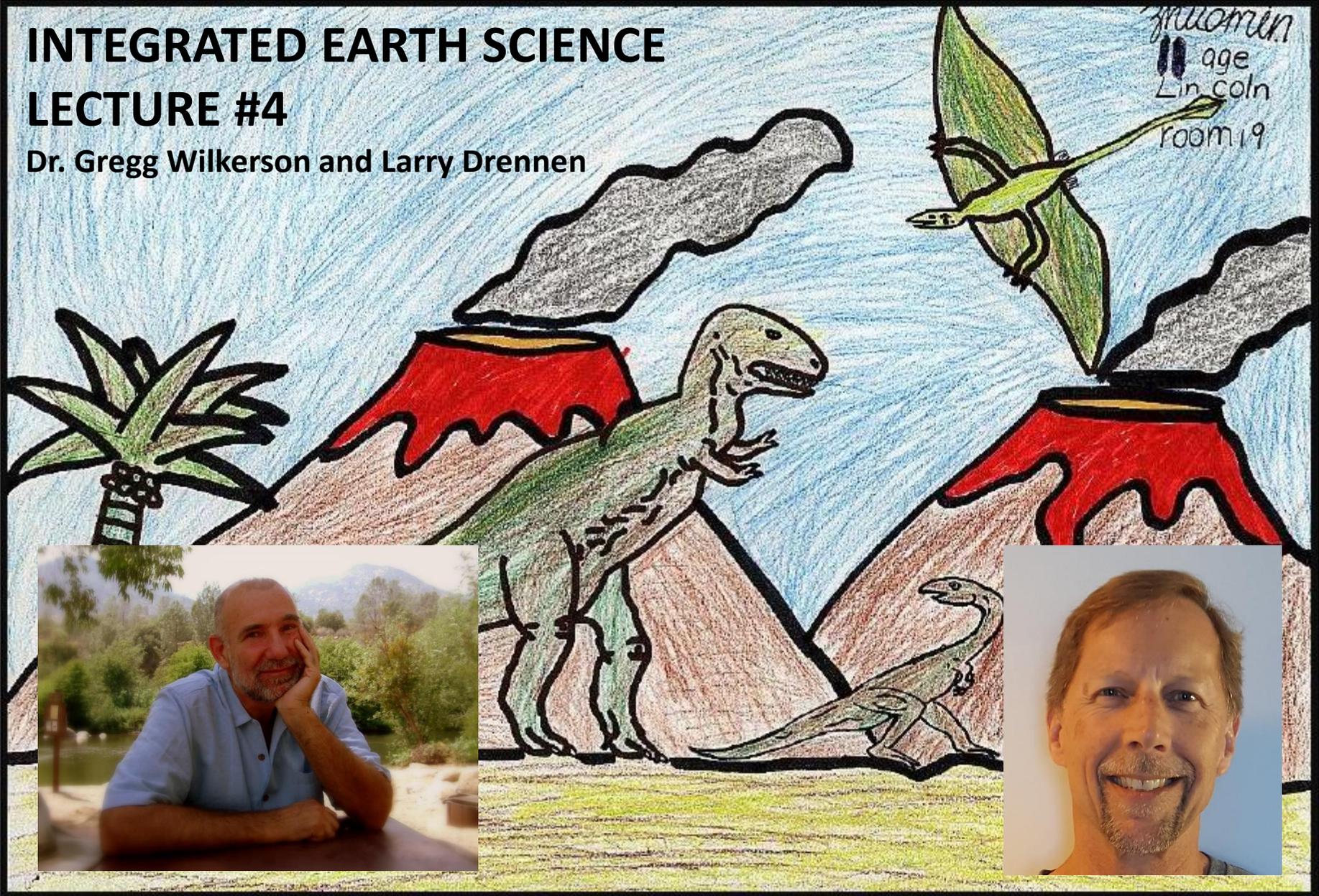


Volcanoes and Other Mountains

INTEGRATED EARTH SCIENCE LECTURE #4

Dr. Gregg Wilkerson and Larry Drennen



<http://www.ucmp.berkeley.edu/trex/artpage.html> Volcano and PT Animation 3:30

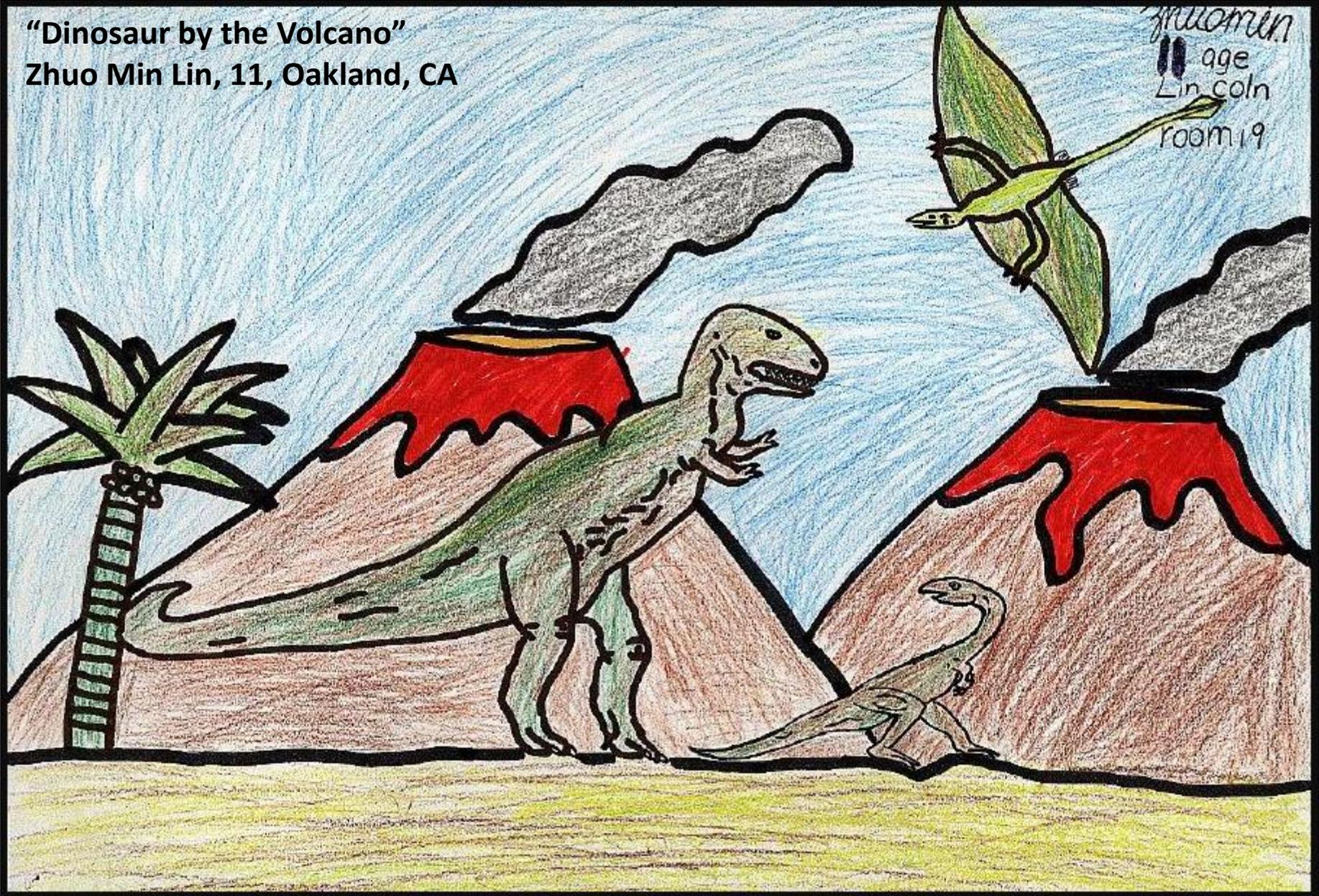
How to draw a volcano

Volcanoes and Other Mountains

"Dinosaur by the Volcano"

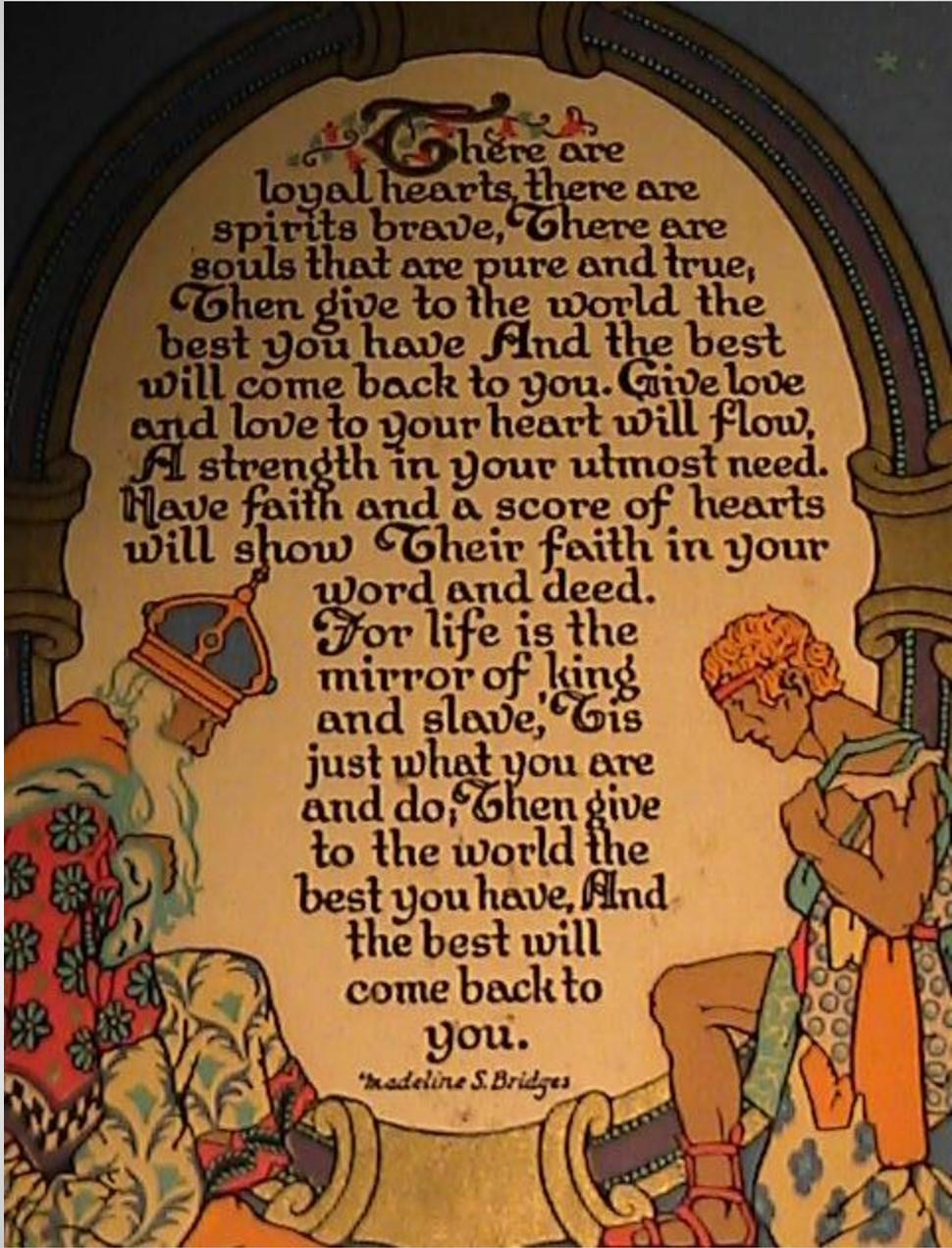
Zhuo Min Lin, 11, Oakland, CA

Zhuo Min Lin
age
Lincoln
room 19



LIFE'S MIRROR
Madeline S.
Bridges (1844-
1920)





There are
loyal hearts, there are
spirits brave, There are
souls that are pure and true,
Then give to the world the
best you have And the best
will come back to you. Give love
and love to your heart will flow,
A strength in your utmost need.
Have faith and a score of hearts
will show Their faith in your
word and deed.
For life is the
mirror of king
and slave, 'Tis
just what you are
and do, Then give
to the world the
best you have, And
the best will
come back to
you.

