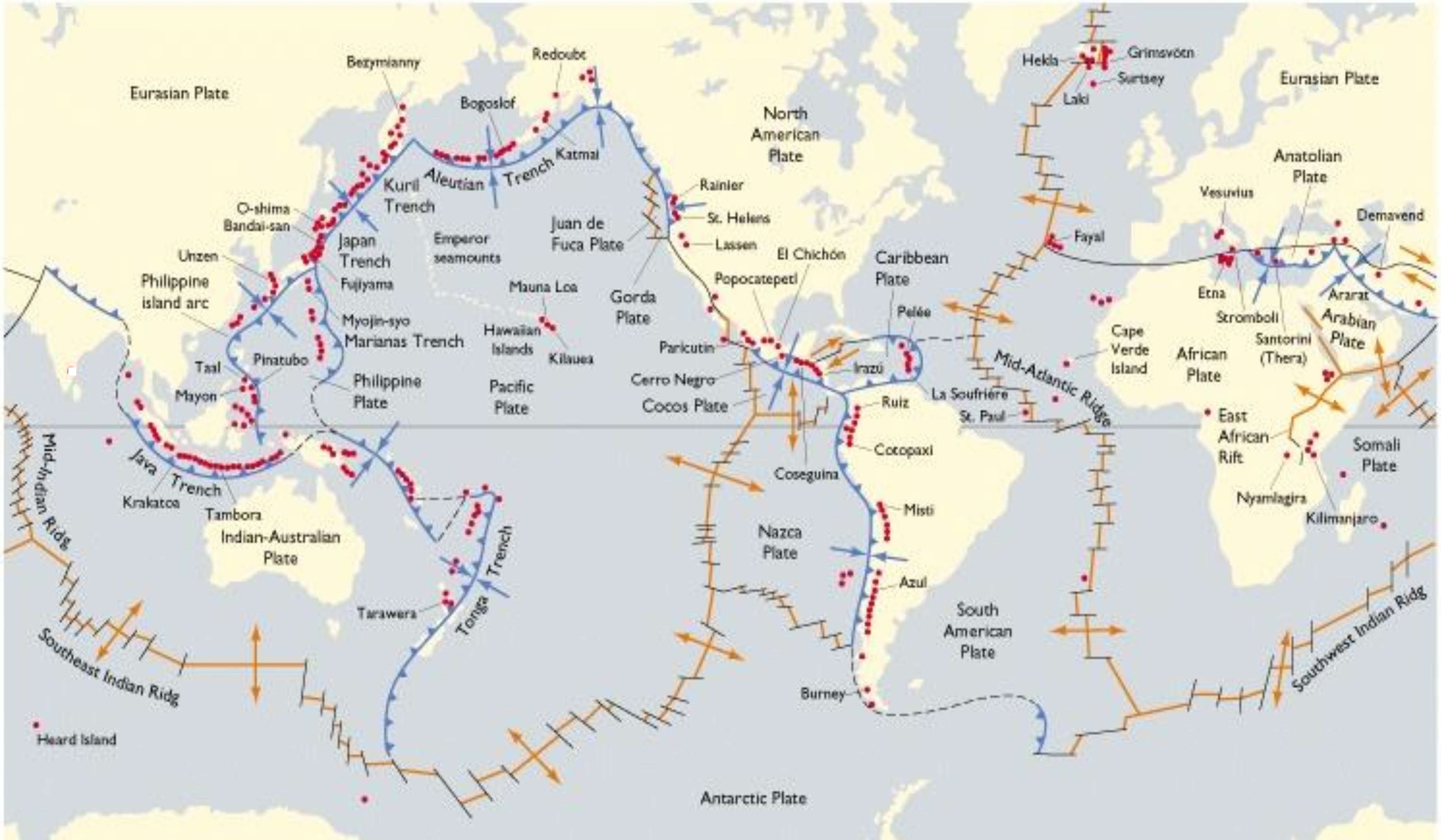
- Divergent plate boundaries

- Within plate “hotspots”

