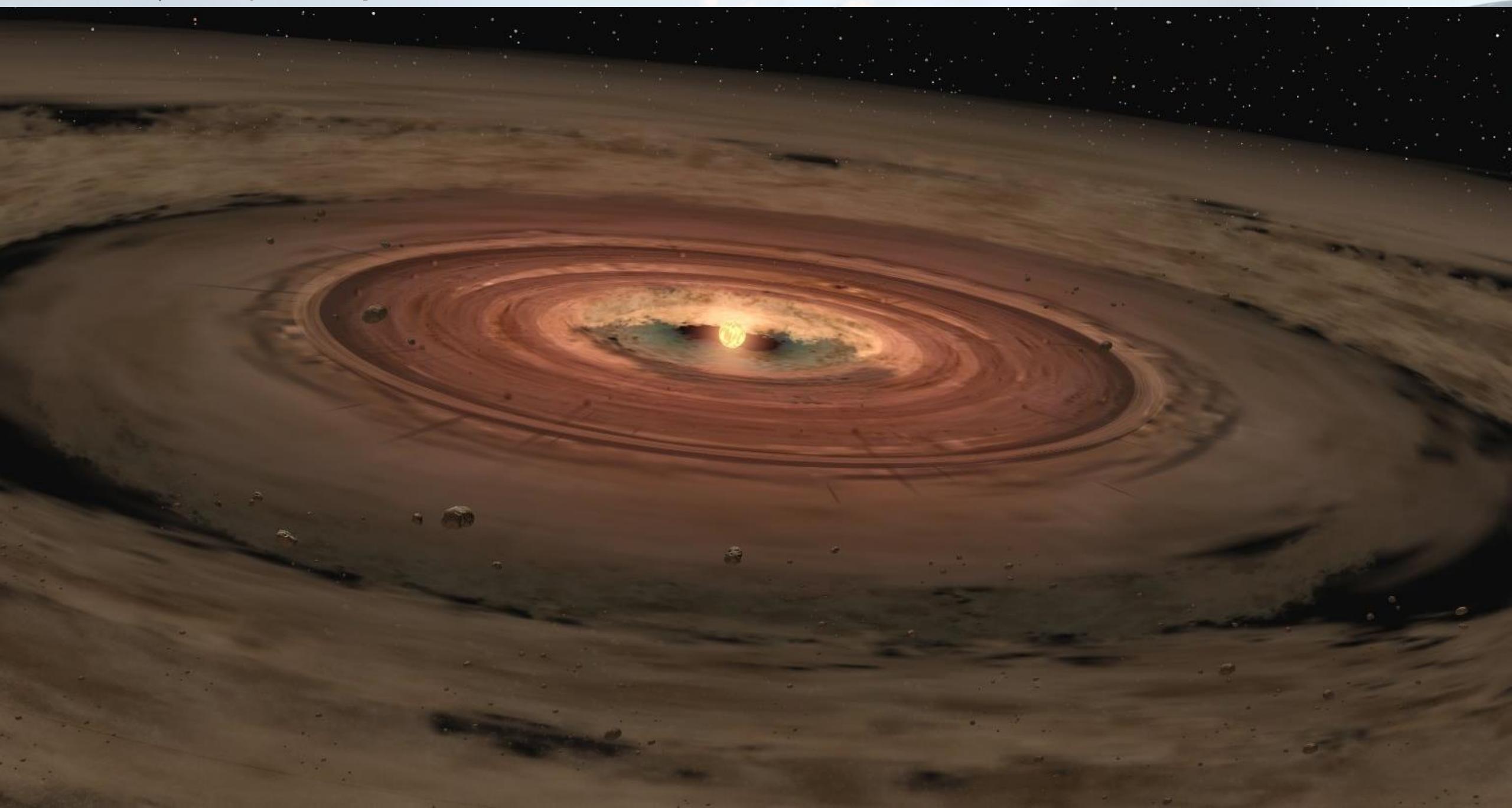
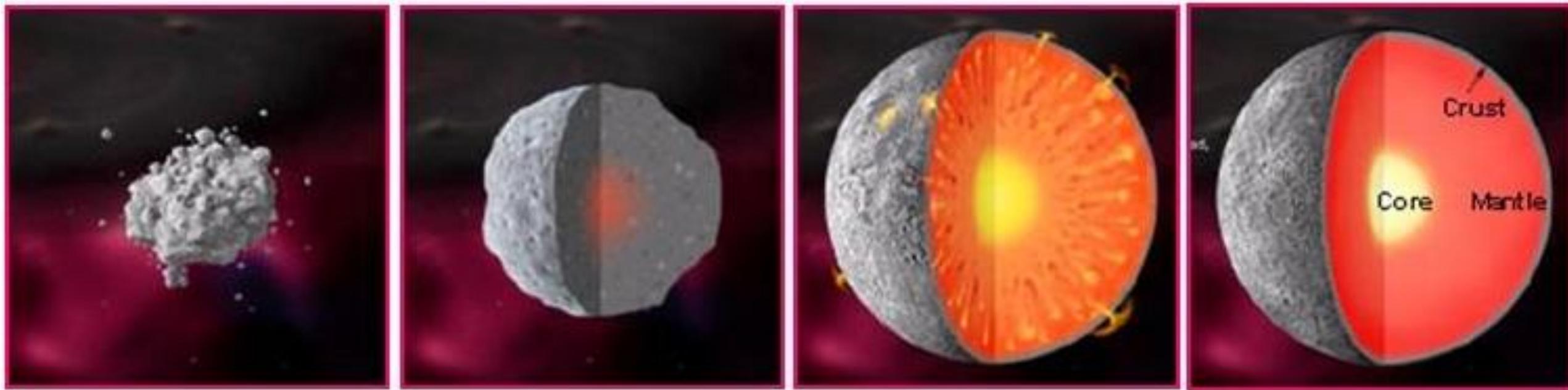




# GY4051 Earth Science and Society

## *Volcanoes*

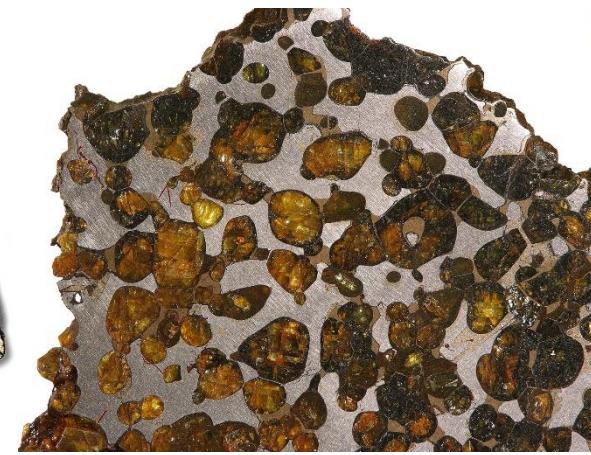




**Crust/pre-differentiation**  
Stony Chondrite  
(accreted dust & grains)



**Mantle**  
Stony Achondrite  
(crystallised from melt)

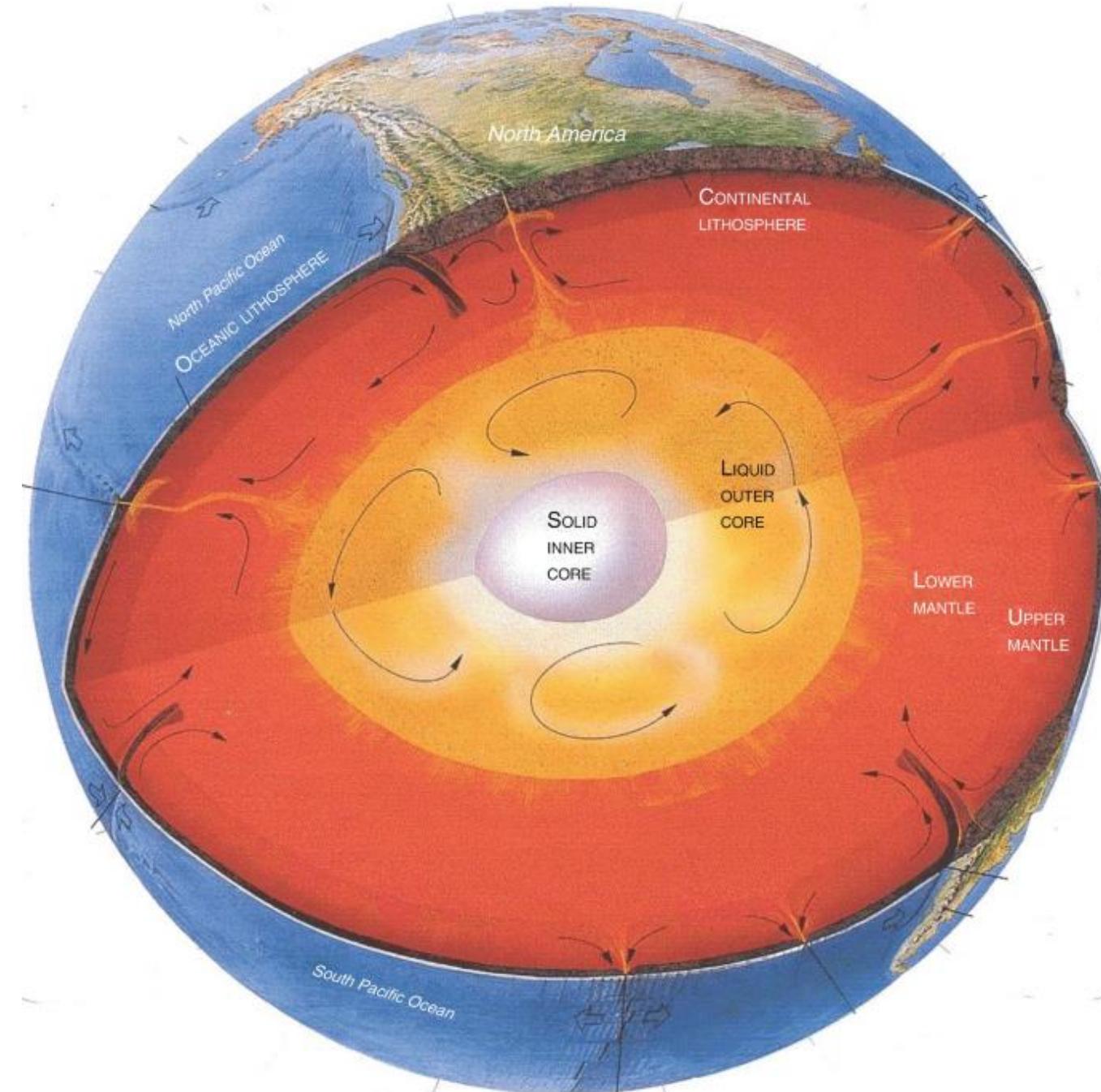


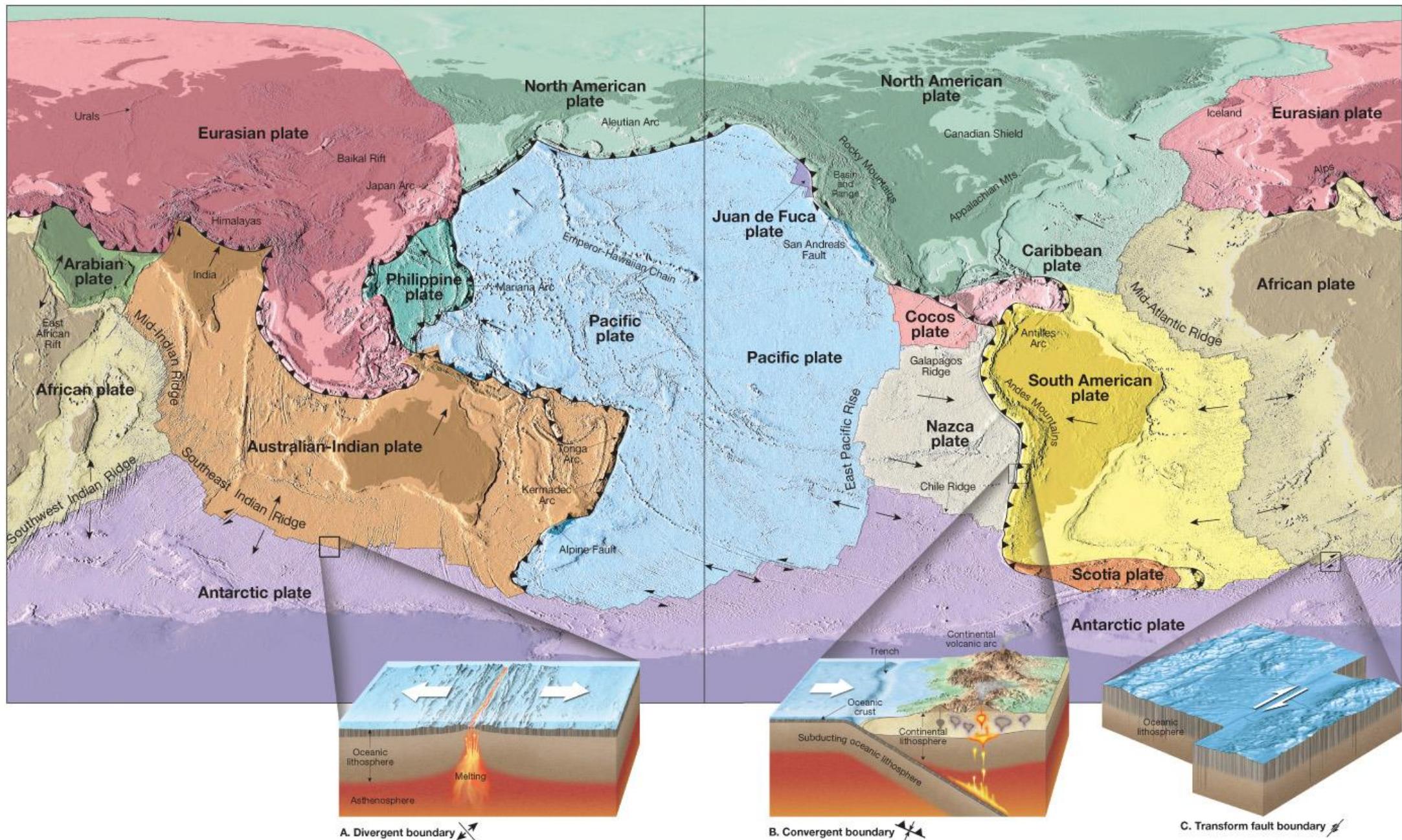
**Core-Mantle boundary**  
Pallasite  
(Iron + olivine)

