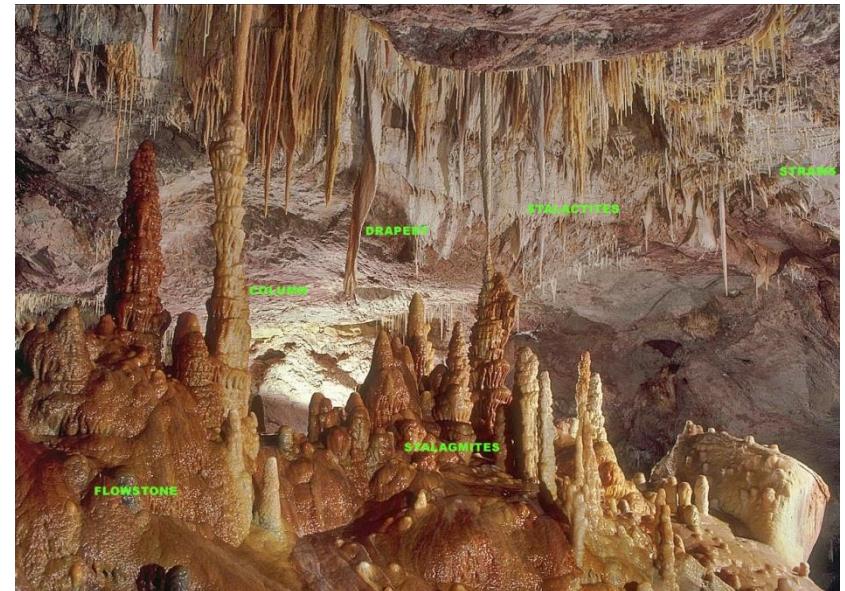


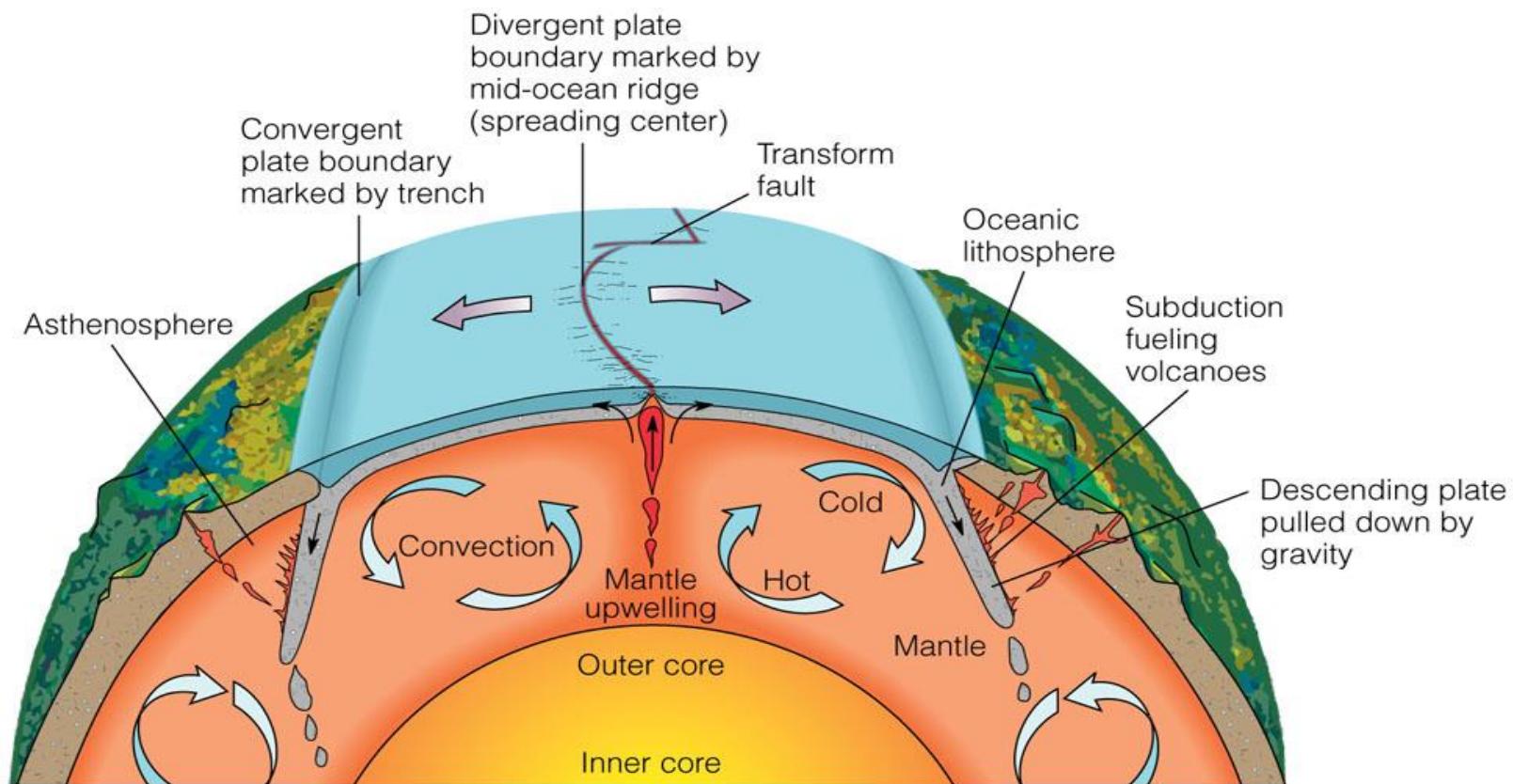


IDC 203: INTRODUCTION TO EARTH SCIENCES



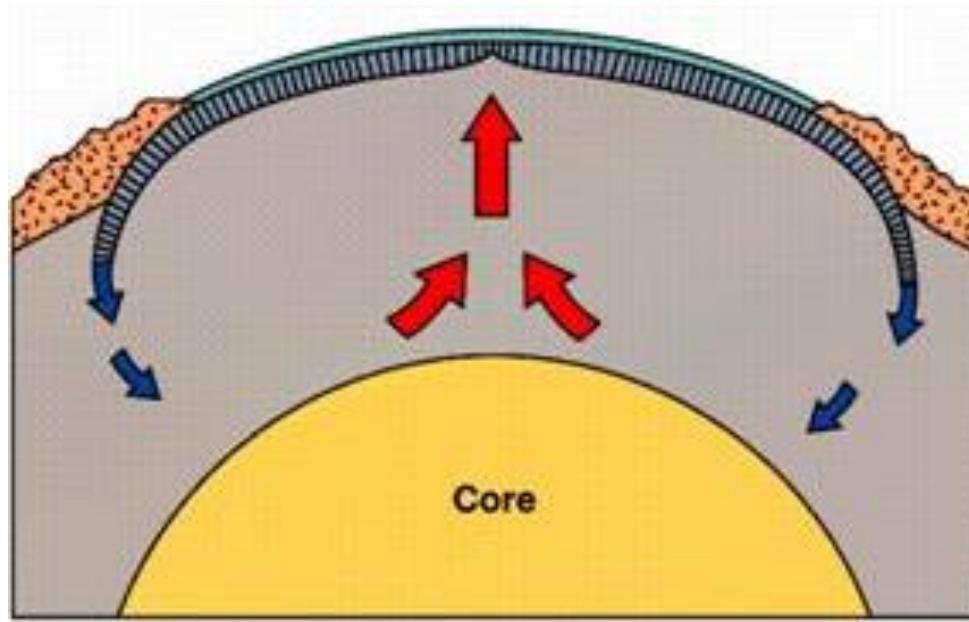
Convection currents

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



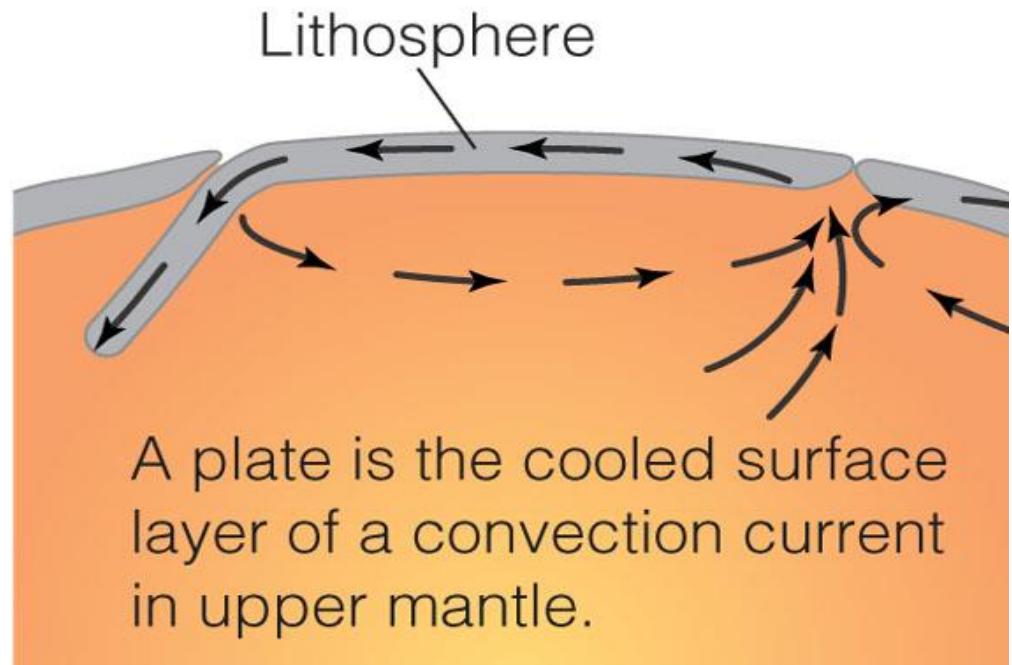
Convection currents

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?