The Volcanism associated with plate tectonics



The world`s active Volcanoes

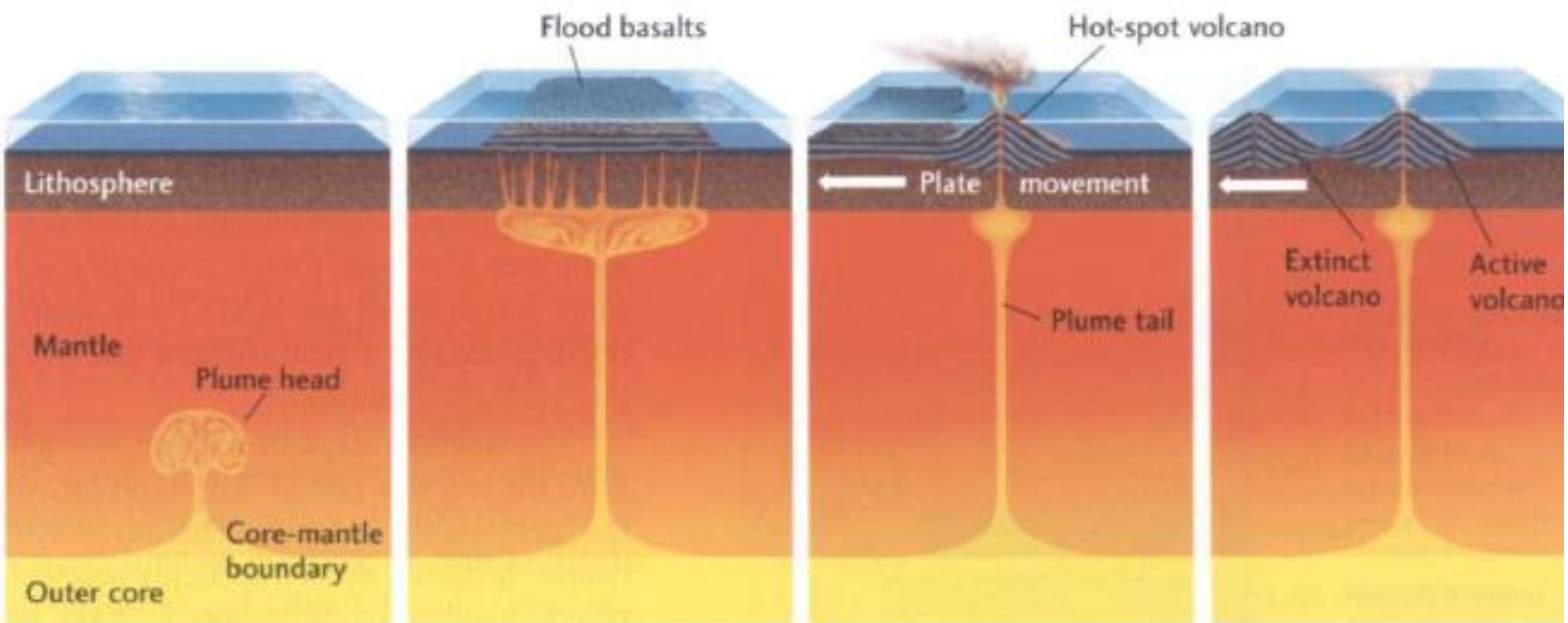


Hotspots/Mantle plumes

•Arises in the core mantle boundary

•Large turbulent blob of hot materials- ‘plume head’

