
U3A
Volcanoes

# Volcanoes

- A volcano is a hill or a mountain formed by the extrusion of lava or ejection of volcanic ash and rock fragments from the vent

- volcanoes are commonly conical in shape

- a volcanic crater is a basin-like depression over the vent, usually at the summit of a cone

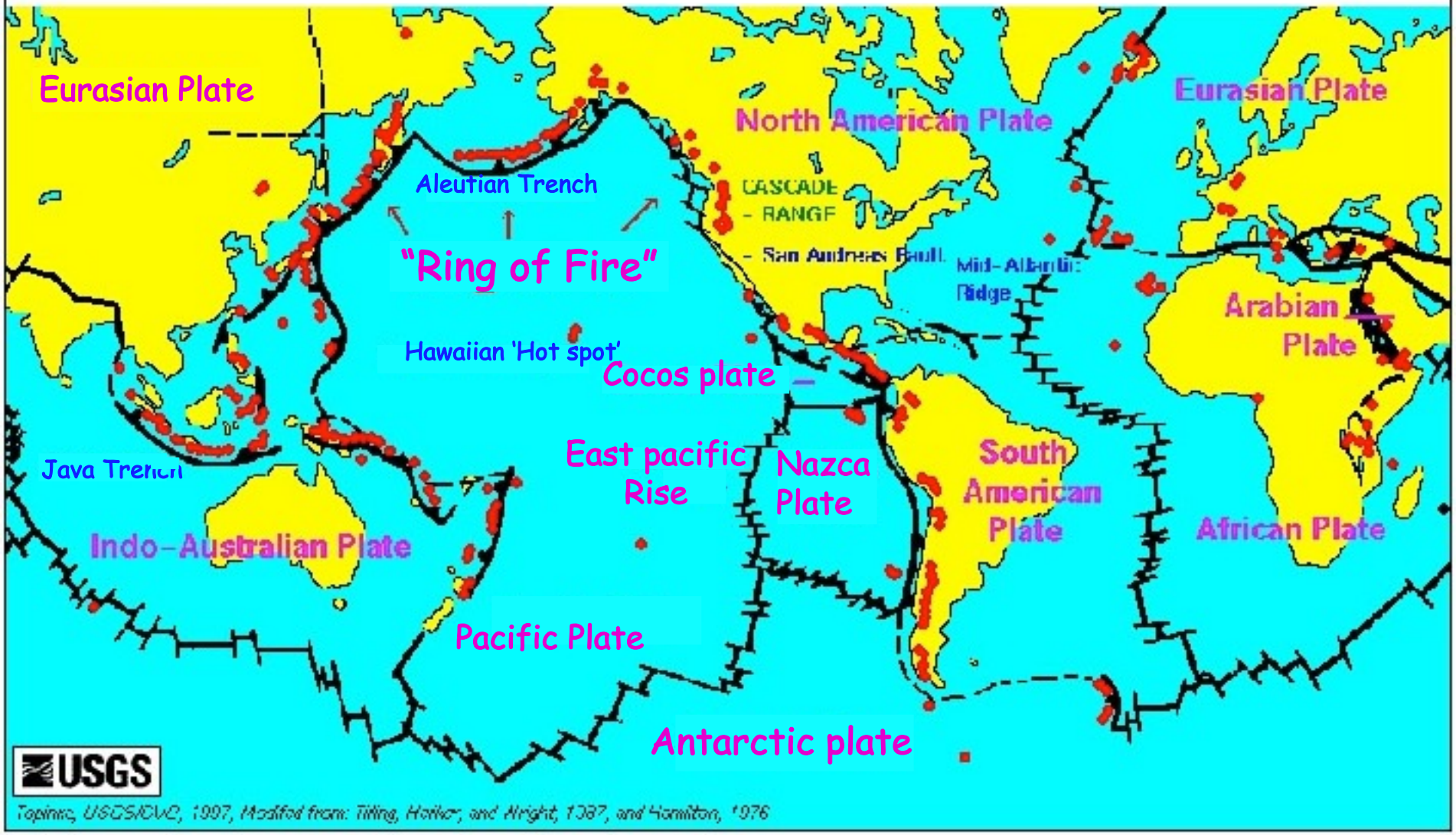
- a caldera is a much larger volcanic depression formed by collapse of the surface after withdrawal of magma or an explosive eruption


Parinacota -Chile

# Distribution of volcanoes

- There are about 750 volcanoes in the world
- two-thirds are around the Pacific "Ring –of-fire"
- global distribution of volcanoes roughly follows global distribution of earthquakes
- others are:
  - in the Mediterranean
  - on ocean islands
  - in continental rifts

# Global distribution of active volcanoes



# Distribution of volcanoes

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- others are:
  - in the Mediterranean
  - on ocean islands
  - in continental rifts
- there are no active volcanoes on the Australian mainland (but some are very young) however, the highest mountain in Australian territory is an active volcano on Heard Island in the Southern Ocean (Big Ben 2800m)

Big Ben – Heard Island

# Global distribution of active volcanoes

- There are between 300 – 700 active volcanoes in the world
- not all are erupting at the same time, only very few
- volcanoes may have long periods of dormancy
- some volcanoes thought to be extinct may erupt after a a long period of dormancy
- most volcanic activity is on the seafloor

# Volcanic magma types

- Low silica magmas (basaltic)
  - fluid lavas with low viscosity
  - lavas flow easily and may cover large areas
  - dissolved gases escape easily
  - relatively quiet eruptions