Madeline S. Bridges

Volcanoes & Other Mountains

Mt. Etna, Sicily

8/24/18



- Introduction to Volcanoes
- Volcanoes and Plate Tectonics (Boundaries)
- Magma / Magma Composition
- Volcanic Landforms

Geology in the News

Mt. Etna, Sicily

Mt. Etna 7/30/19 4:30

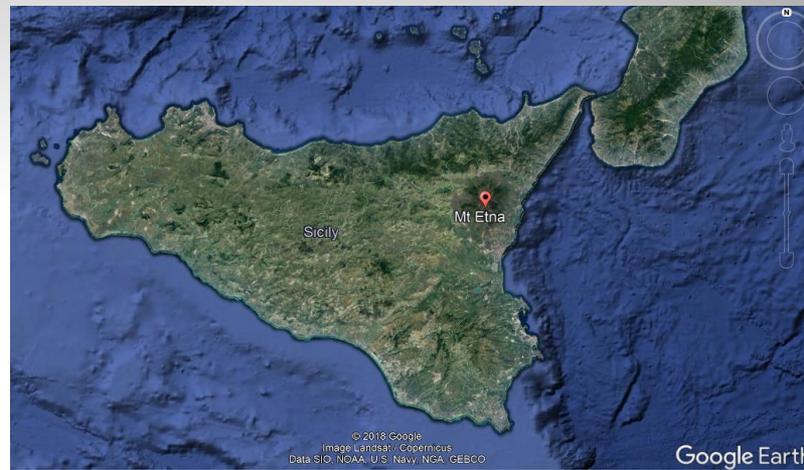
12/22/18



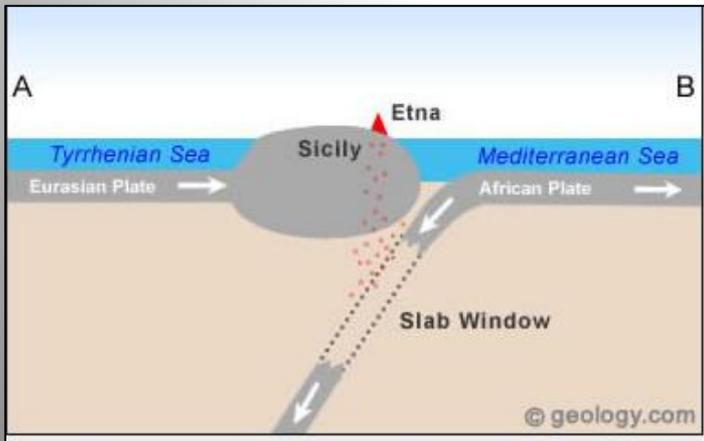
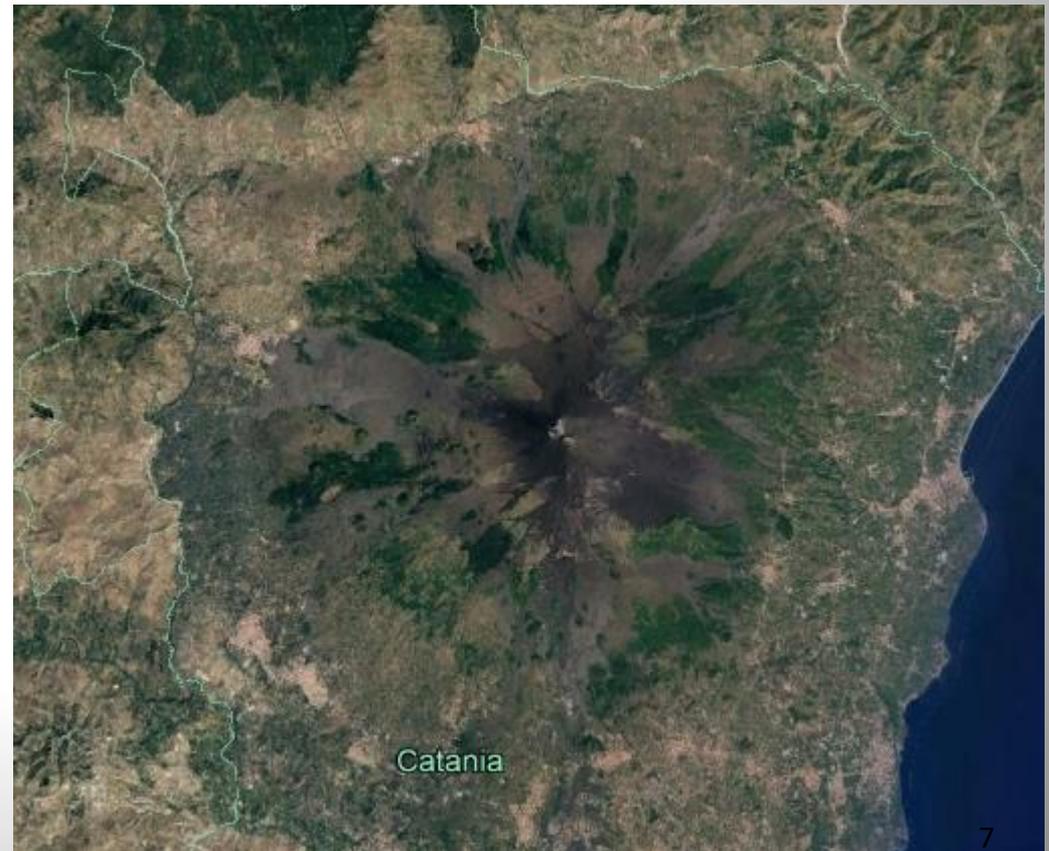
<https://www.forbes.com/sites/robinandrews/2018/12/24/a-new-fissure-on-mount-etna-just-started-erupting-heres-everything-you-need-to-know/#2c398b1414c4>