•At top of the mantle the plume head generates large amount of magma



Speculative model for the formation of Hot spots

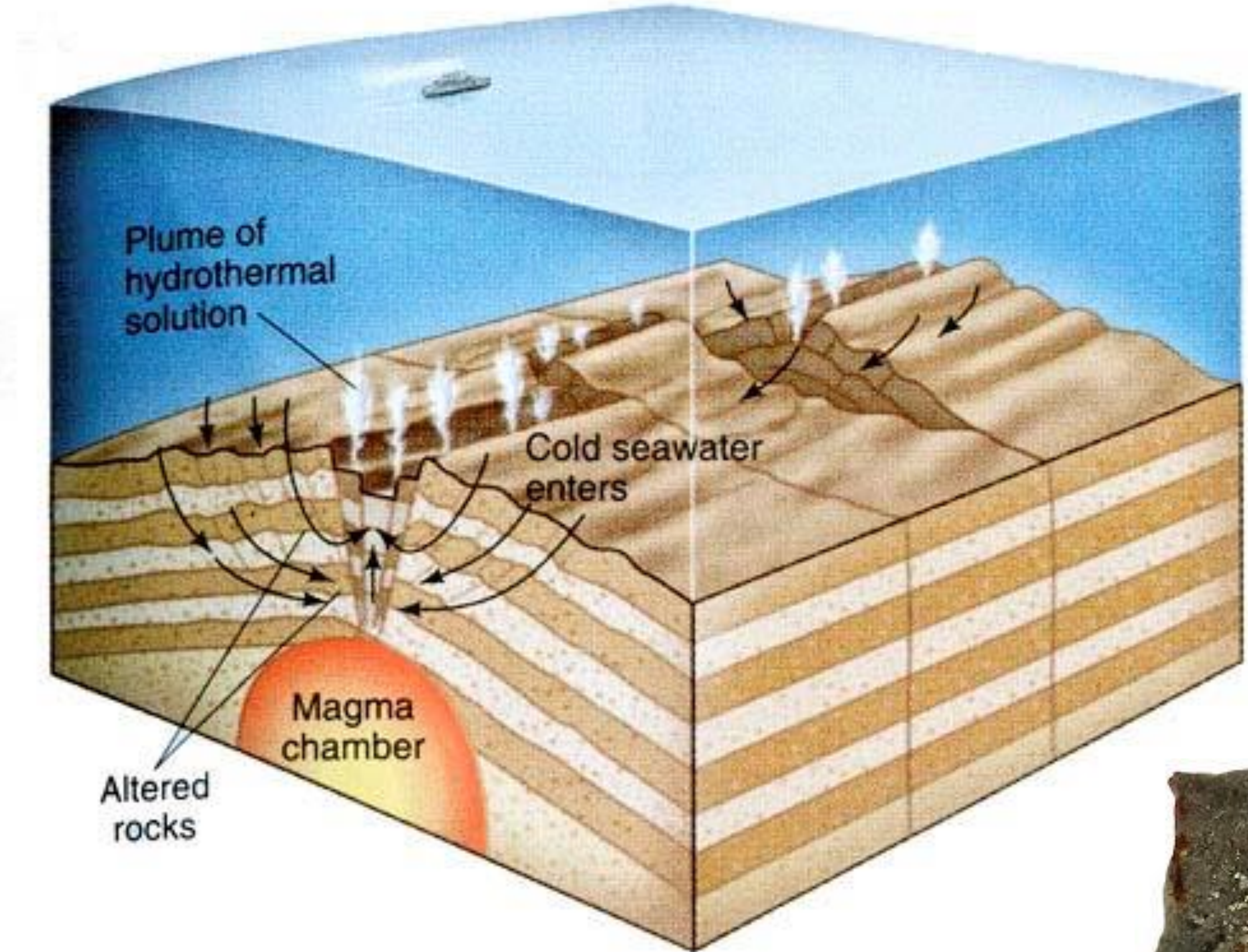
- **Effect of volcanoes on Human**

Effect of Volcanoes on Human

- **Mineral deposits**
- **Geothermal energy**
- **Volcanic hazards**