- High silica magmas (rhyolitic)
  - thick lavas with high viscosity
  - lavas form thick flows, domes, or ash flows
  - escape of dissolved gases is retarded
  - eruptions are commonly violent

Lava river, Mauna Loa- Hawaii

# Volcanic eruptions

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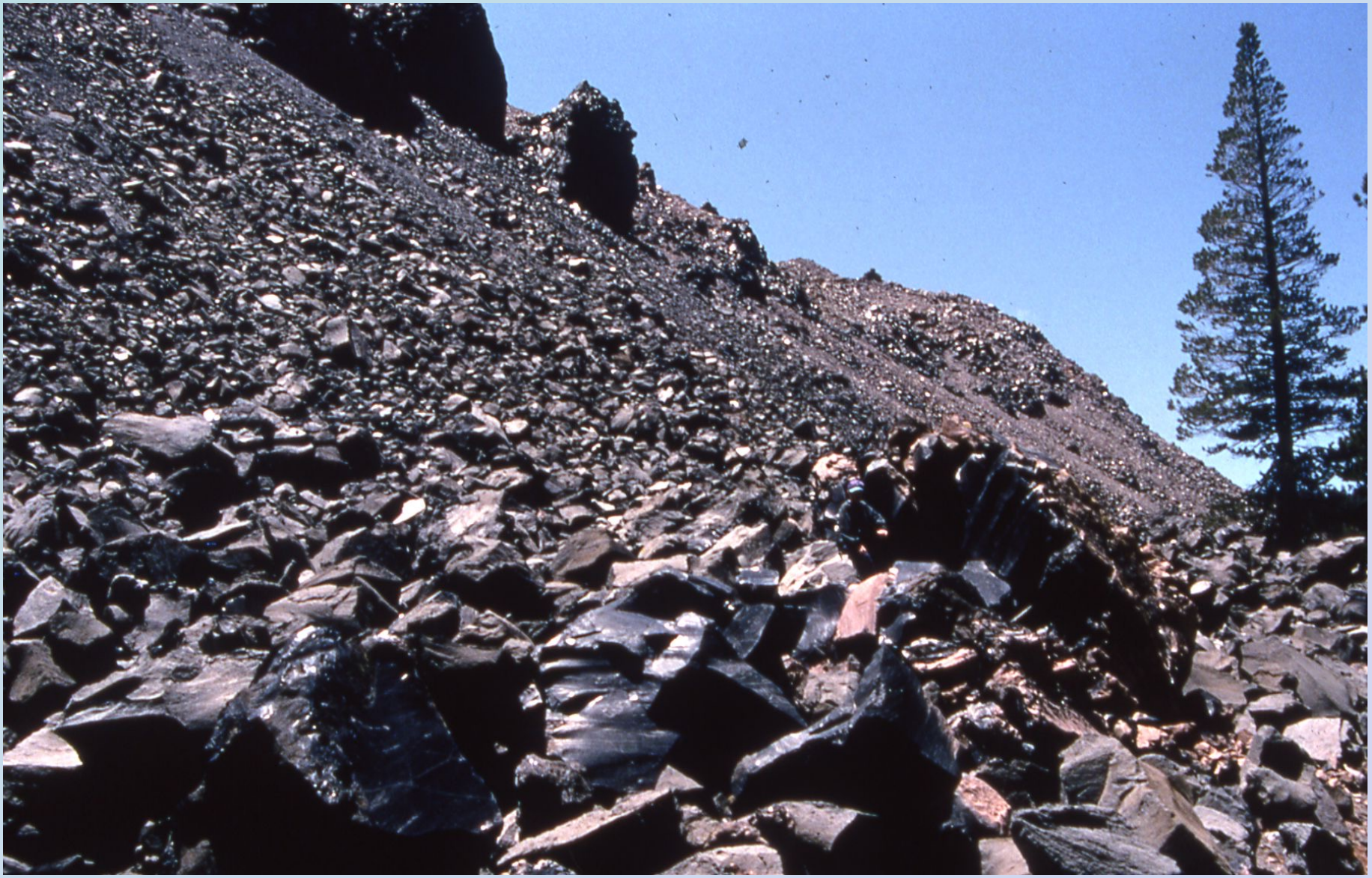
- High silica magmas (rhyolitic)
  - thick lavas with high viscosity
  - lavas form thick flows, domes, or ash flows
  - escape of dissolved gases is retarded
  - gas-rich eruptions are typically violent

Lava river - Hawaii



Obsidian flow – Glass Mountain, Califirnia

# Quiet or explosive eruptions

- Violence of eruptions is controlled mainly by two major factors:
  - amount of dissolved gas
  - ease with which the gas can escape (viscosity of magma)

- Viscosity of lava (determining how easily gas can escape) is controlled by:
  - temperature → higher temperature → lower viscosity
  - silica content → higher the silica content → higher viscosity
  - gas content → higher dissolved gas content → lower viscosity

- Explosive eruptions
  - result from high silica magmas with high gas content

# Water and silica content control type of eruption

- Low silica magmas → low viscosity

  high silica magmas → high viscosity

- dissolved gas content reduces viscosity of magma (providing it remains dissolved)

- the more water dissolved in magma → the more gas → lower viscosity

- if gas is suddenly released from a high silica magma as it approaches the surface → viscosity of magma increases dramatically (melt to near solid)