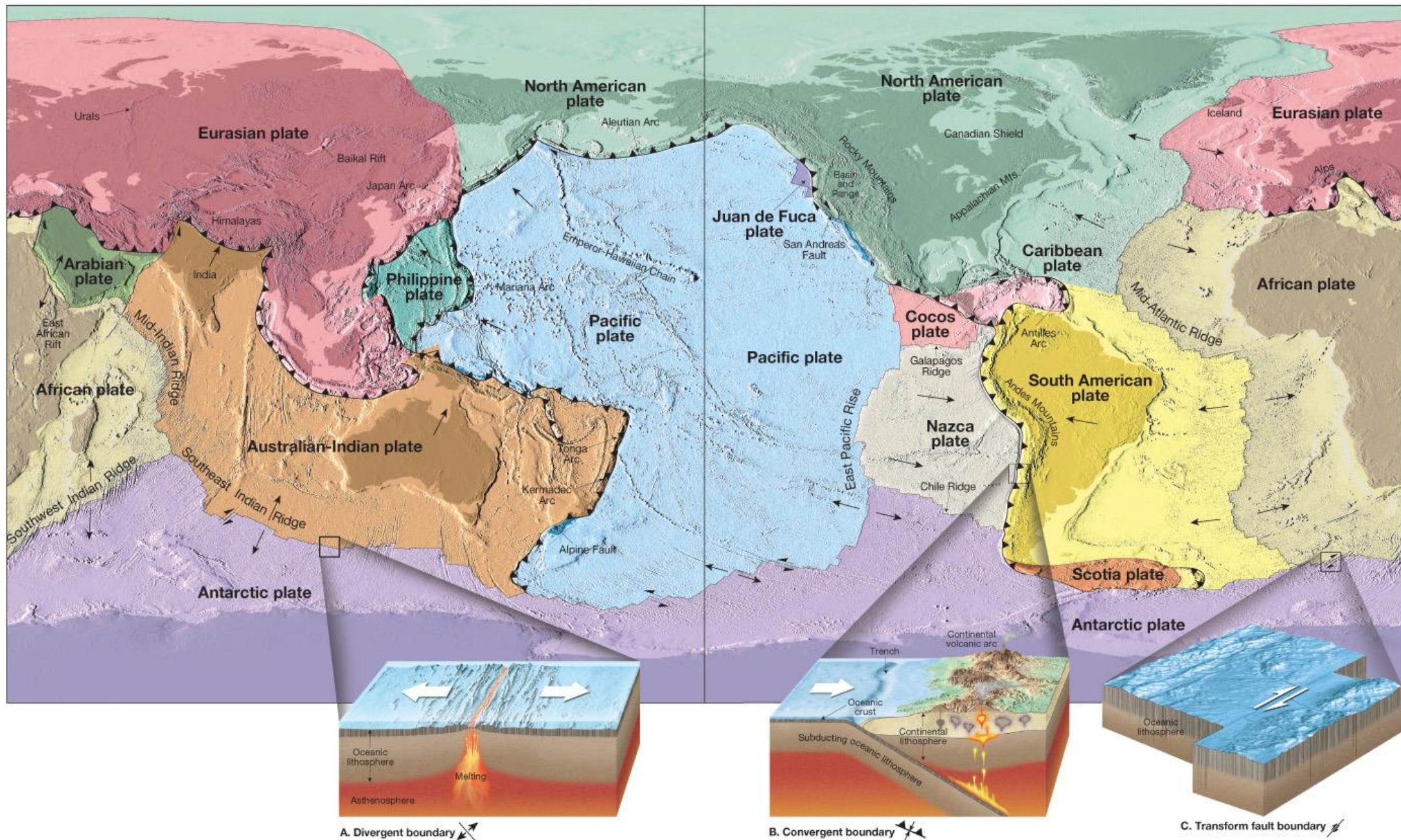


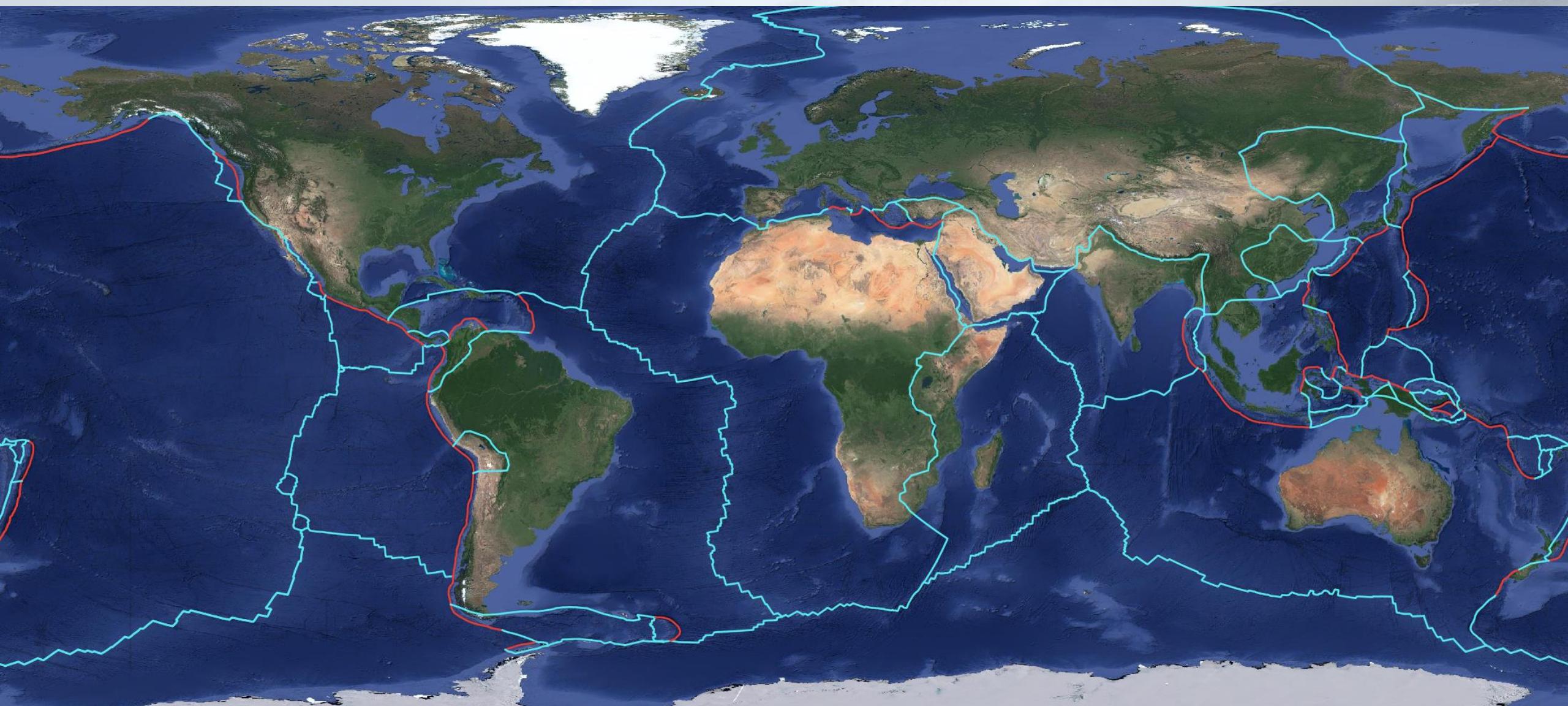
**Core**  
Iron

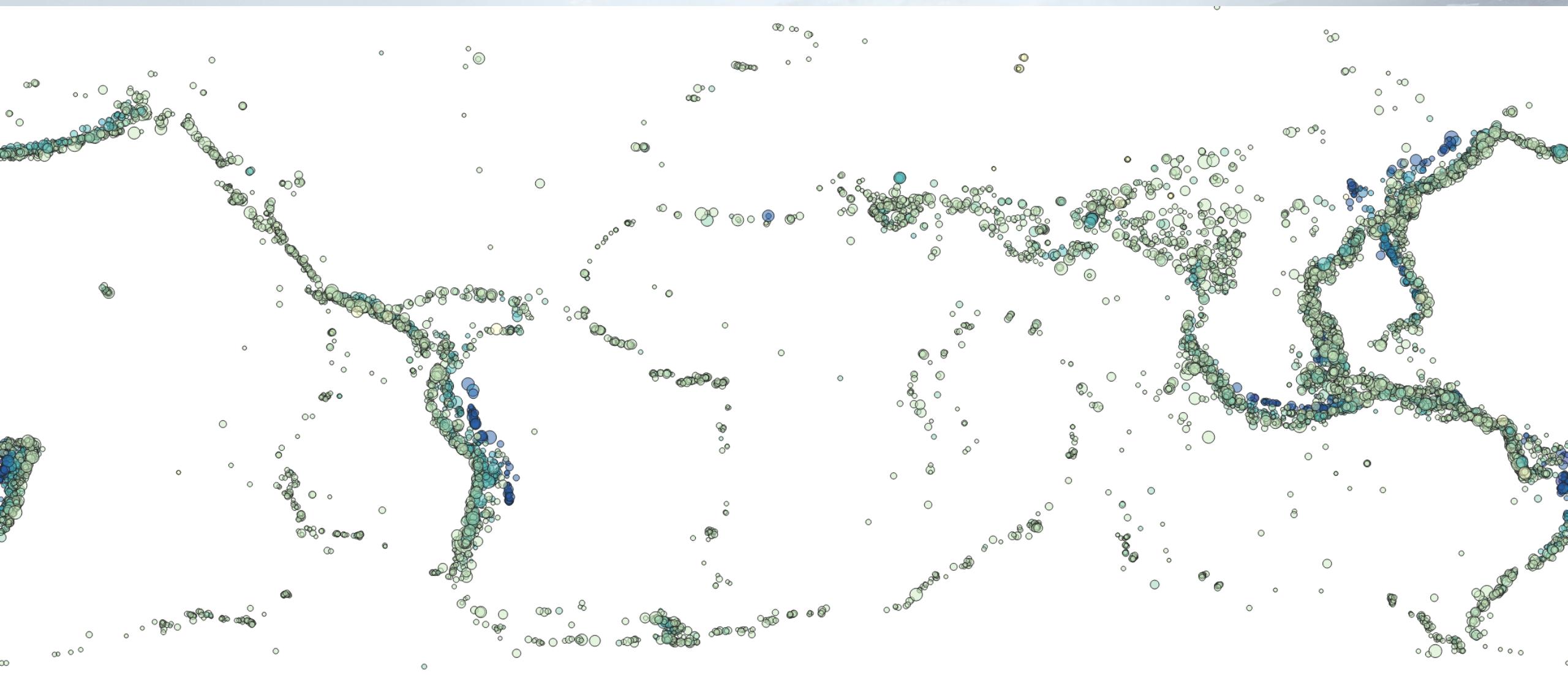


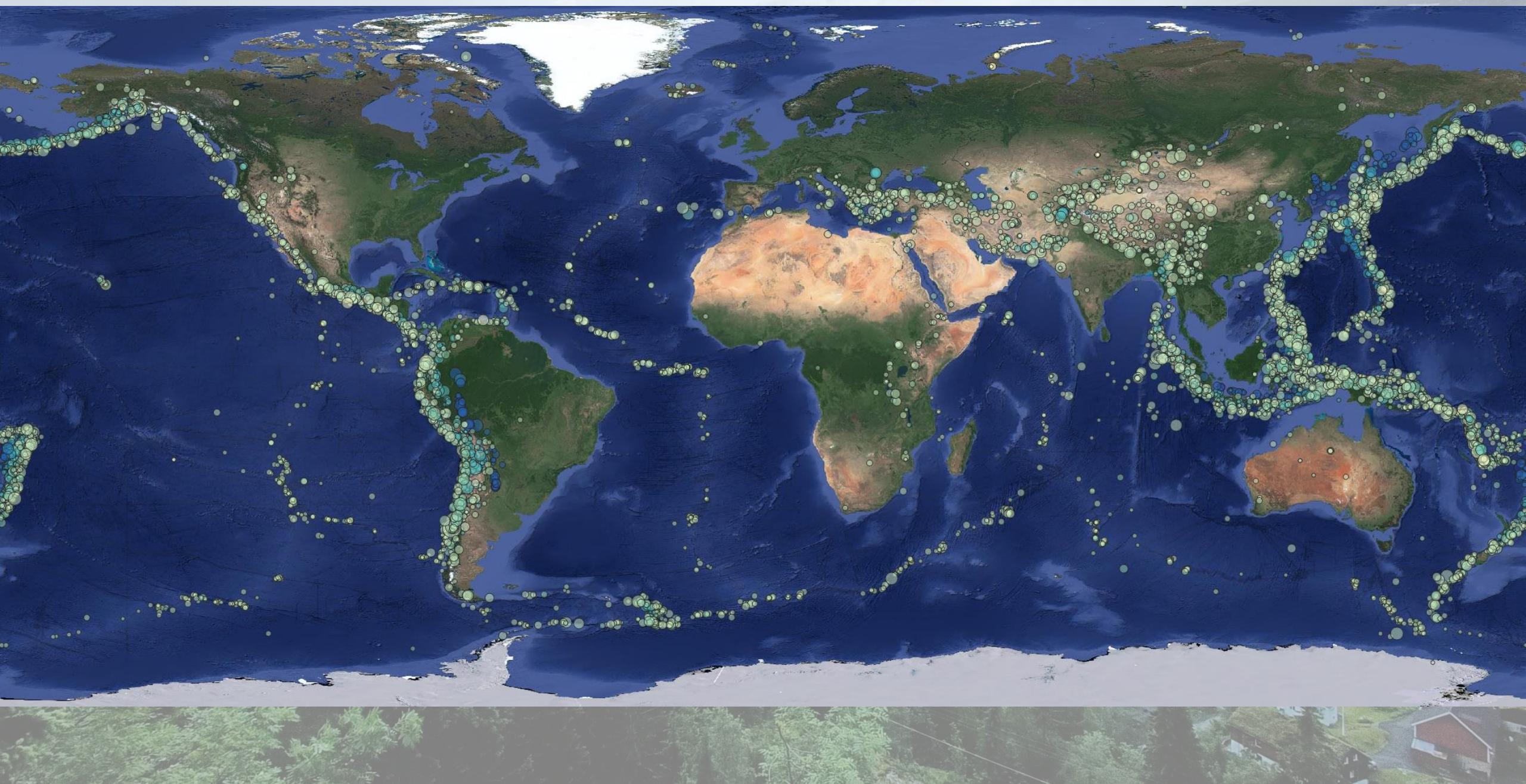


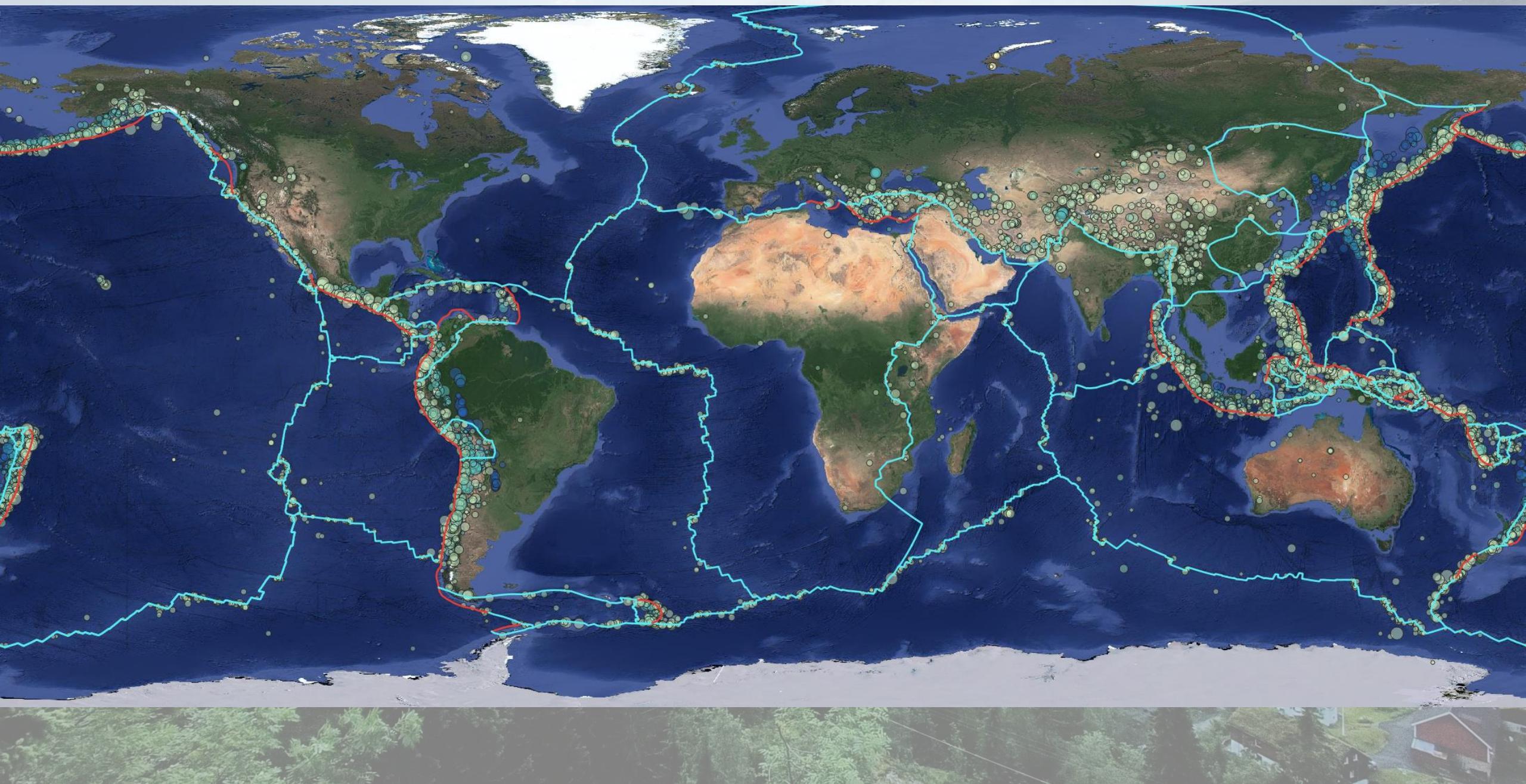


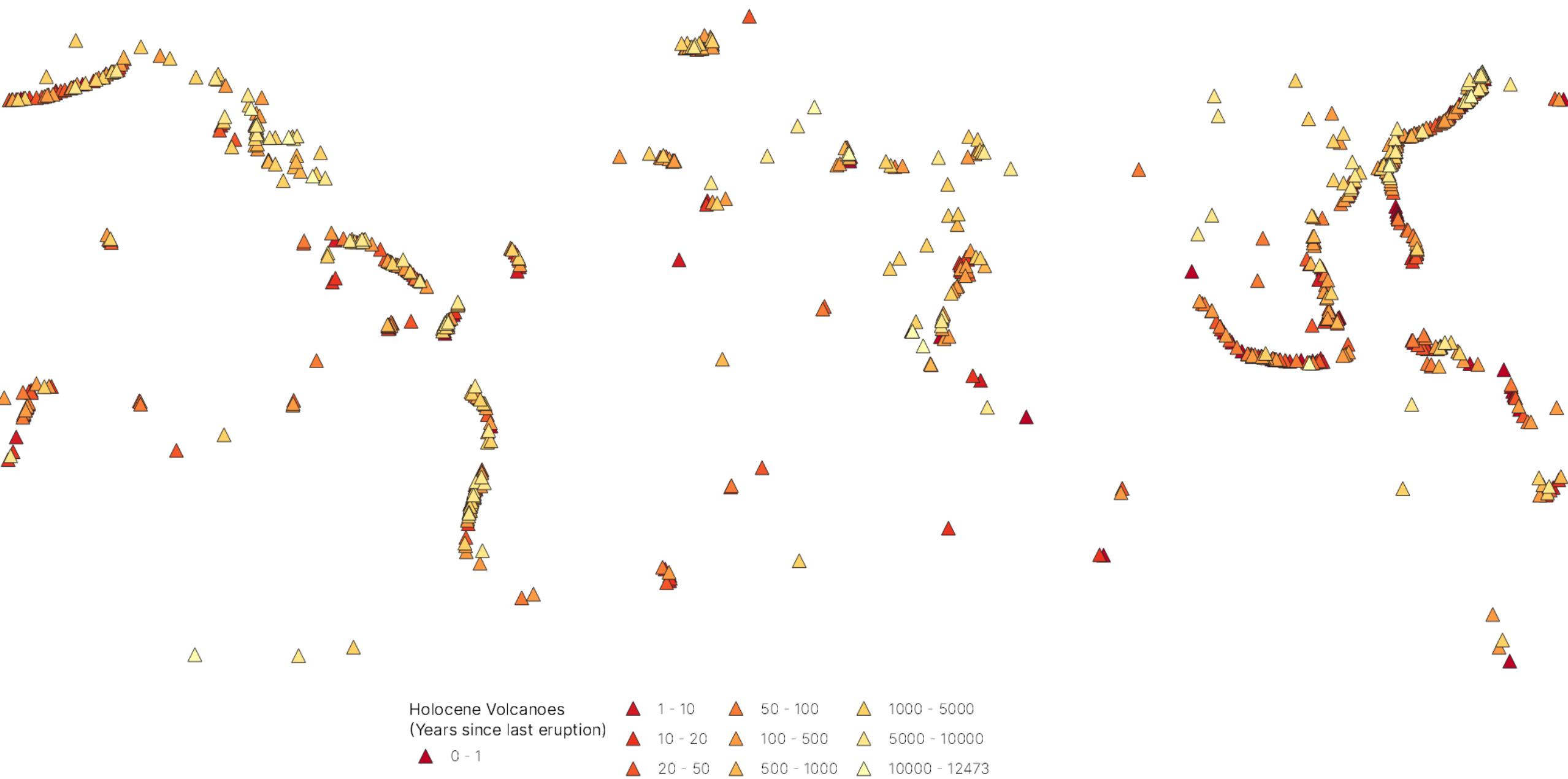


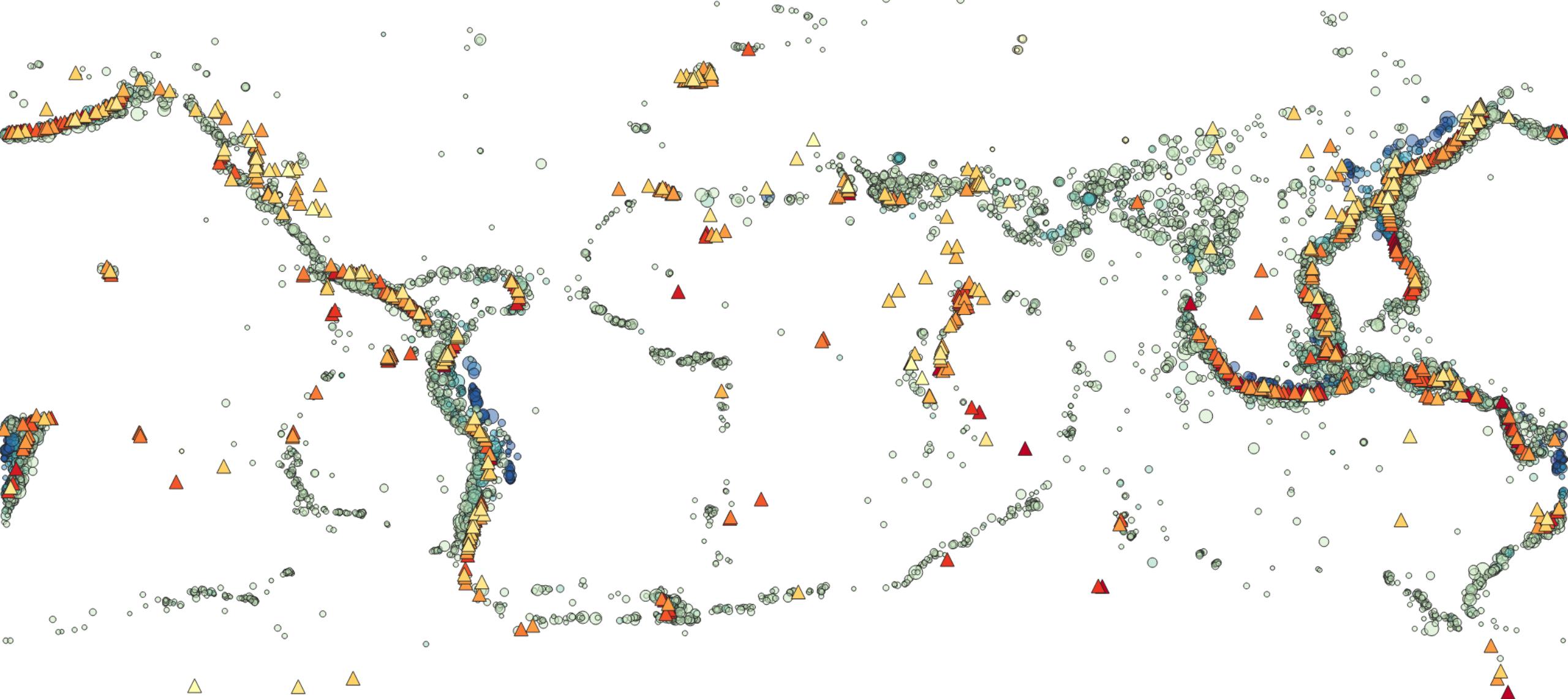












Holocene Volcanoes  
(Years since last eruption)

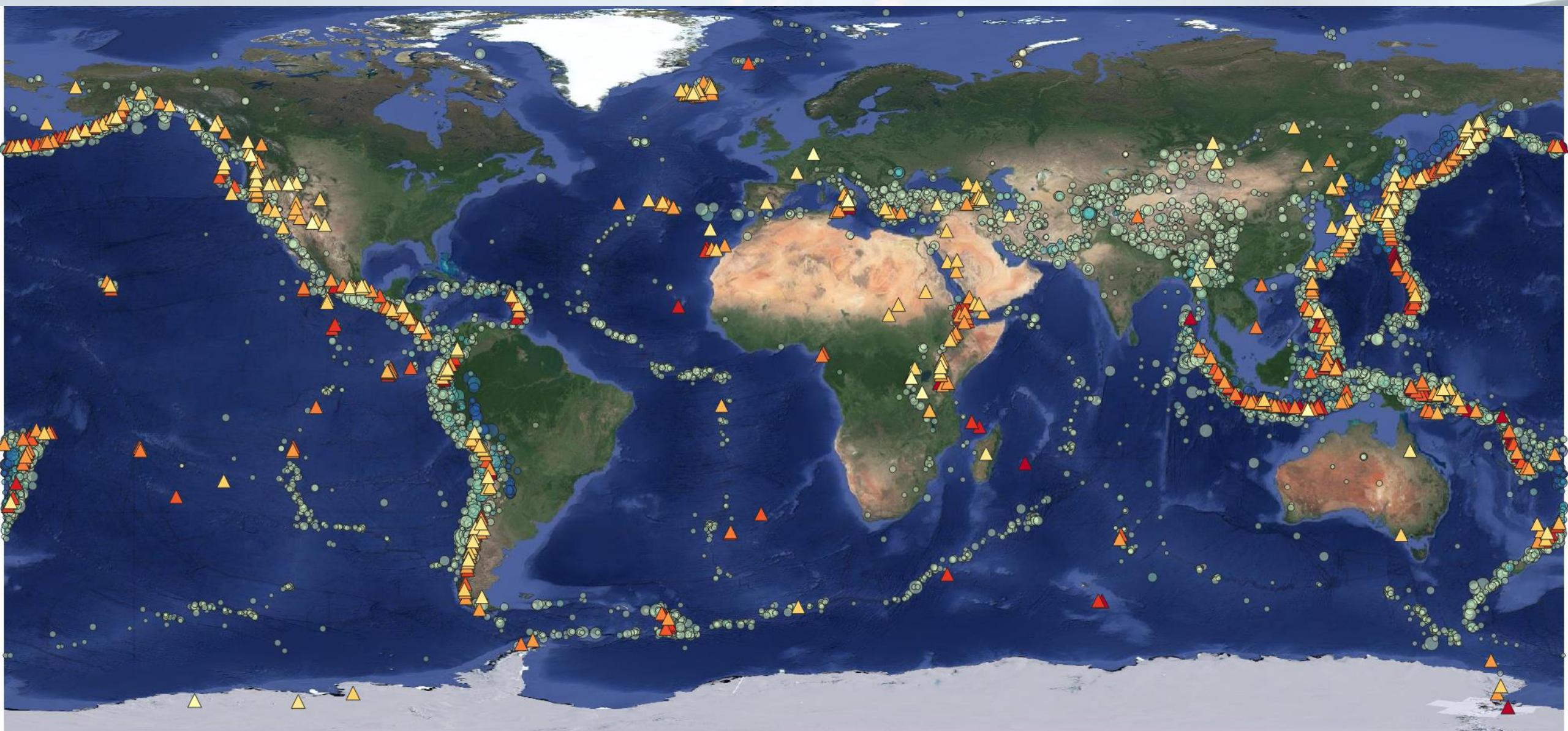
▲ 0 - 1

▲ 1 - 10      ▲ 10 - 20      ▲ 20 - 50      ▲ 50 - 100      ▲ 100 - 500      ▲ 500 - 1000      ▲ 1000 - 5000      ▲ 5000 - 10000      ▲ 10000 - 12473

Earthquakes (by depth)  
(size indicates magnitude)

○ -0.097 - 0

○ 0 - 30      ○ 30 - 60      ○ 60 - 250      ○ 250 - 410      ○ 410 - 520      ○ 520 - 660      ○ 660 - 688



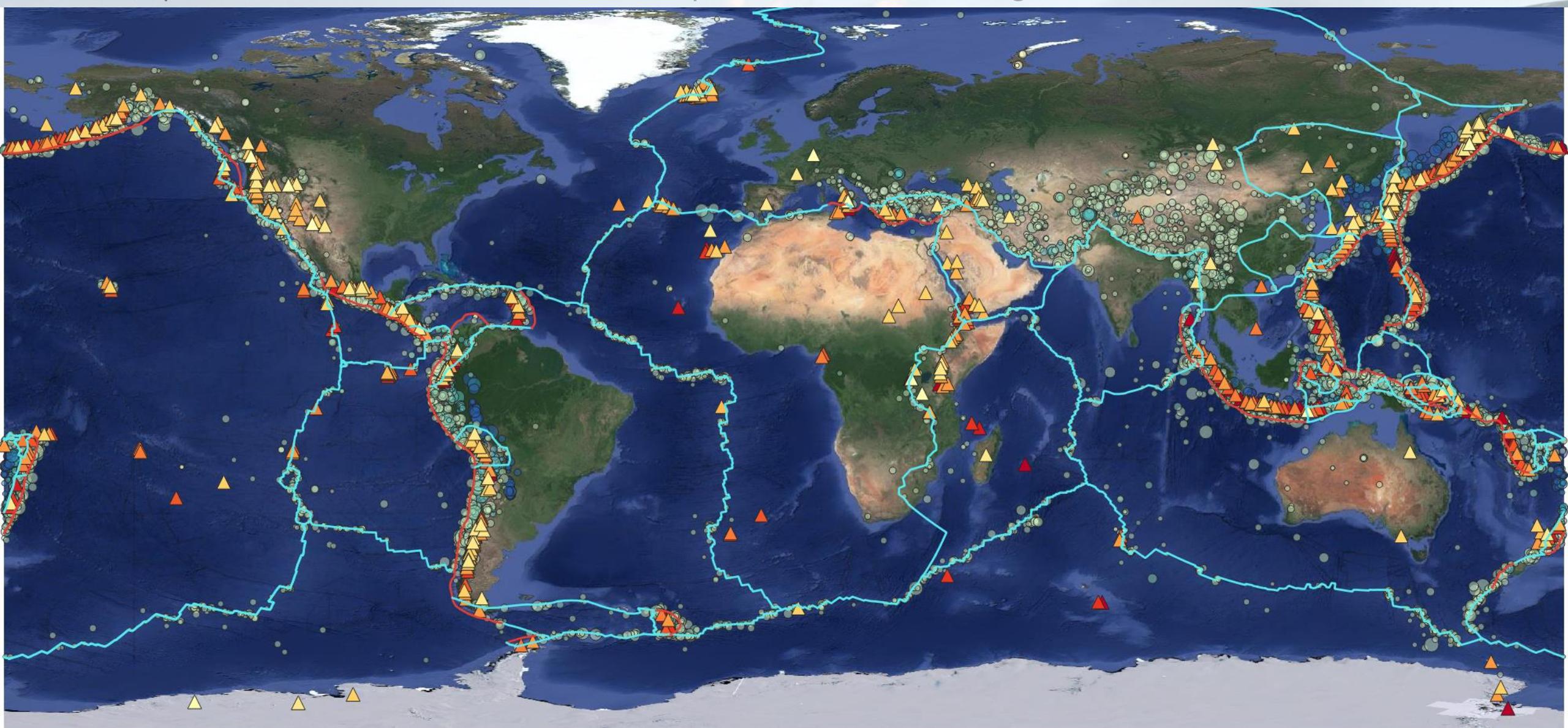
Holocene Volcanoes  
(Years since last eruption)

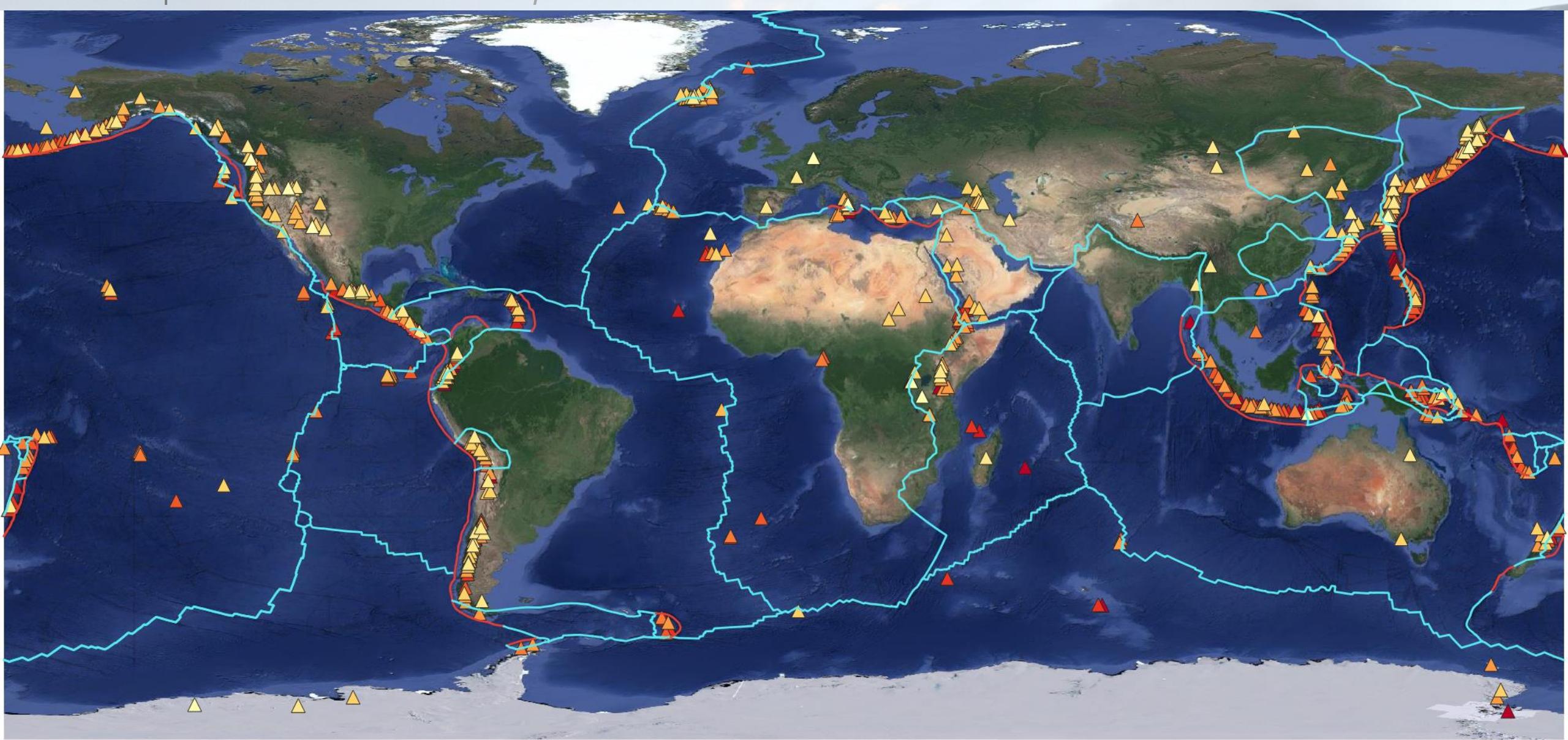
▲ 0 - 1  
▲ 1 - 10  
▲ 10 - 20  
▲ 20 - 50  
▲ 50 - 100  
▲ 100 - 500  
▲ 500 - 1000  
▲ 1000 - 5000  
▲ 5000 - 10000  
▲ 10000 - 12473