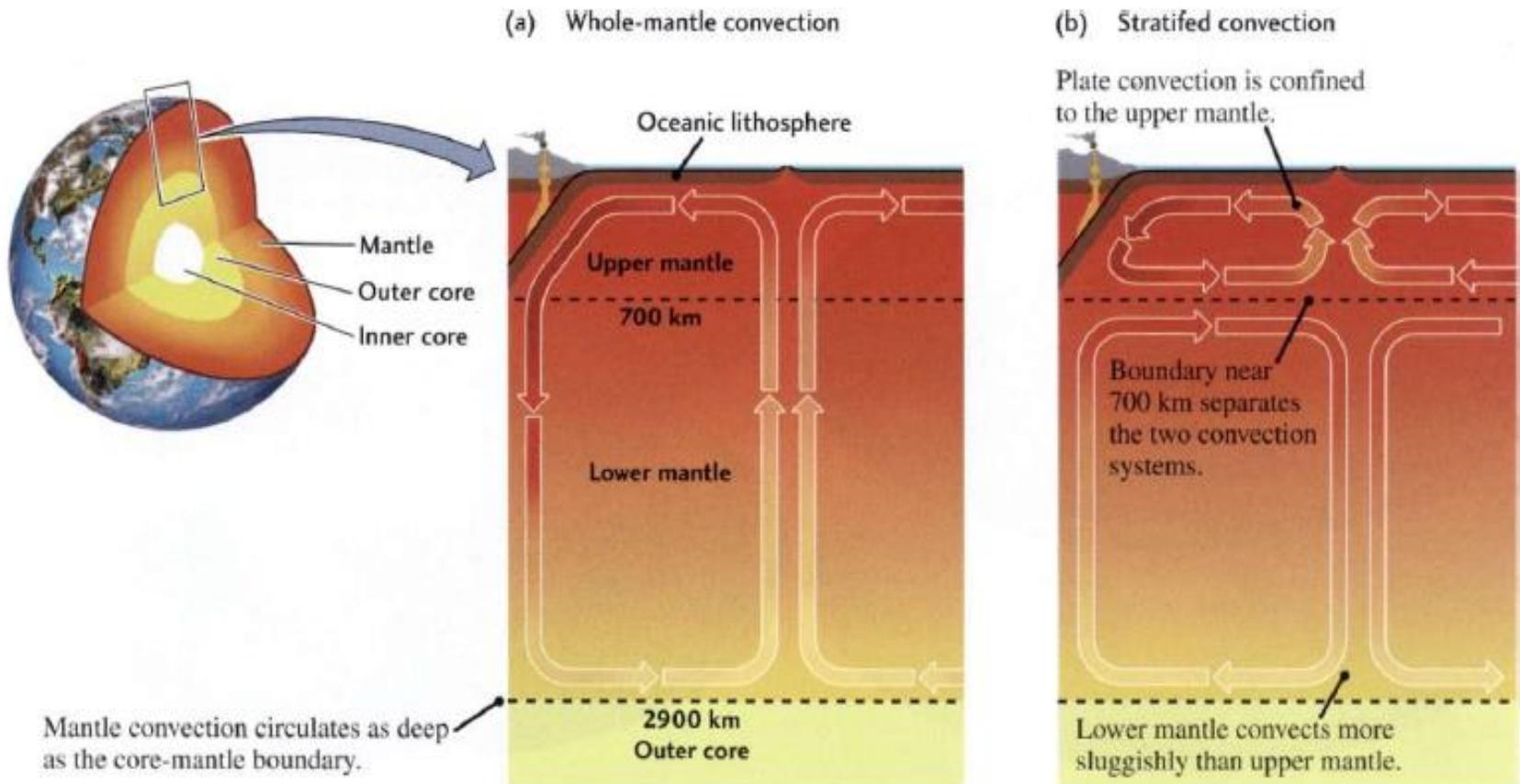


Figure 2.14 Two competing hypotheses for the mantle convection system.

Two competing hypotheses for the mantle convection system

Rates and History of plate movements

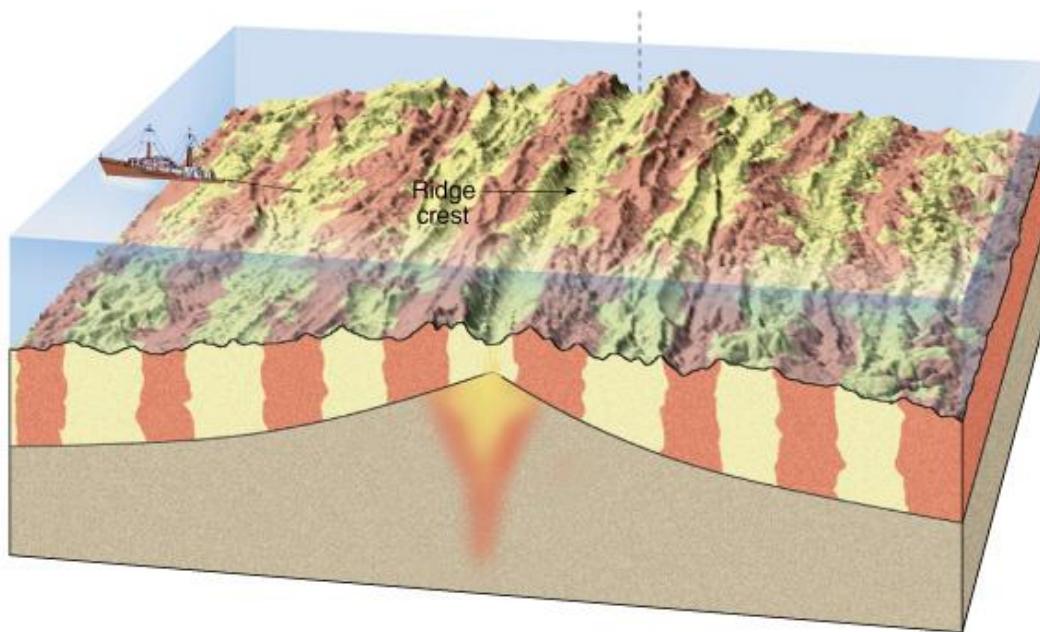
How fast do plates move?

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

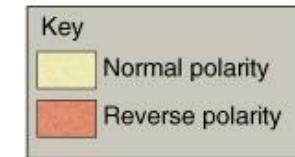
Is the velocity of plate movements today the same as it was in the Geologic past?