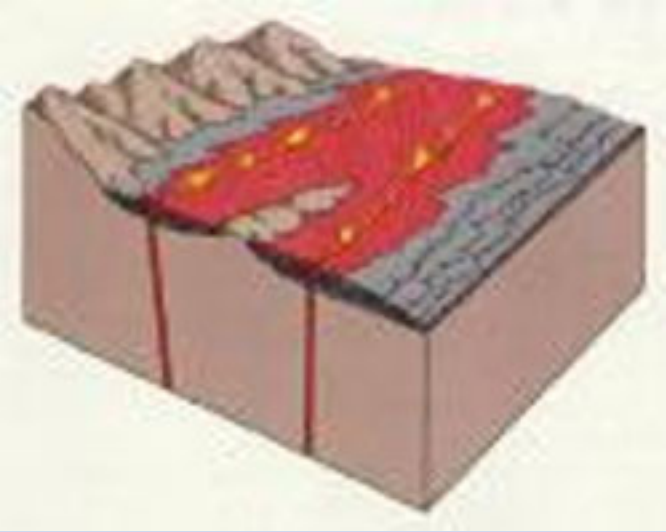
- shock freezing of magma retards gas release → violent eruption

# Summary of effects of silica and dissolved water on volcanic activity

| Silica content | Dissolved gas content: Low | Dissolved gas content: High |
| --- | --- | --- |
| Low | Fissure eruptions<br>Shield volcanoes | Cinder cones<br>Maars |
| High | Lava domes | Composite volcanoes<br>Large calderas |

# Flood lavas

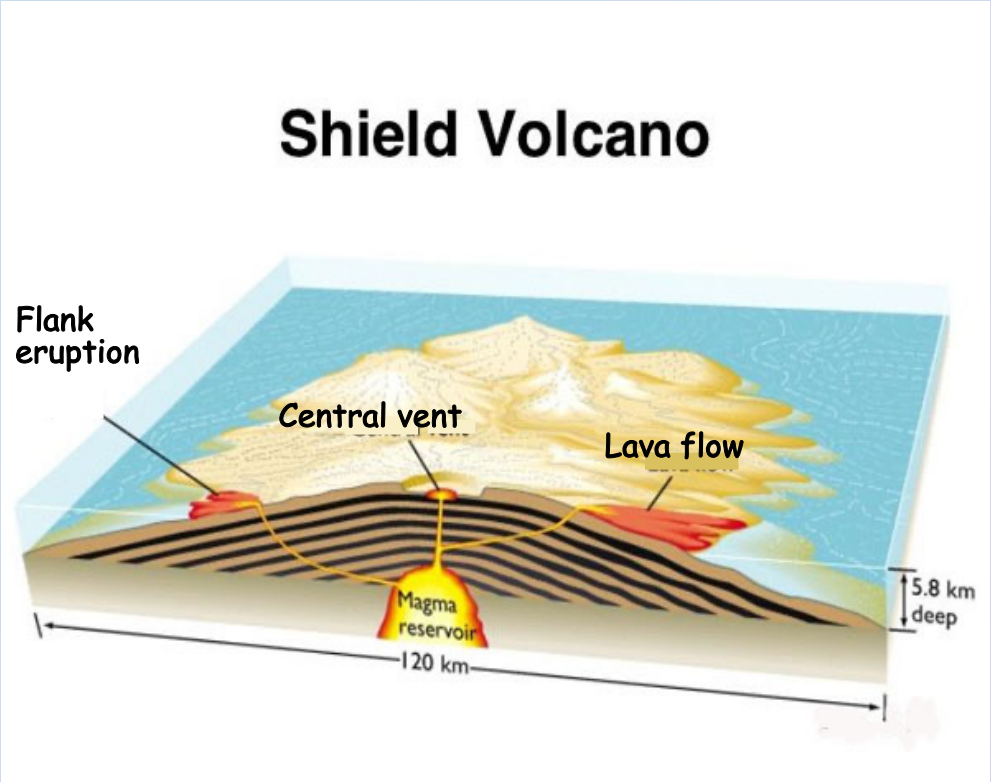
- Produced by fissure eruptions
- extensive floods of highly fluid basalt lavas
- build up sheets of thin flows over a wide area
- flood the landscape, can fill valleys, produce broad flat plains
- no central volcanoes are produced
- e.g. Iceland, Hawaii



Fissure eruption – Kilauea 1983

# Shield volcanoes

- Very broad, gently sloping cones (2 – 10°)
- almost entirely solidified lava
- formed from very fluid basalt flows
- quiet eruptions, not explosive (low water content)
- e.g. Hawaii



Shield volcano – Mauna Loa, Hawaii

# Cinder cones (scoria cones)

- Small steep-sided cones (30°) of basalt scoria
- made up of loose vesicular rock fragments (& some lava)
- generally less than 500m high
- short-lived, mildly explosive eruptions
- e.g. Mt Elephant in western Victoria

Lava fountain - Hawaii

Cinders M Etna

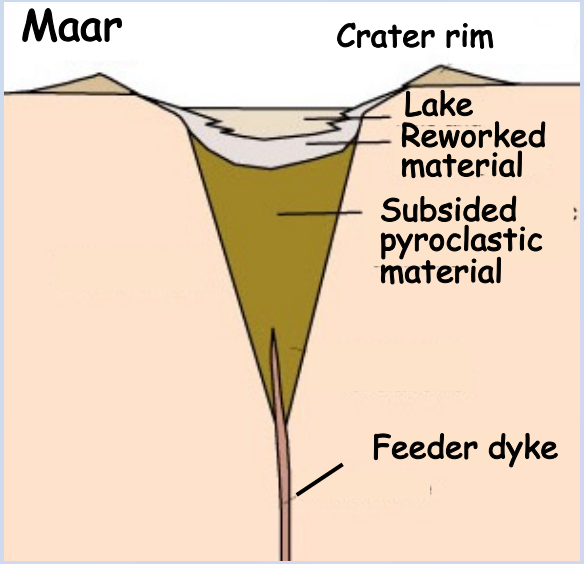
Cinder cone Monti Silvestro, Mt Etna, Sicily