▲ 1 - 10  
▲ 10 - 20  
▲ 20 - 50  
▲ 50 - 100  
▲ 100 - 500  
▲ 500 - 1000  
▲ 1000 - 5000  
▲ 5000 - 10000  
▲ 10000 - 12473

Earthquakes (by depth)  
(size indicates magnitude)

○ -0.097 - 0  
○ 0 - 30  
○ 30 - 60  
○ 60 - 250  
○ 250 - 410  
○ 410 - 520  
○ 520 - 660  
○ 660 - 688





Tectonic Plate boundaries

Subduction Zone

Constructive or Conservative

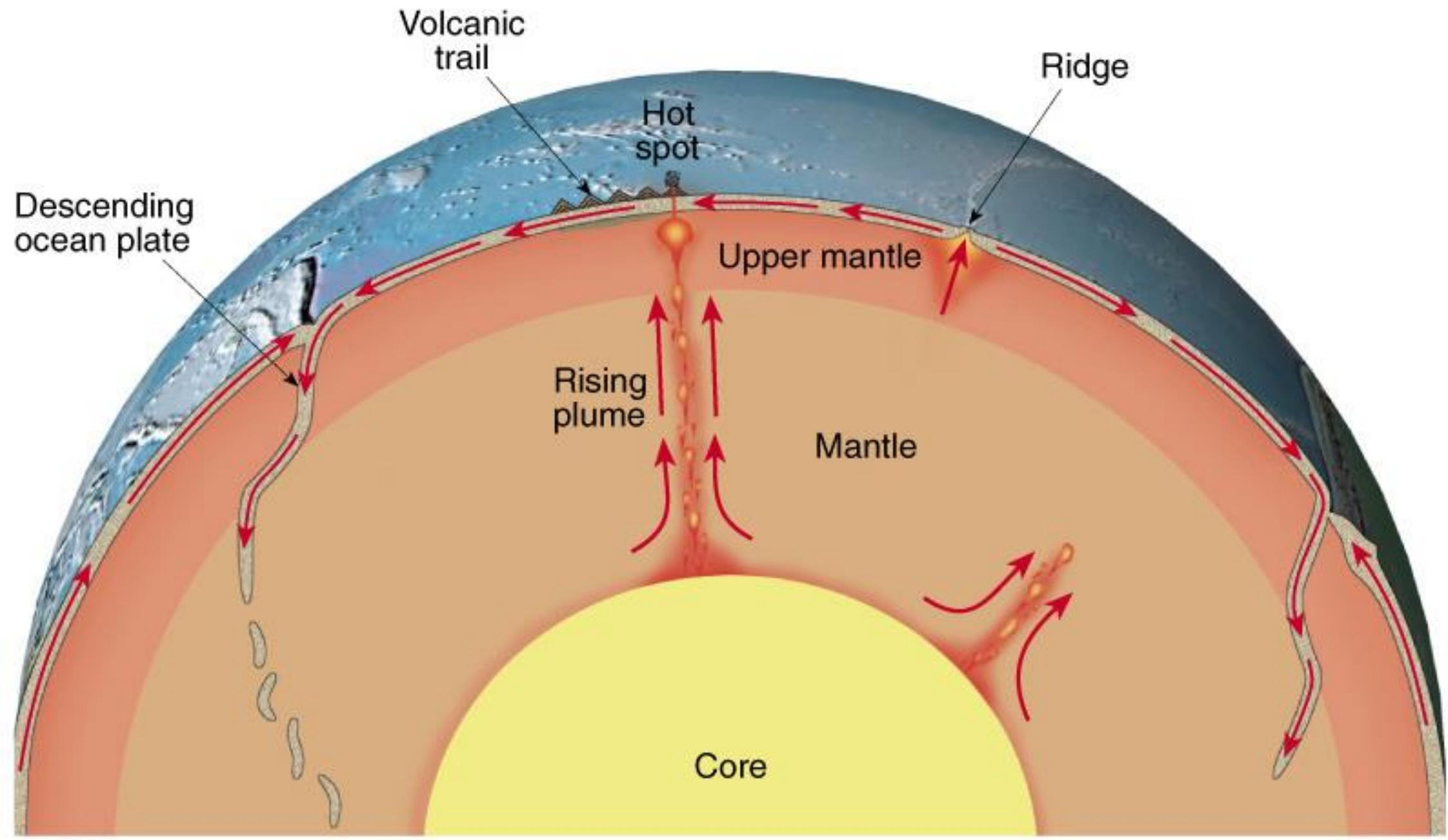
Holocene Volcanoes  
(Years since last eruption)

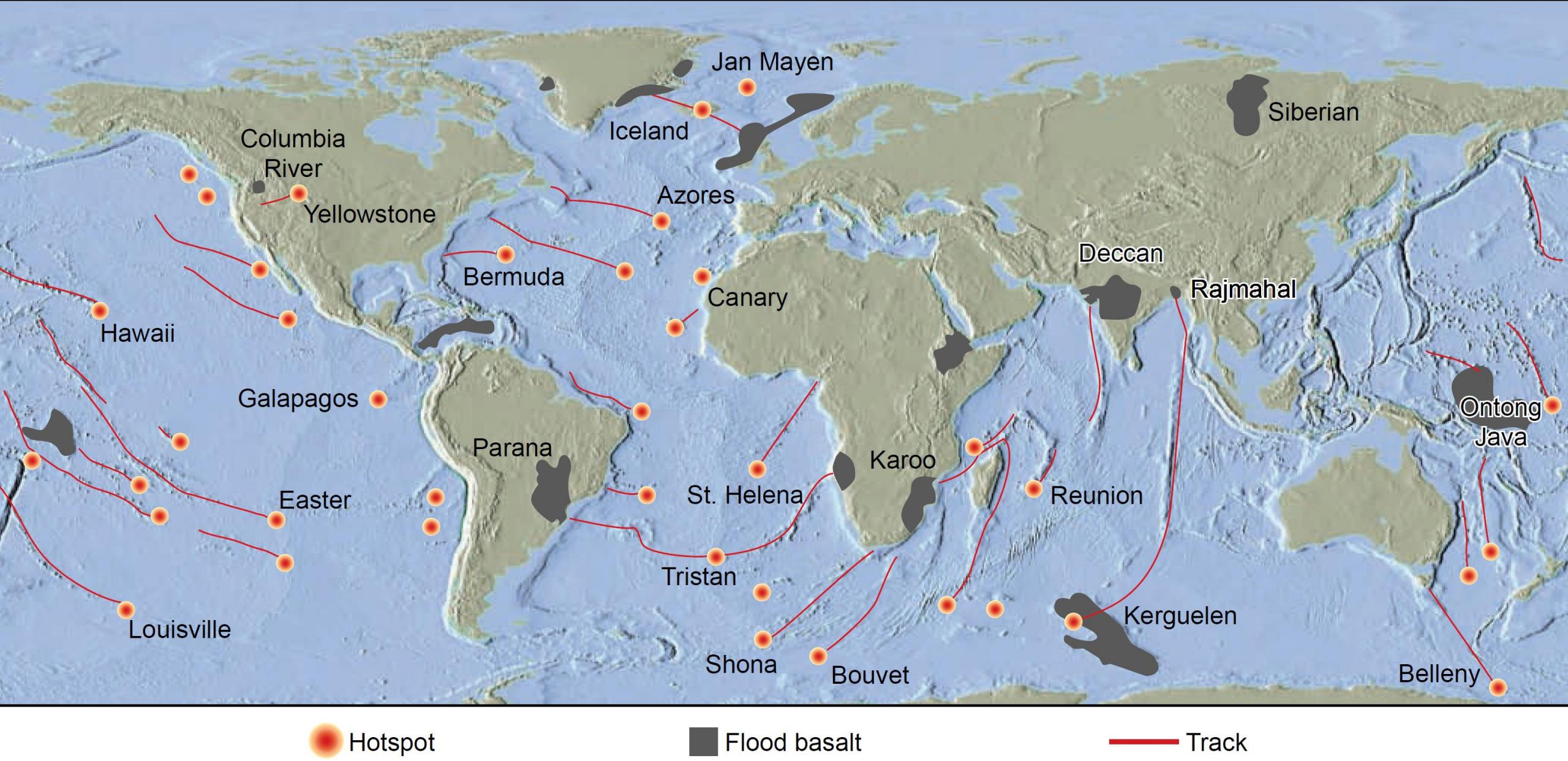
▲ 0 - 1

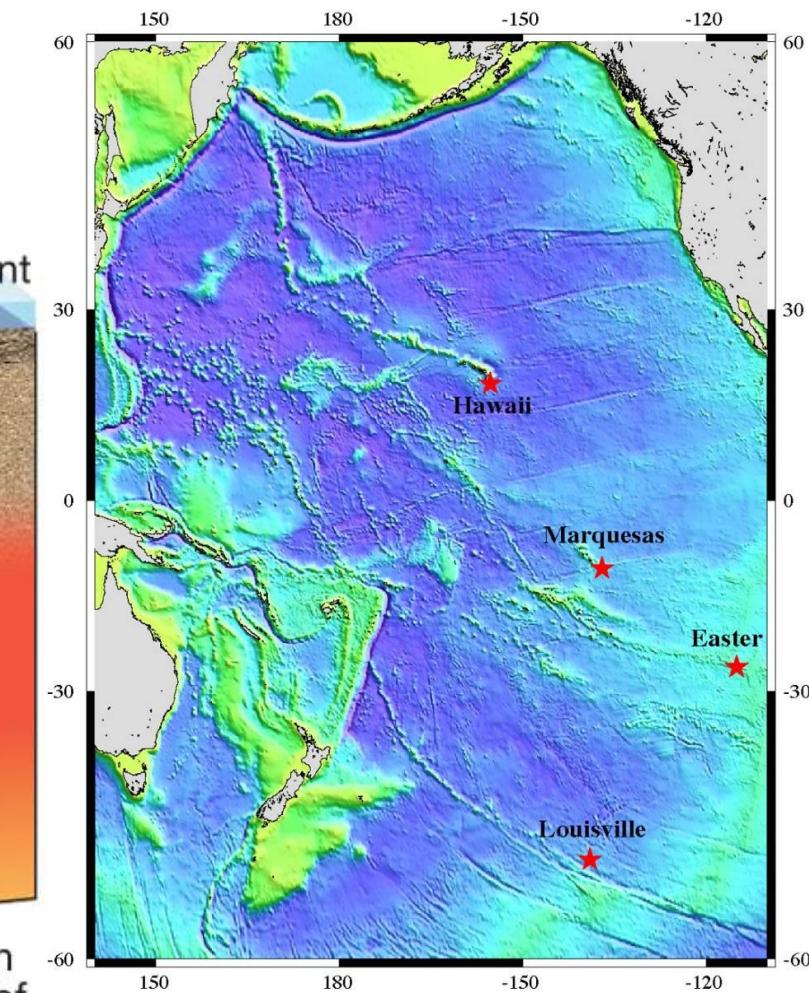
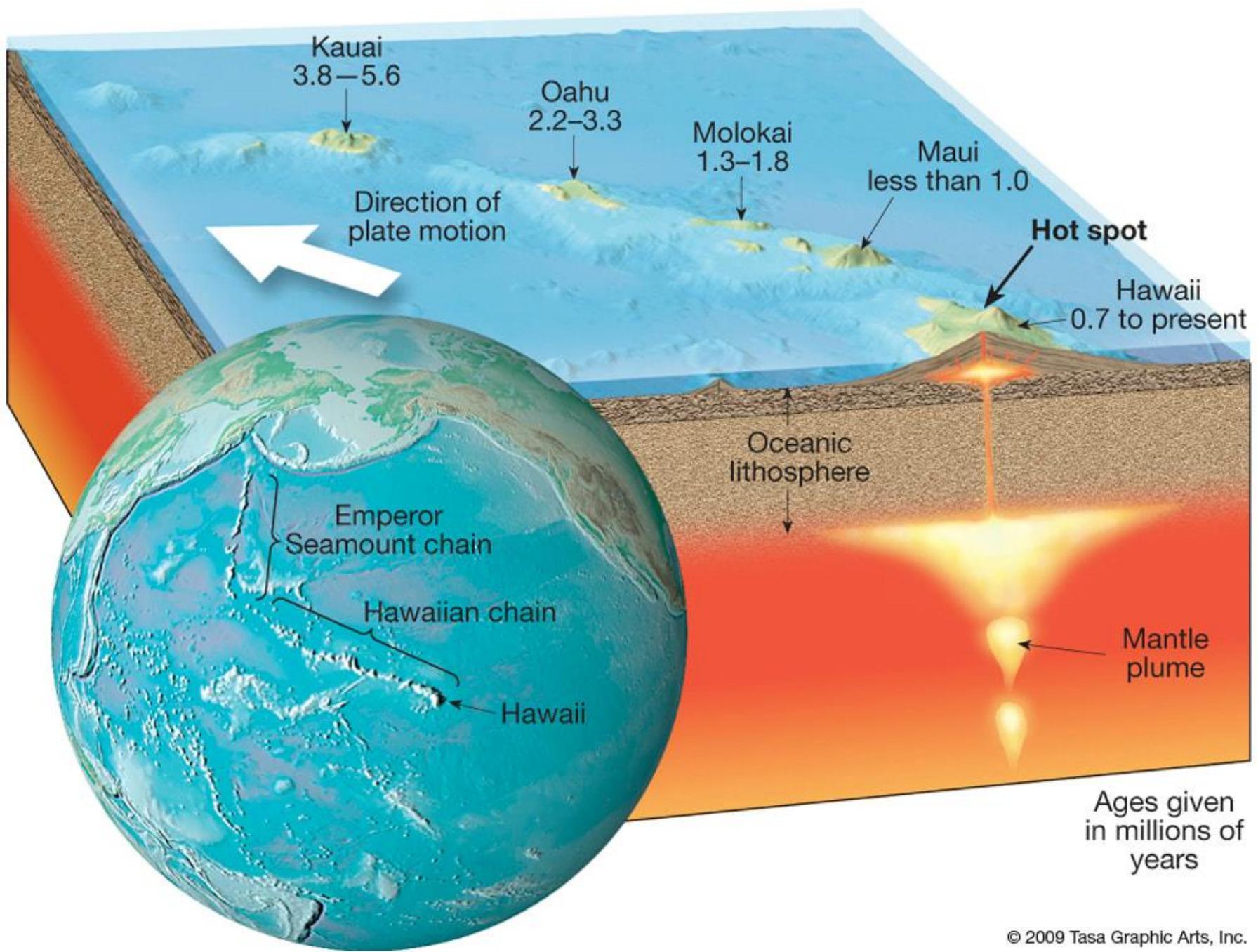
▲ 1 - 10 ▲ 50 - 100 ▲ 1000 - 5000

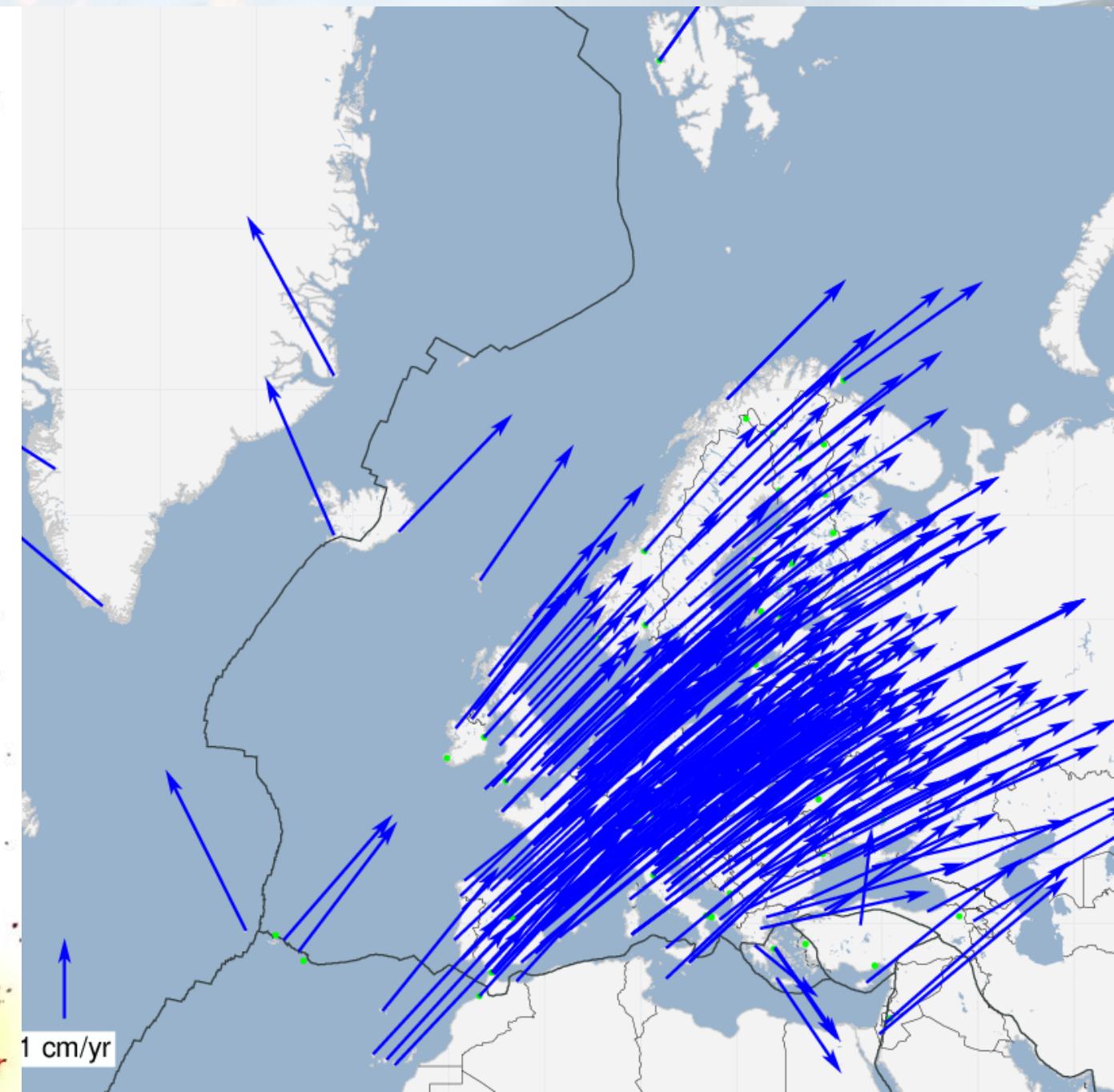
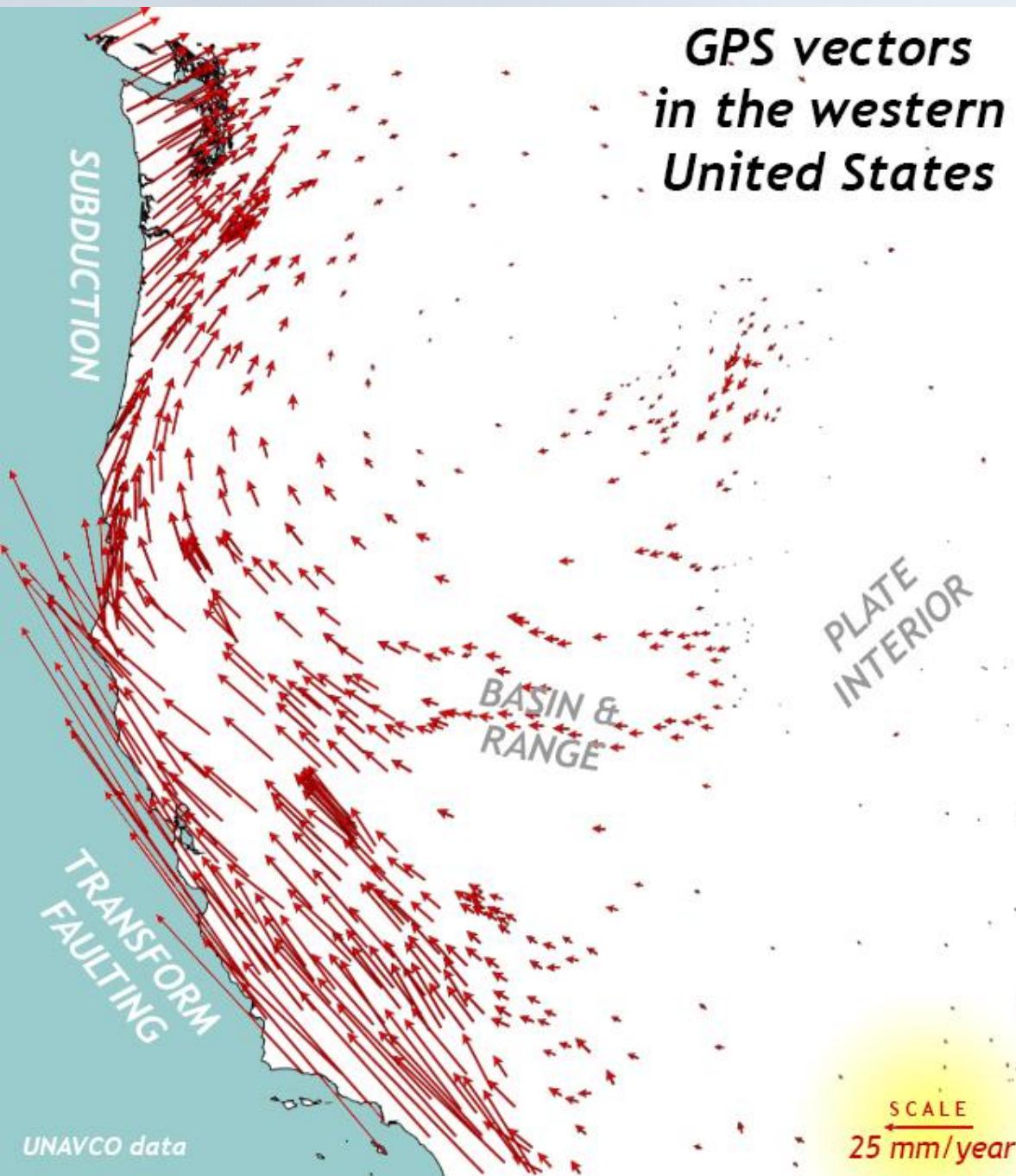
▲ 10 - 20 ▲ 100 - 500 ▲ 5000 - 10000