Geology in the News



Mt. Etna,
Sicily



Geology in the News

Volcanoes and Other Mountains

Hawaii Volcano
Observatory



Kilauea Volcano

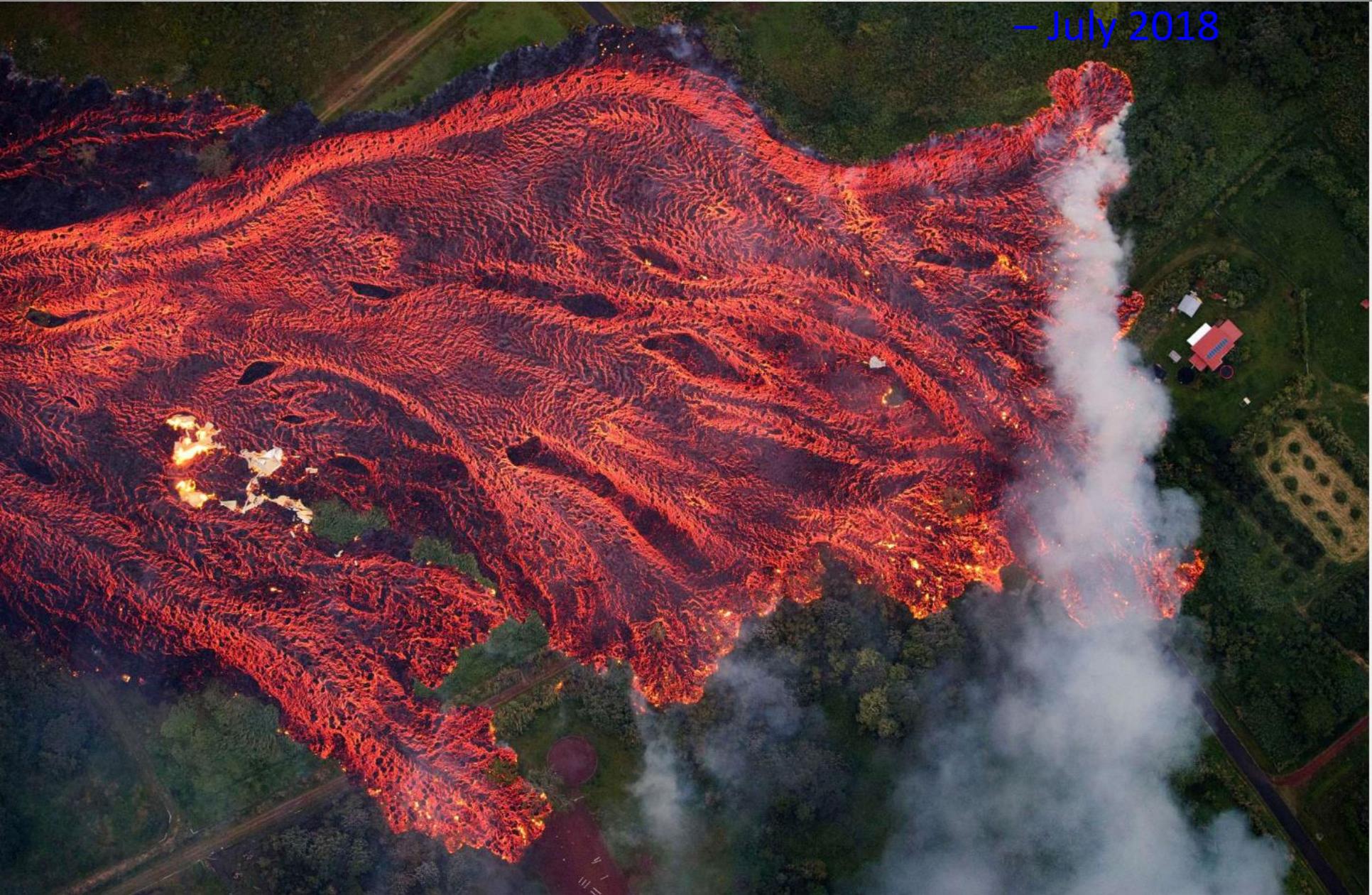
Volcanoes and Other Mountains

Kilauea, Hawaii –
July 2018 12:31



Volcanoes and Other Mountains

Kilauea, Hawaii
– July 2018



Volcanoes and Other Mountains

Kilauea, Hawaii – July 2016 1:51

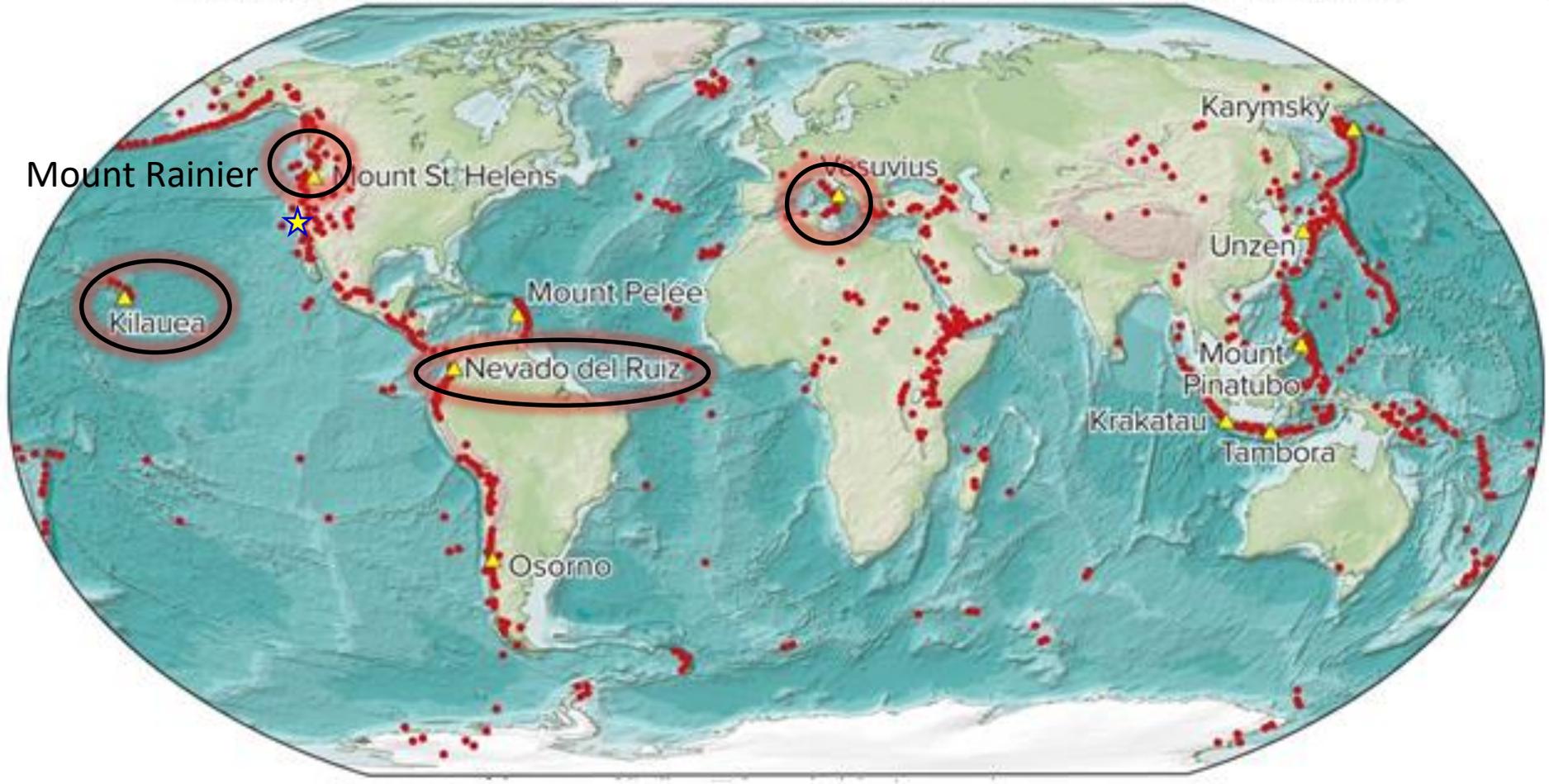


Courtesy:
Paradise Helicopters

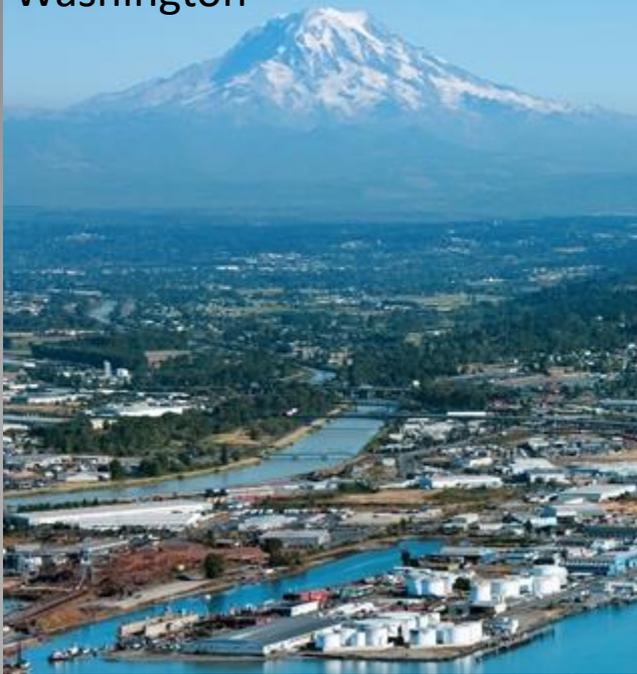
Plate Tectonics – Volcanoes and Other Mountains

Global distribution of active volcanoes

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Mt. Rainier near Tacoma, Washington



Volcanoes and Other Mountains

National Geographic Article about Mt. Rainier



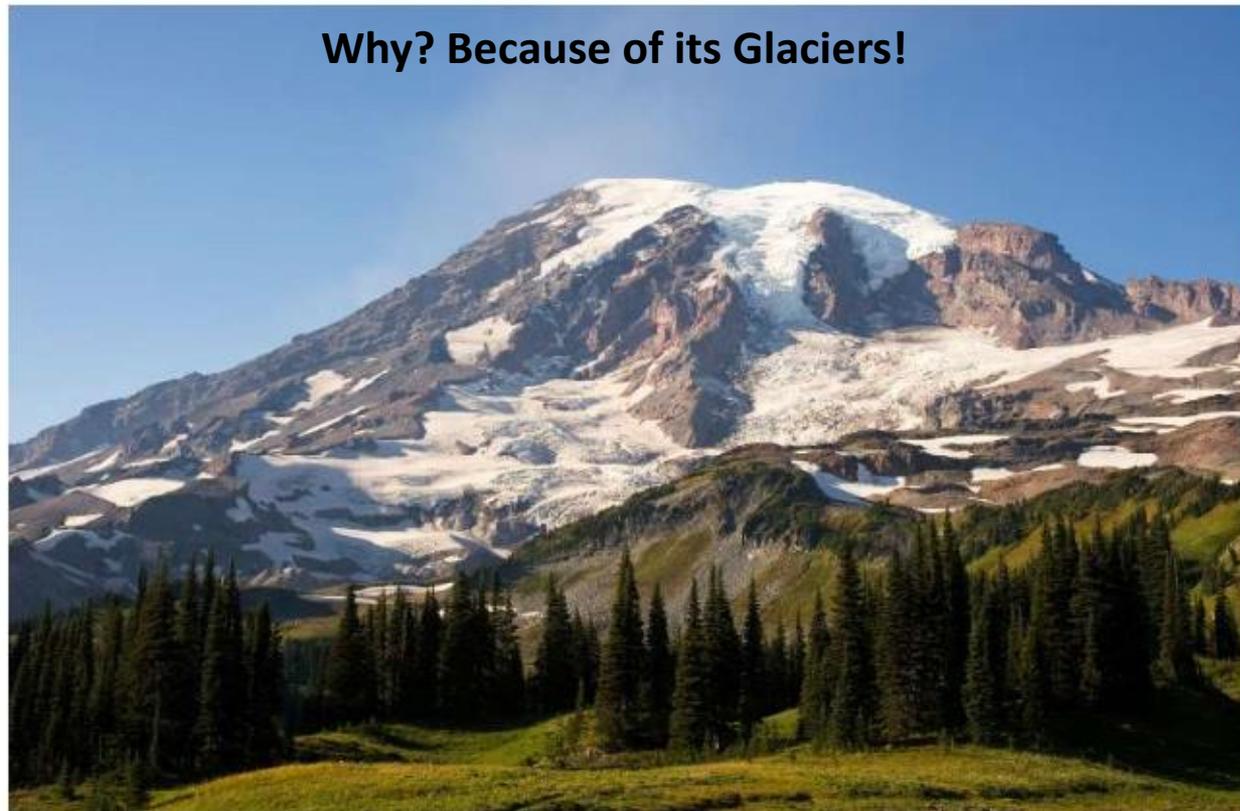
Dr Janine Krippner ✓

@janinekrppner

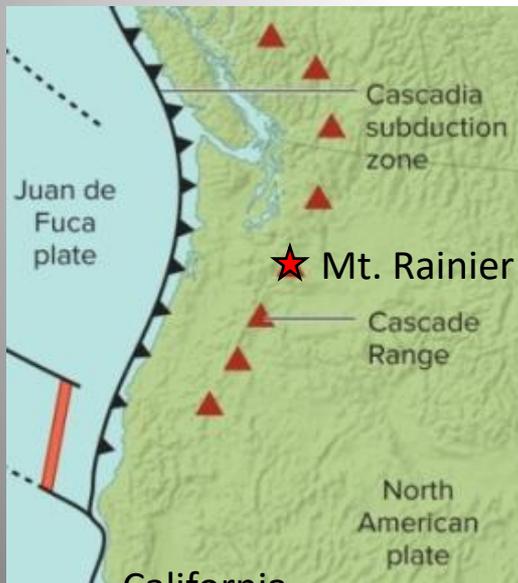
Kiwi "Volcanologist at @CUGeology"

"Rainier is one of the most dangerous volcanoes in the world," she says. "It's a huge concern."

Why? Because of its Glaciers!



© Photograph by Wolfgang Kaehler, LightRocket/Getty Images Snow and ice decorate the flanks of Mount Rainier, a volcano in Washington State.

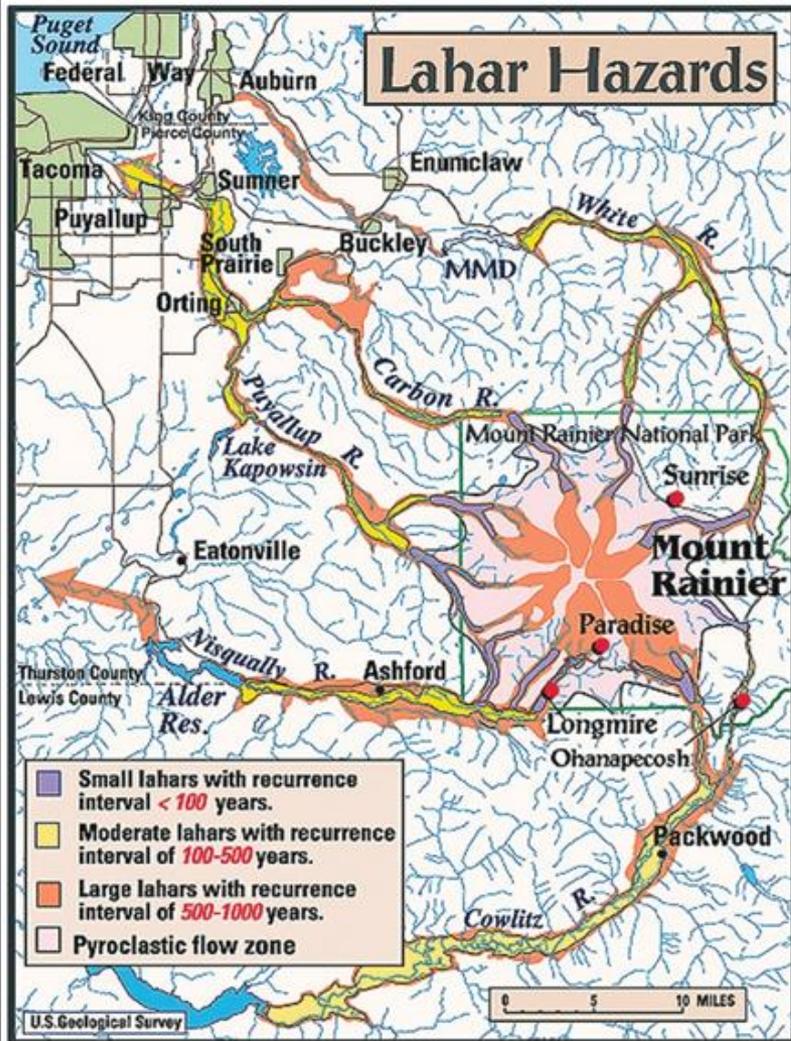


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Mount Rainier Lahar Hazards

Lahars – mudflows formed when volcanic debris mixes with streams or melting ice

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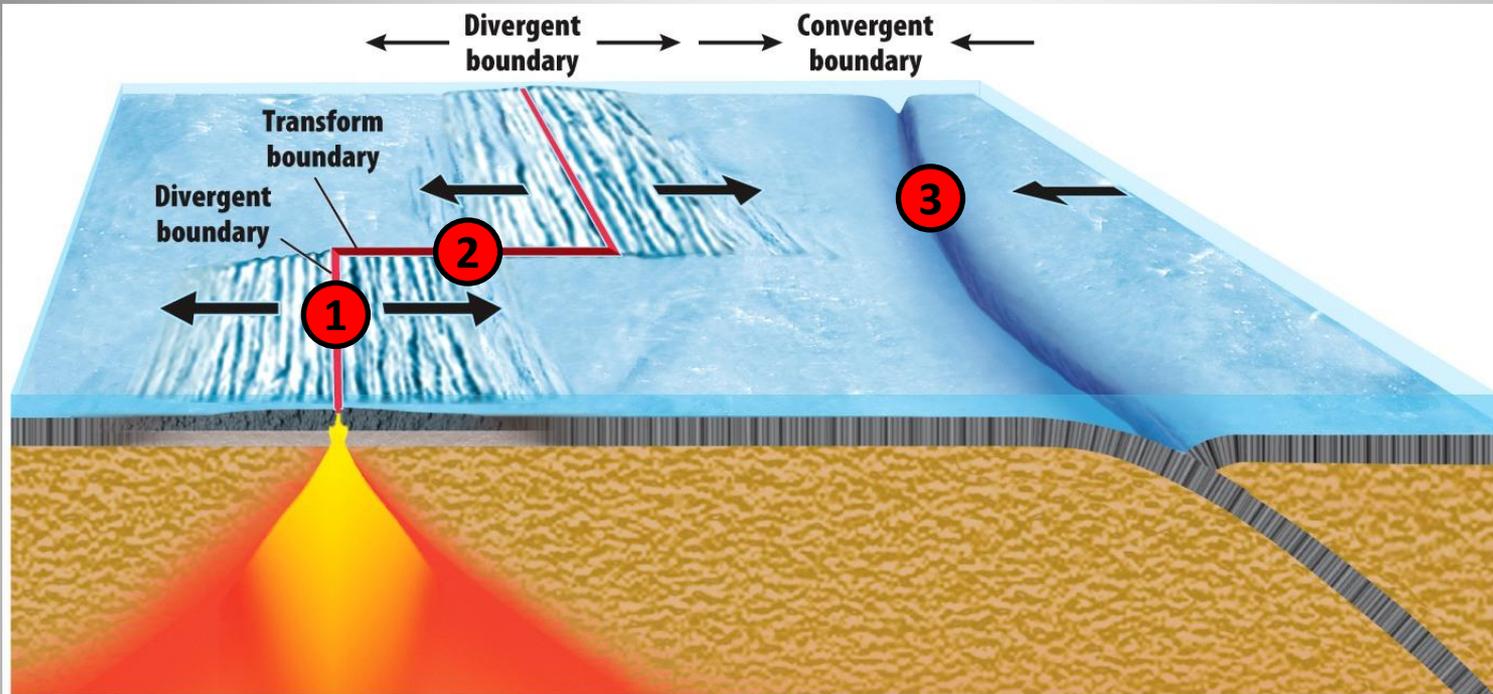
USGS