Paracutin - Mexico

Cinder cone – Mt Elephant, Derinallum, Victoria

# Maars

- Low rings of volcanic ash around broad crater
- made of cinders, ash and rock fragments
- produced by explosive eruptions where normally dry basalt magma has come into contact with groundwater/sea water (phreatomagmatic eruptions)
- e.g. Diamond Head, Hawaii; Tower Hill in western Victoria

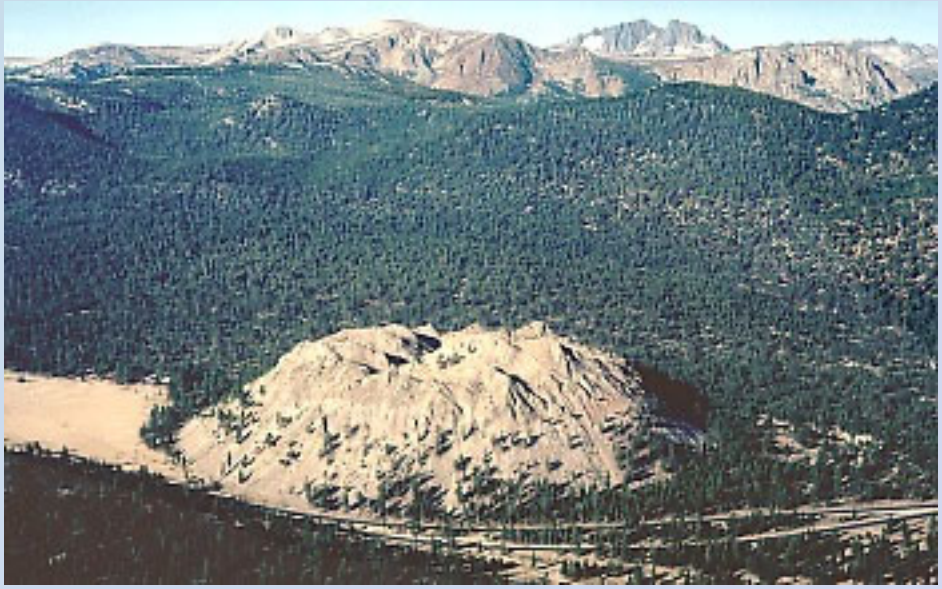


Diamond Head maar – Waikiki Beach, Hawaii

# Tower Hill, western Victoria

# Lava domes

- Small steep-sided domes or 'spines'
- formed from very viscous lava (unable to flow freely)
- non-explosive, usually gas-poor rhyolite
- produced immediately above volcanic vent
- e.g. Hanging Rock in central Victoria



Rhyolite dome, California

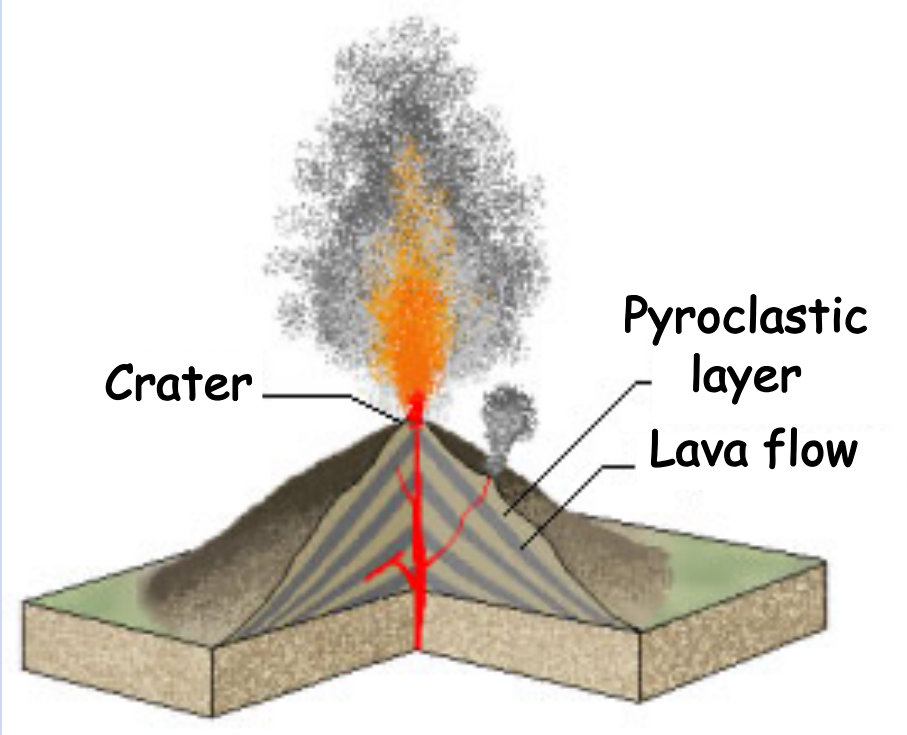
Volcanic spines

Rhyolite dome, Eastern Sierra Nevada Range, Calif., USA

Trachyte dome - Hanging Rock, Victoria

# Composite volcanoes (stratovolcanoes)

- Large volcanoes of intermediate slope, conical shape
- made up of alternating layers of lava and pyroclastic material (rock fragments and ash)
- built up over long periods of time (long periods of dormancy)
- intermittent and often explosive eruptions
- mainly andesitic lavas (~55% Si)
- e.g. Mt St Helens, Mt Fuji