Effect on climate

Hydrothermal deposits

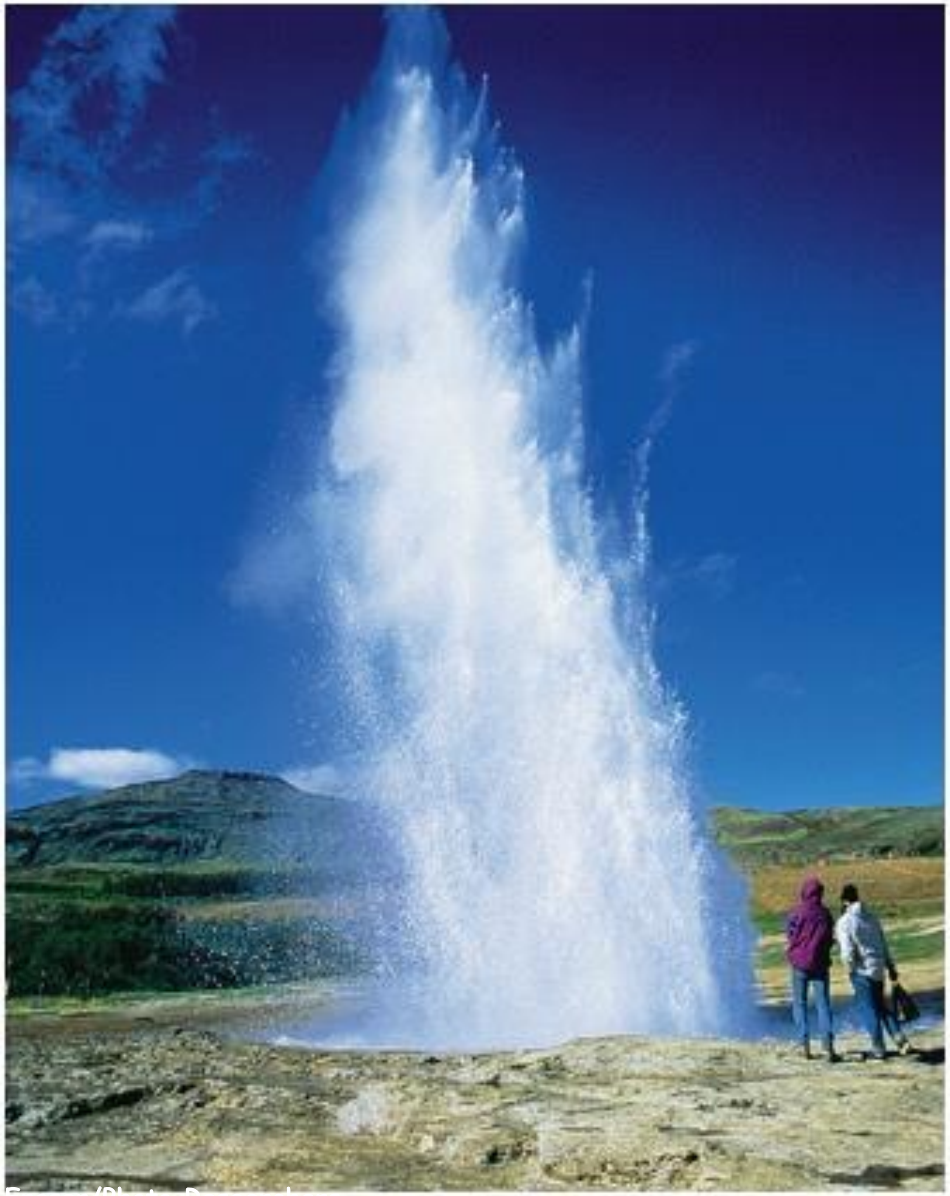


Hydrothermal deposits

White smokers

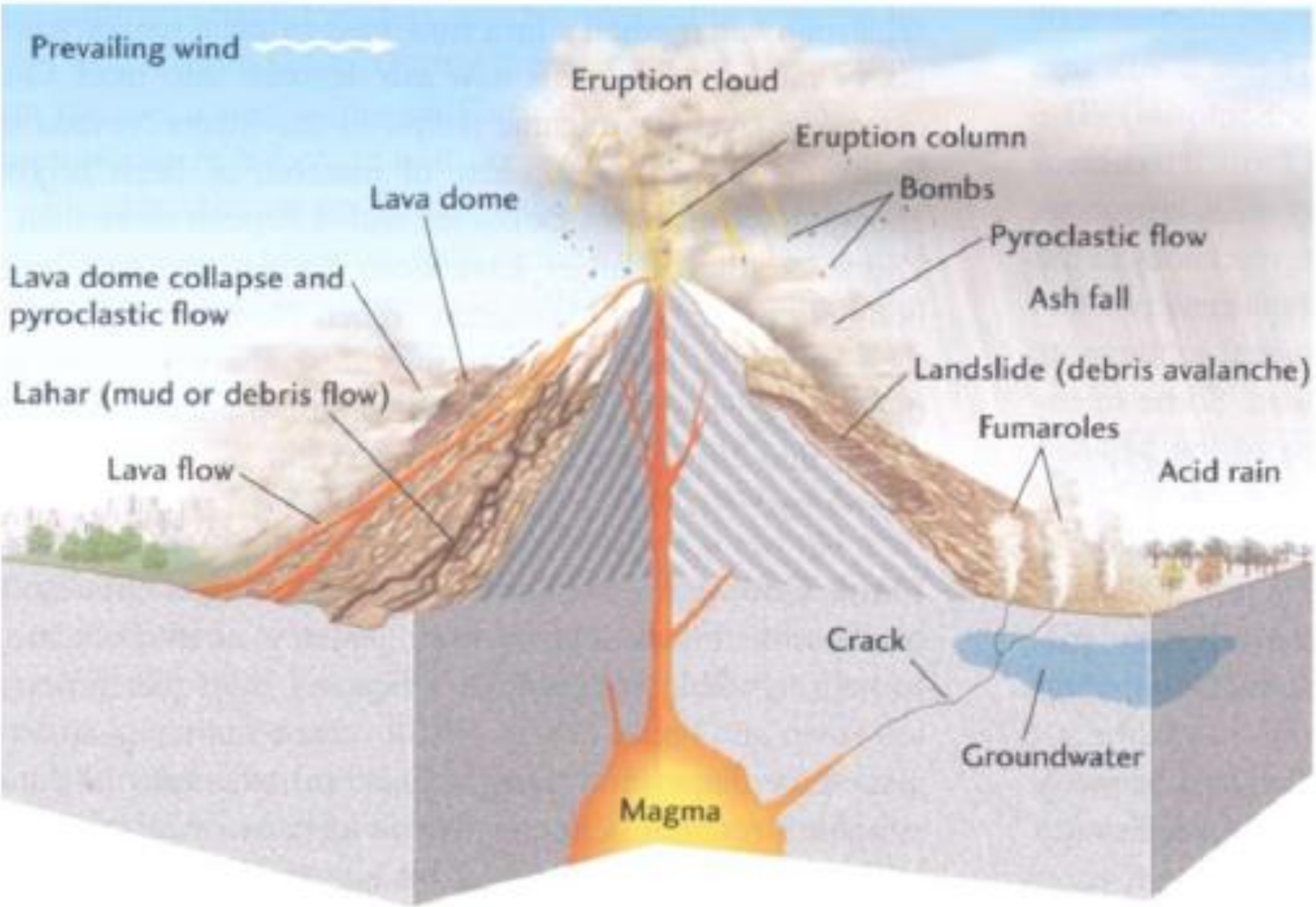
Black smokers

Geothermal energy



Stokkur Geyser in Iceland

Types of Volcanic Hazards



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

Pyroclastic flows: e.g. Mt. Pelee, 1902

- 28,000 killed

Tsunami: e.g. Krakatoa, 1883

- 36,417 killed

Lahars (mudflows): e.g. Nevado del Ruiz, 1985

- 23,000 killed

Volcanic mudflows (Lahar)

A mixture of water and pyroclastic material in a concrete-like slurry capable of moving up to 100 km/hour