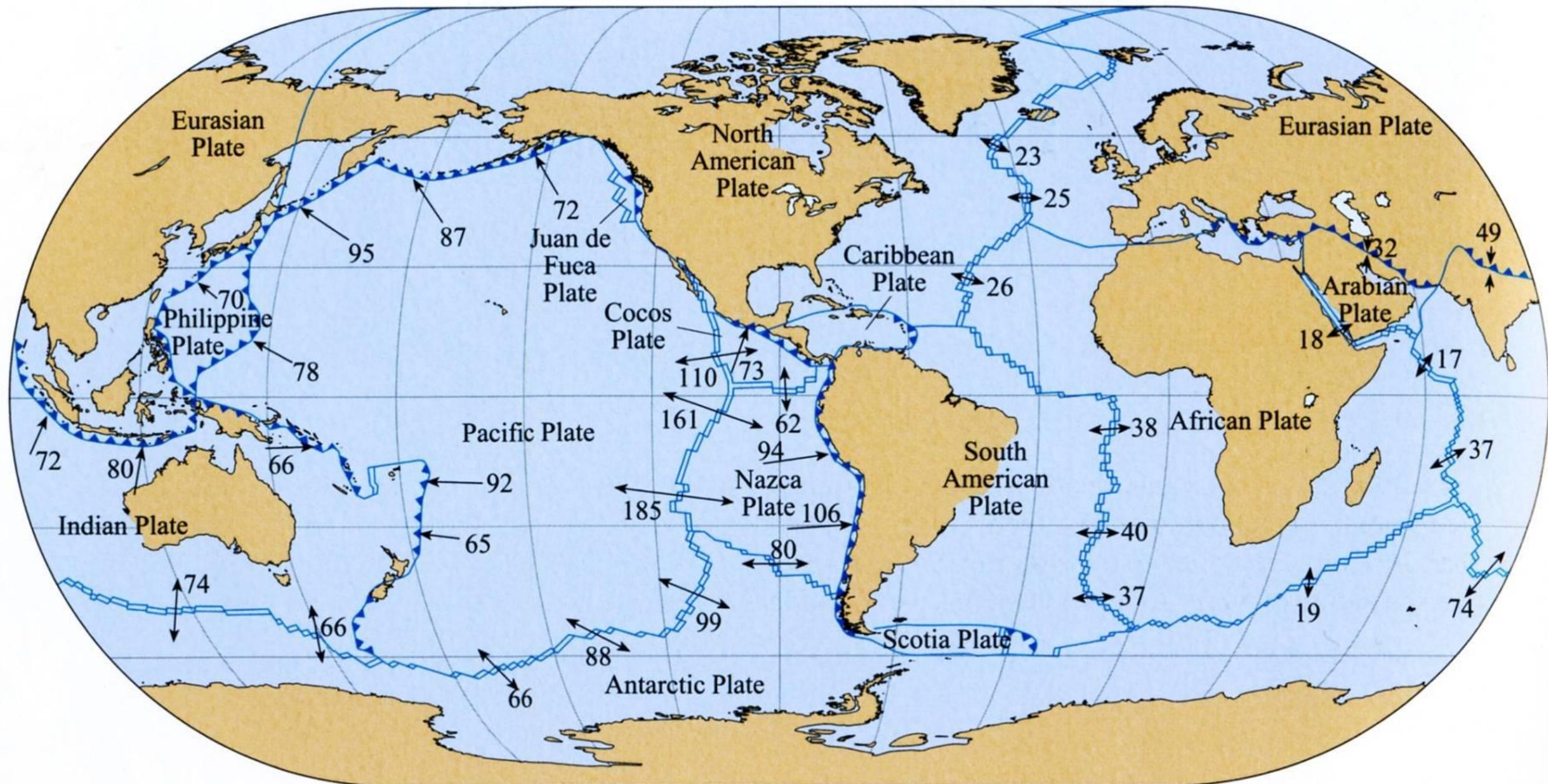
▲ 20 - 50 ▲ 500 - 1000 ▲ 10000 - 12473

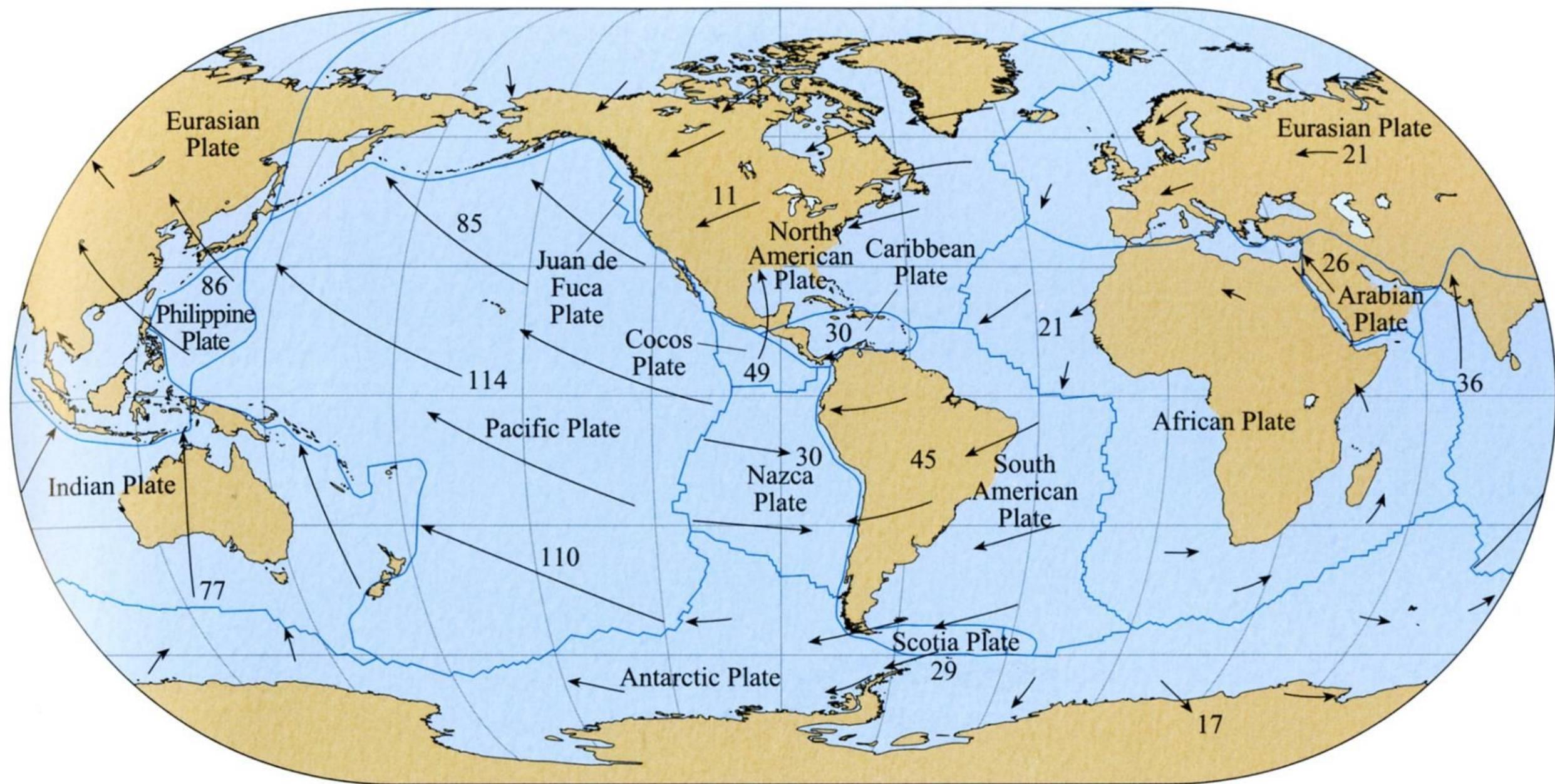


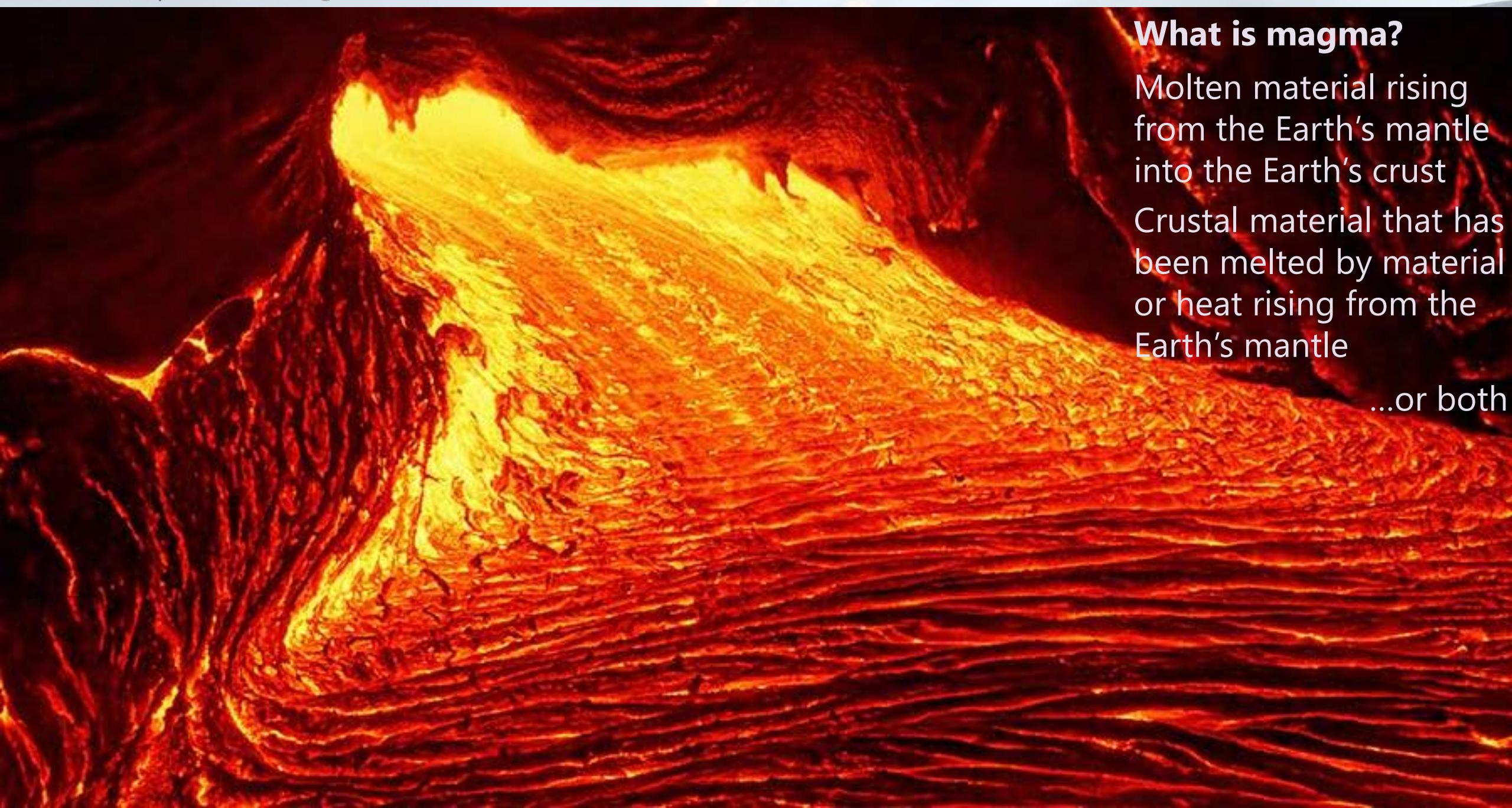












## What is magma?

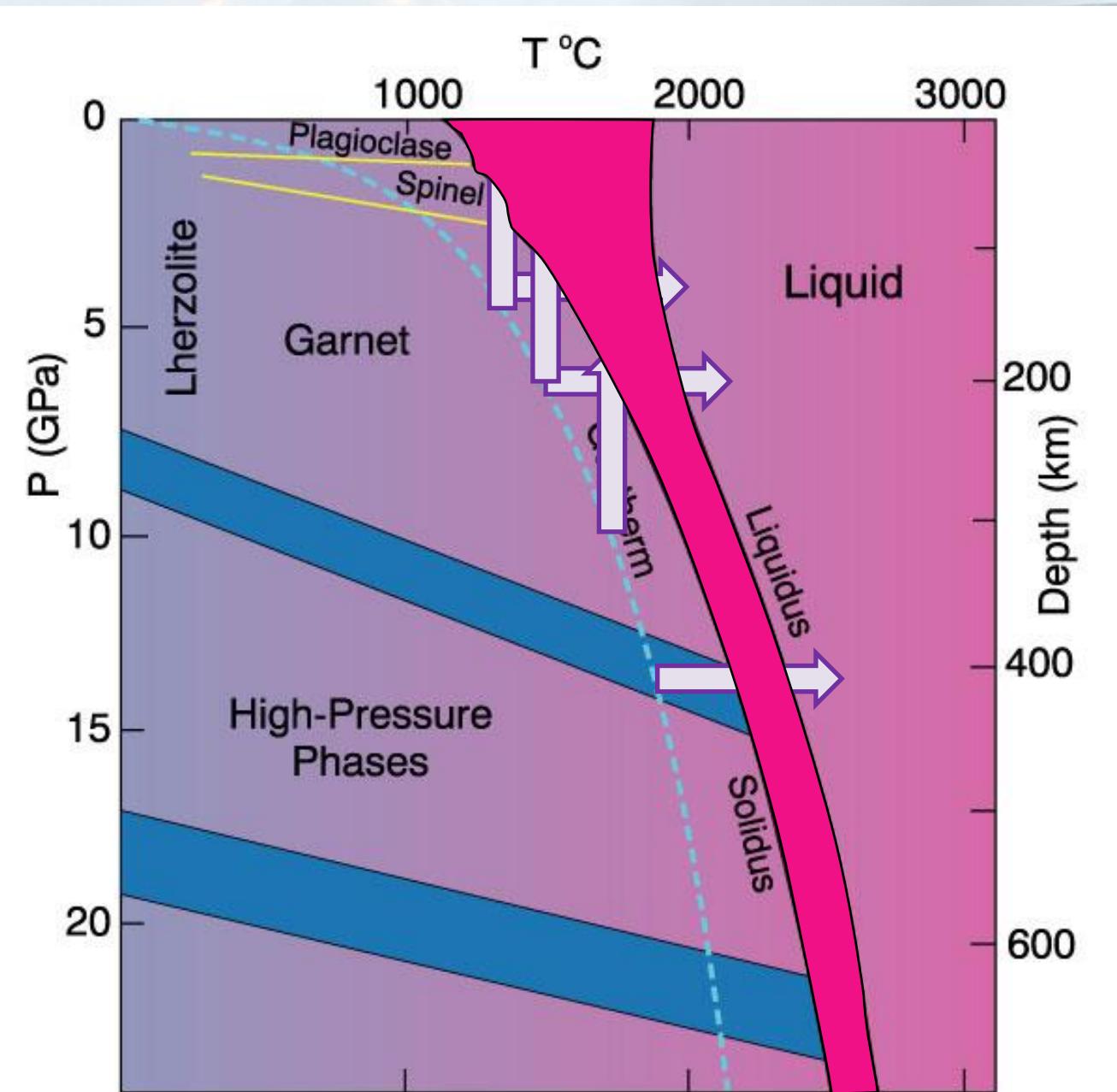
Molten material rising from the Earth's mantle into the Earth's crust

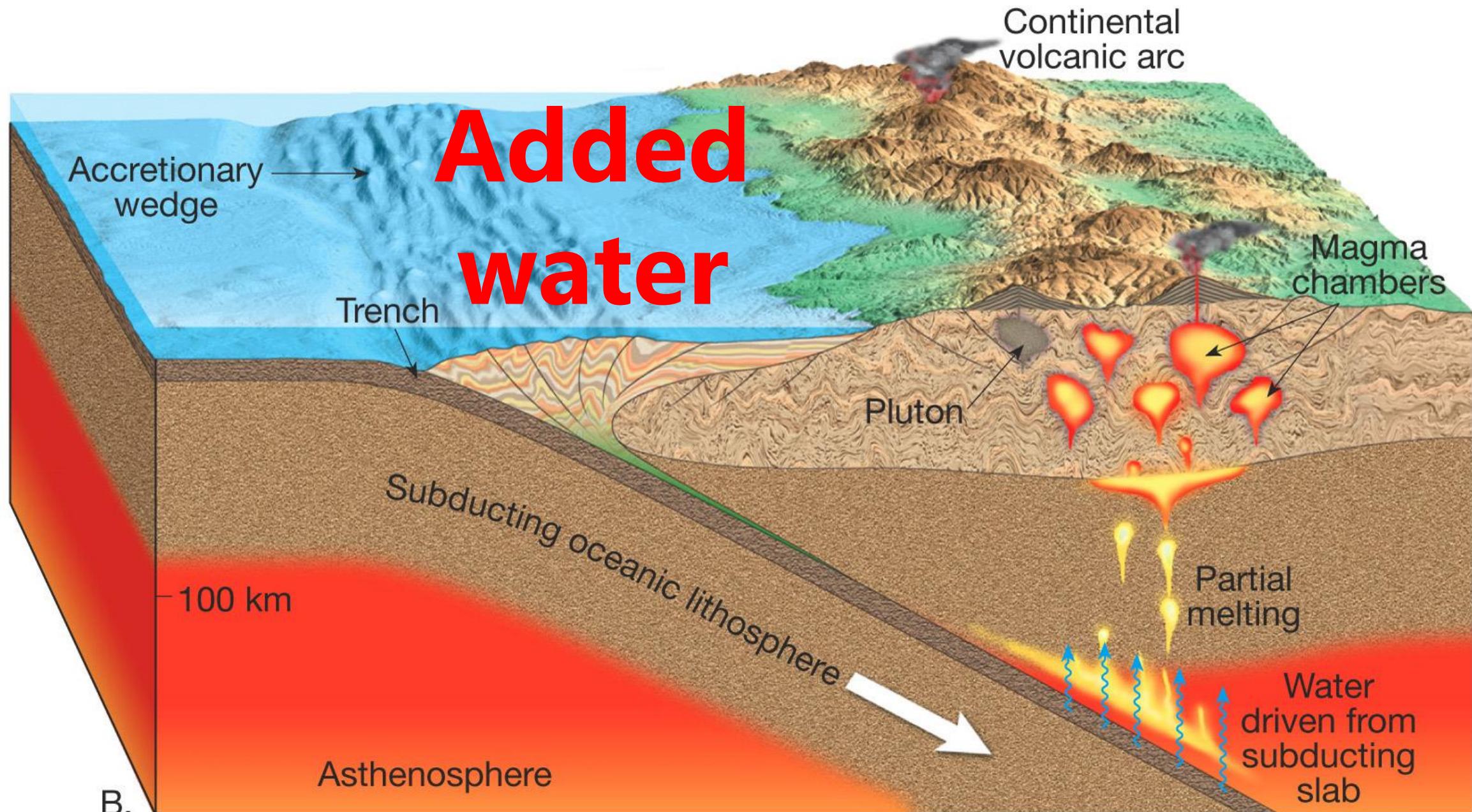
Crustal material that has been melted by material or heat rising from the Earth's mantle

...or both

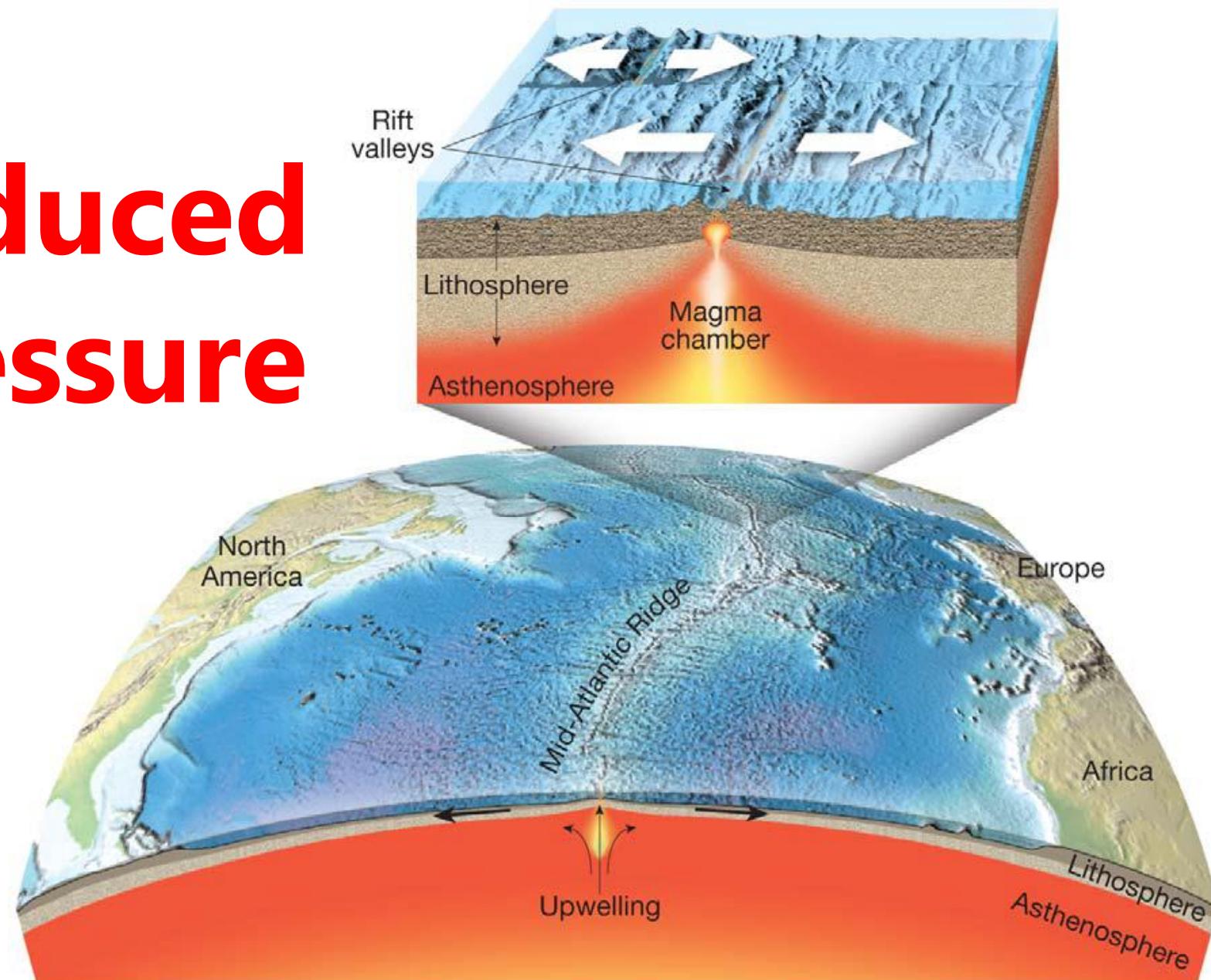
## Three ways:

- Increase the temperature
- Lower the pressure
- Add water

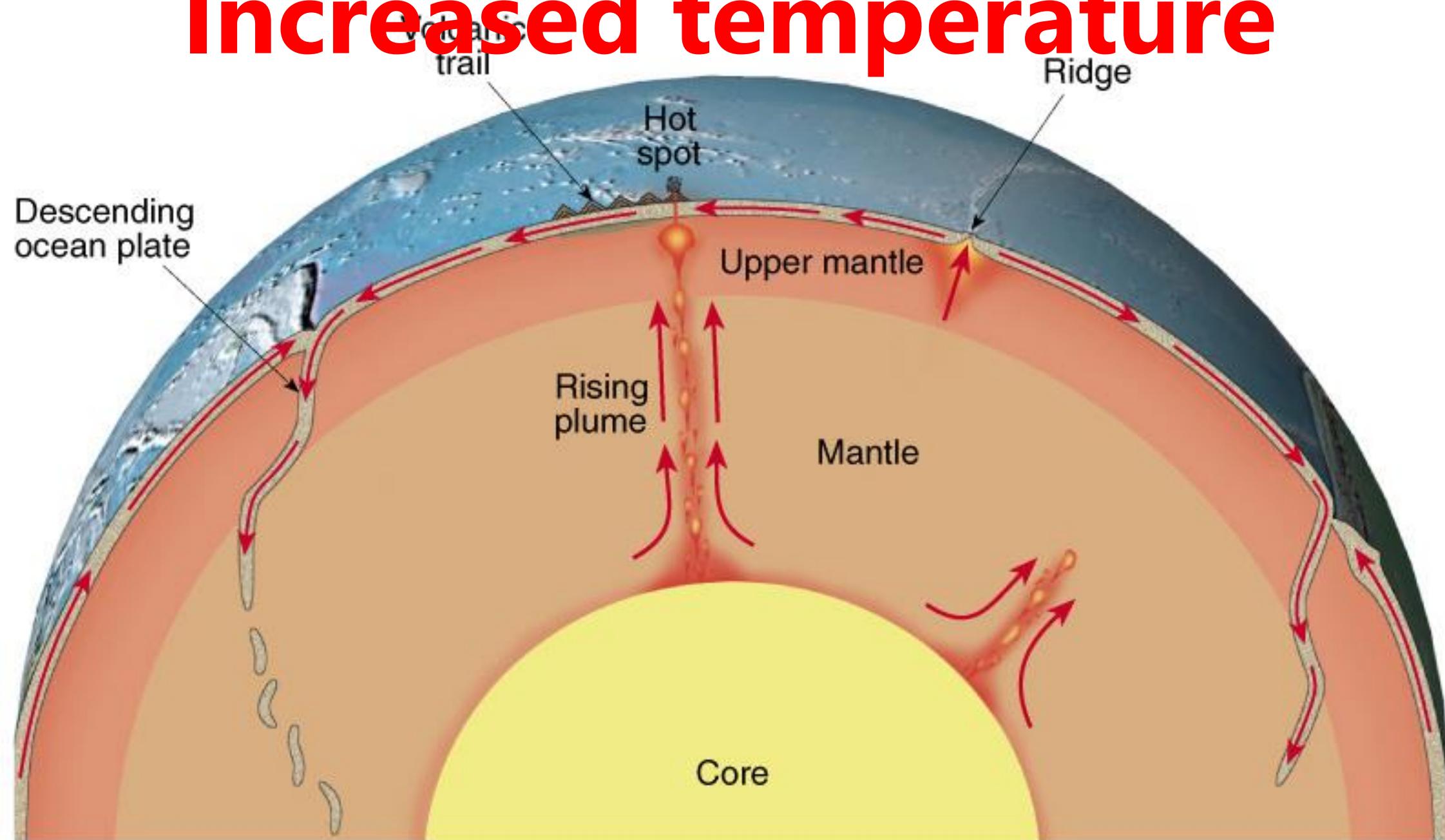


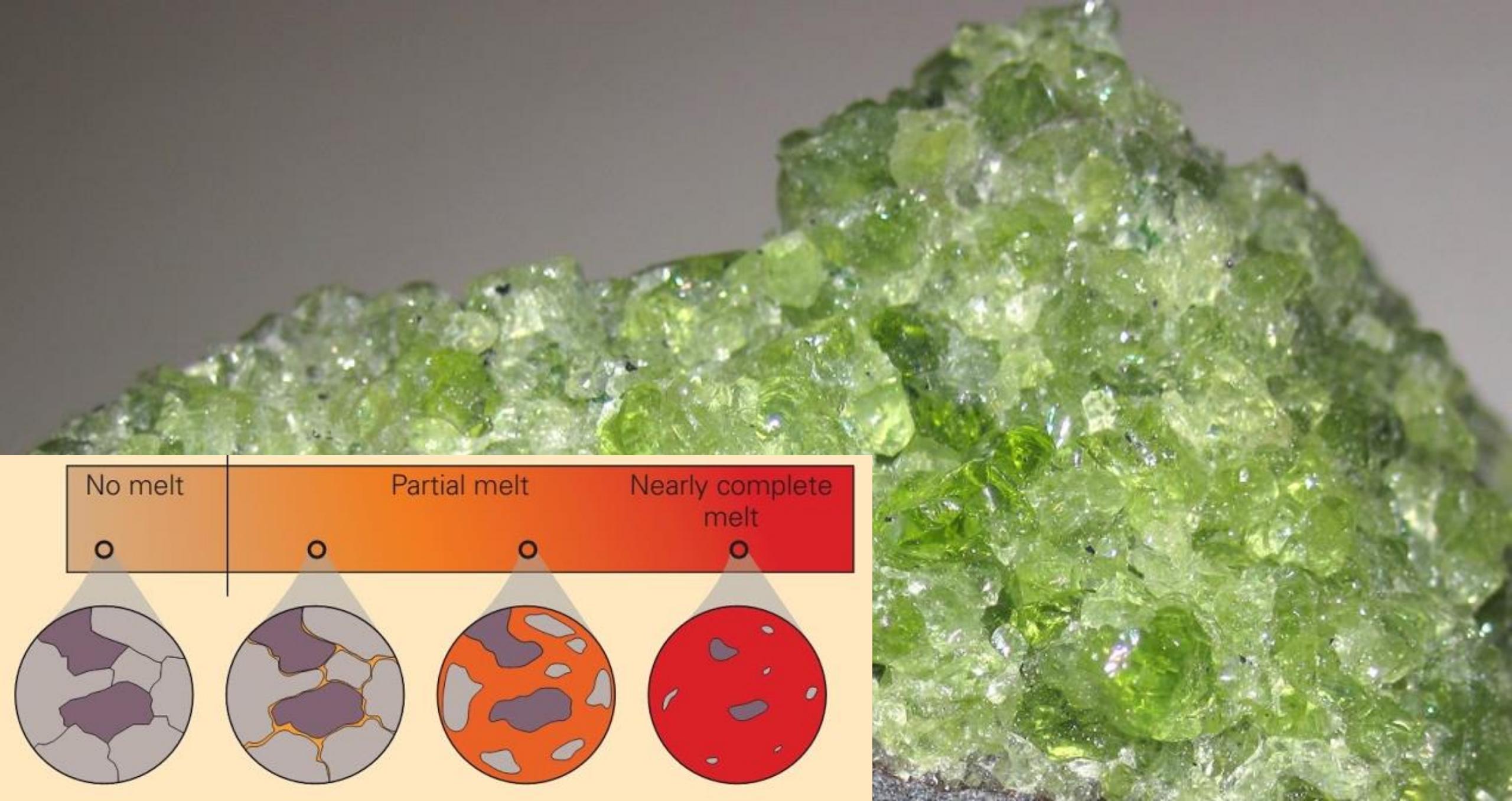


# Reduced pressure



# Increased temperature

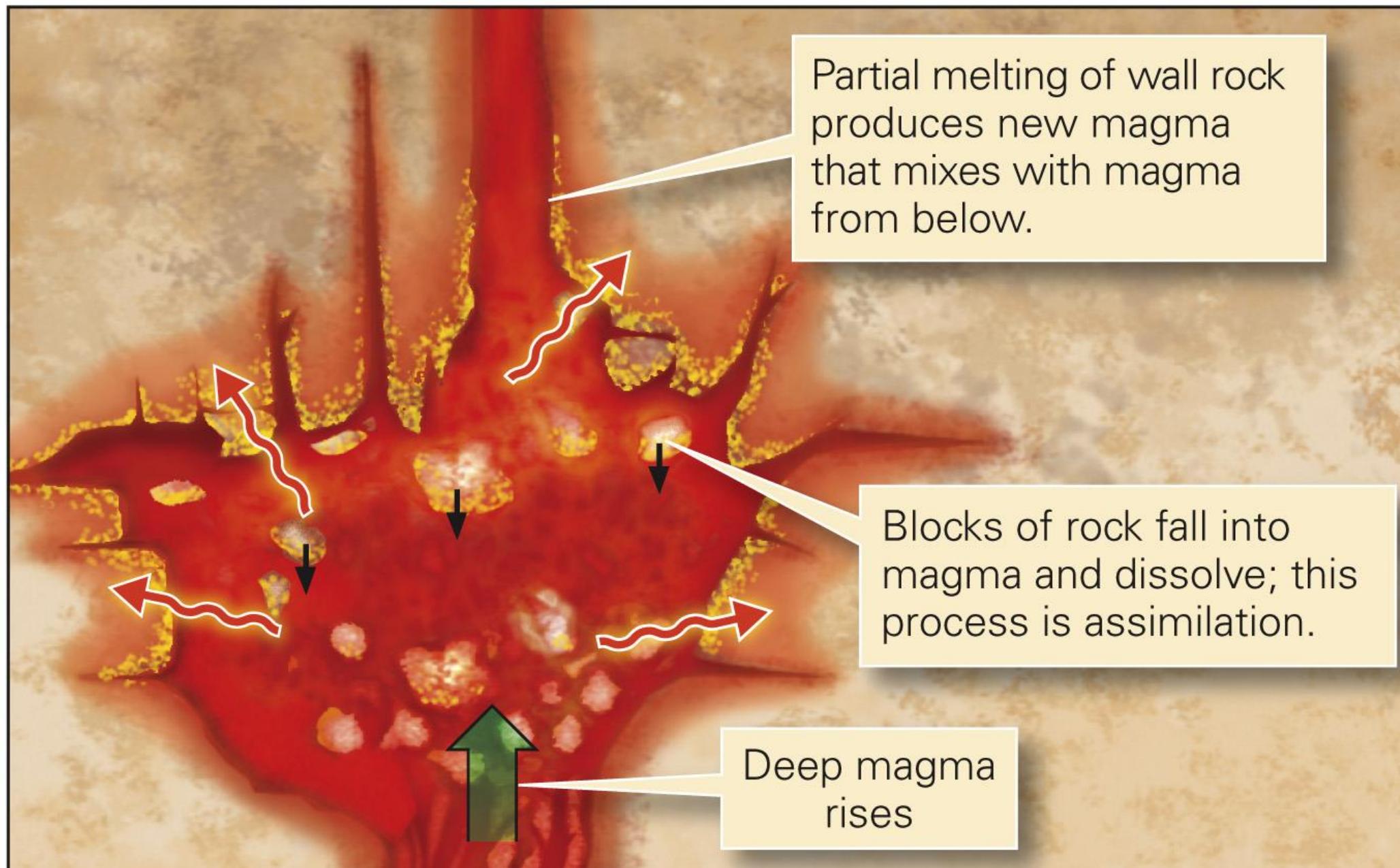


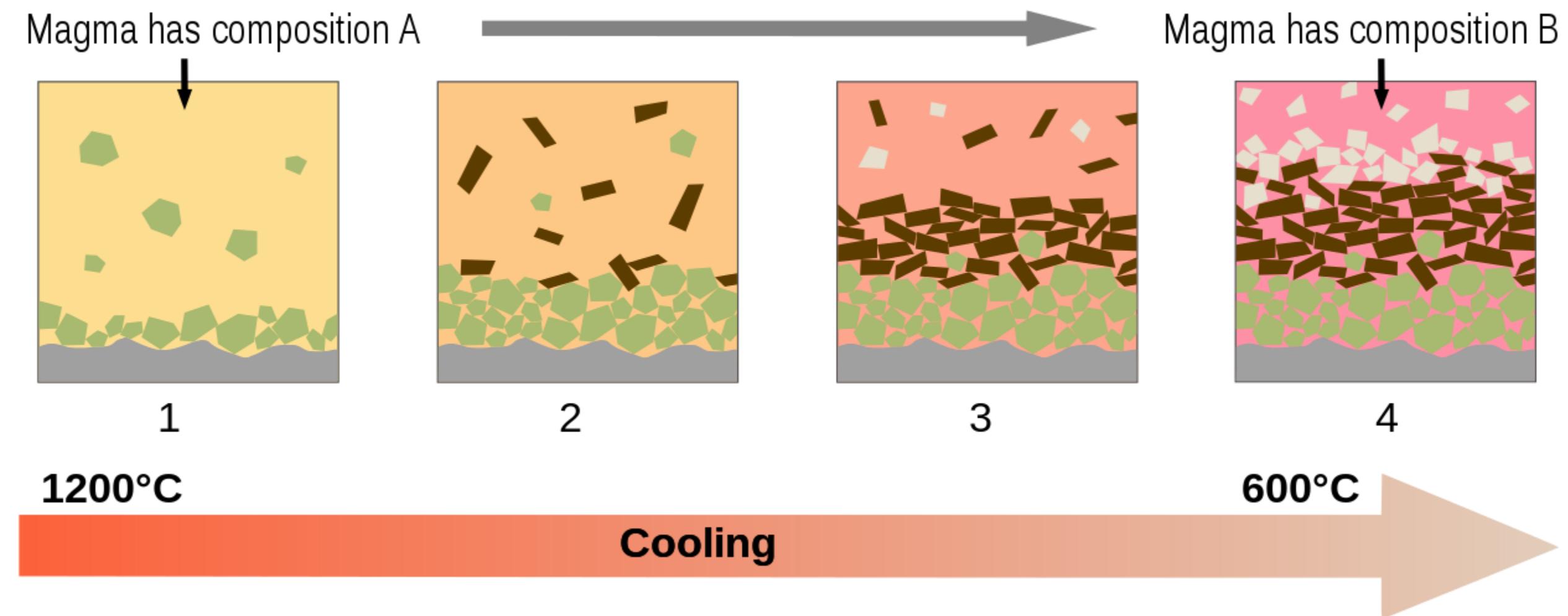


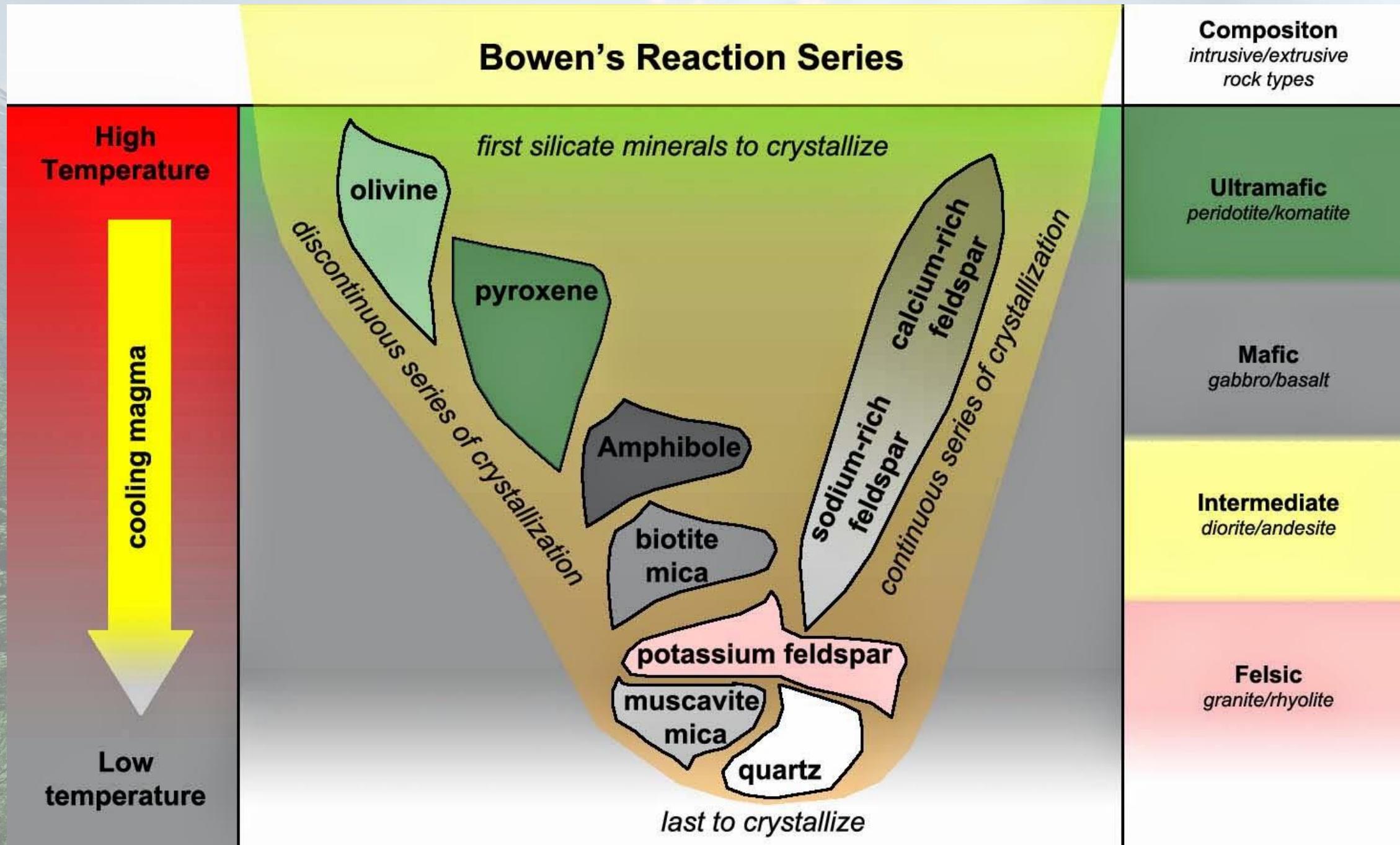


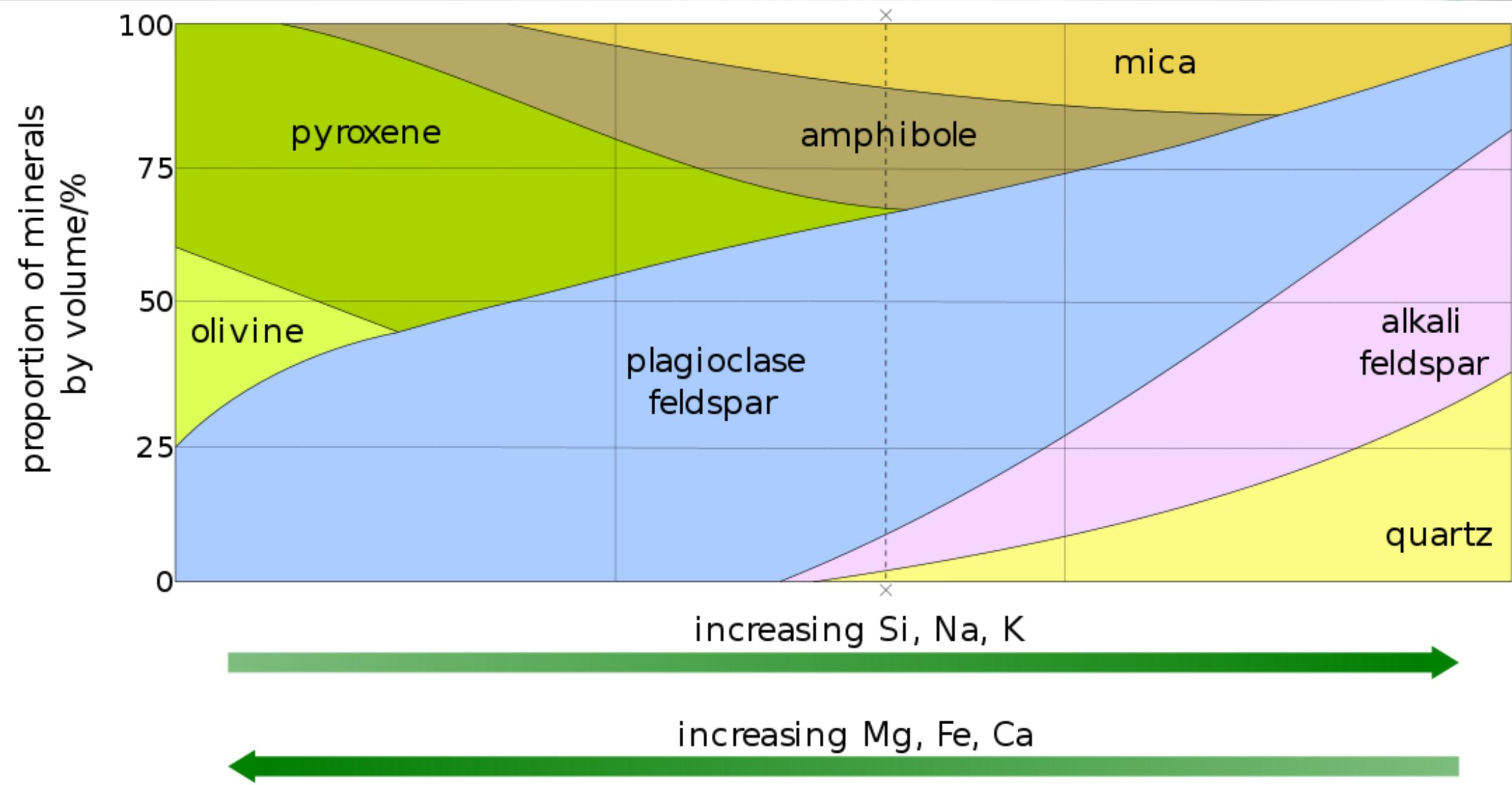
A cartoon character with a large, bulbous nose, wearing round green-tinted glasses and a white lab coat over a green shirt, is shouting with a distressed expression. He is positioned in front of a dark, rocky, and lava-filled volcanic landscape. A speech bubble originates from his mouth, containing the text:

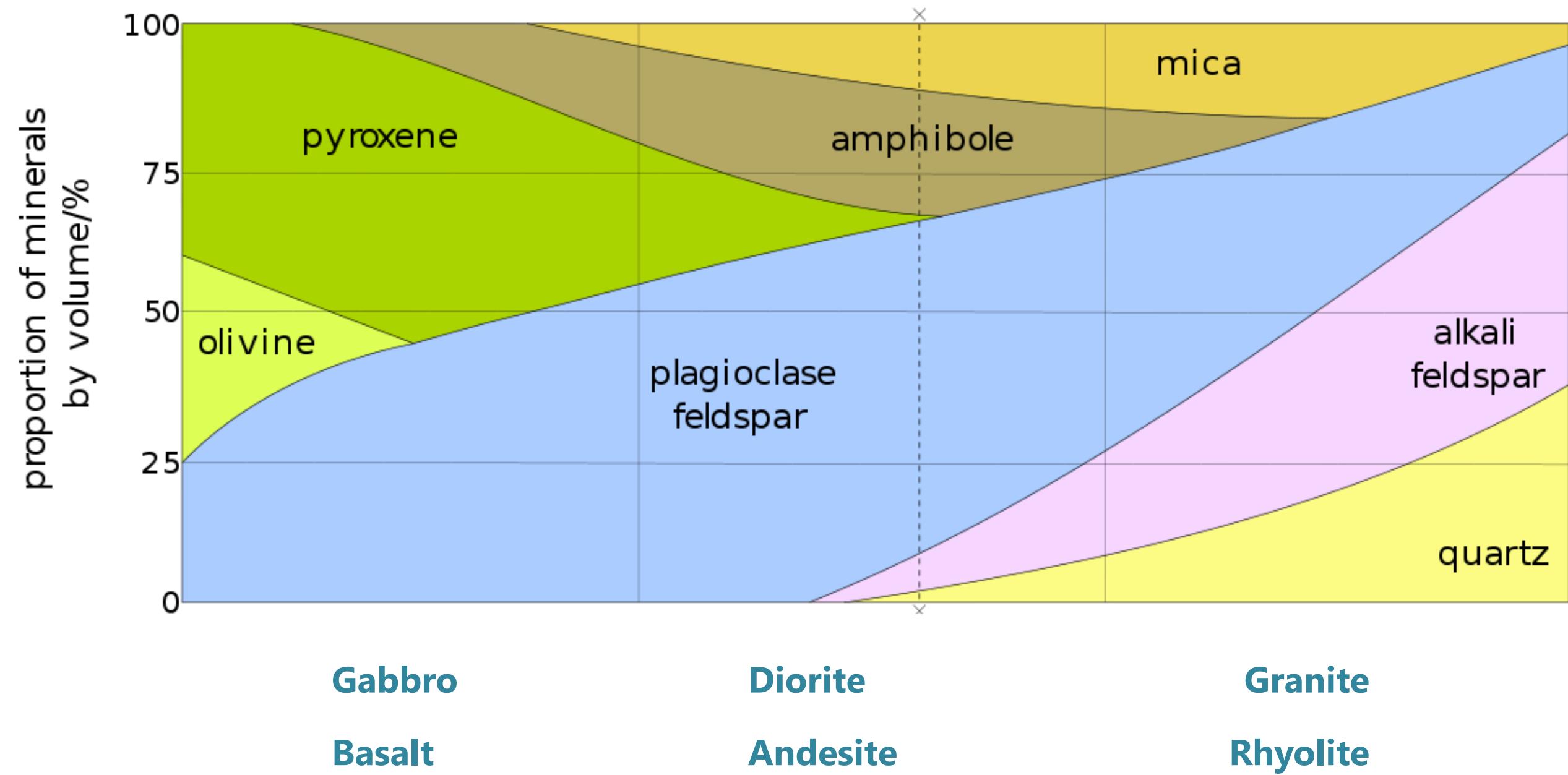
**PROFESSOR!**  
**LAVA!**  
**HOT!**

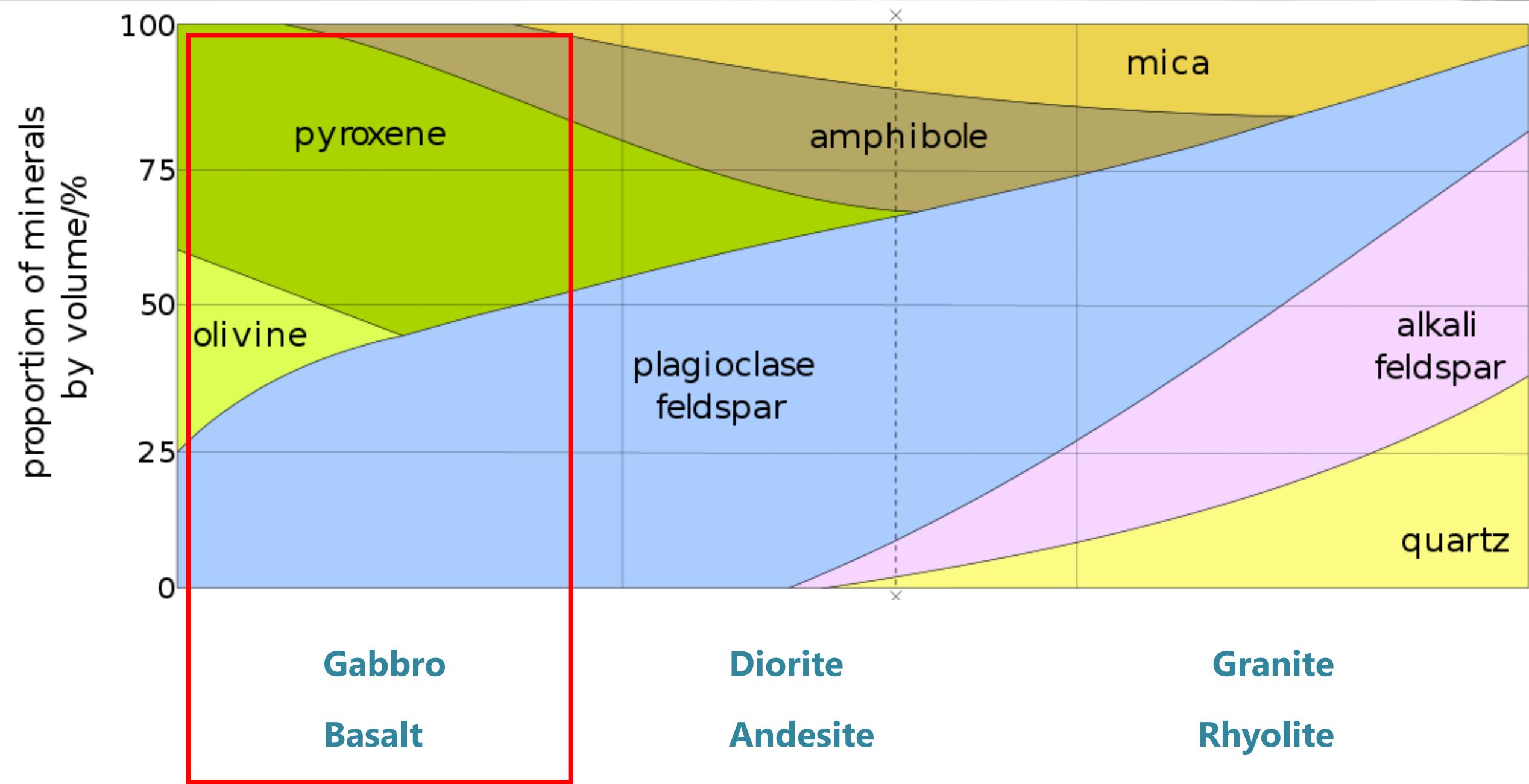












# INTRUSION

**GABBRO**

Coarse-Medium

*Phaneritic*

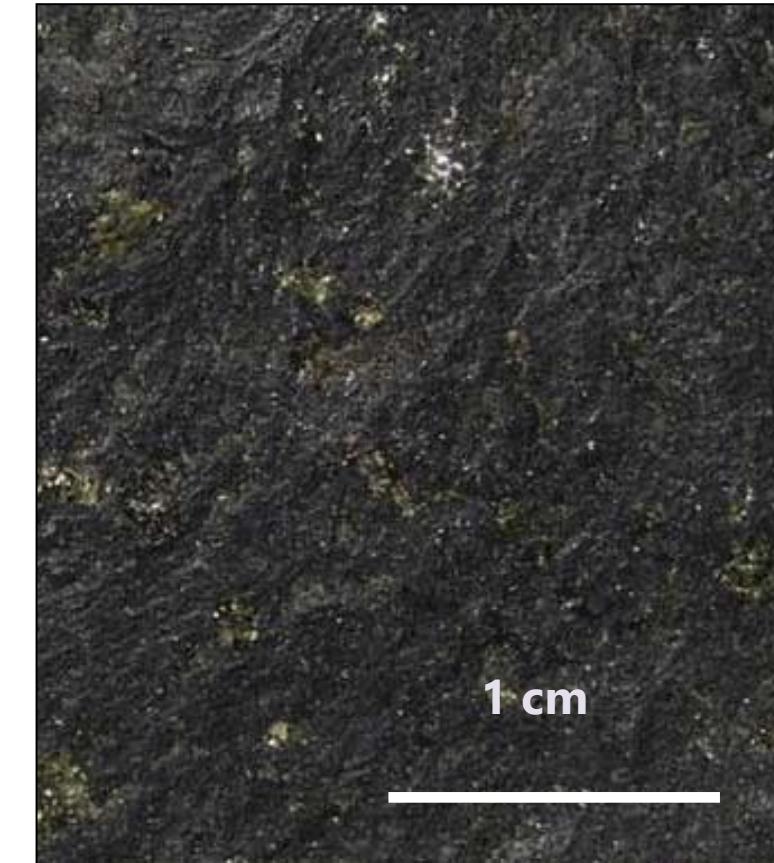


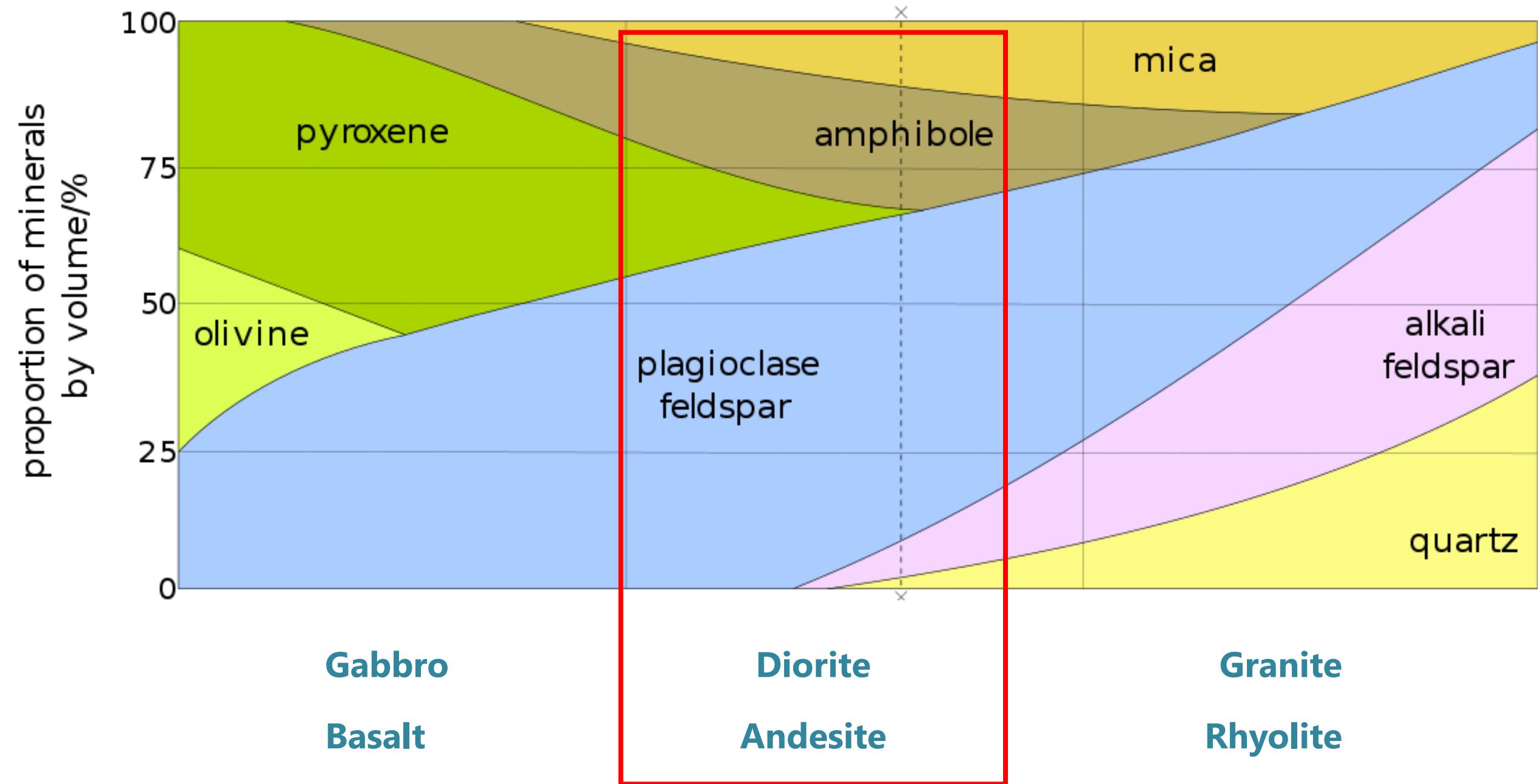
# ERUPTION

**BASALT**

Fine

*Aphanitic/porphyritic*





# INTRUSION

**DIORITE**

Coarse-Medium

*Phaneritic*



# ERUPTION

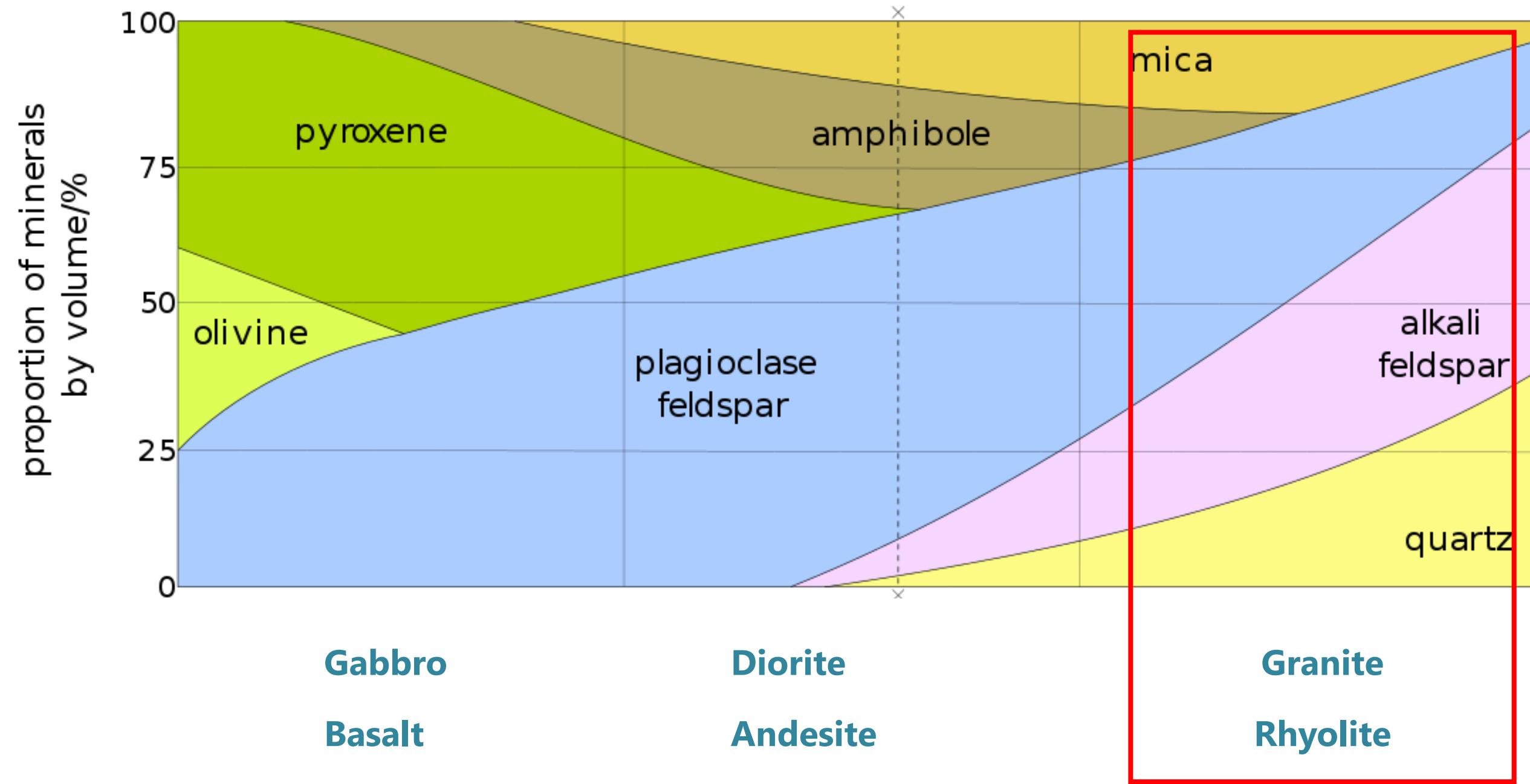
**ANDESITE**

Fine

*Aphanitic/porphyritic*



1 cm



# INTRUSION

## GRANITE

Coarse

*Phaneritic/porphyritic*

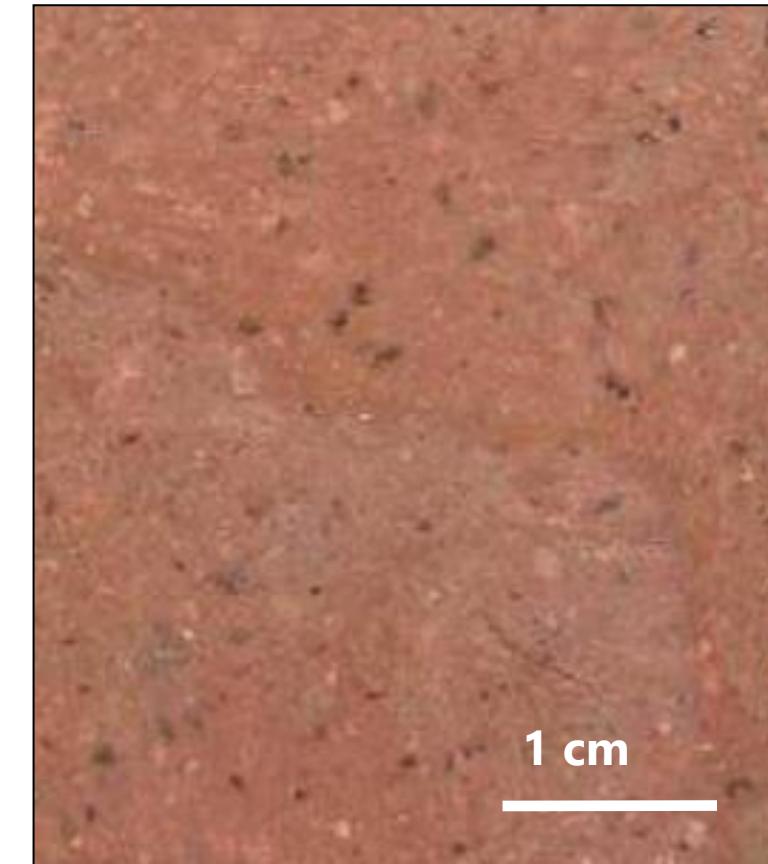


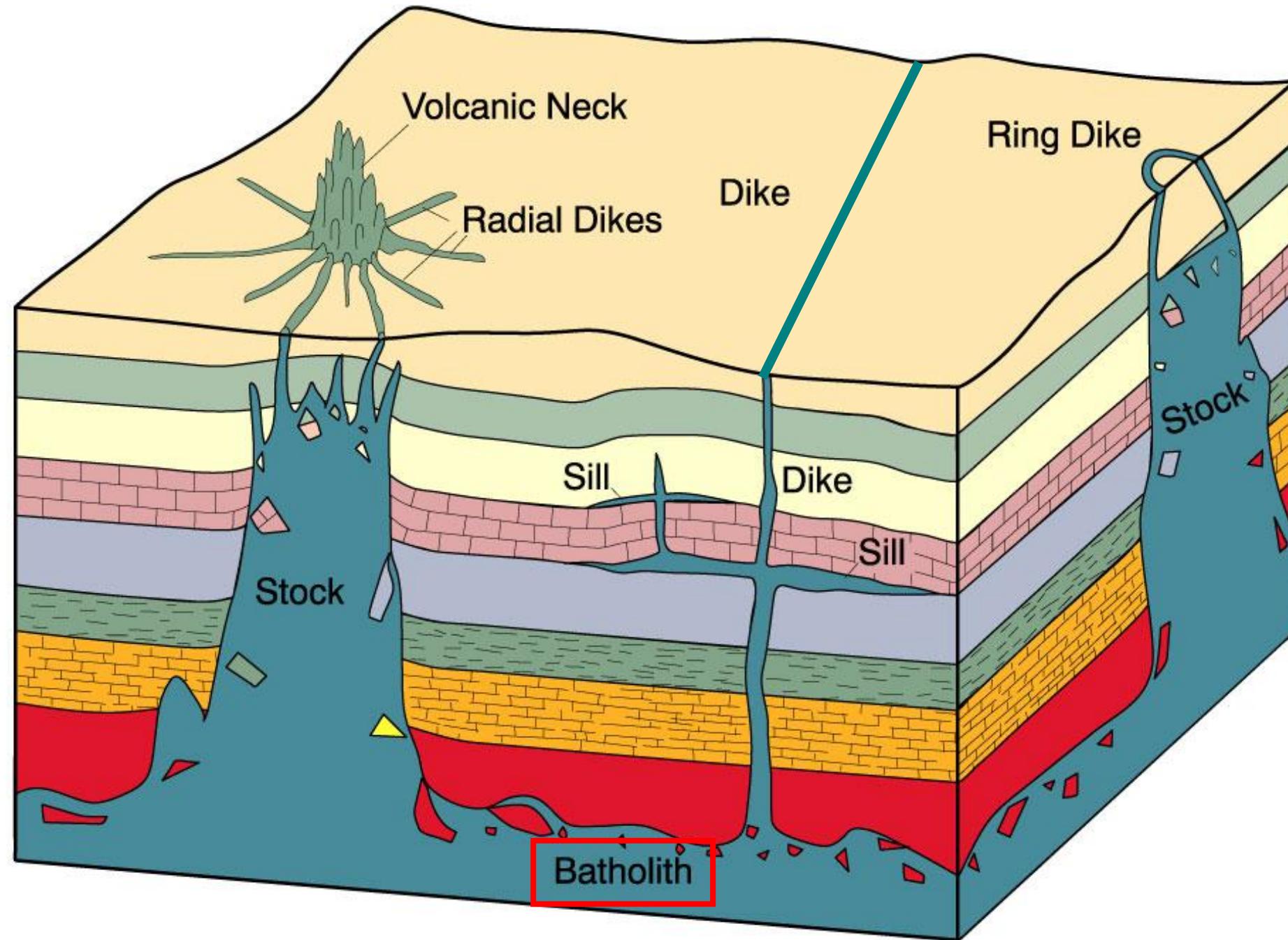
# ERUPTION

## RHYOLITE

Fine