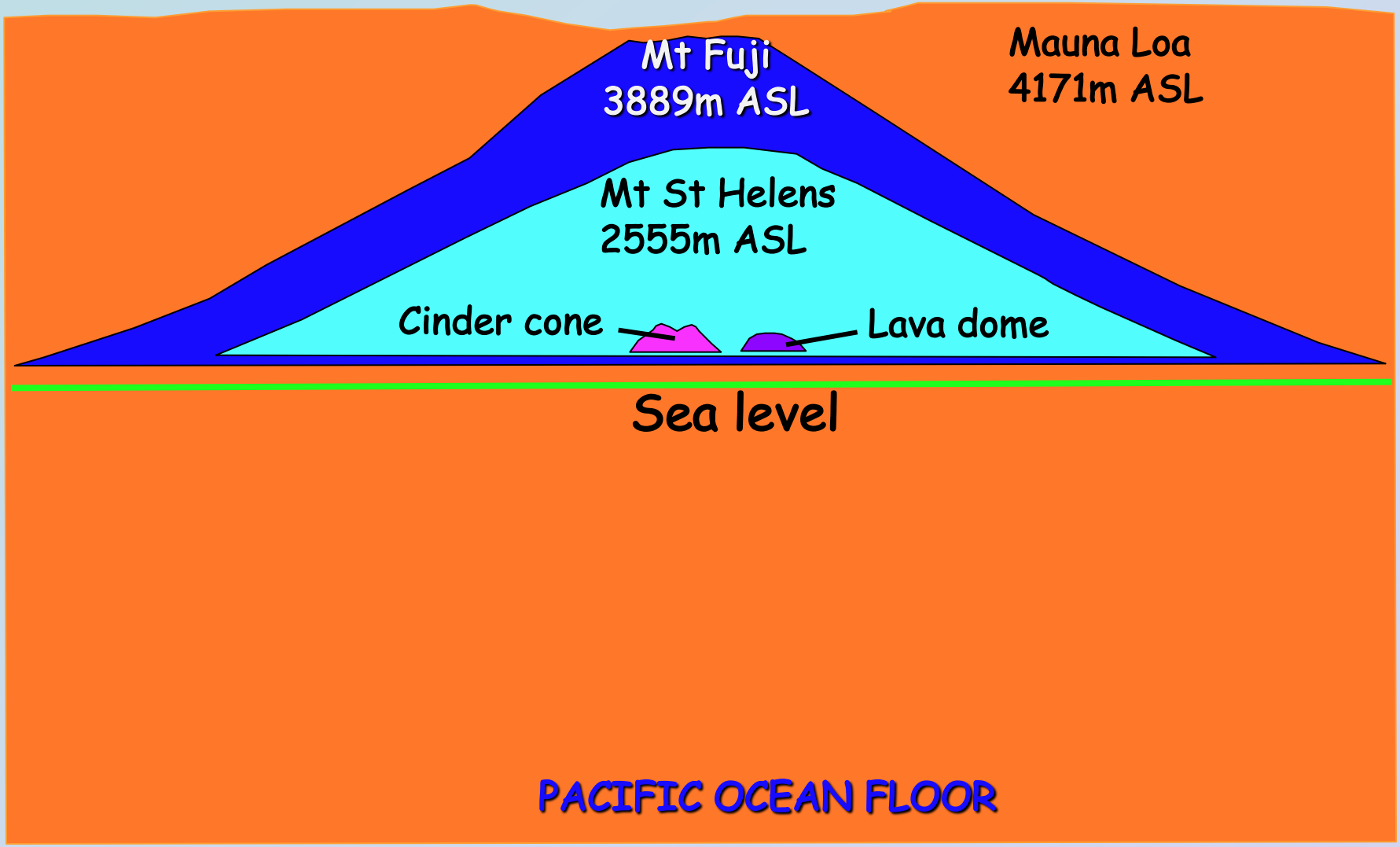


Stratovolcano – Mt Ngaurahoe, NZ

Plinian eruption

Mt St Helens, Washington, USA

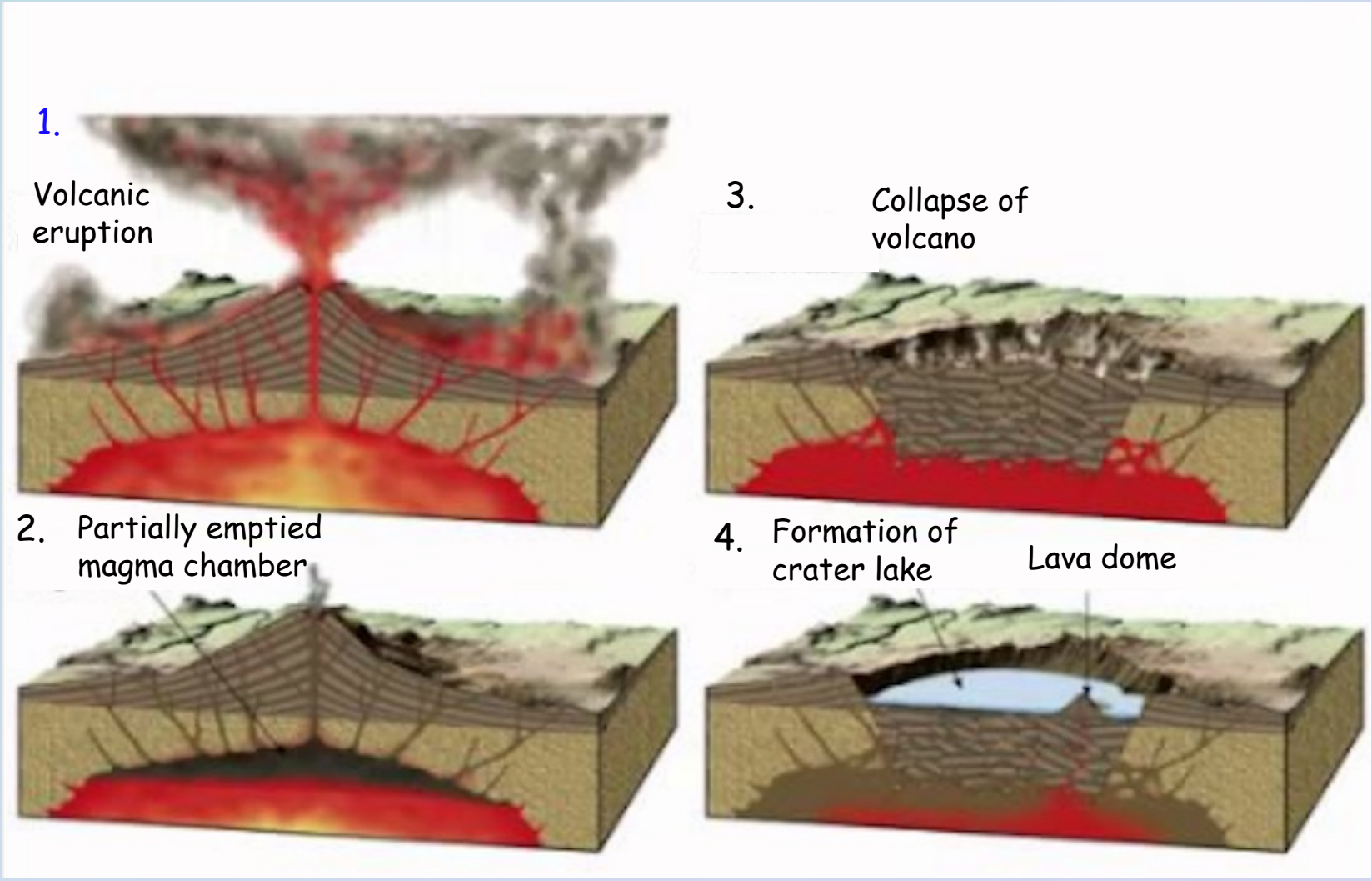
# Relative sizes of volcanoes



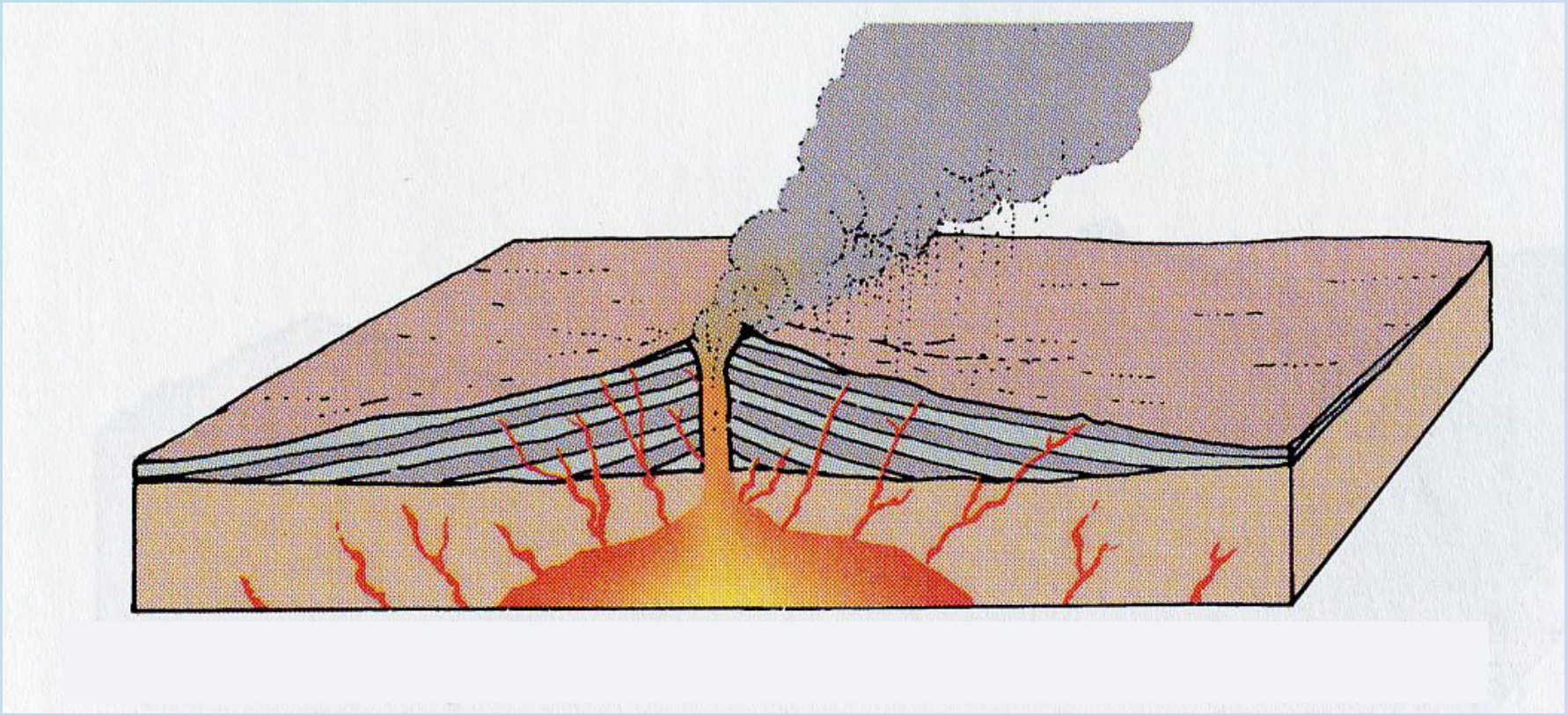
# Large calderas

- Caldera eruptions → the largest, most violent and catastrophic eruptions
- extremely violent, gas-rich rhyolite magmas
- produced by collapse over a large magma chamber
- may be tens of kilometers across
- products are pumice and ash moving as very fast ash flows
- resulting rocks are ignimbrites – welded tuffs