Volcanic mudflows

23,000 killed in 1985 by volcanic mudflows, Nevada del Ruiz

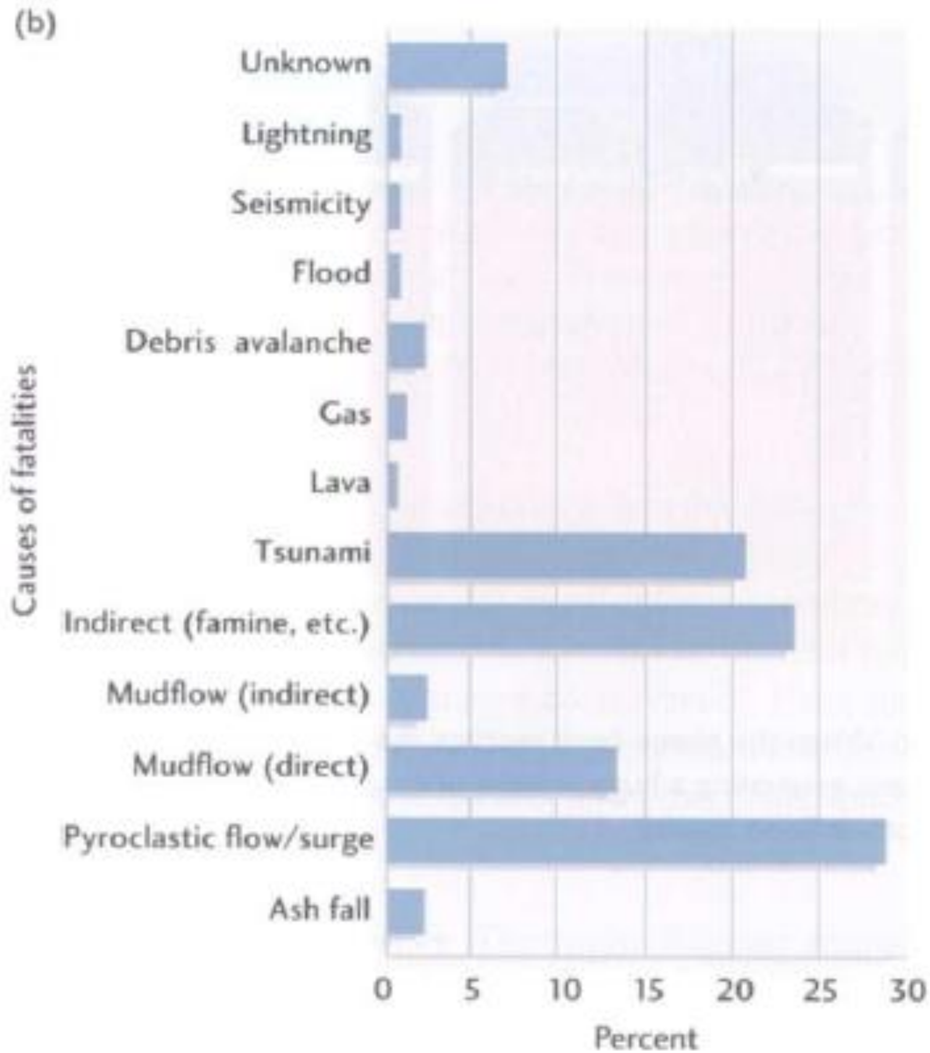
Lava flows

Sanjuan, Mexico buried by Lava flows

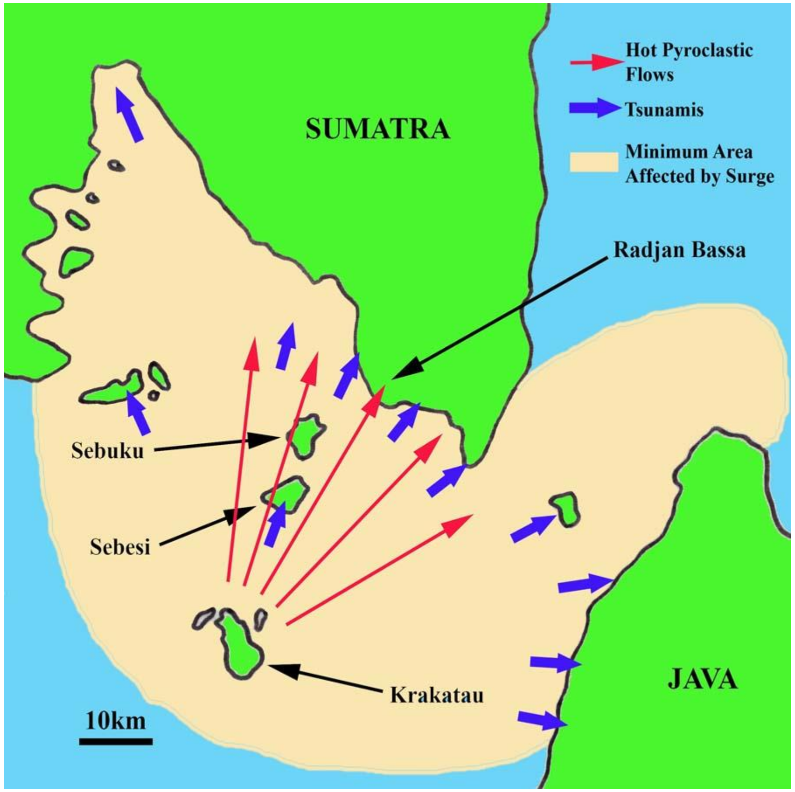
Ash Fall

20th Century's 2nd Largest Volcanic Eruption - Mt Pinatubo-Eruption

Causalities associated with Volcanic Hazards since AD 1500



Effect on climate



In the year following the eruption, average Northern Hemisphere summer temperatures fell by as much as 1.2 °C (2.2 °F)

Predicting/controlling Eruptions

Instrumented monitoring can detect signals such as earthquakes, swelling of volcano and gas emissions that warn of impending eruptions

e.g., St Helens in 1980, Mount Pinatubo in the Philippines in 1991