Example: In 1985, Colombia's **Nevado del Ruiz** volcano, erupted

- Neither lava nor pyroclastic flows of hot gas and ash were the killer elements.
- Instead, the volcano's summit glaciers quickly melted and rapidly mobilized the loose sediment on the volcano's flanks.
- A "series of lahars: viscous, violent slurries that rushed down on the town of Armero at about 30 miles an hour - as its residents slept.
- The town and its inhabitants were smothered within mere moments" killing 23,000 people
- The eruption is now known as one of the worst volcanic disasters in human history

At least 80,000 people live in the Mt. Rainier lahar danger zone

Plate Boundaries

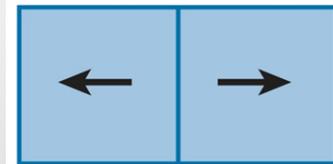


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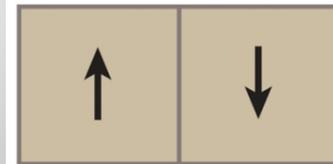
1. **Divergent:** New lithosphere forms as plates pull apart.
2. **Transform:** Plates grind past each other, no change in lithosphere.
3. **Convergent:** One plate dives beneath another (subduction) or two plates collide without either subducting.

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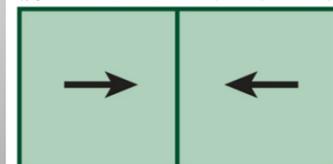
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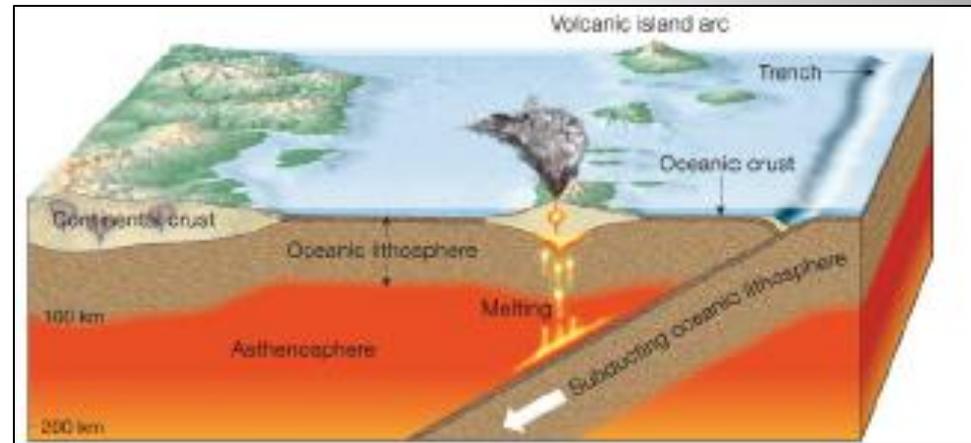
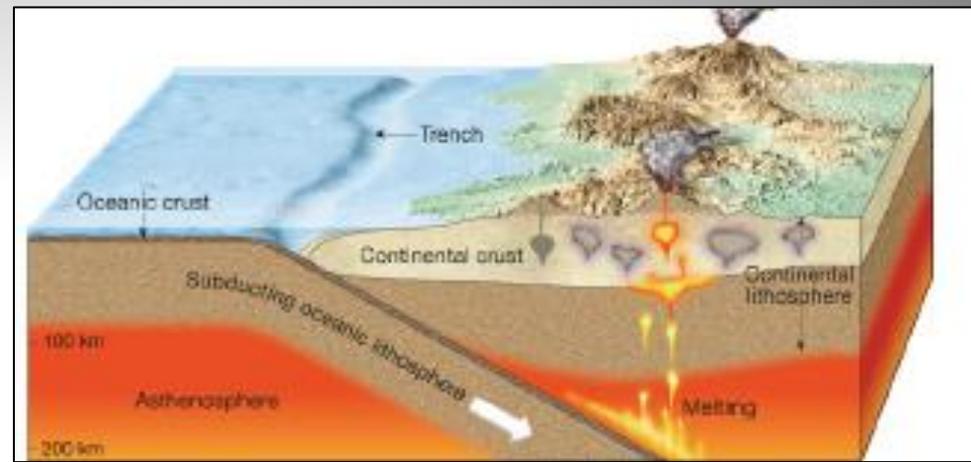
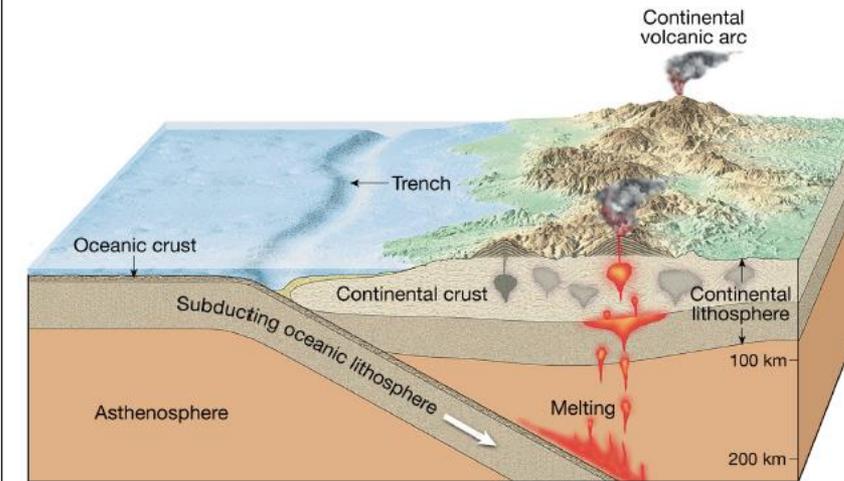


Convergent plate boundaries

Convergent Boundaries

1. Ocean-Continent Convergence

SUBDUCTION!



1. Ocean to continent
 - a) Continental volcanic arc
2. Ocean to ocean
 - a) Volcanic island arc
3. Continent to continent
 - a) High mountains

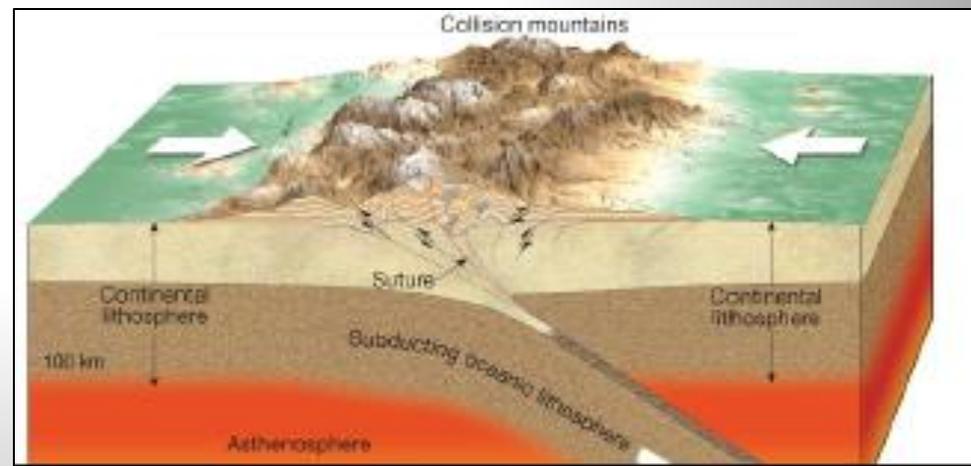
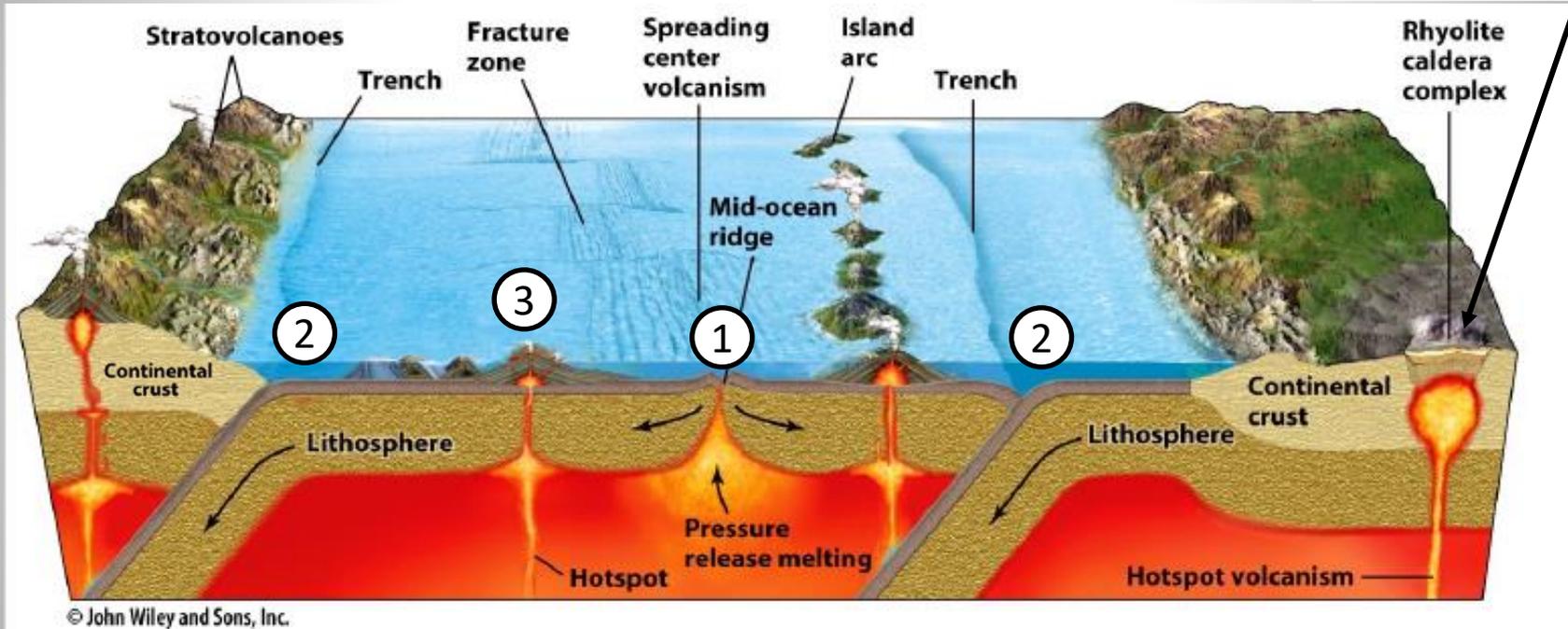
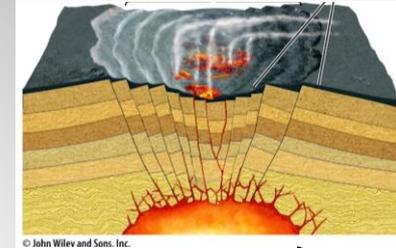


Plate Tectonic Setting of Volcanoes

Plate tectonics determines:

1. Variations in magma's chemical composition, viscosity (ability to flow), gas content and volume
2. Whether eruptions are peaceful or explosive.
3. Kinds of volcanoes / shape