# Caldera formation

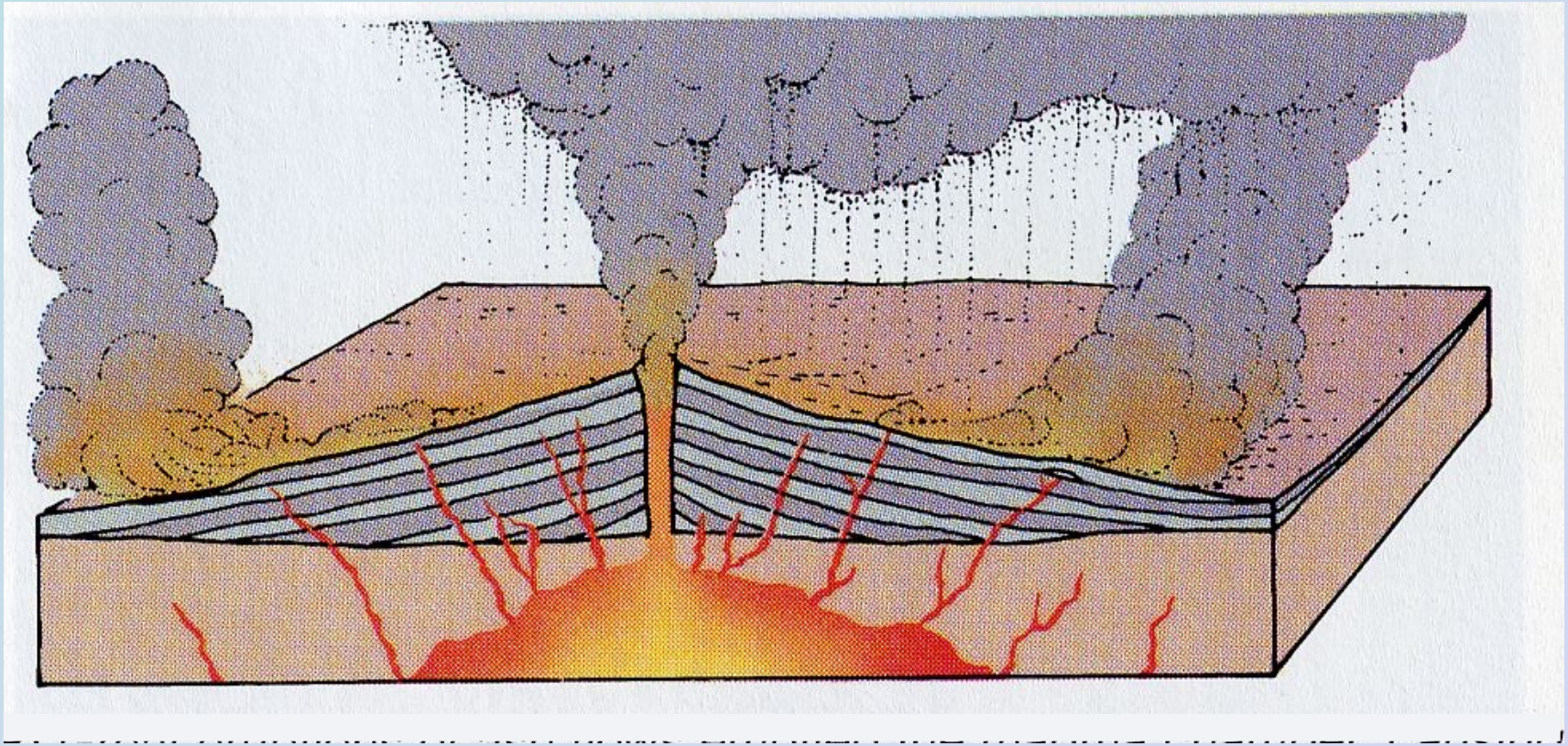


# Stage 1 in formation of a caldera



Early eruptions form a large composite volcano

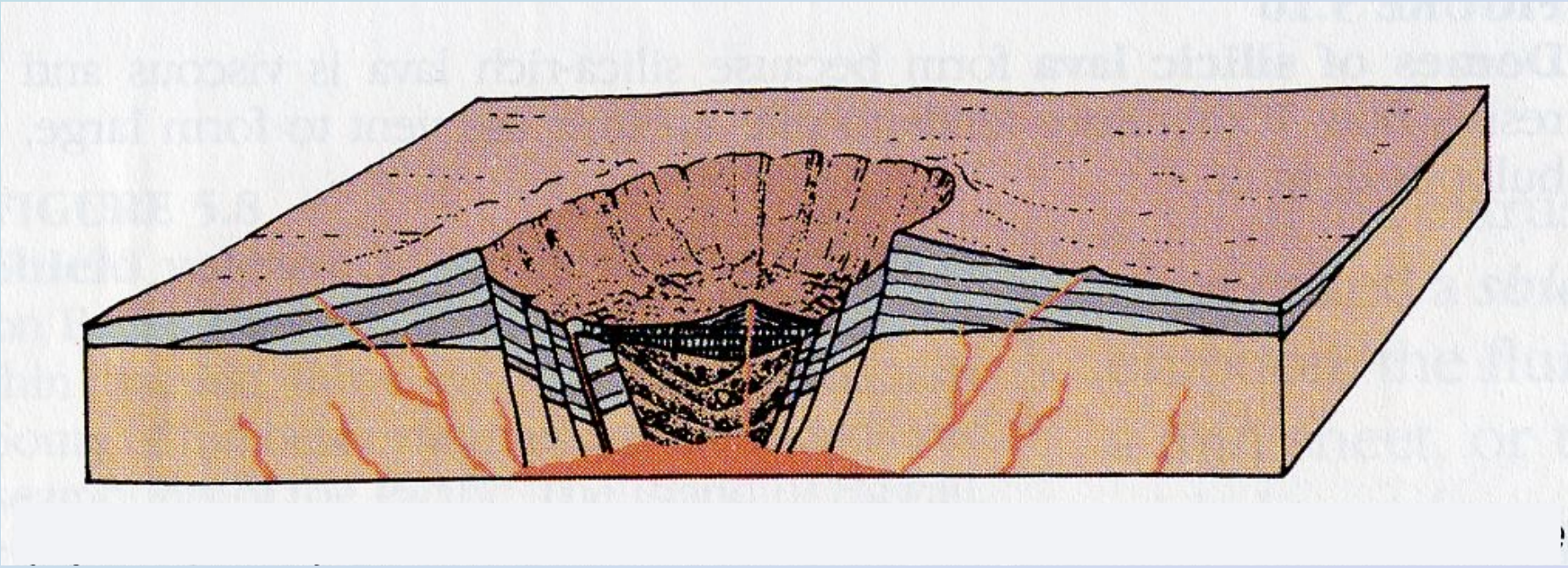
# Stage 2 in formation of a caldera



Great eruptions of ash flows empty the chamber

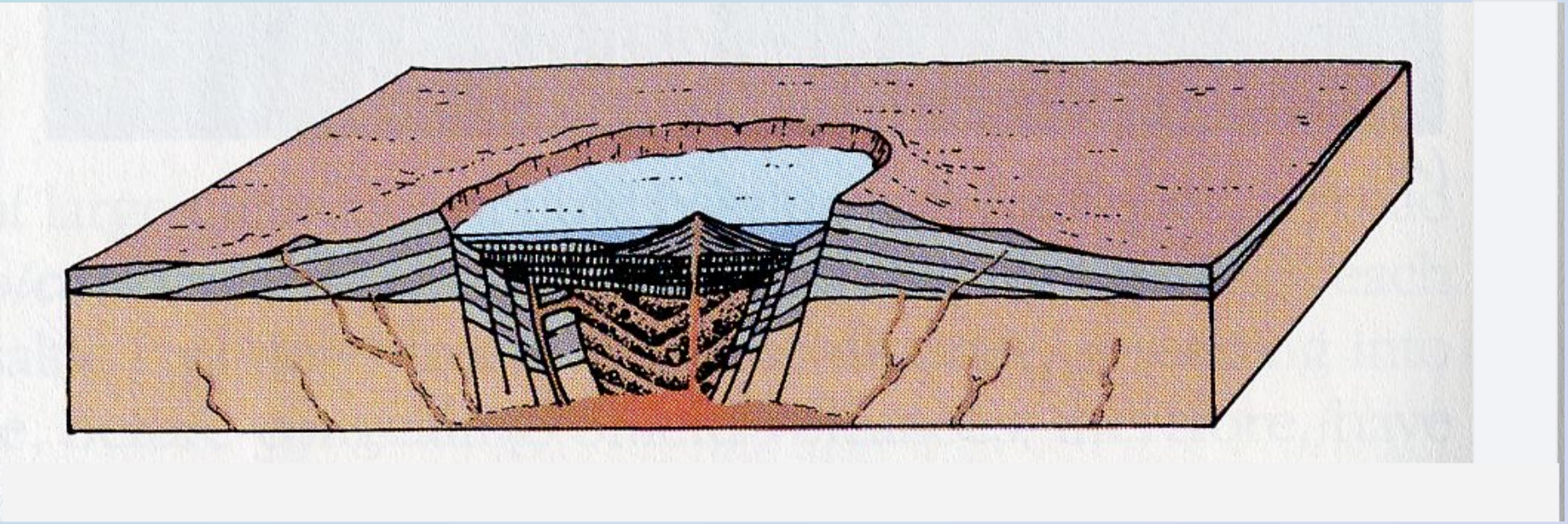
→ leaving the summit unsupported

# Stage 3 in formation of caldera



Collapse of the summit into the magma chamber forms the caldera

# Stage 4 in formation of caldera



A lake commonly forms in the caldera and later eruptions may produce small volcanic islands

Lake Taupo – North Island NZ

Crater Lake and Wizard Island - Oregon