Rates and History of plate movements

Paleomagnetism

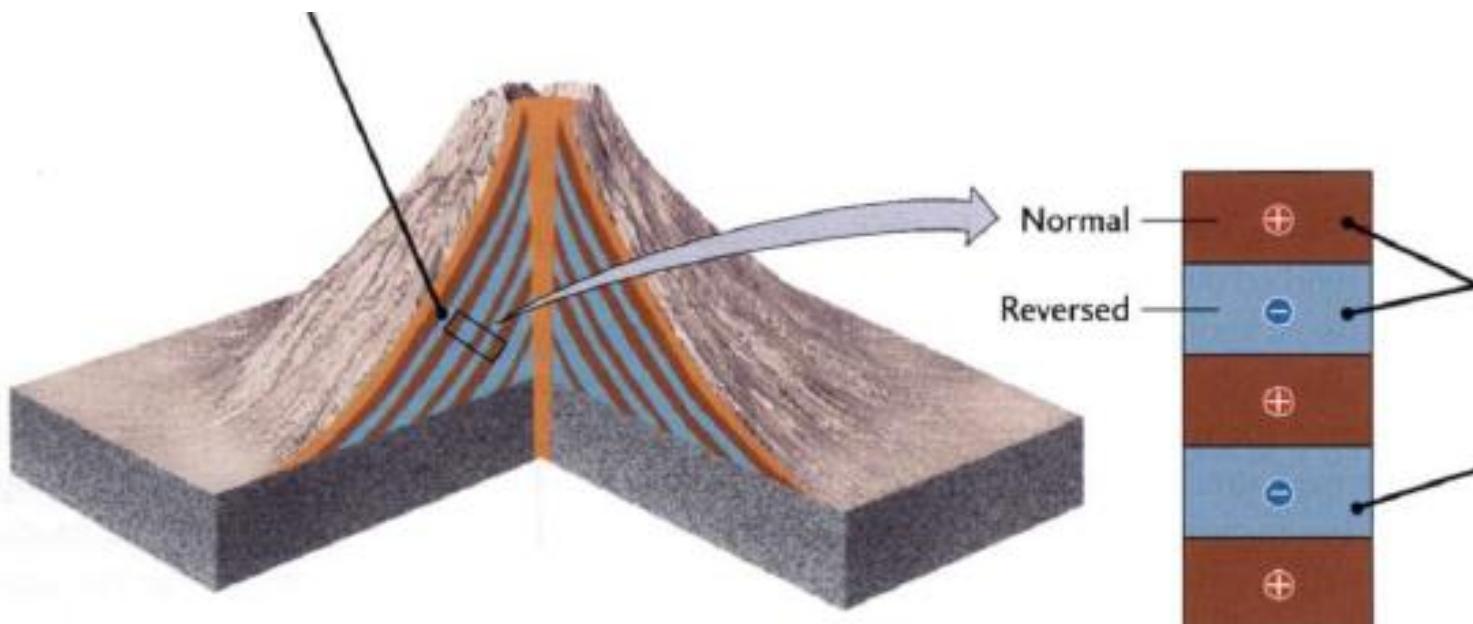


B. Research vessel towing magnetometer across ridge crest

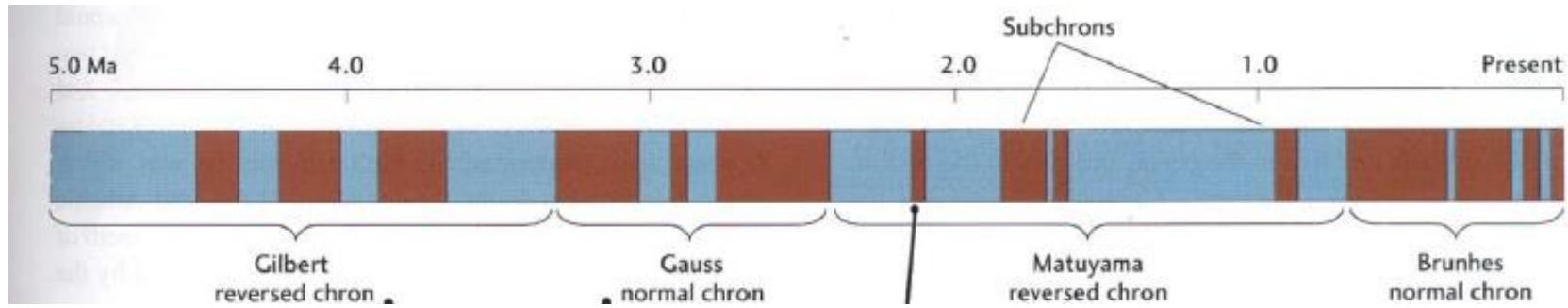


C. Location map

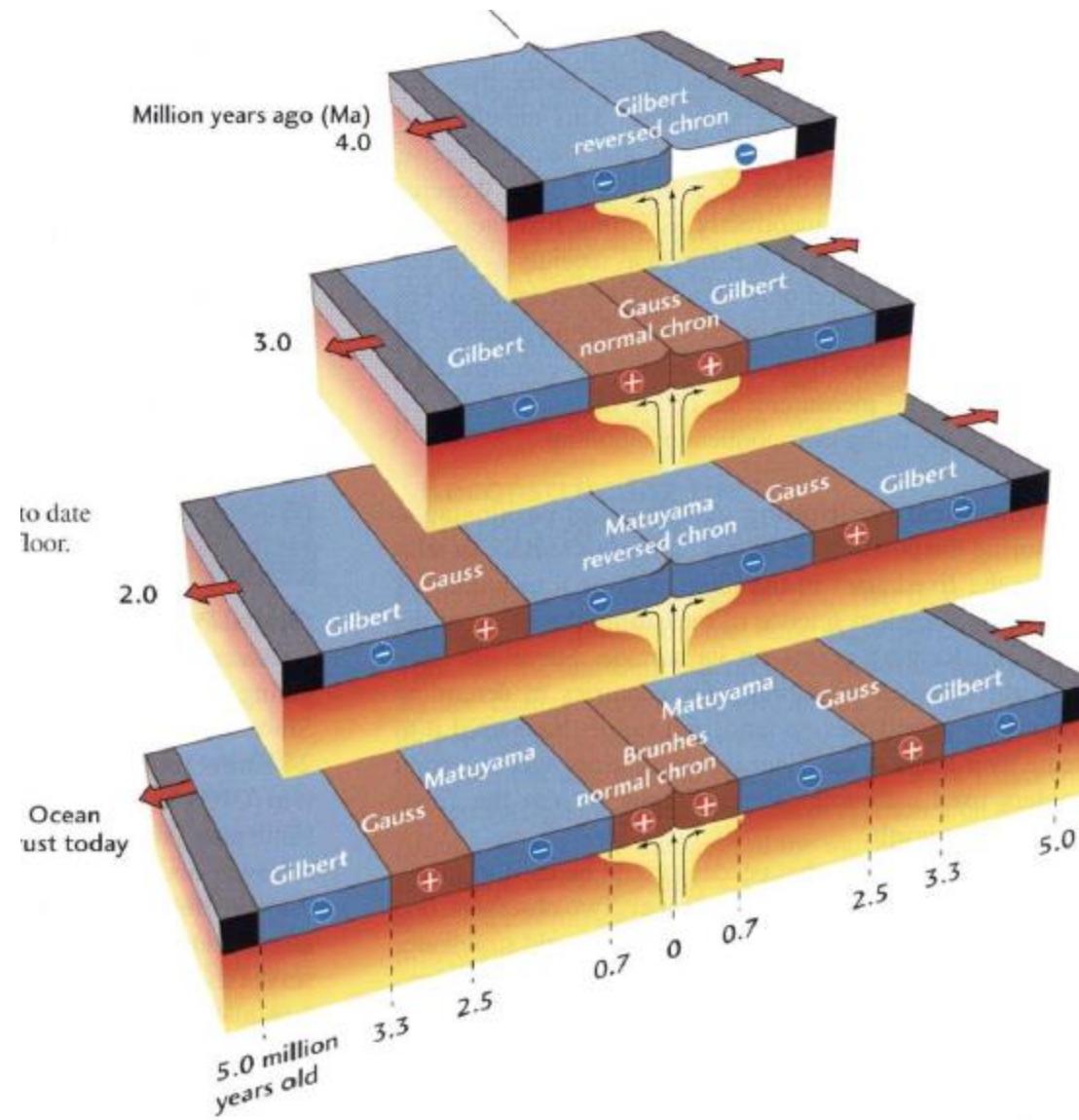
Paleomagnetism

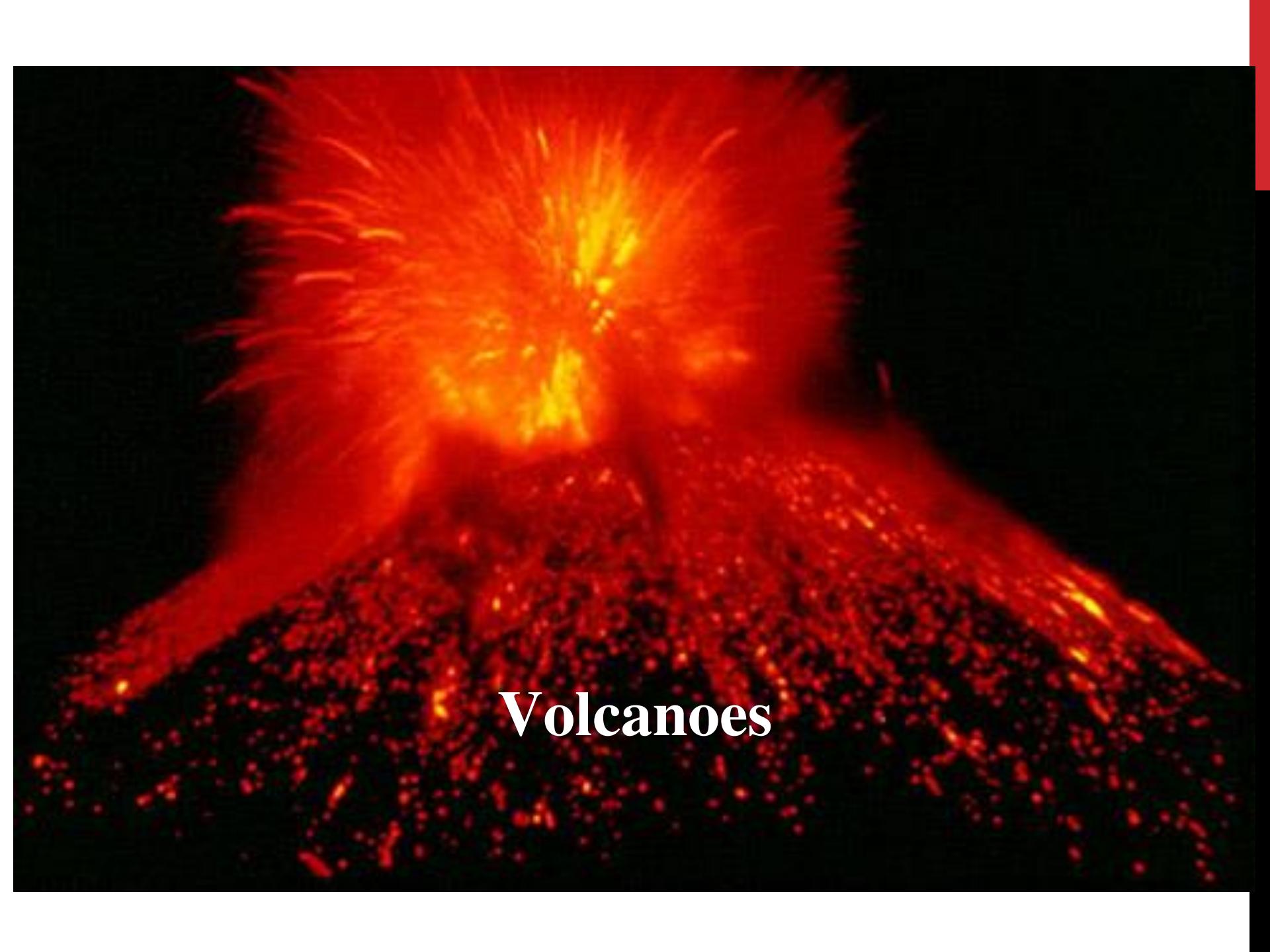


Paleomagnetism



Paleomagnetism



A photograph of a volcano erupting at night. The volcano's peak is a intense orange and yellow, with a large plume of smoke and ash rising into the dark sky. The base of the volcano is covered in lava and rock. The word "Volcanoes" is overlaid in white text.

Volcanoes

Eruption at Pompeii

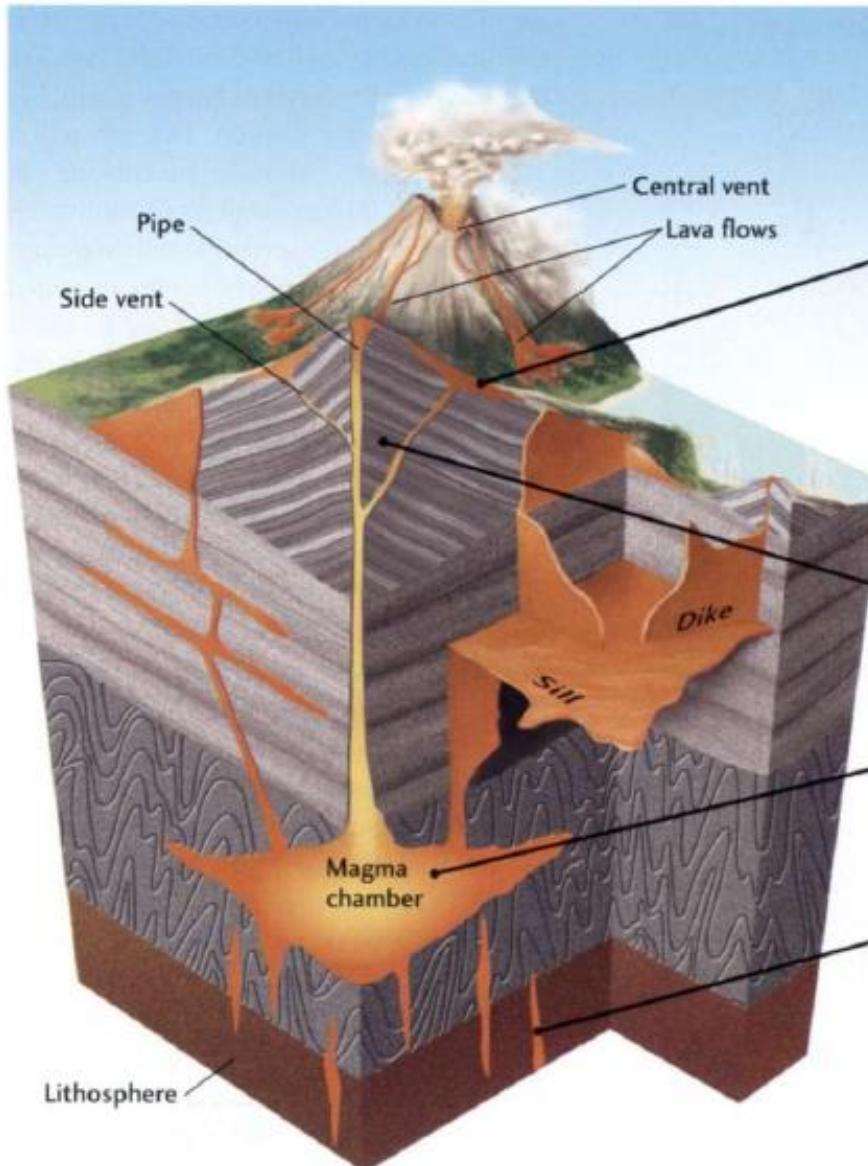


MAY 1990 ERUPTION OF KILAUEA, HAWAII



James Cachero/Sygma

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 SiO₂
- 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 within rhyolitic 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