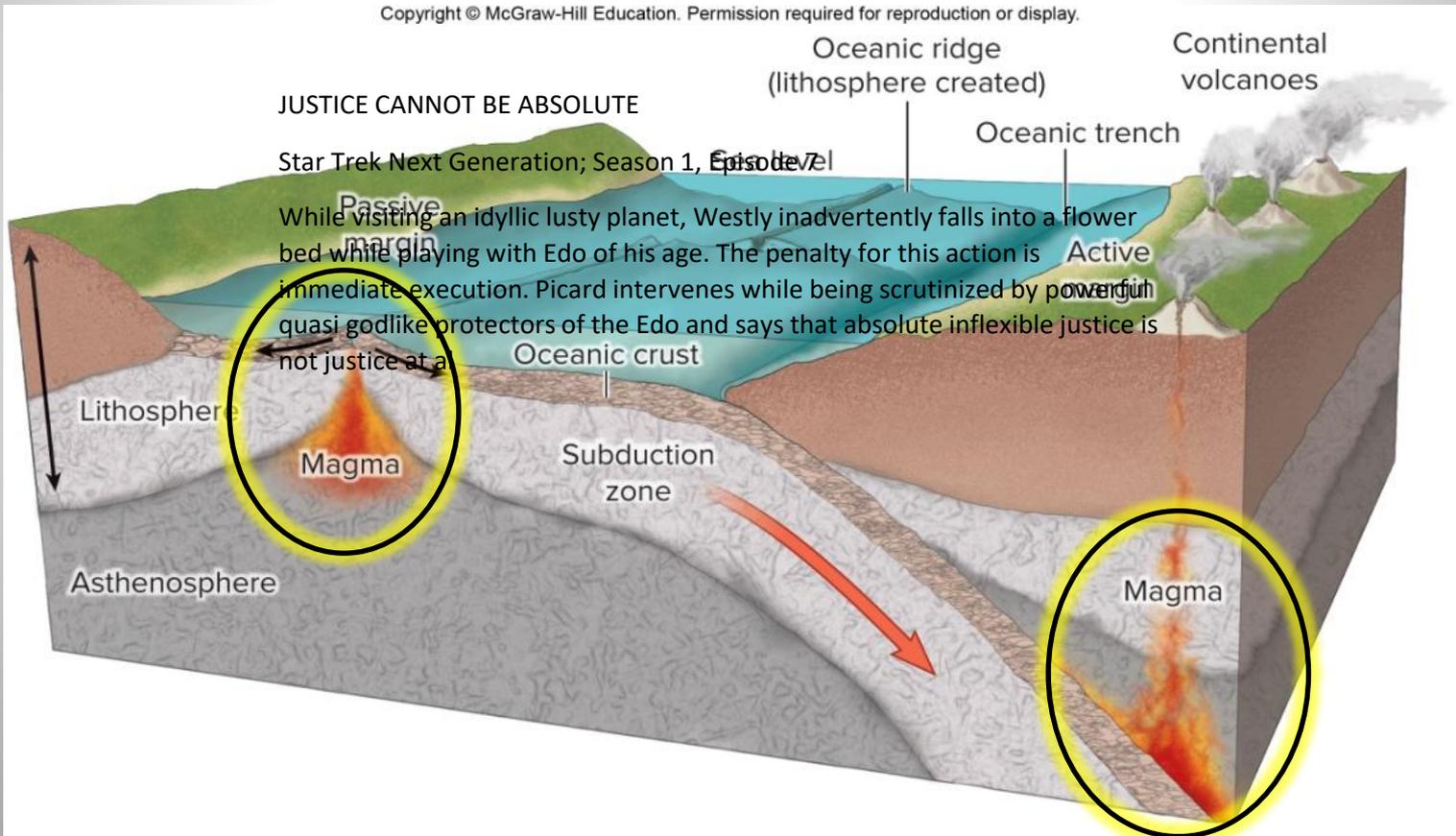


Where do volcanoes form?

1. Oceanic Spreading Centers ~ 80% of all volcanic activity
 - a. Continental Rifts ~ 2% of all volcanic activity
2. Convergent Plate Boundaries ~ 10% of all volcanic activity
3. Hot Spots and Large Igneous Provinces ~ 8% of all volcanic activity

Plate Tectonics: Volcanoes and Other Mountains

- Interactions of plates along their boundaries = new crust, plate collisions > volcanoes, mountain building, earthquakes
- Many of these processes involve the partial or complete melting of rocks
- **Which generates magma**





Star Trek Moment

“Justice”, Next Generation, Season 1, Episode 7

While visiting an idyllic lusty planet, Westly inadvertently falls into a flower bed while playing with Edo of his age. The penalty for this action is immediate execution. Picard intervenes while being scrutinized by powerful quasi godlike protectors of the Edo and says that absolute inflexible justice is not justice at all

[WATCH IT](#)

The Rock Cycle: It all starts with Magma...

Molten or semi-molten material beneath or in the Earth's crust from which igneous rock is formed

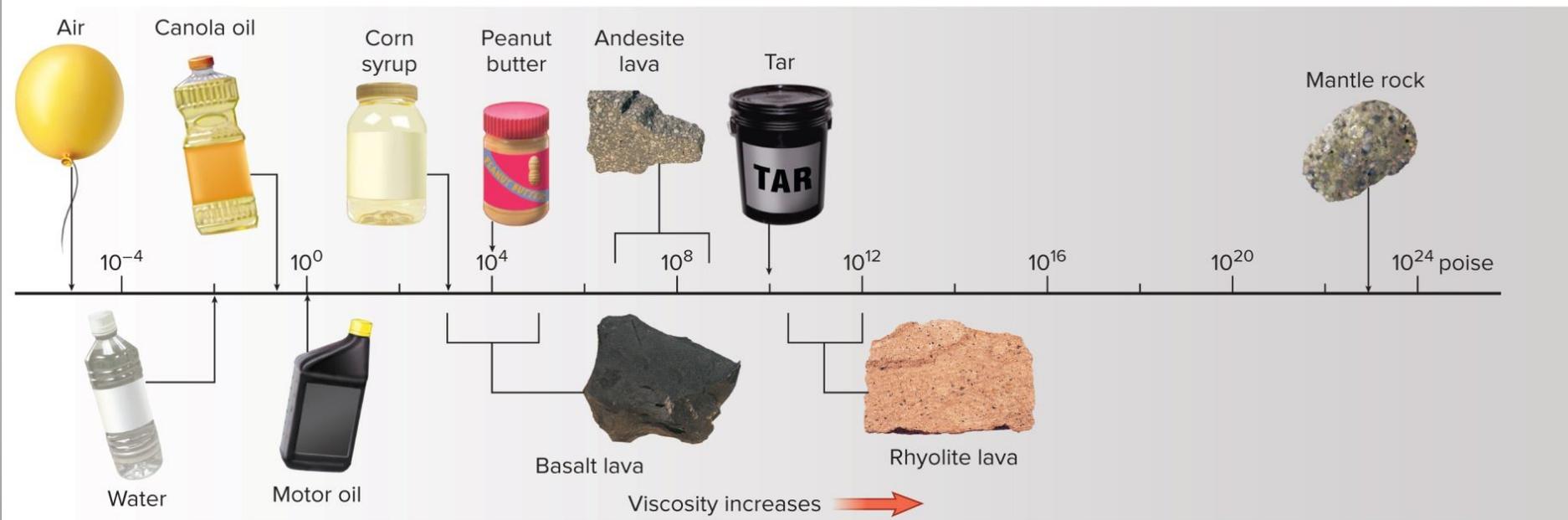


It all starts with Magma...

Key Terminology: Viscosity = resistance to flow

Viscosity varies with composition & temperature

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Remember: Something that is less viscous flows better than something that is more viscous

Magma Viscosity

Volcanoes and Other Mountains

All other factors being equal, which magma would flow the fastest?

- A. High viscosity magma
- B. Low viscosity magma
- C. Neither, magma does not have viscosity

Viscosity & Magma

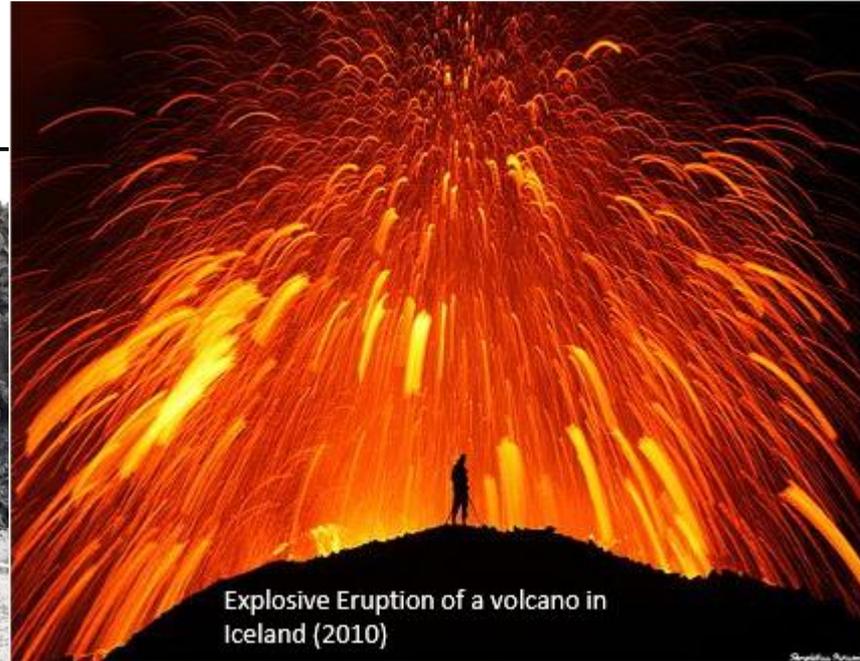
Higher

Viscosity

High Viscosity

Lower

Low Viscosity



Explosive Eruption of a volcano in Iceland (2010)

Intermediate Viscosity

<https://cdn.thinglink.me/api/image/510266754094596097/1240/10/scaletowidth>

https://www.universehttps://www.google.com/search?tbm=isch&q=andesitic+flow&chips=q:andesitic+flow,g_4:andesite+lava&sa=X&ved=0ahUKEwj9sNfW9JfdAhVQPawKHSarBz8Q4IYILigA&biw=2000&bih=1003&dpr=0.96#imgrc=Kcxq6-R6uXsfJM:today.com/31387/lava-viscosity/

[http://www.hilldale.k12.ok.us/vimages/shared/vnews/stories/5081b48c40831/ES_Section2409.1%20\(Volcanic%20Eruptions%20pg.250-255\).pdf](http://www.hilldale.k12.ok.us/vimages/shared/vnews/stories/5081b48c40831/ES_Section2409.1%20(Volcanic%20Eruptions%20pg.250-255).pdf)

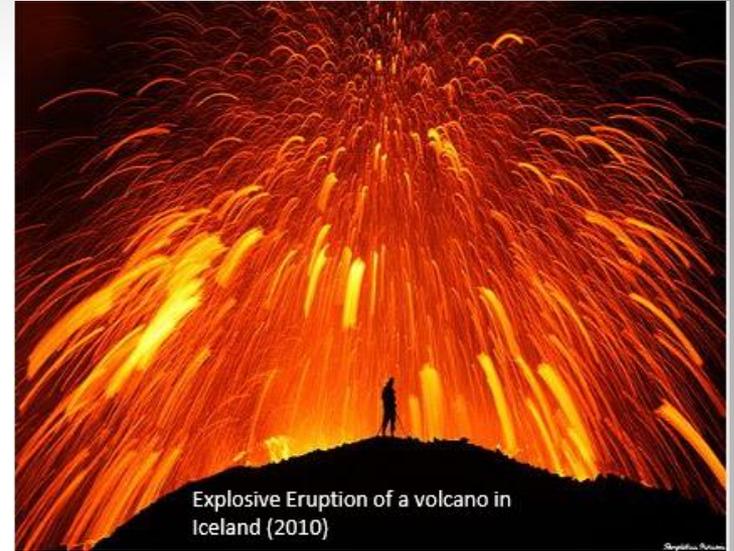
Magma Viscosity & Volcanic Gases

Escaping volcanic gases drive eruptions

Gases are dissolved in magma

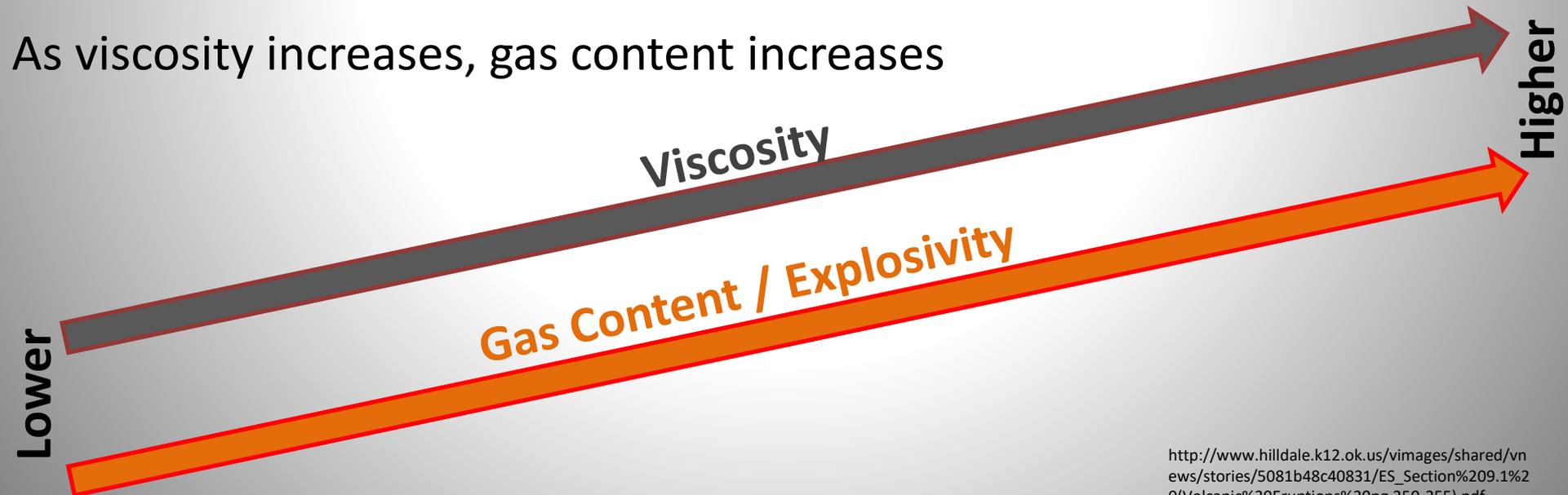
Gases are released as pressure decreases