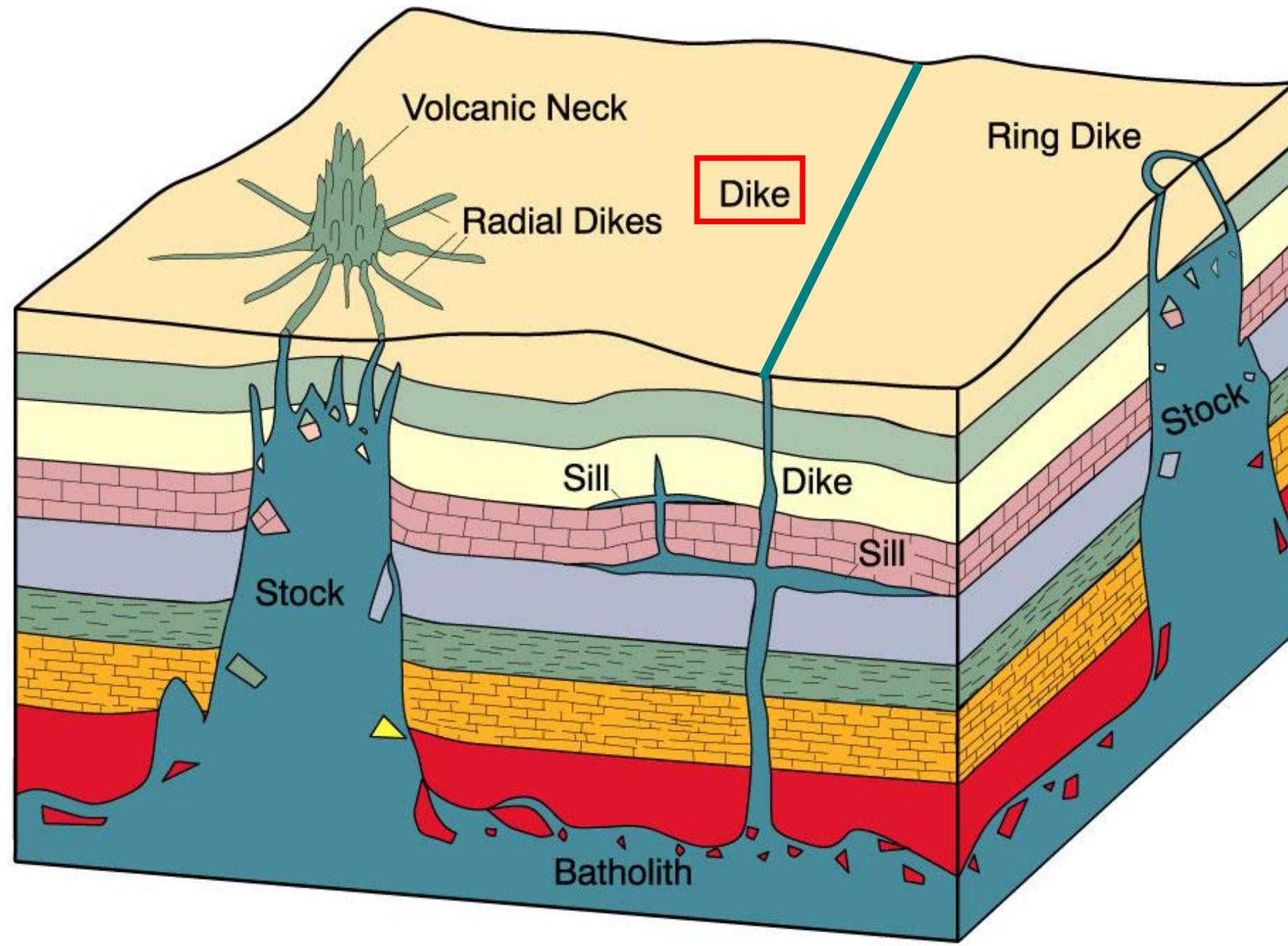
*Aphanitic*







**Yosemite National Park**  
California

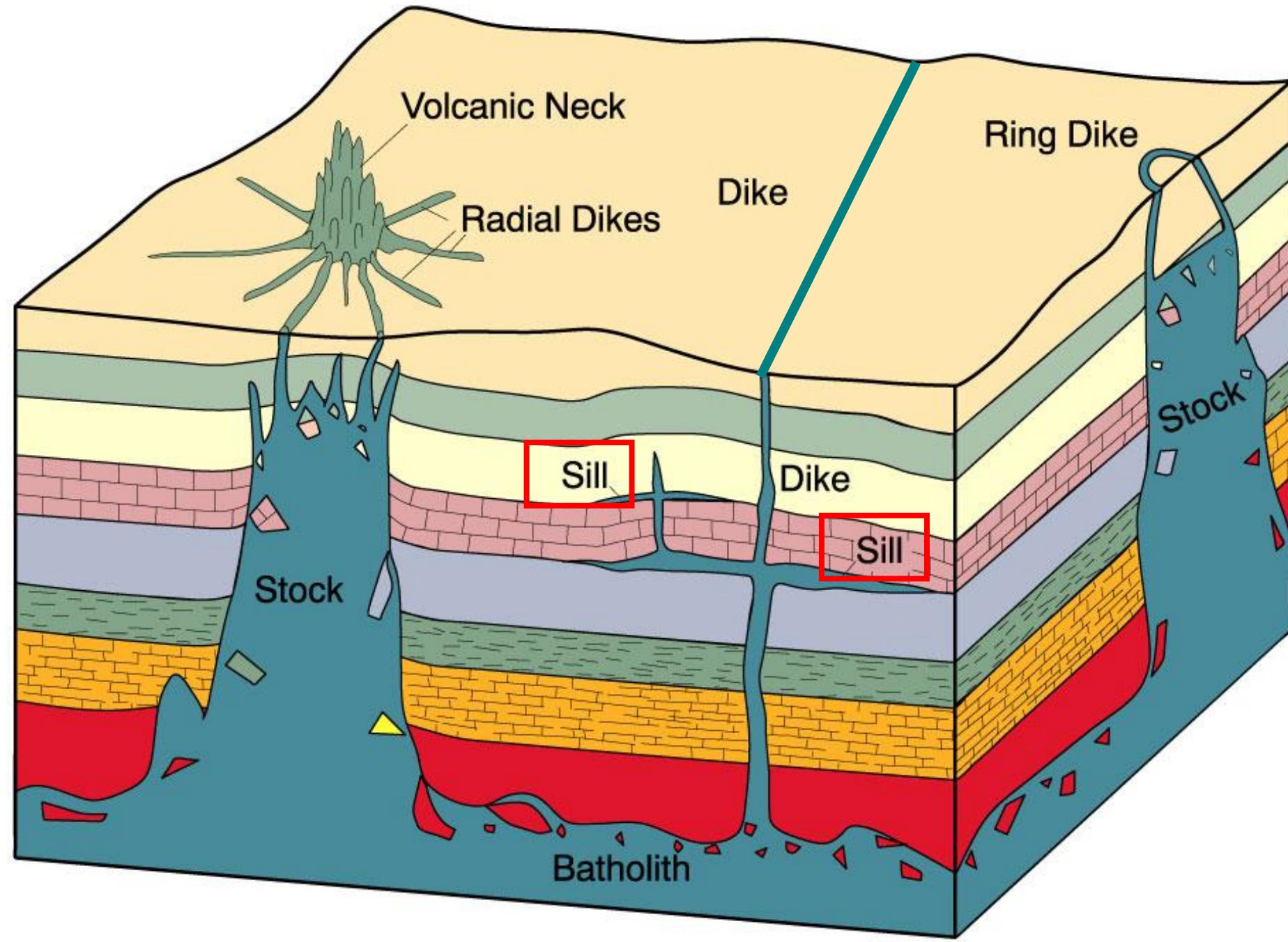


**Achill**  
Mayo



**Knockmahon**  
Waterford



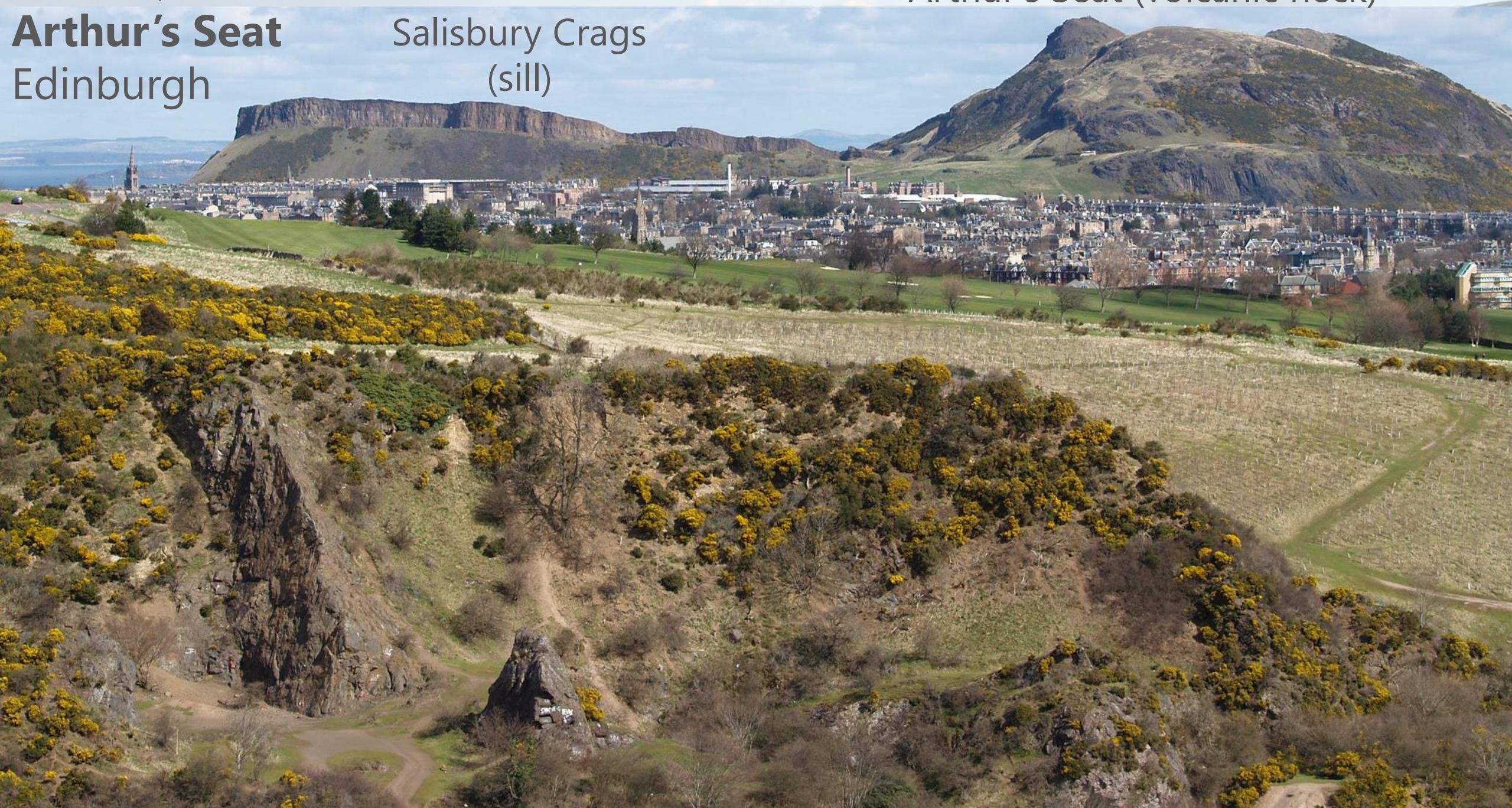


Volcanoes | Sills

# Arthur's Seat Edinburgh

Arthur's Seat (volcanic neck) GY4051

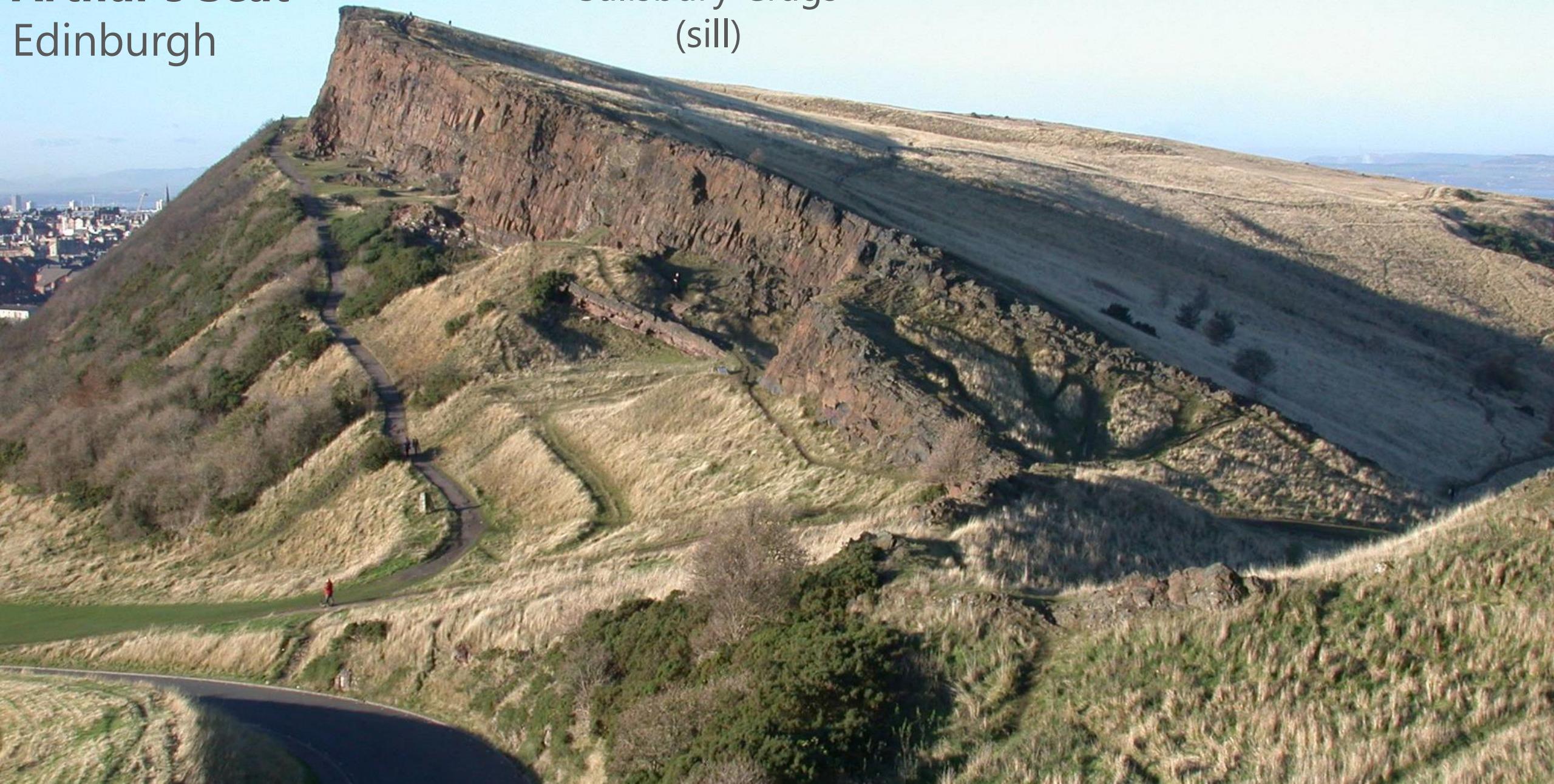
Salisbury Crags  
(sill)

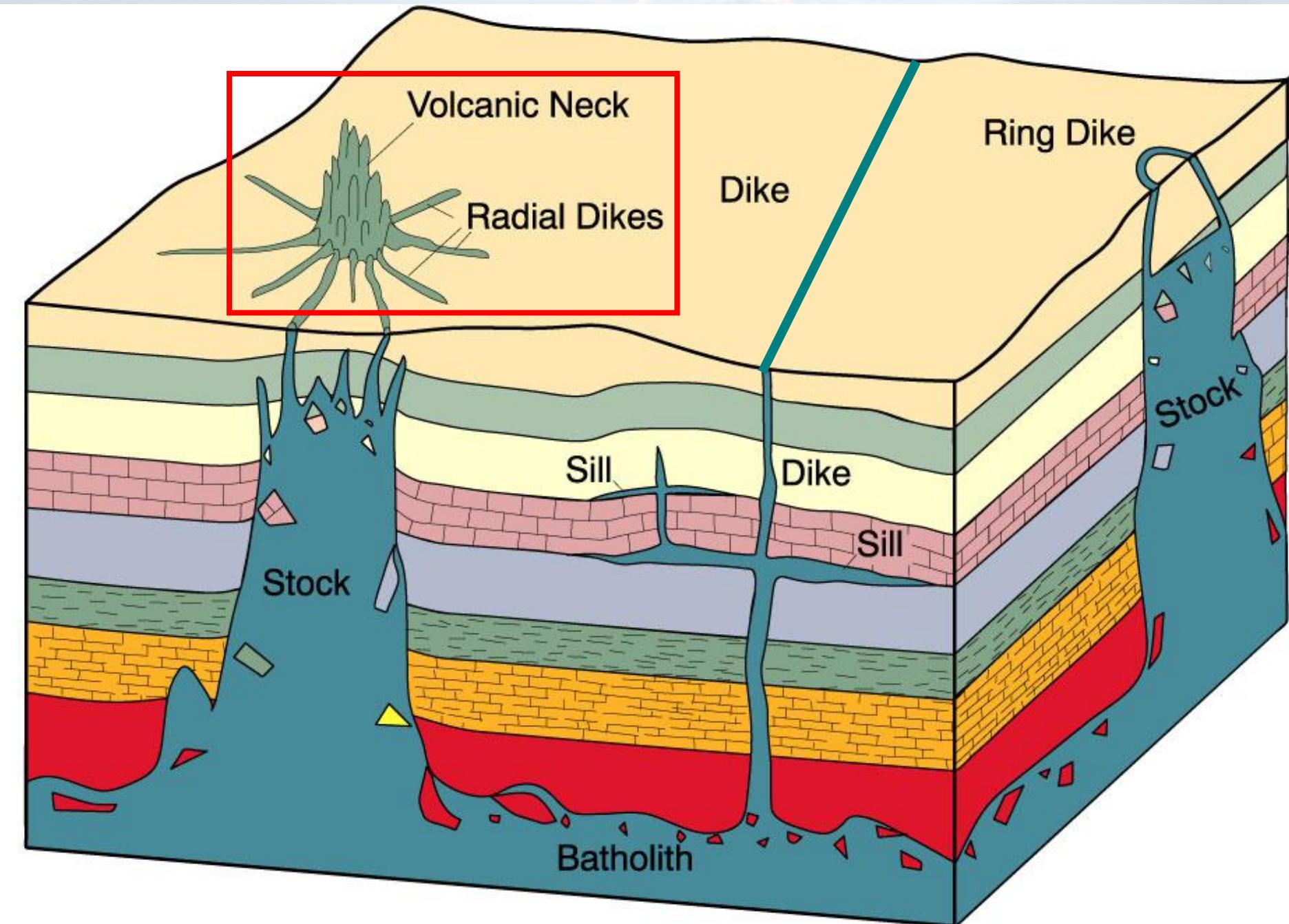


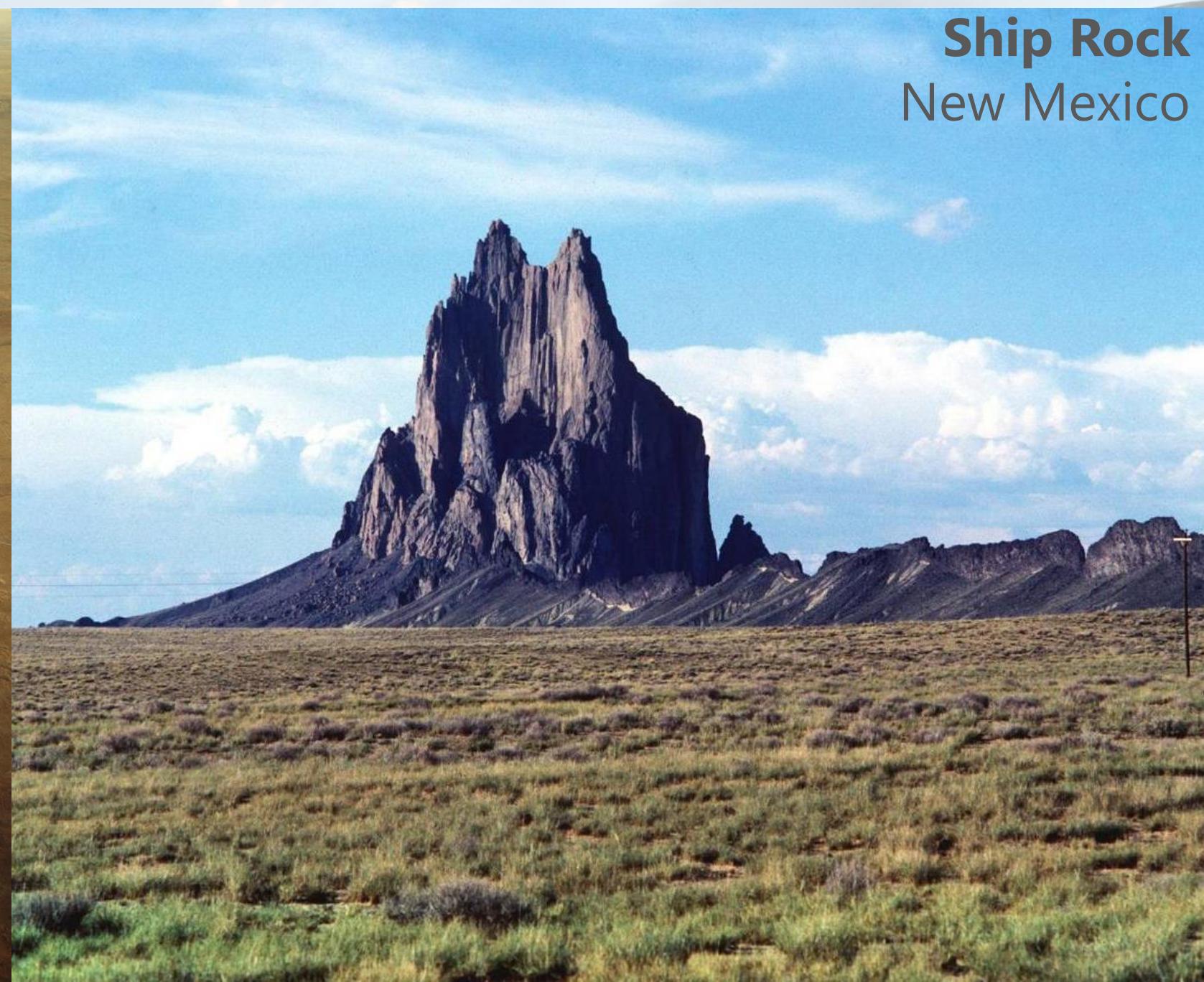
# Arthur's Seat

## Edinburgh

Salisbury Crags  
(sill)







**Ship Rock**  
New Mexico





© Leigh Hilbert Photography





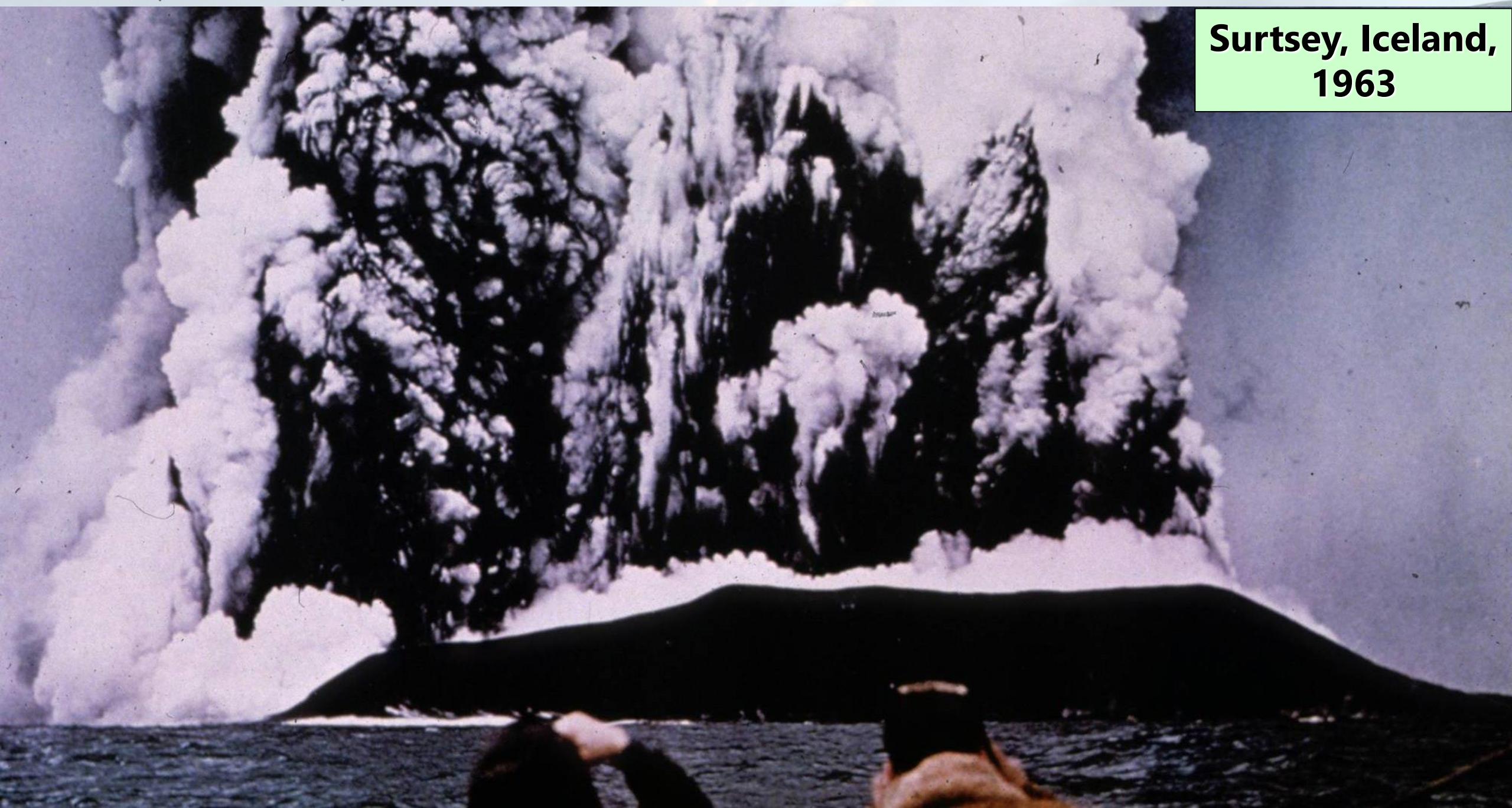




... during ...