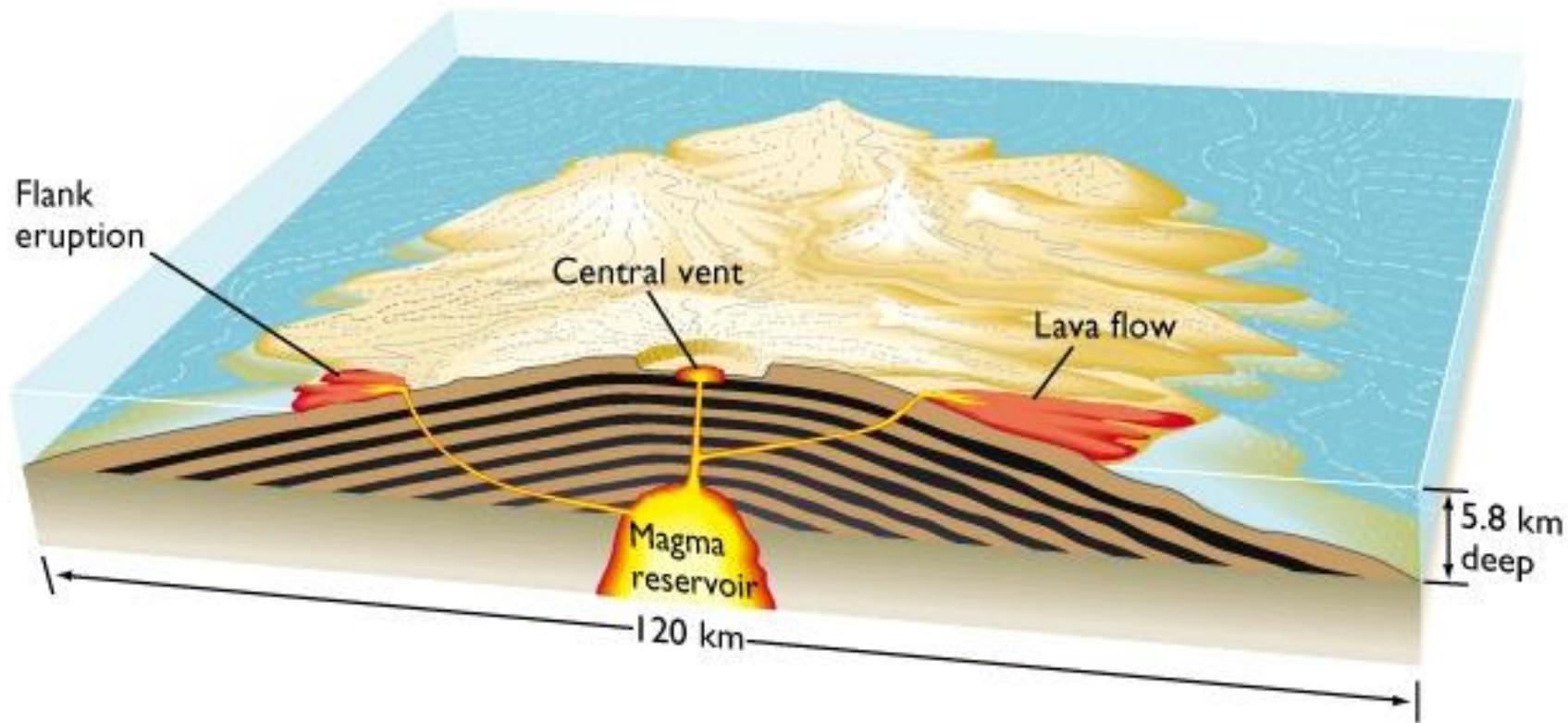
- **Composition of magma**
 - gas content
 - chemical composition
- **Type of material erupted (lava versus pyroclasts)**
- **Environmental condition in which it erupts
(submarine vs. continental)**