- Just like opening a can of soda



Explosive Eruption of a volcano in Iceland (2010)

As viscosity increases, gas content increases



Silica Content and Magma Viscosity

– Why is it so important?

It determines how violent and dangerous the eruption will be

Viscosity depends on silica content

- less silica = lower viscosity
- more silica = higher viscosity

***Higher Silica =
Higher viscosity =
More violent eruptions***



Mt. Saint Helens, 1980

Plate-Tectonic Setting of Volcanoes

- **Subduction** carries oceanic plate (with water-rich sediments) into hotter mantle, where water lowers melting temperature of rock
- Rising magma melts continental crust it passes through, changing composition of magma

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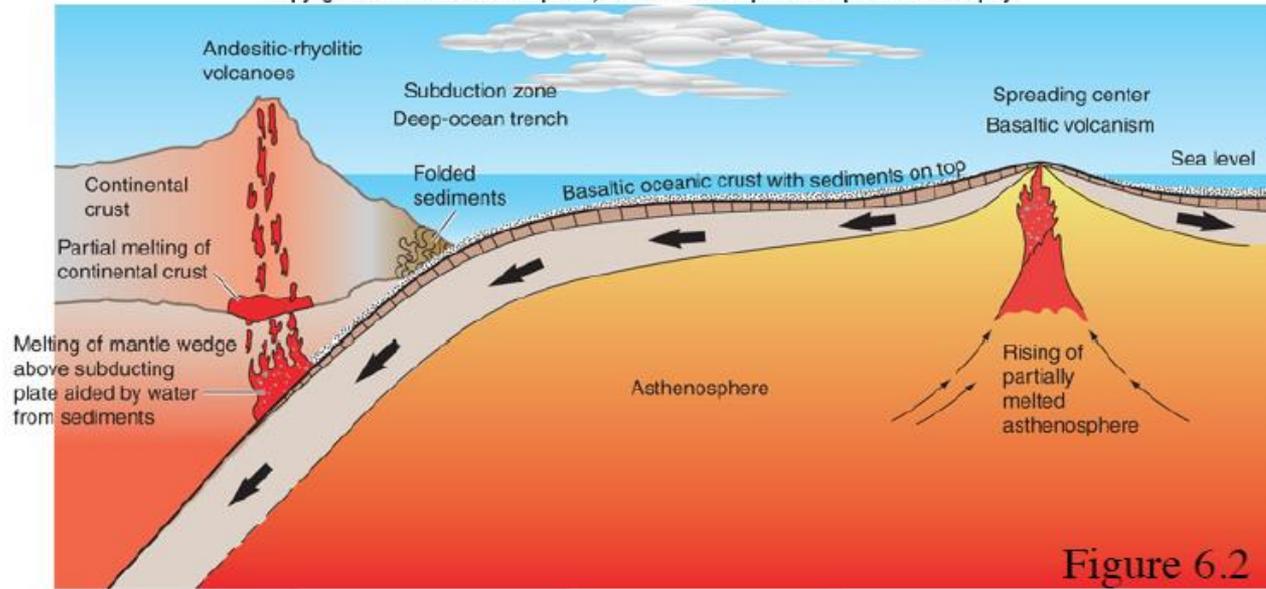


Figure 6.2

Subduction zones have **violent eruptions** because:

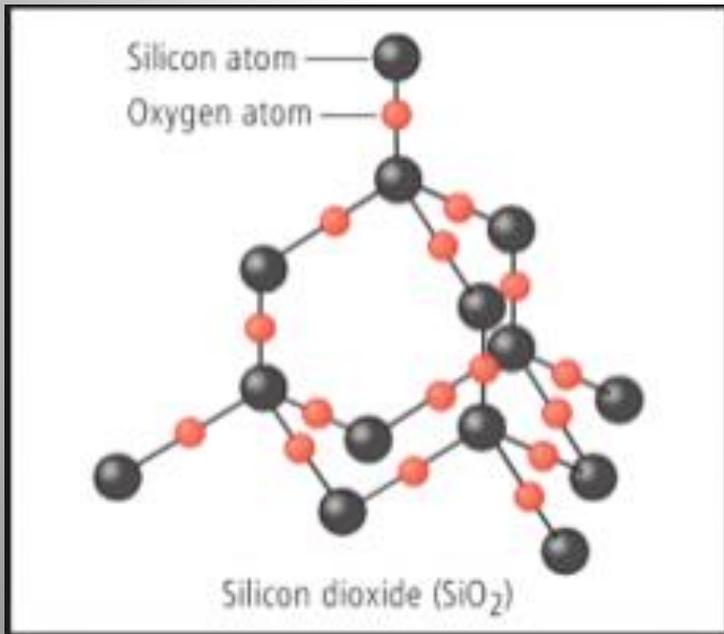
- Magma is generated by partial melting of the subducting plate with abundant water
- Magmas and water rise into overlying crust to melt additional rocks producing magmas of variable composition (increased silica content = SiO_2)
- Magma **temperature decreases** while **SiO_2 , water content, and viscosity increase**

A word about Silica

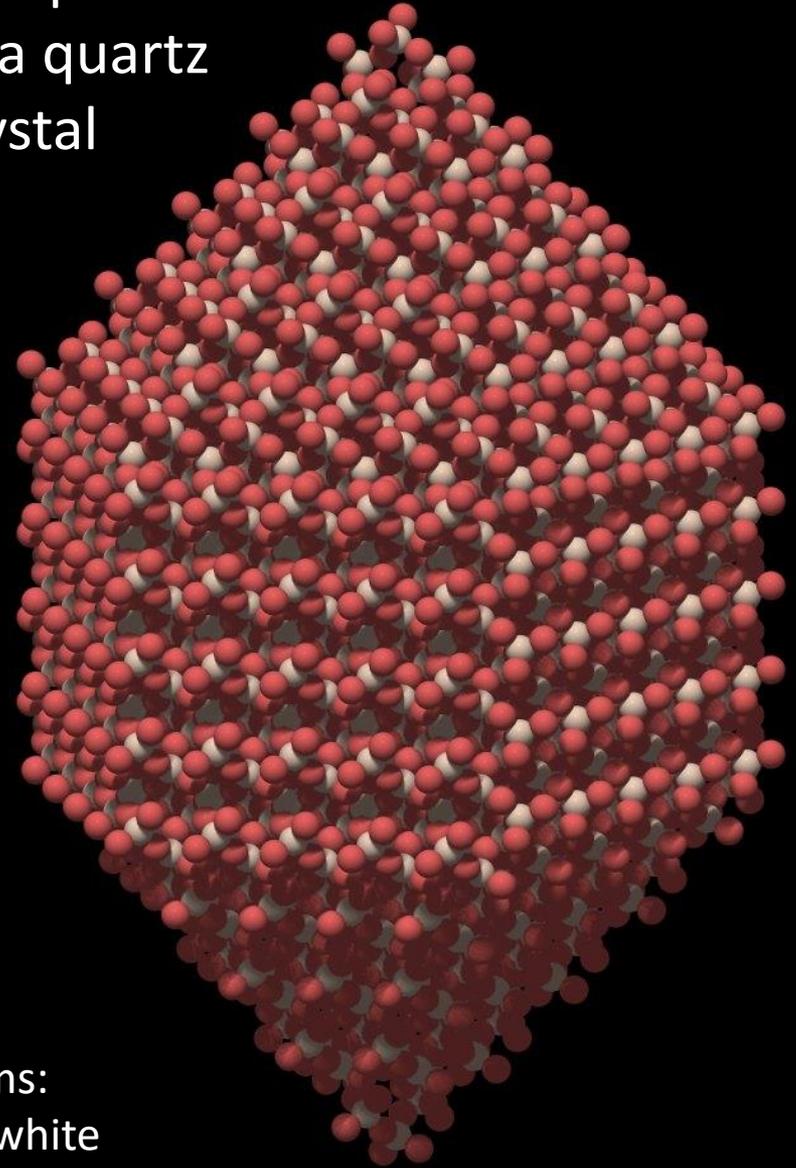
Silica (Silicon Dioxide - SiO_2)

- Quartz

Silica and Silicate Minerals (e.g. feldspars) make up more than 90% of the Earth's crust



Computer model
of a quartz
crystal



Atoms:
Si – white
O – red

Silica tetrahedral – 4 Oxygen atoms around a central Silicon atom

Understanding Magma Viscosity

Volcanoes and Other Mountains

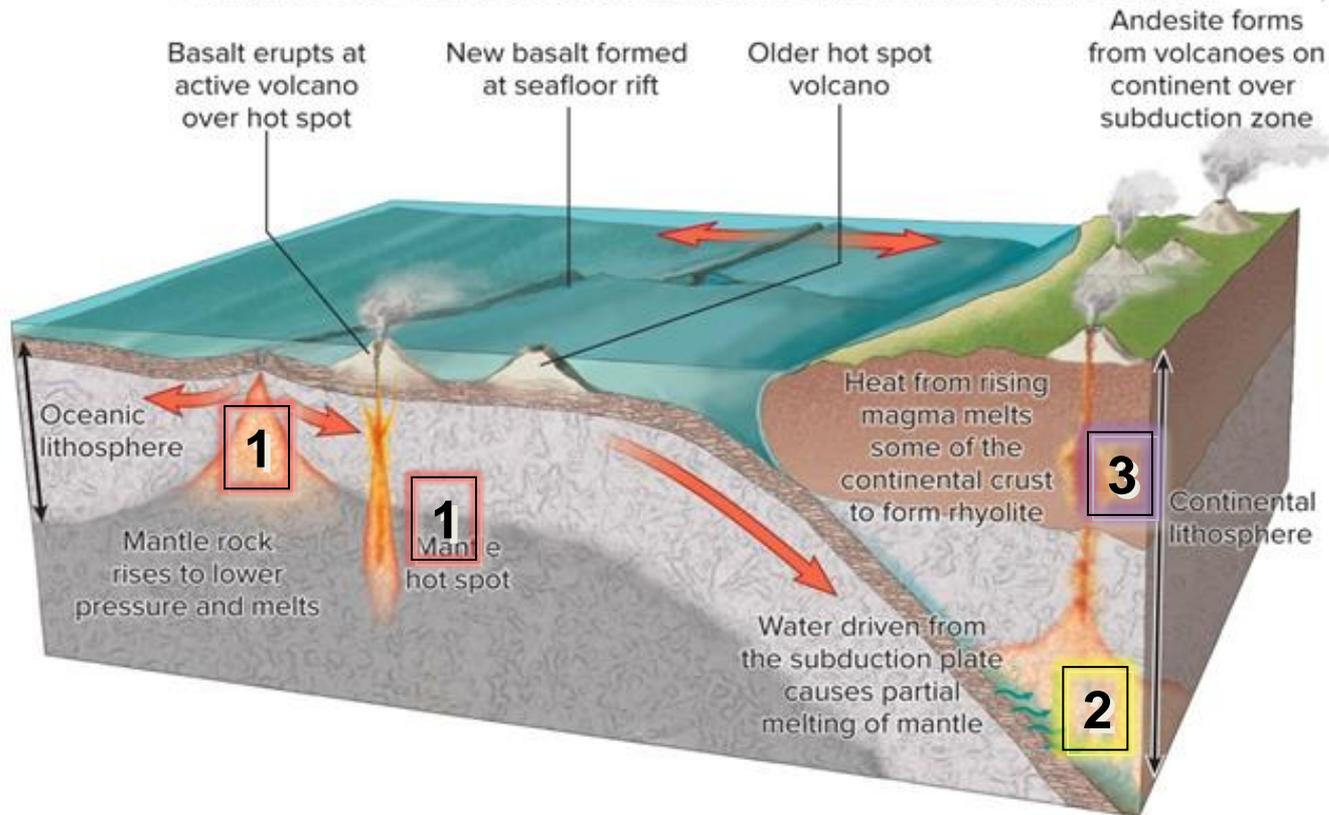
Which type of magma most likely has the lowest viscosity?