**... after**





**Surtsey, Iceland,  
1963**

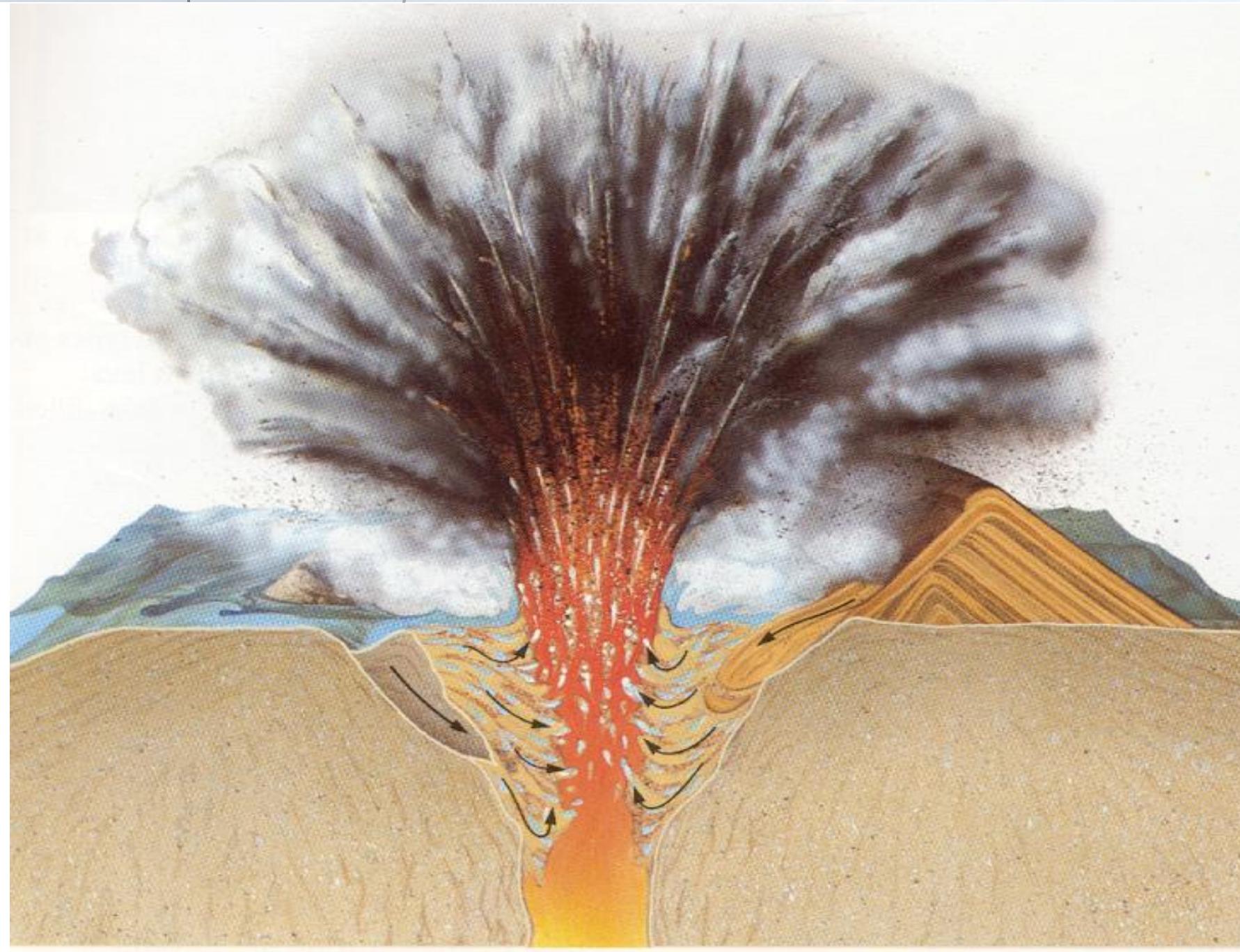


Eyjafjallajökull, 2010

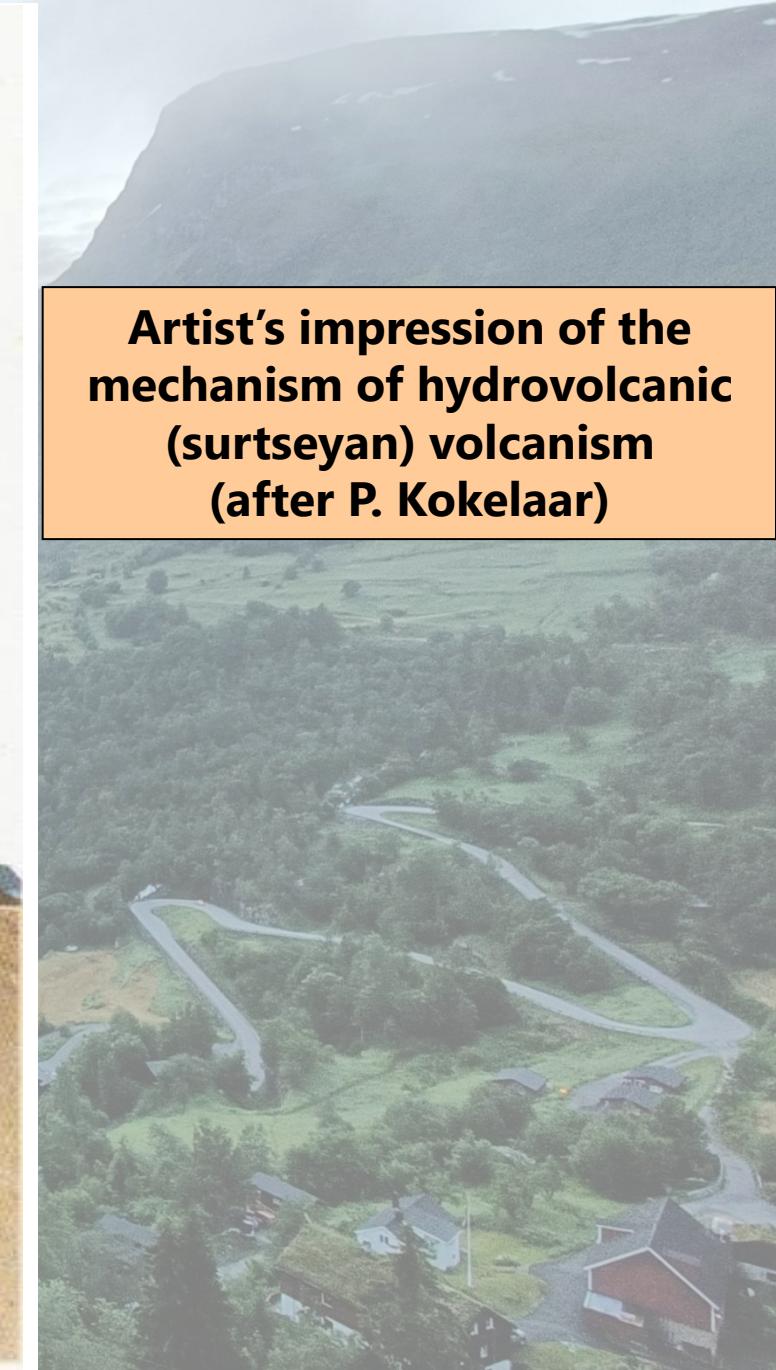


Eyjafjallajökull, 2010

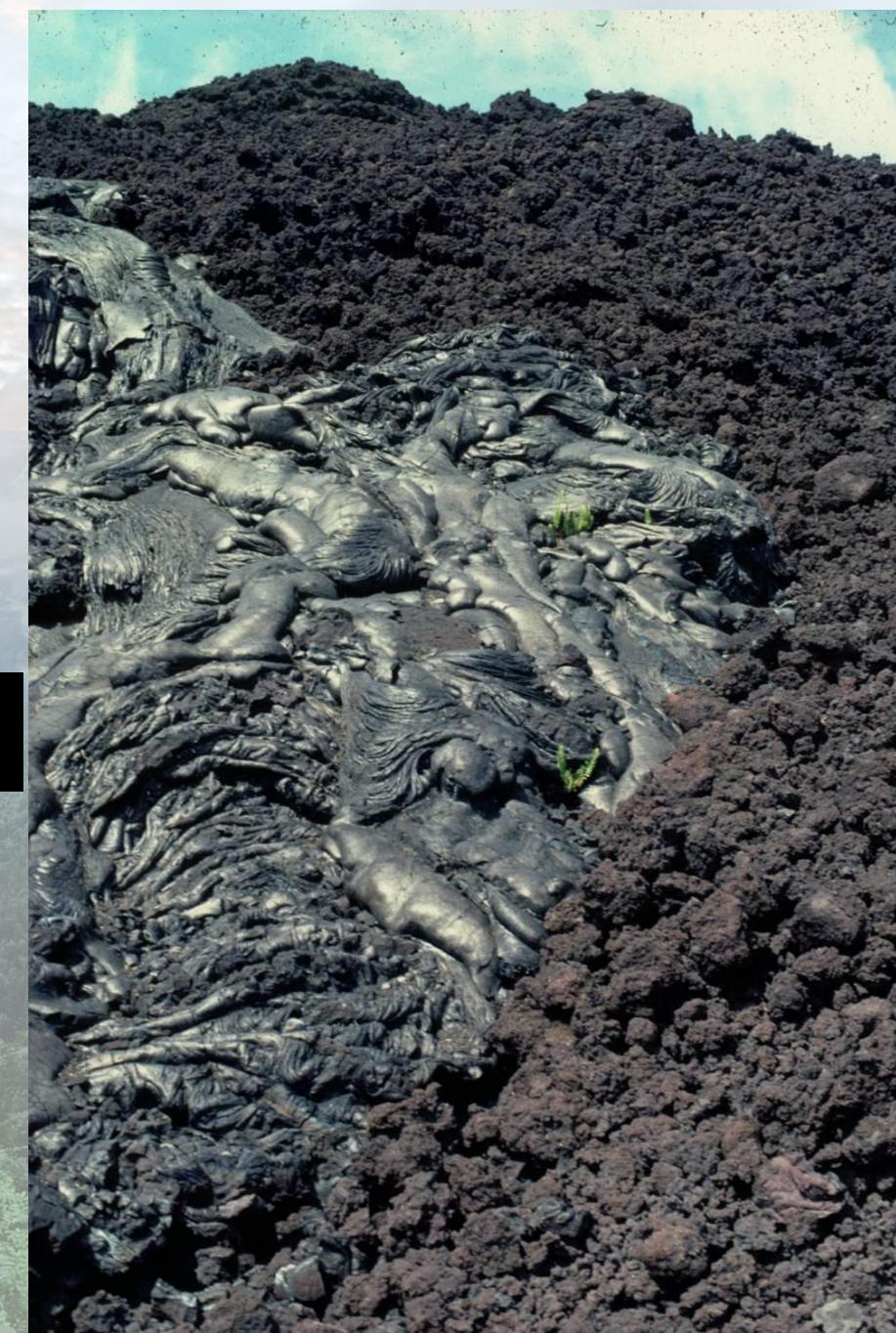
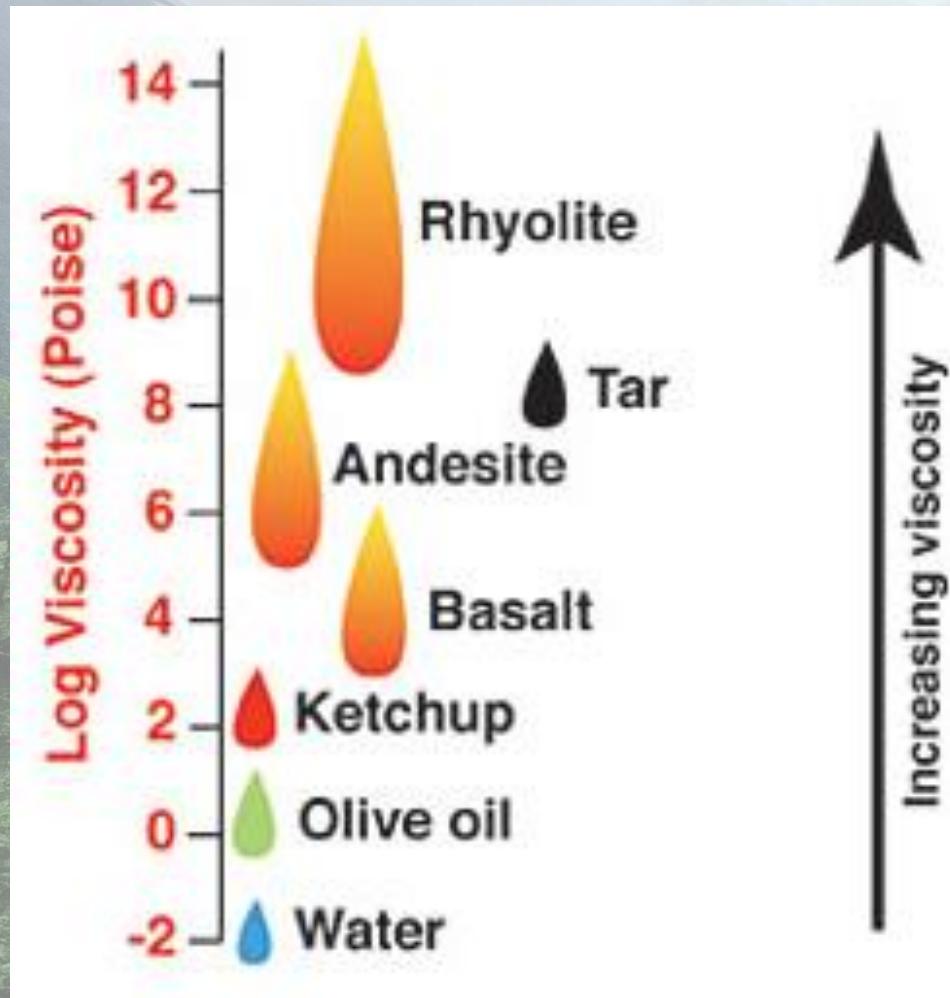
FLIGHT

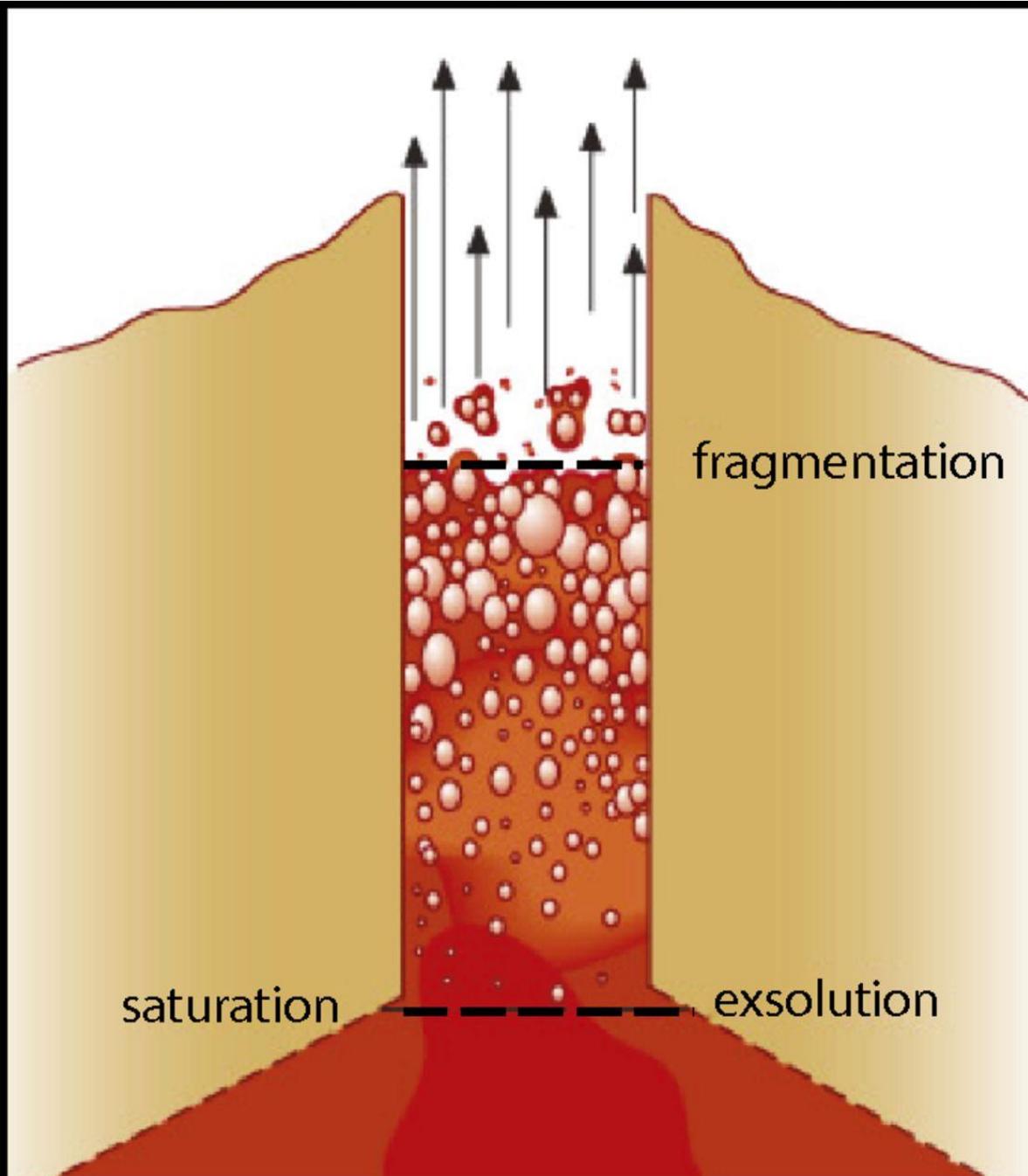


**Artist's impression of the  
mechanism of hydrovolcanic  
(surtseyan) volcanism  
(after P. Kokelaar)**





























**Montserrat**

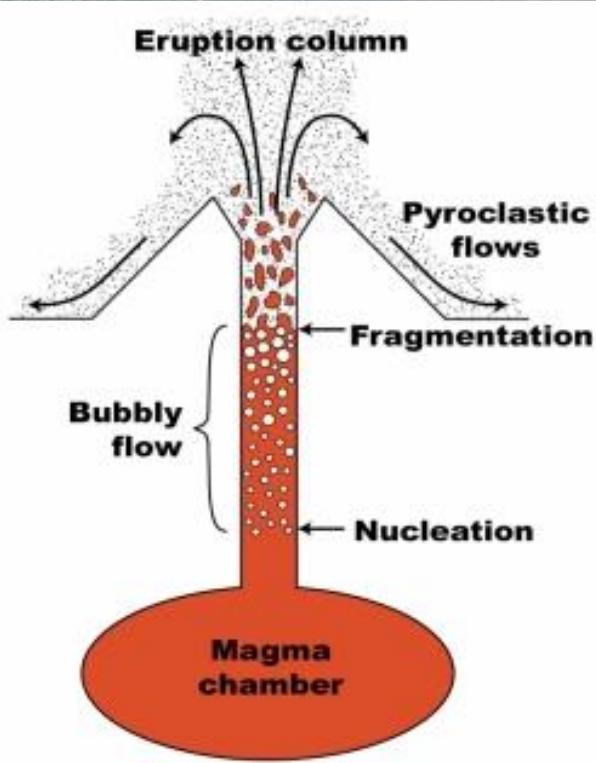


Taal, Phillipines, 14 January 2022



Mayon Volcano,  
Philippines, 1984

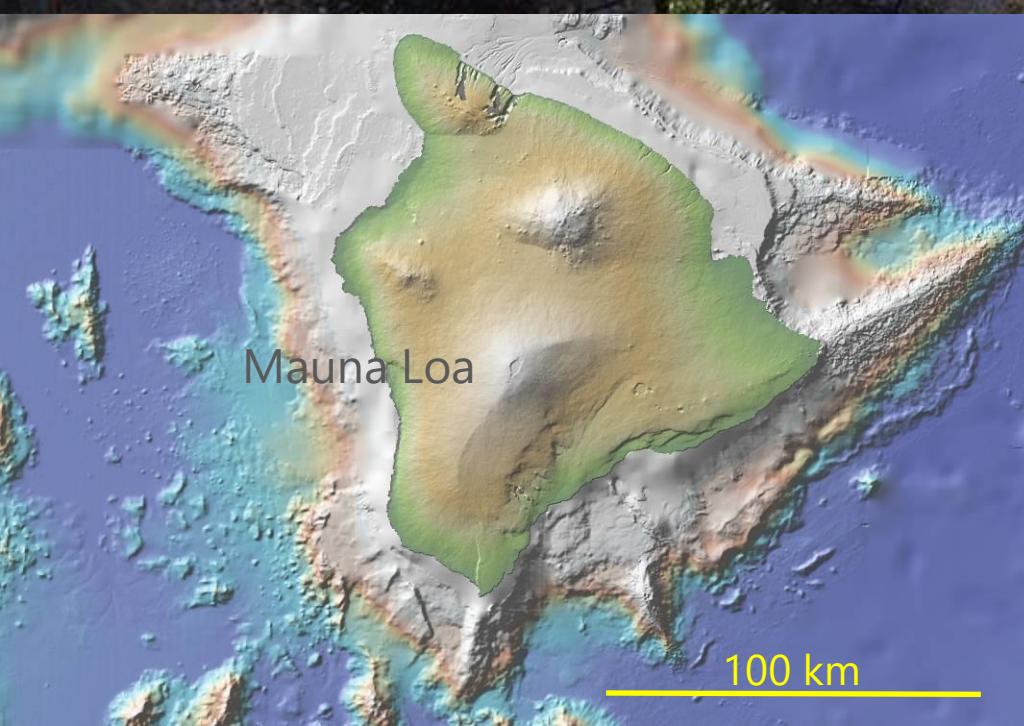
Unzen, Japan,  
June 24, 1993







Pompeii was overwhelmed by a pyroclastic flow during the AD 79 eruption of Vesuvius



# Composite volcanoes

have what we think of as typical  
volcano shapes

A composite volcano, Mount Mayon, viewed from across a valley filled with green rice fields.

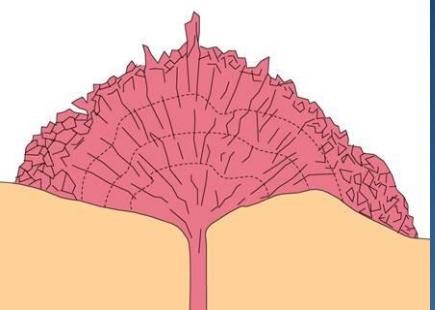
**Mayon**  
Philippines



## Composite volcanoes

have what we think of as typical  
volcano shapes

Mt Fuji, Japan



**Mt. Lassen**  
Cascades

# Laki Iceland



# Types of volcano drawn at the same scale



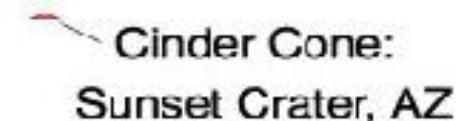
Shield Volcano: Mauna Loa, HI  
basic lava (low viscosity)



Composite Volcano:  
Mt. Rainier, WA.



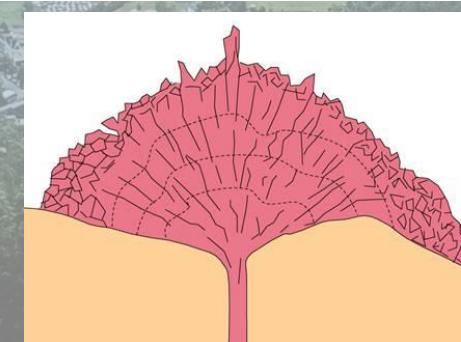
Dome:  
Lassen Peak, CA



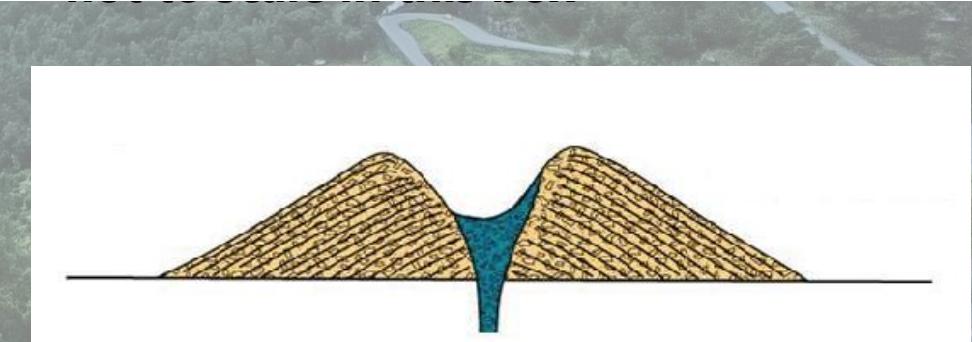
Cinder Cone:  
Sunset Crater, AZ



lava and ash

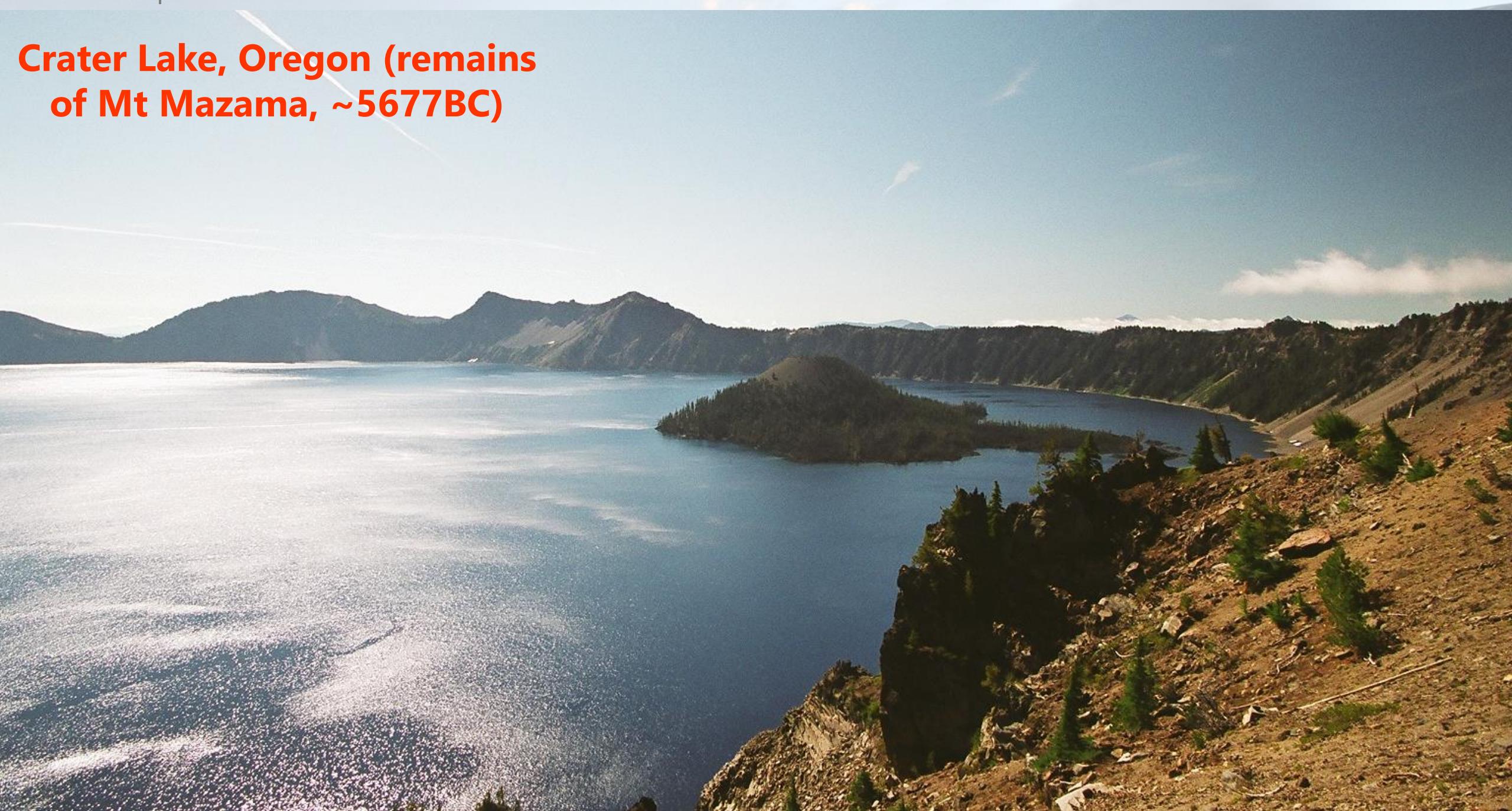


silicic lava  
(high viscosity)



cinders and  
volcanic bombs

**Crater Lake, Oregon (remains  
of Mt Mazama, ~5677BC)**





# Solfatara Crater, Campi Flegrei, Napoli



# Solfatara Crater, Campi Flegrei, Napoli



The mythological home of the  
Roman God of Fire, Vulcan

# Solfatara Crater, Campi Flegrei, Napoli



Still has hot mud pools and volcanic gas vents called fumaroles. Closed to tourists since 3 died in 2017.

# Solfatara Crater, Campi Flegrei, Napoli



# Solfatara Crater, Campi Flegrei, Napoli



Large rock ejected from eruption of Solfatara crater, visible in the roadside right behind where I took the previous photo

# Monte Nuovo Crater



# Monte Nuovo Crater



Name literally means “New Mountain”  
– it formed in 1538

# Vesuvius crater



**The buildings in Pompeii, like this one...**



**...are literally made  
from volcanic ash**



# Naples, Italy – as seen from the crater of Vesuvius



# Naples, Italy – as seen from the crater of Vesuvius

The islands and peninsulas at the far end of the bay are in Campi Flegrei



Lava flow