Central Eruptions

Shield Volcanoes

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

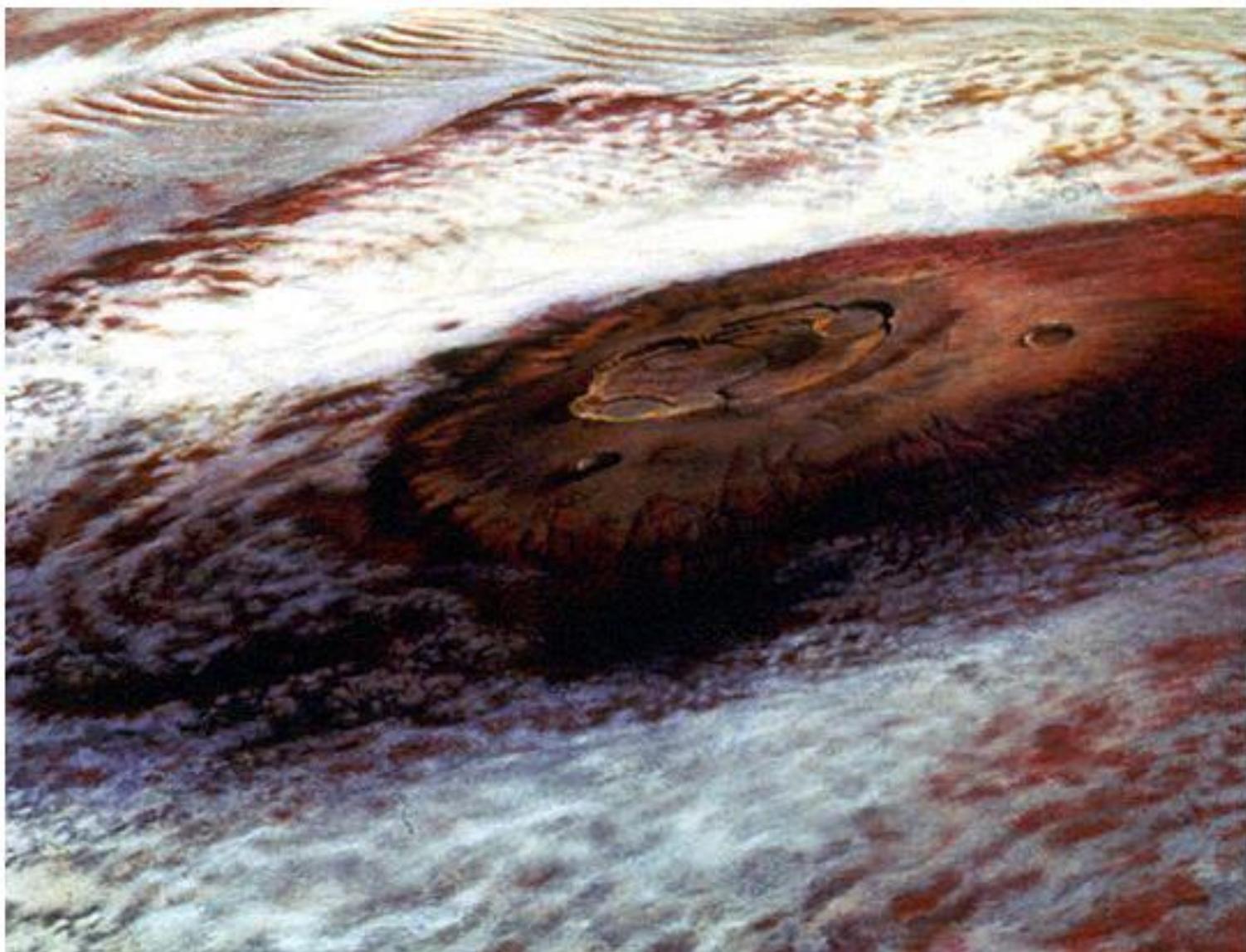
Shield Volcanoes



Shield Volcanoes



Olympus Mons Shield Volcano

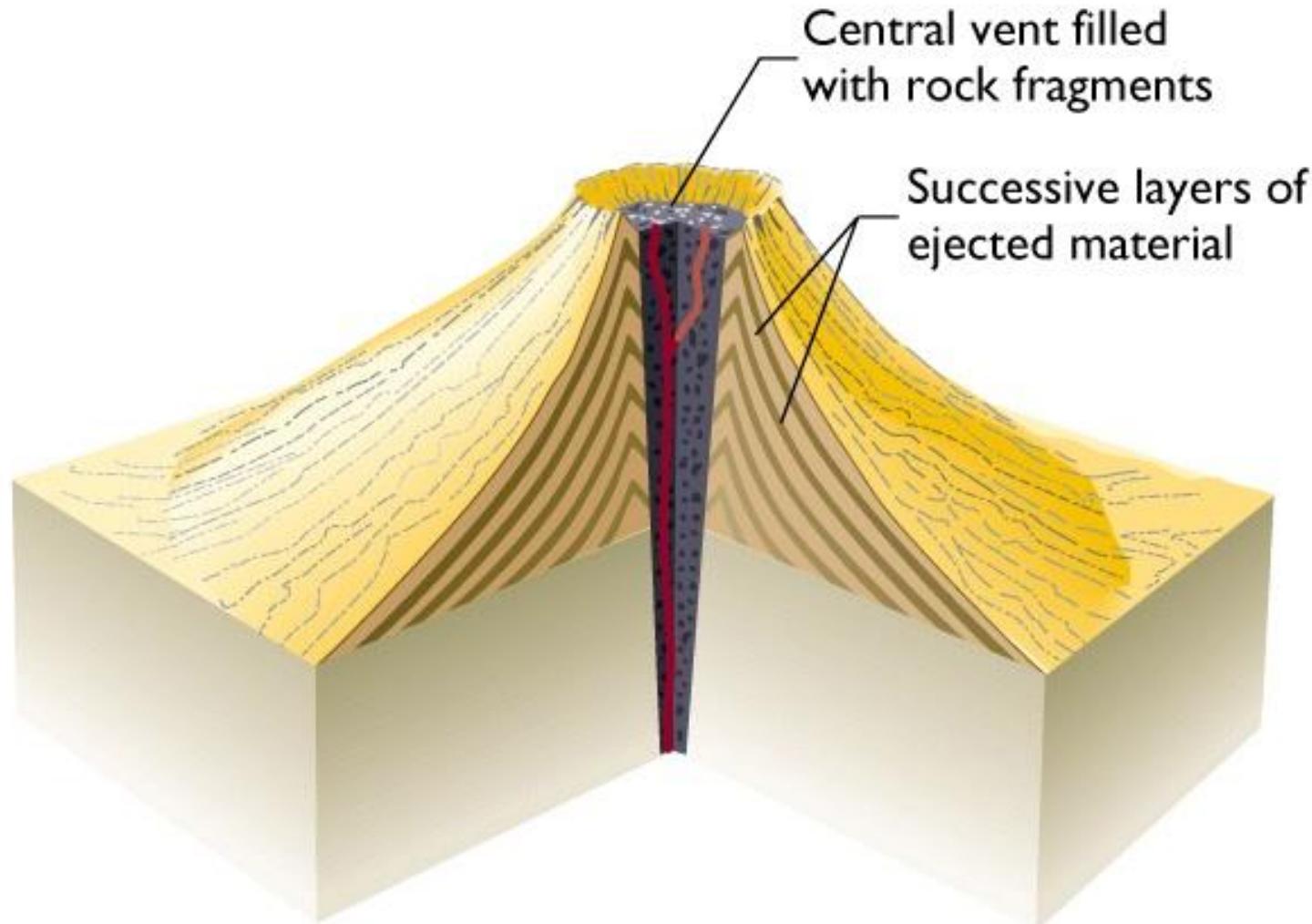


Central Eruptions

Cinder Cones

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

Cinder Cones



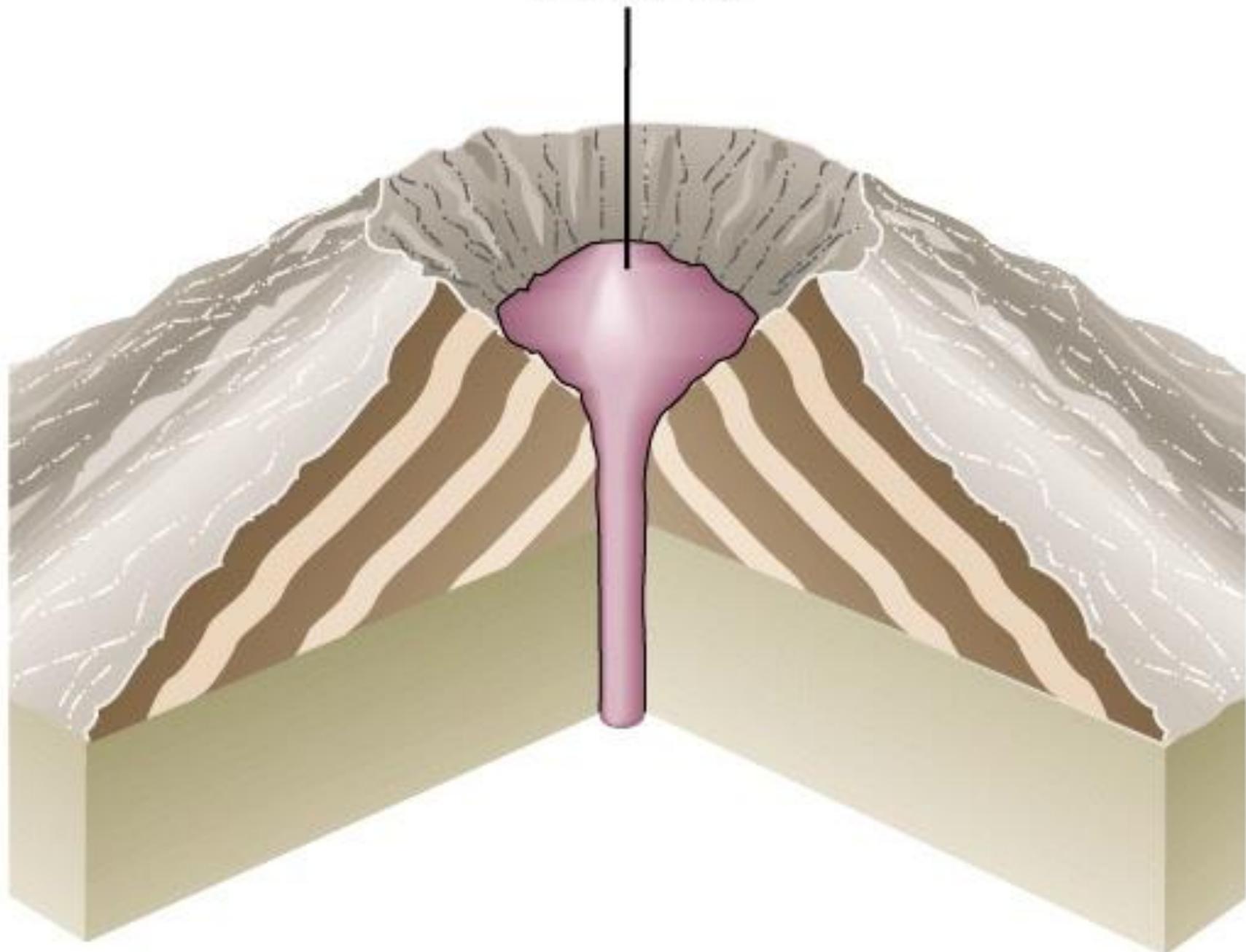


**Cerro Negro Cinder
Cone near Managua
Nicaragua in 1968**

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**

Lyn Topinka/USGS

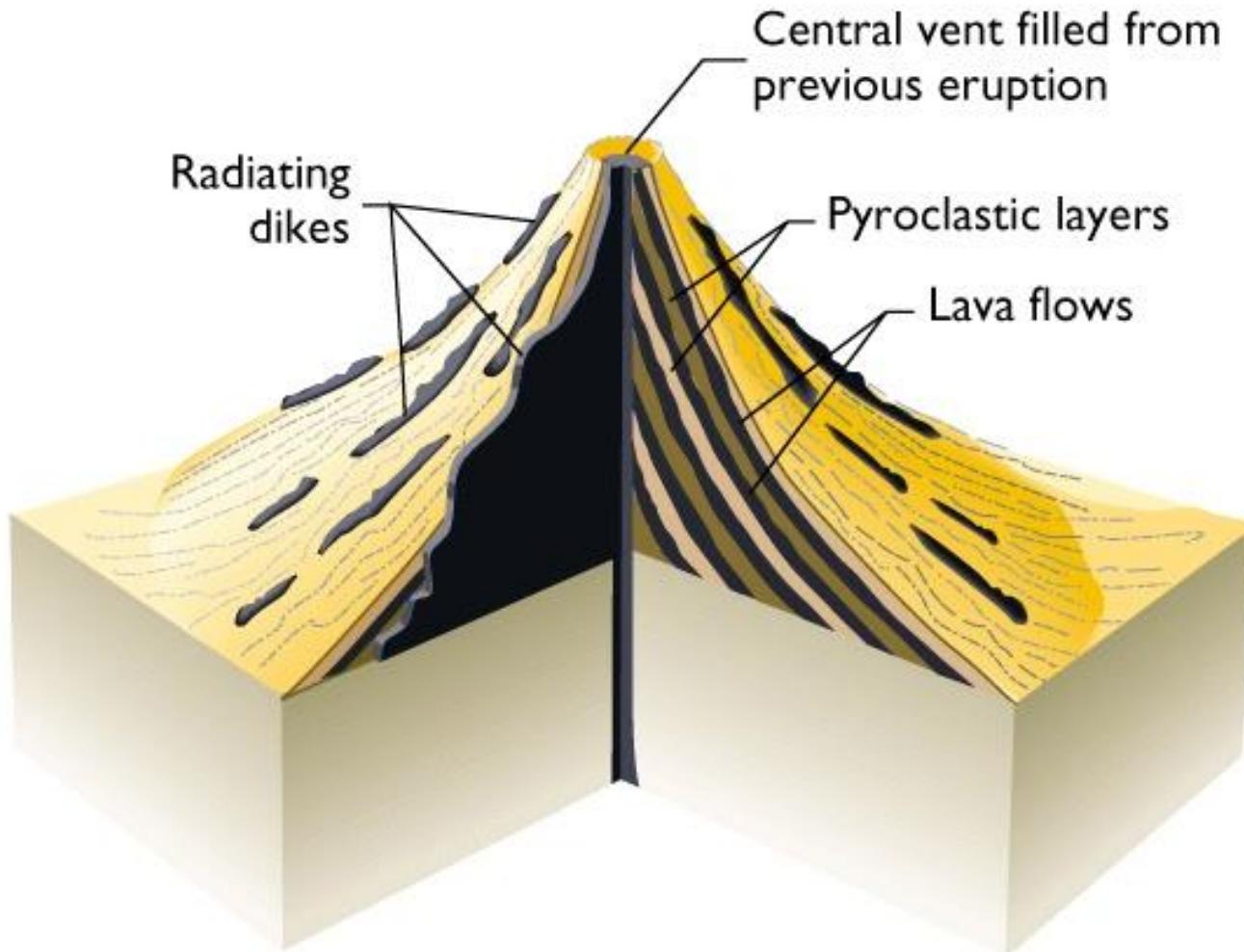
INYO OBSIDIAN DOMES-CALIFORNIA



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

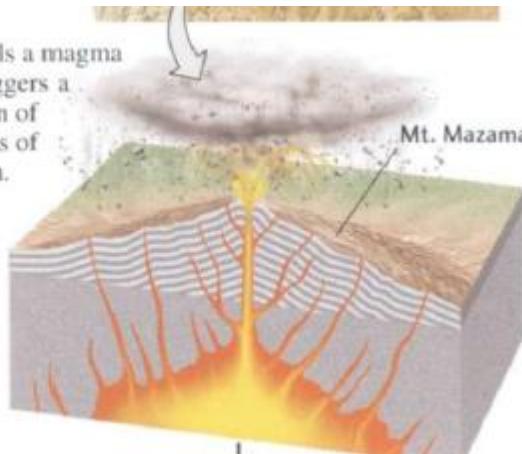
- Depression at top of volcano produced during an eruption
- Great volume of magma are discharged rapidly from a large magma chamber, the chamber can no longer support it

Calderas

Volcanic eruption

STAGE 1

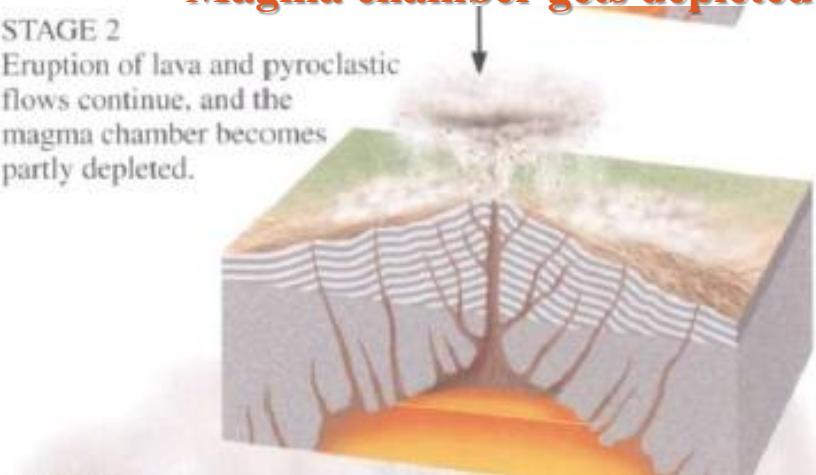
Fresh magma fills a magma chamber and triggers a volcanic eruption of lava and columns of incandescent ash.



Magma chamber gets depleted

STAGE 2

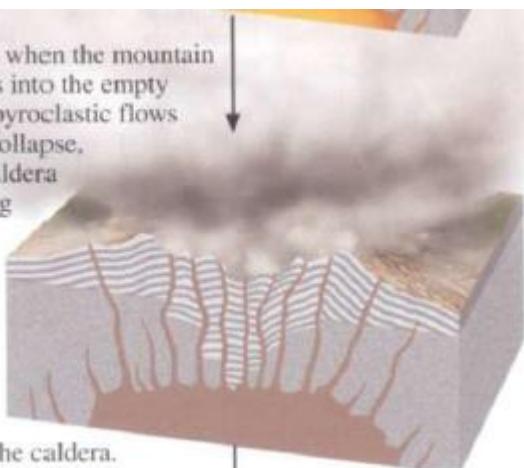
Eruption of lava and pyroclastic flows continue, and the magma chamber becomes partly depleted.