- A. High silica, high temperature
- B. High silica content, low temperature
- C. Low silica content, high temperature
- D. Low silica content, low temperature

Magma Sources and Magma Composition

- Different plate settings generate magma from melting different source rocks

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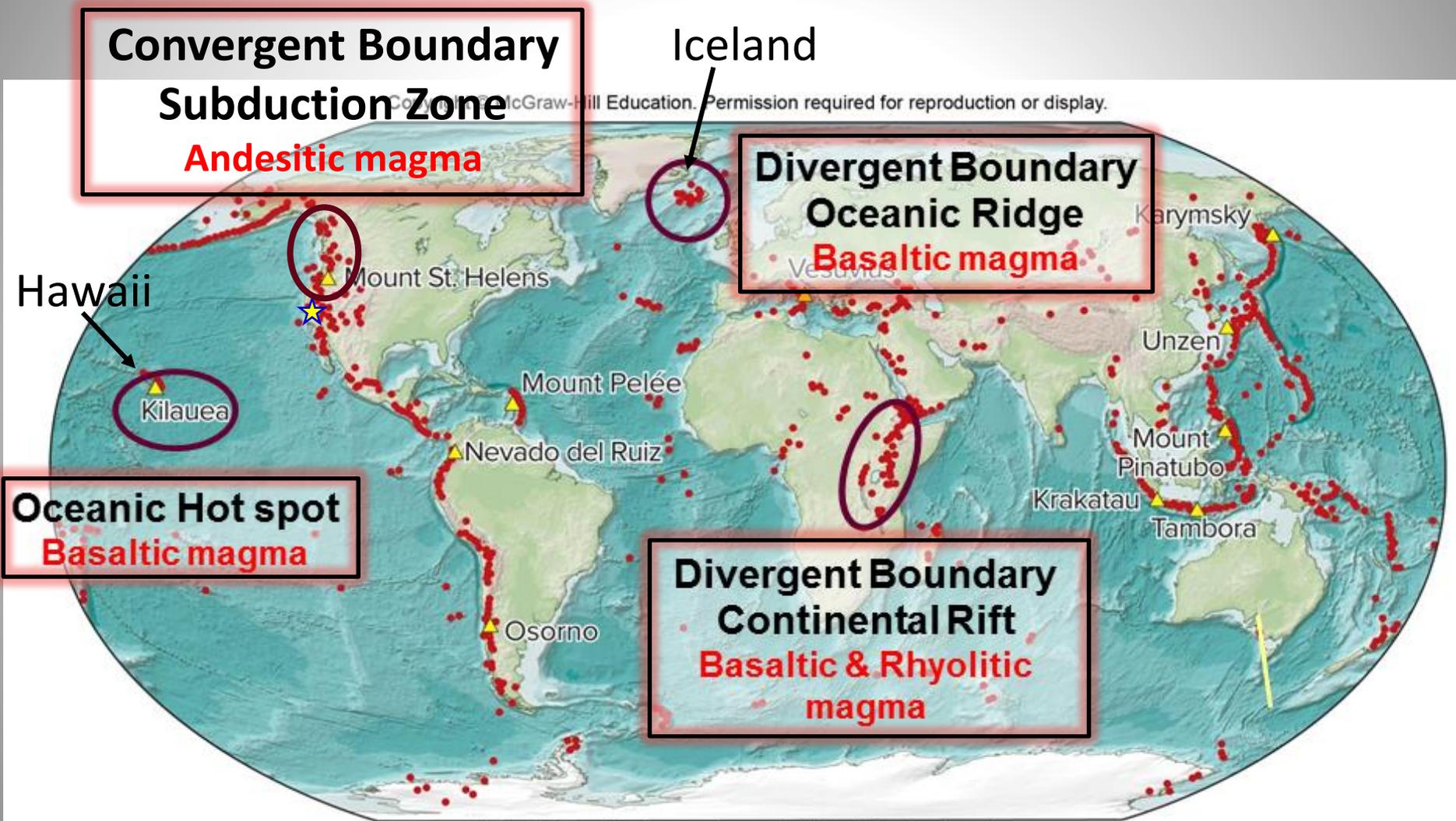


2. Andesitic magma – partial melting of mantle rock (in a subduction zone)

3. Rhyolitic magma - melting of parts of continental crust

1. Basaltic magma – partial melting parts of asthenosphere below oceanic ridge or hot spots
– also at continental divergent boundary and hot spots

Magma Sources and Magma Composition



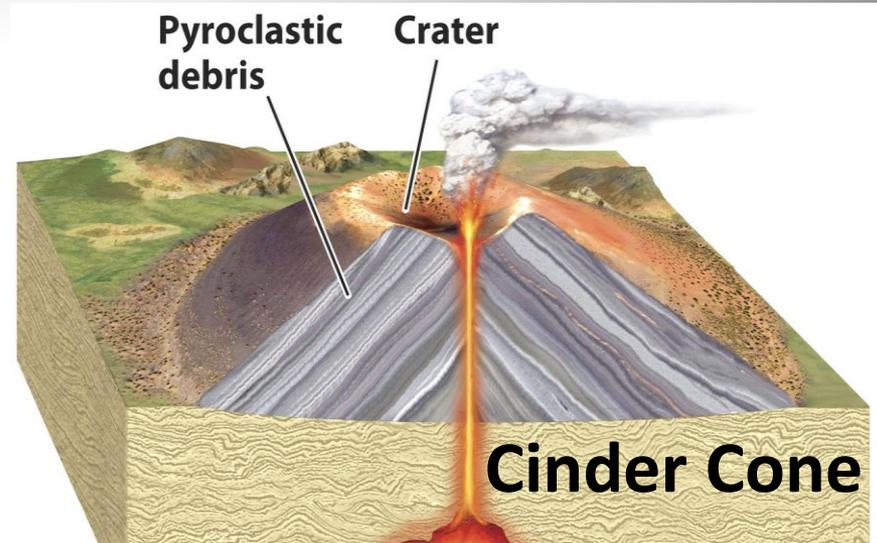
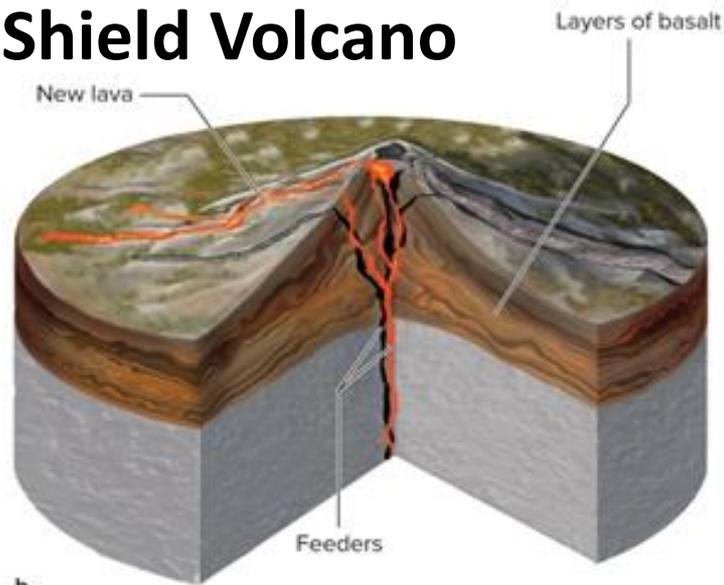
[Jump](#)

Adapted from http://www.volcano.si.edu/world/fnd_regions.cfm

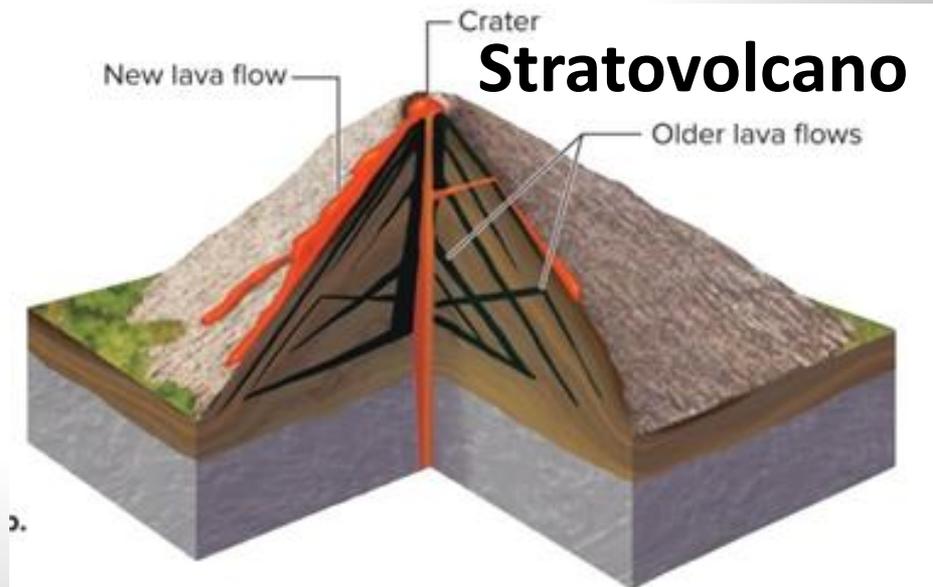
Volcanoes and Volcanic Landforms

Many Variations –
Focus on 3 Types

Shield Volcano



Stratovolcano



Volcanoes and Volcanic Landforms

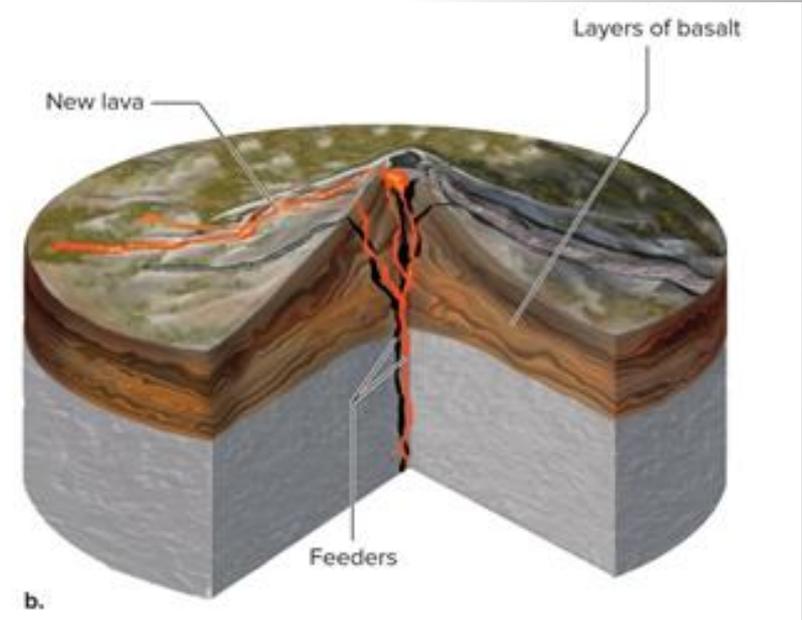
Shield volcanoes (e.g., Hawaiian Islands)

Broad, gentle slopes

Built from many low viscosity lava flows (basalt)

Relatively mild eruptions associated with ***hot spots***,
divergent plate boundaries