Collapse of mountain summit into empty chamber

STAGE 3

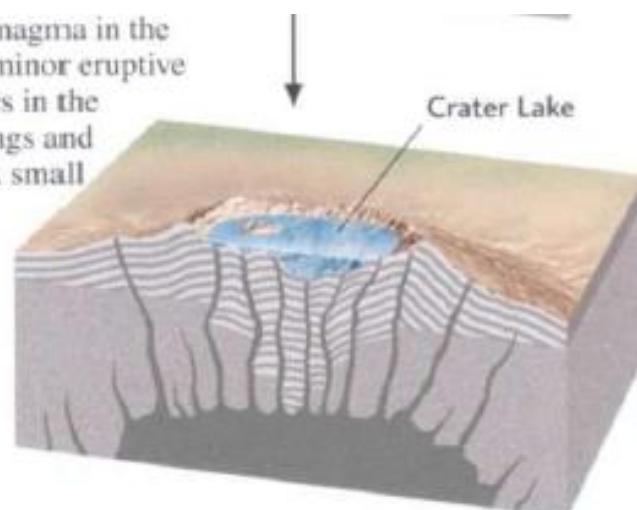
A caldera results when the mountain summit collapses into the empty chamber. Large pyroclastic flows accompany the collapse, blanketing the caldera and a surrounding area of hundreds of square kilometers.



STAGE 4

A lake forms in the caldera.

Final magma in the caldera, minor eruptive activity continues in the springs and vents. A small lake



Mt Fujiyama, Japan

Before May, 1980



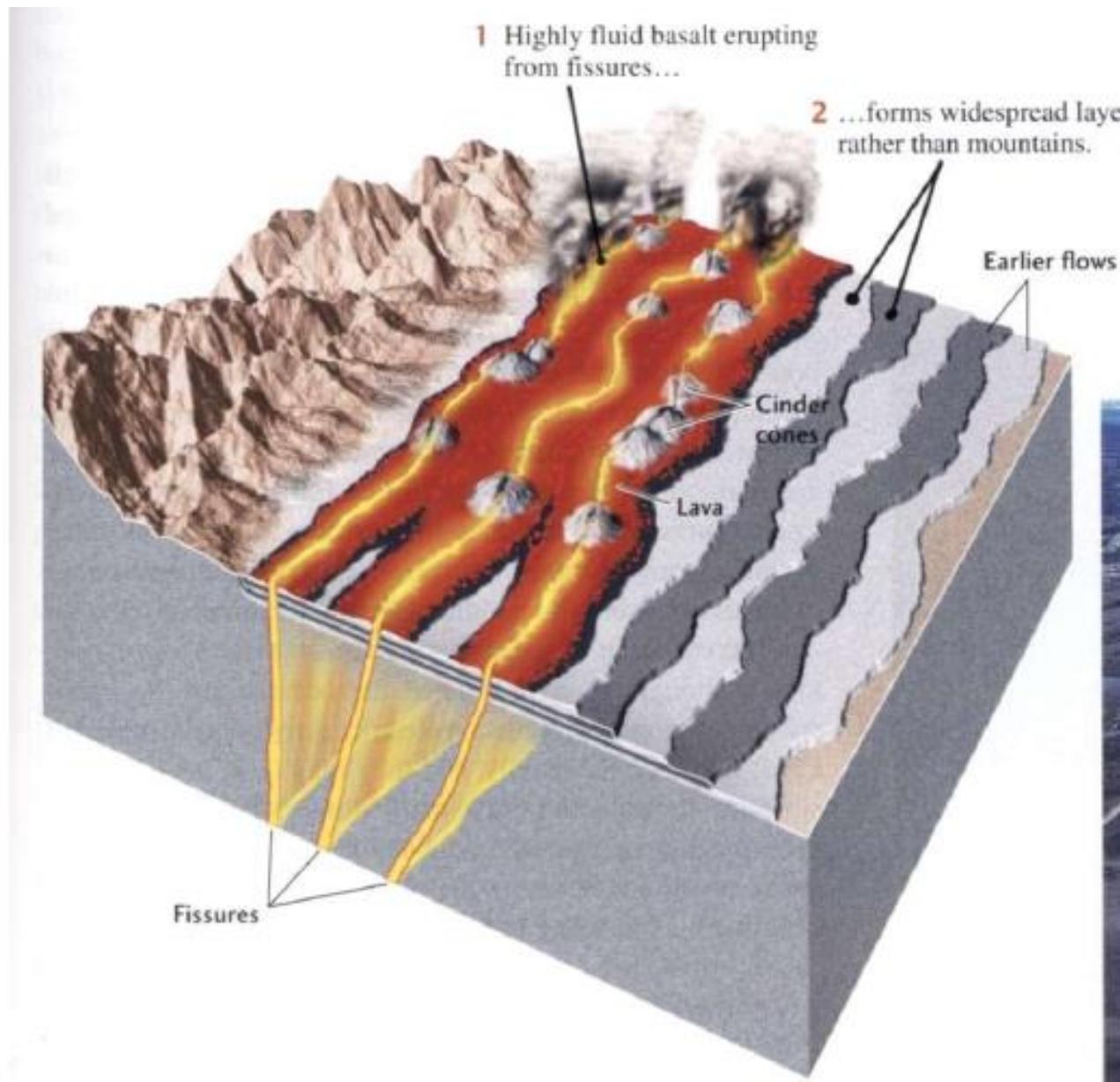
© Muench/Photo Researchers

After May, 1980



David Weintraub/Photo Researchers

Fissure type eruption



Fissure type eruption

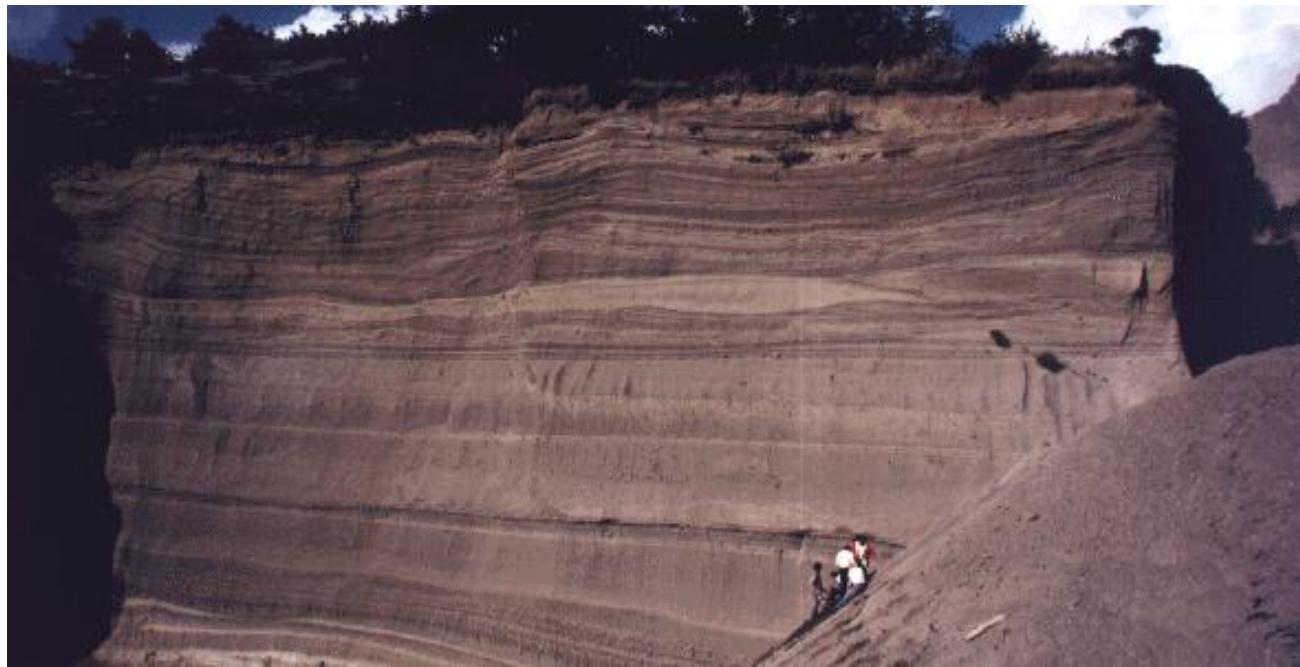
Flood basalts



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

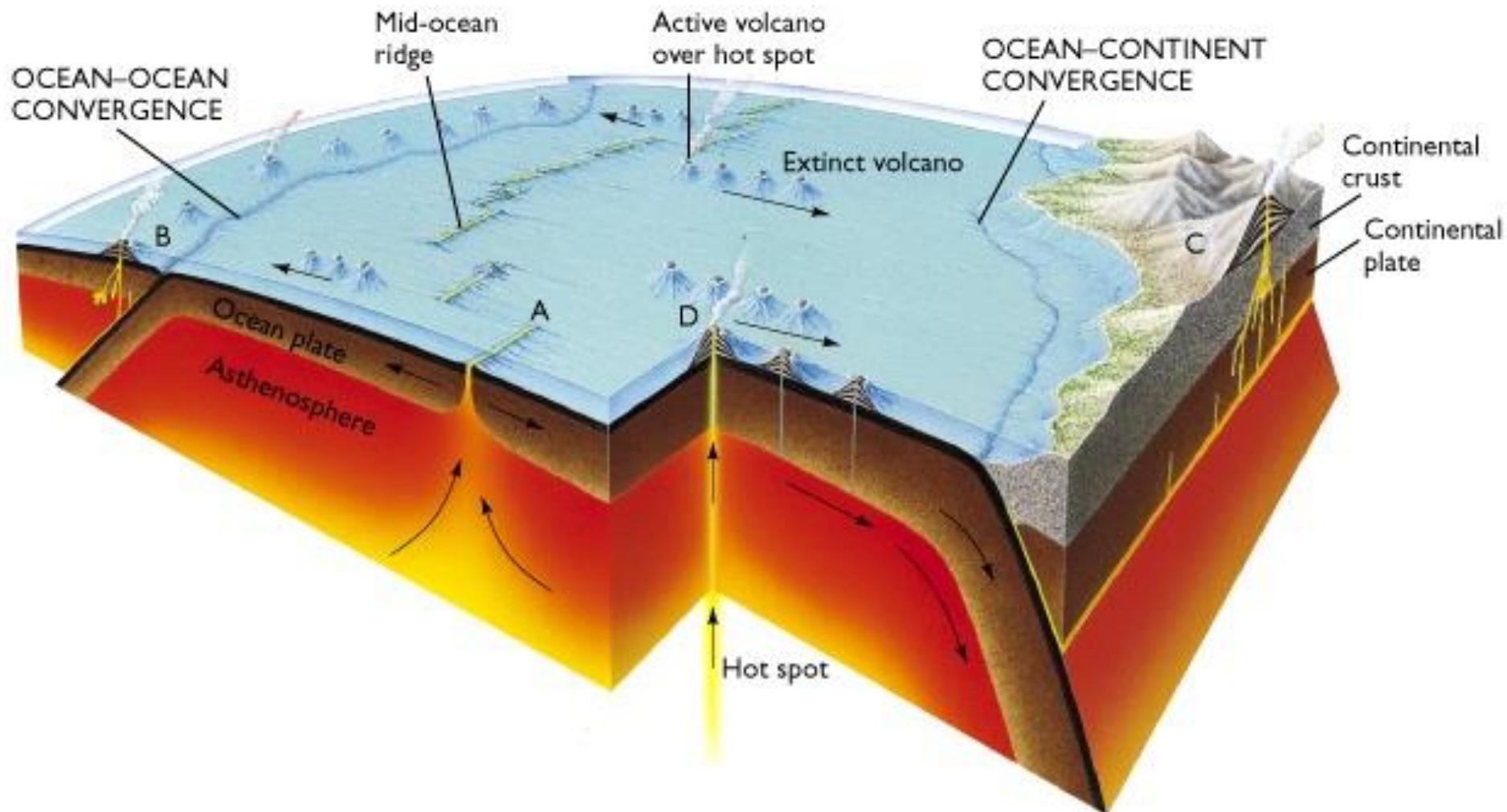


ek/Photo Researchers

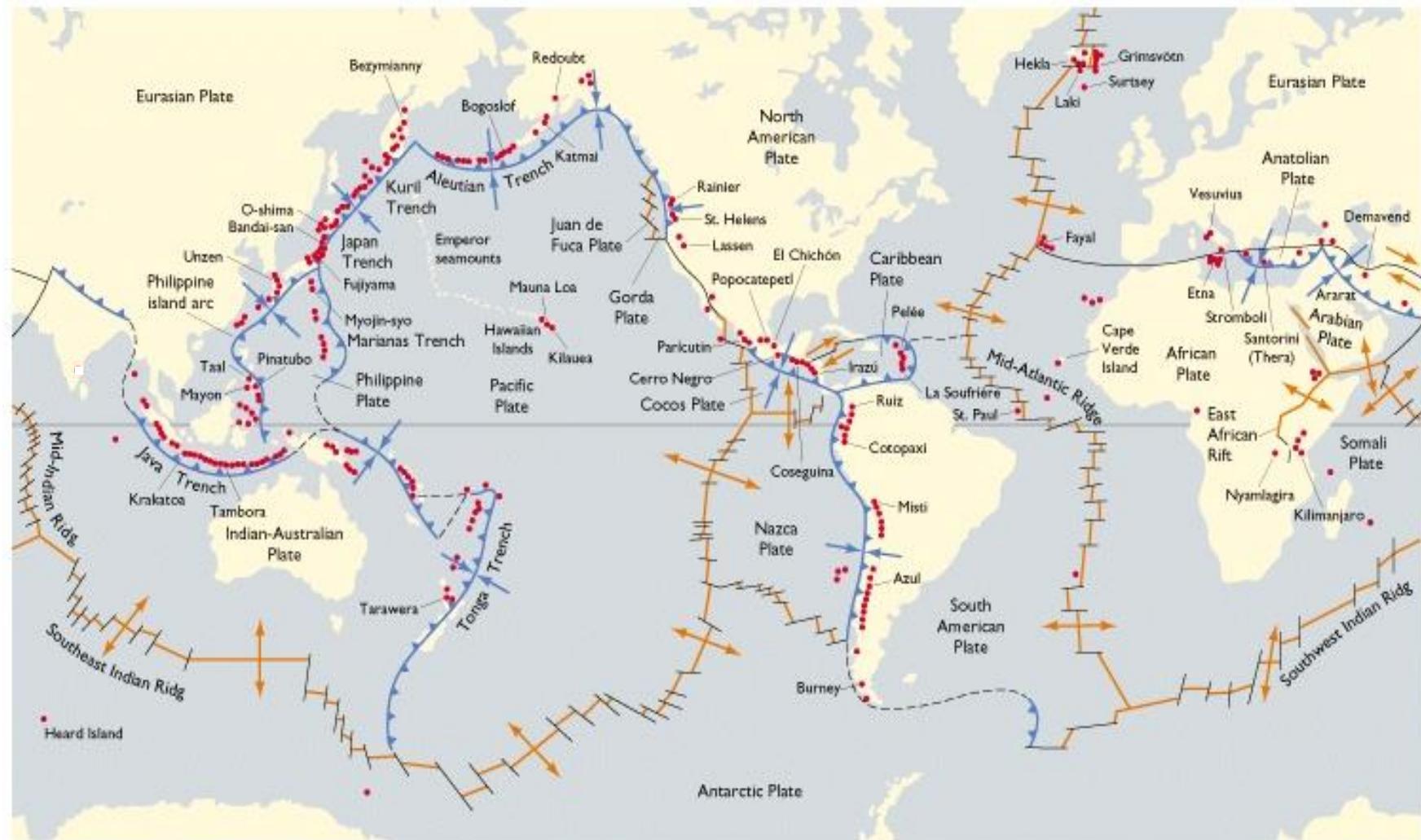
The tectonic setting of Volcanoes

- Convergent plate boundaries
- Divergent plate boundaries
- Within plate “hotspots”

The Volcanism associated with plate tectonics

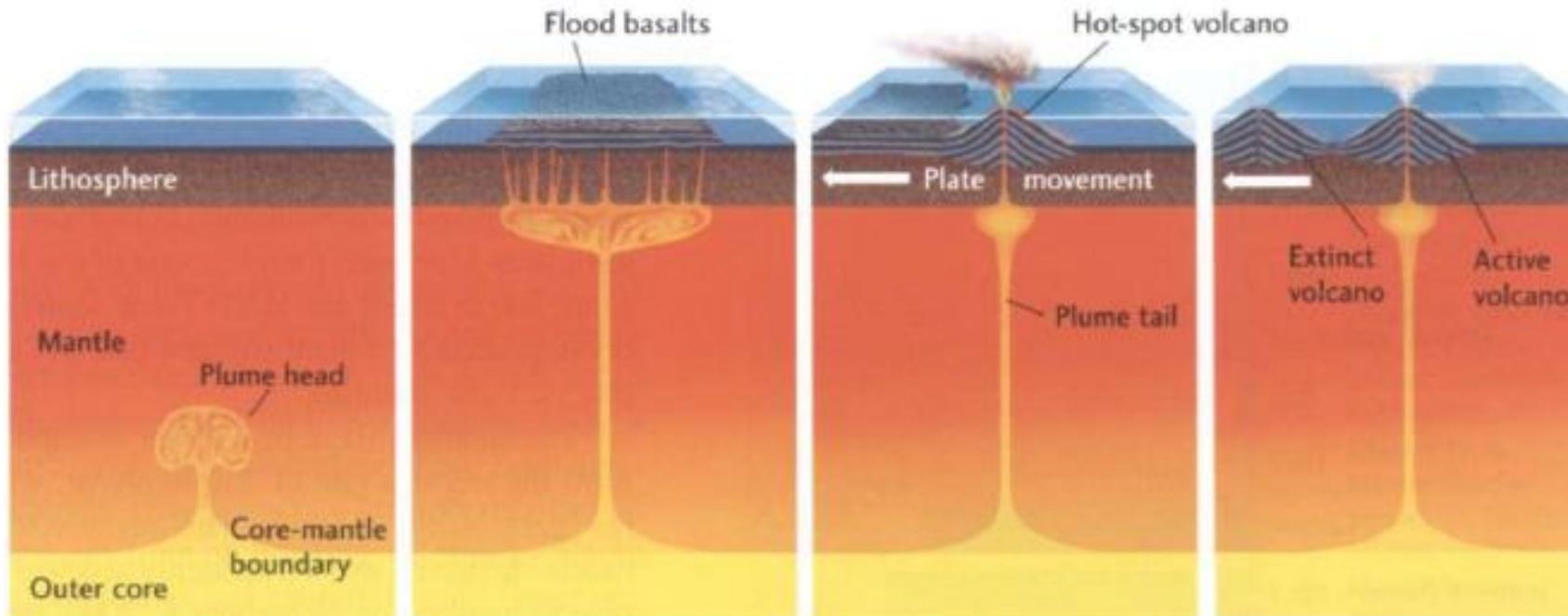


The world's active Volcanoes



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

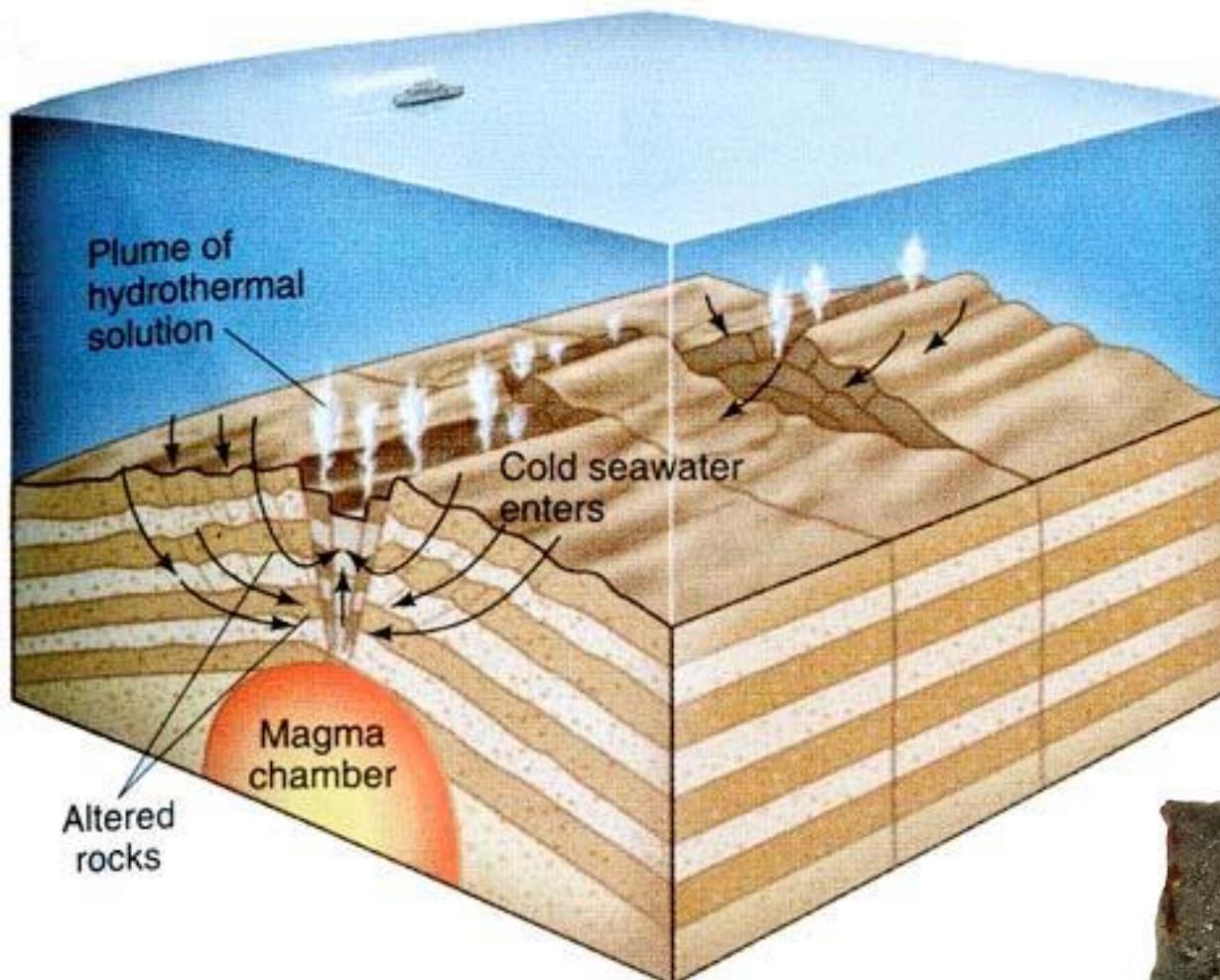
- Effect of volcanoes on Human

Effect of Volcanoes on Human

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

Effect on climate

Hydrothermal deposits



Hydrothermal deposits



White smokers



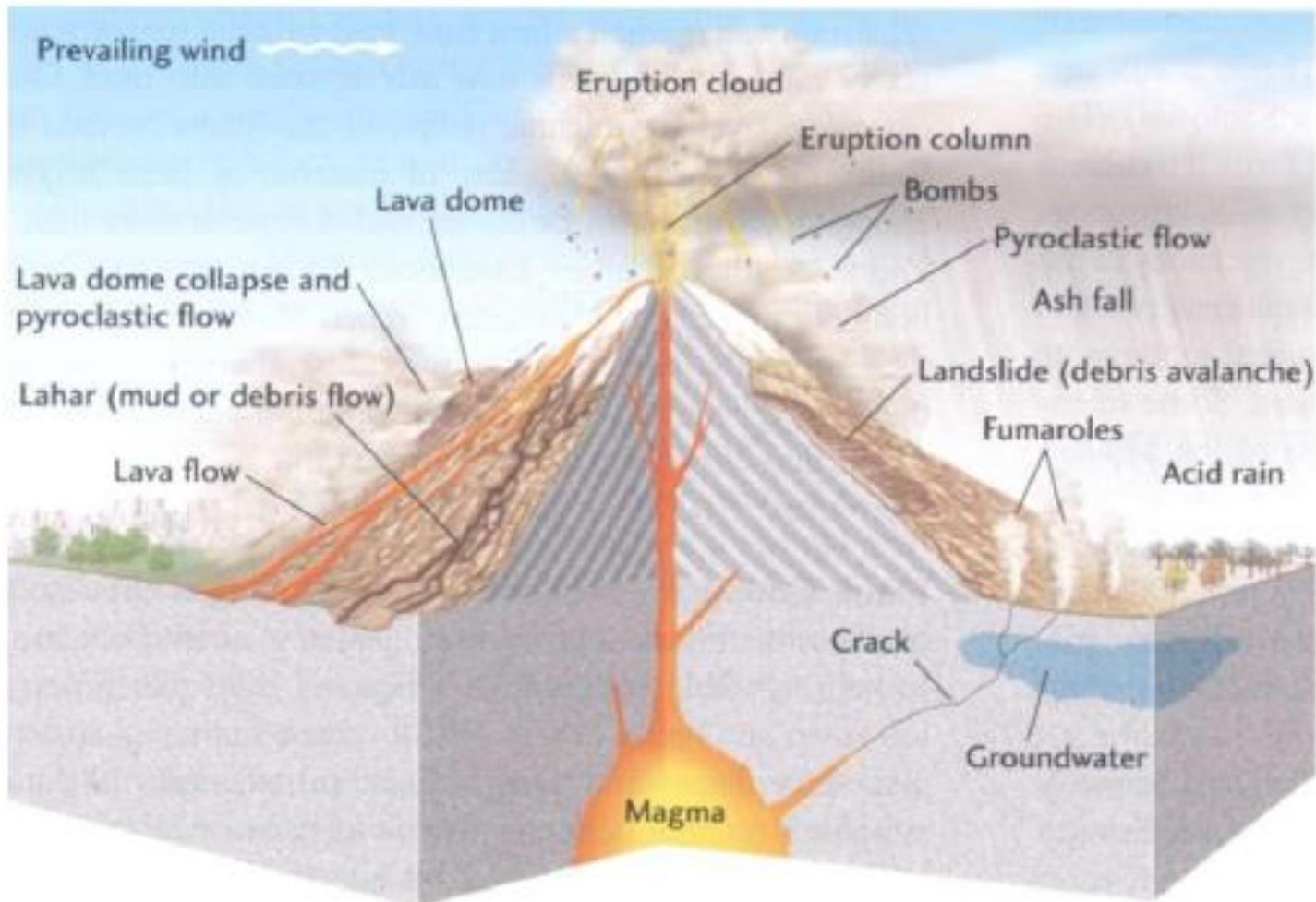
Black smokers

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

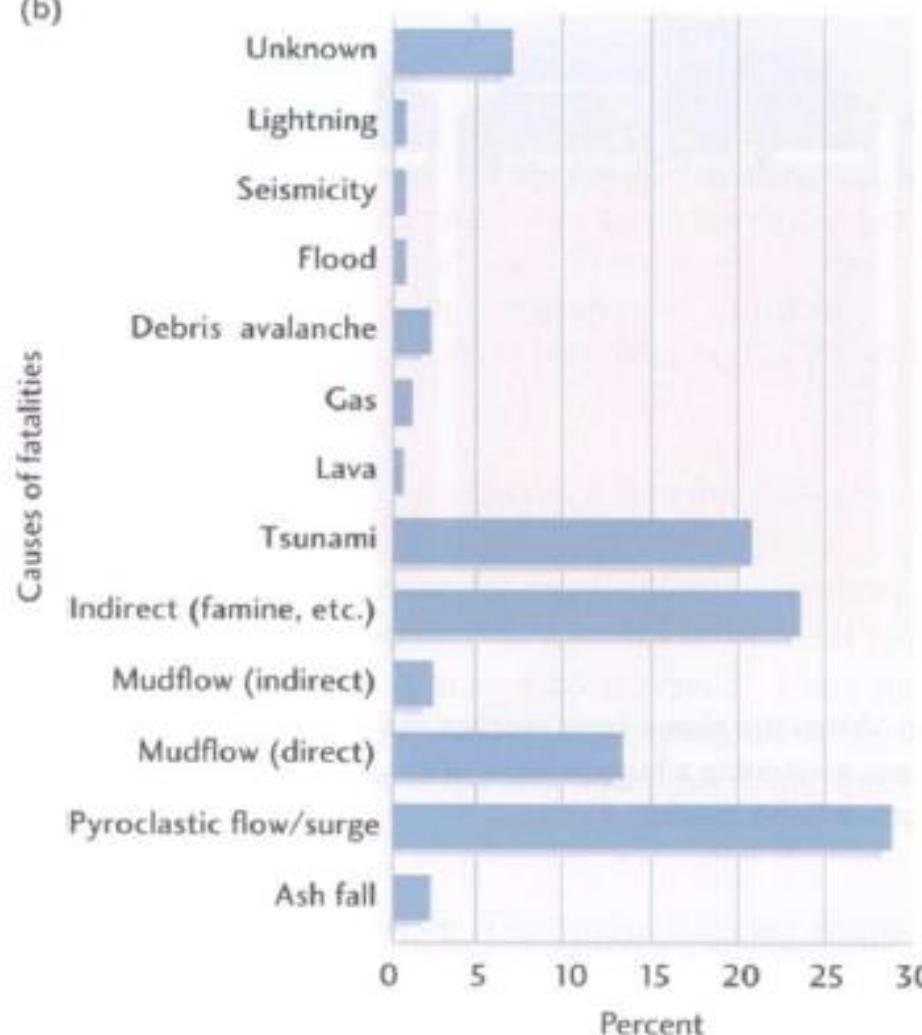
Ash Fall



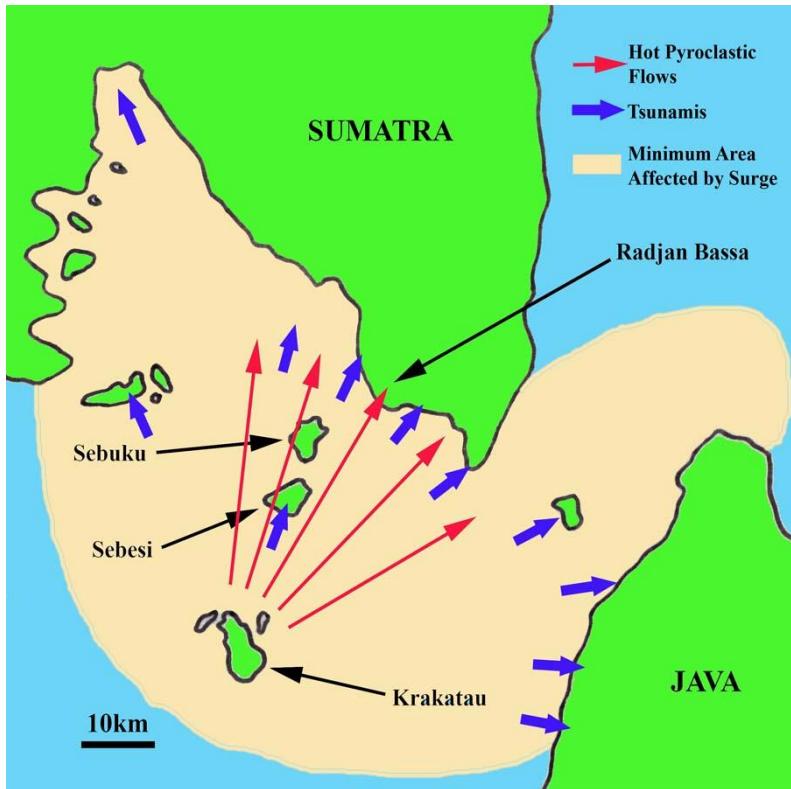
20th Century's 2nd Largest Volcanic Eruption - Mt Pinatubo-Eruption

Causalities associated with Volcanic Hazards since AD 1500

(b)



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