Mauna Loa, Hawaii



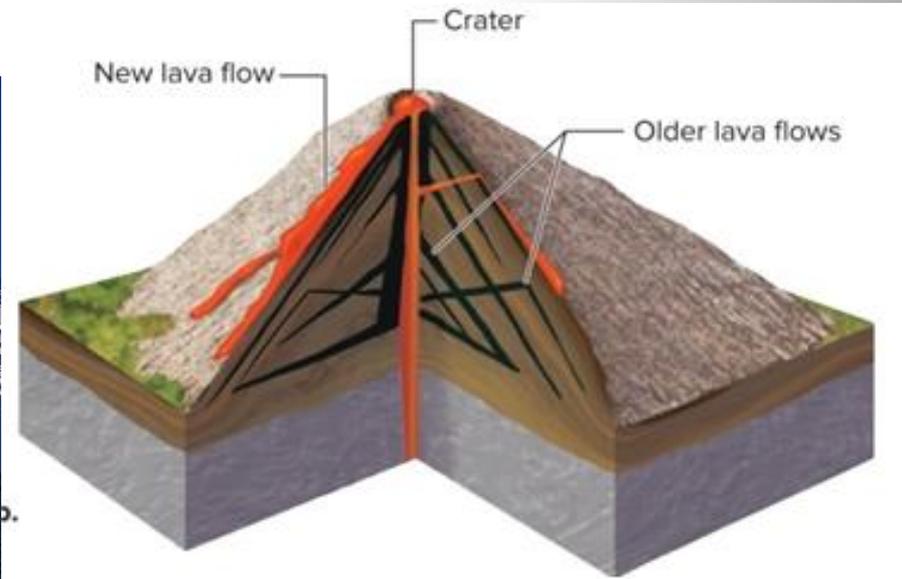
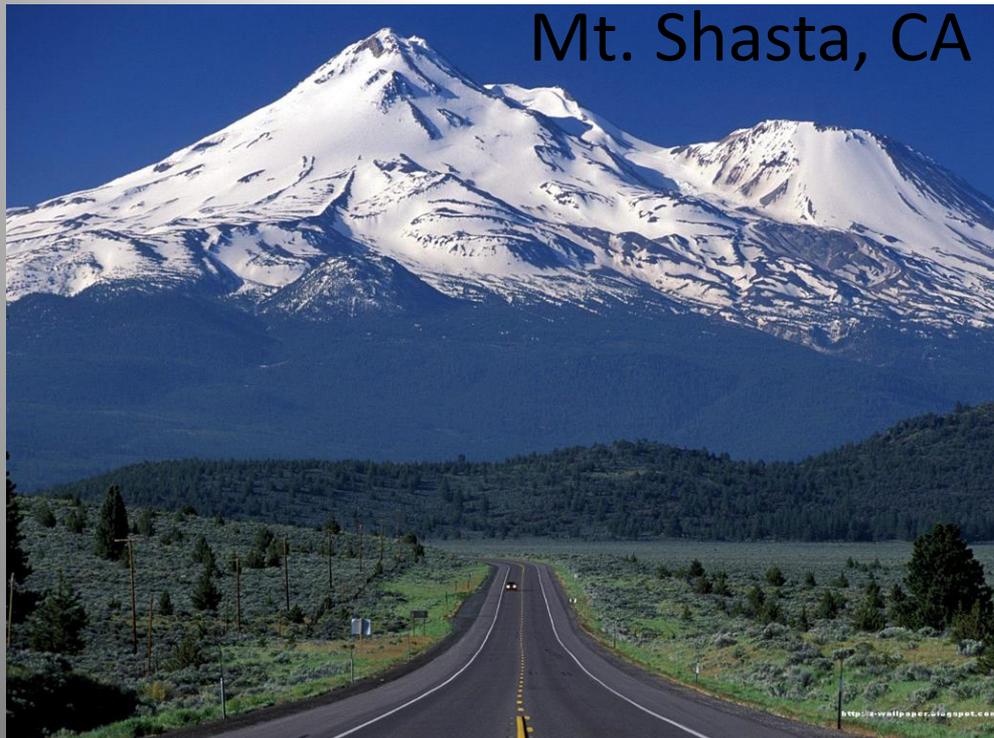
Volcanoes and Volcanic Landforms

Stratovolcanoes (e.g., Mt. Shasta, Mt. Saint Helens)

Most common volcano type

Steeper slopes built from alternating layers of tephra (ejected rock fragments and particles) and medium viscosity lava (andesitic)

Form on plates overriding **subduction zones** at convergent plate boundaries



Except : Continent – Continent
Convergence

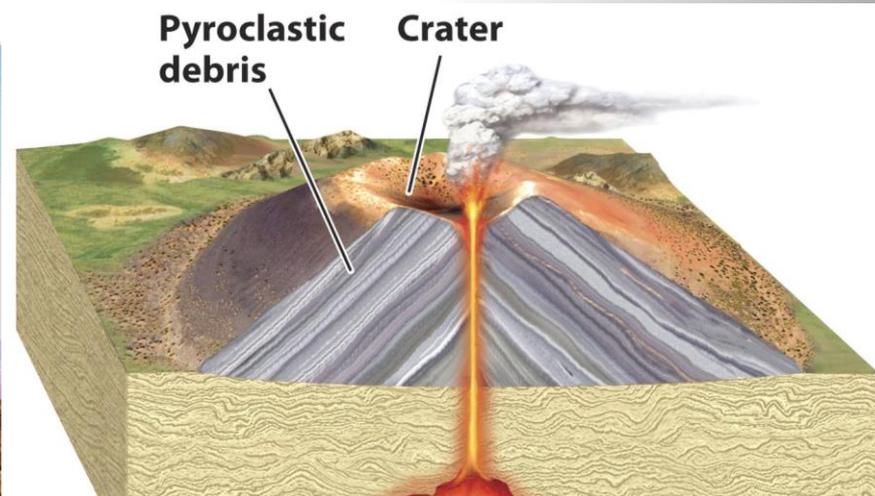
Volcanoes and Volcanic Landforms

Cinder cone volcanoes

Smallest volcanoes, up to 400 meters elevation

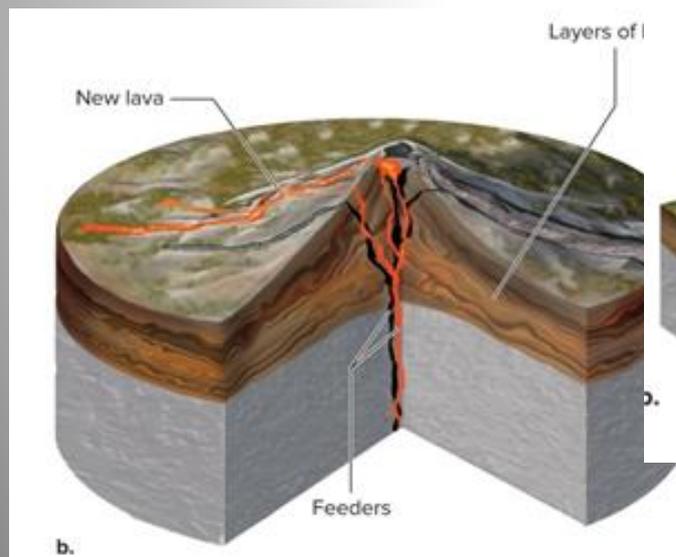
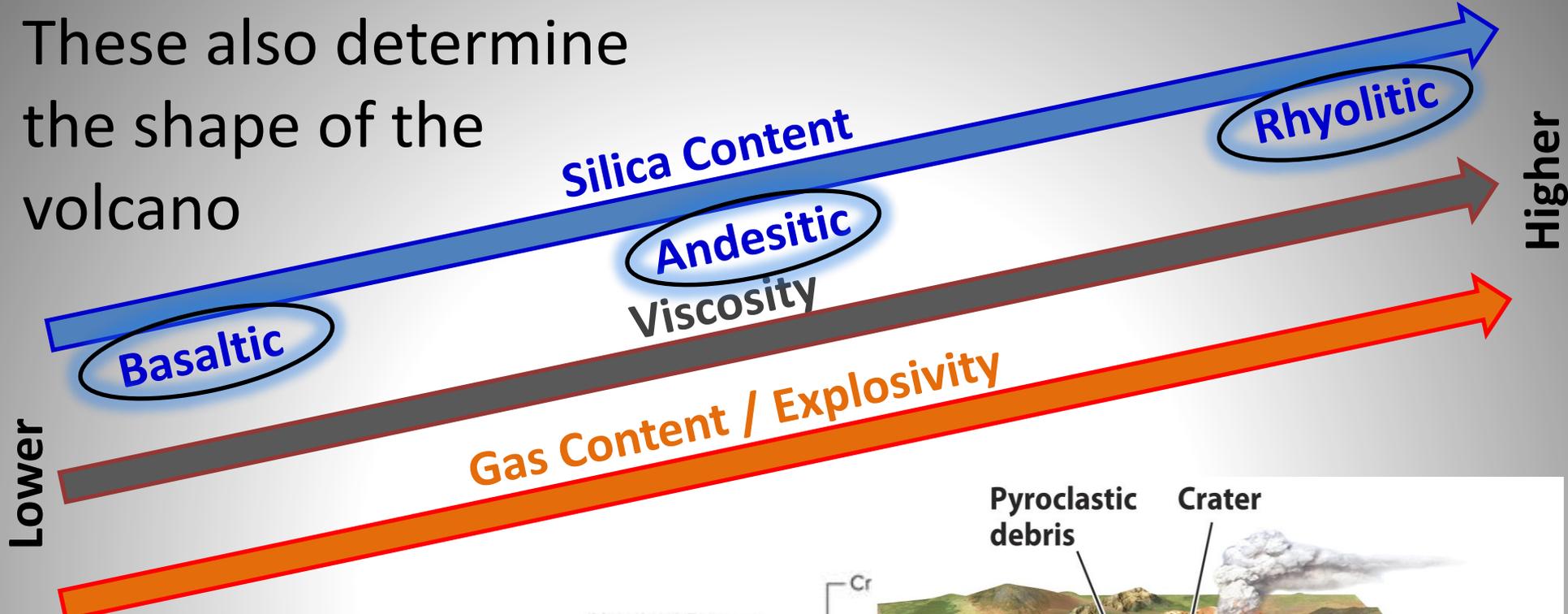
Built from more viscous magma products (coarse tephra)

May form on slopes of shield or stratovolcanoes

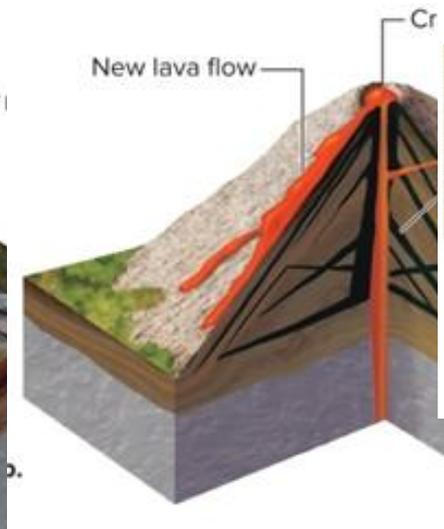


Lone Cone, Little Lake, CA, Highway 395

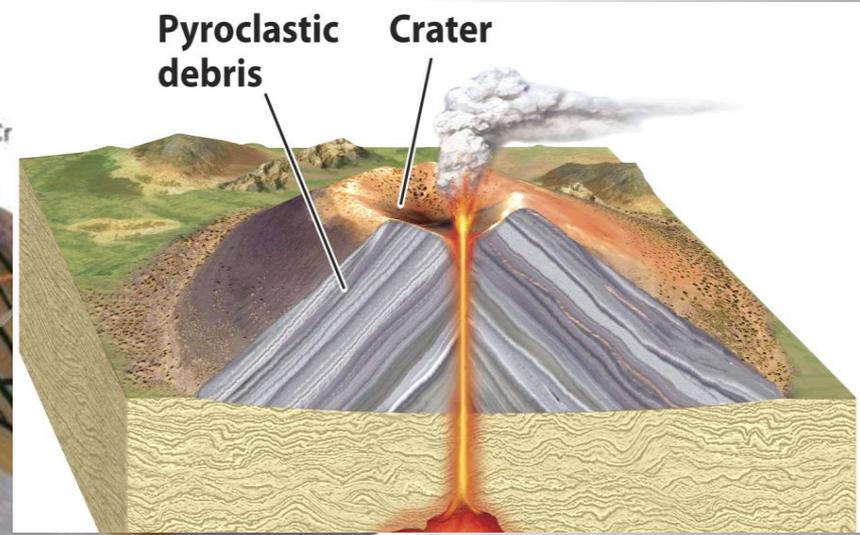
These also determine the shape of the volcano



Shield Volcano



Stratovolcano



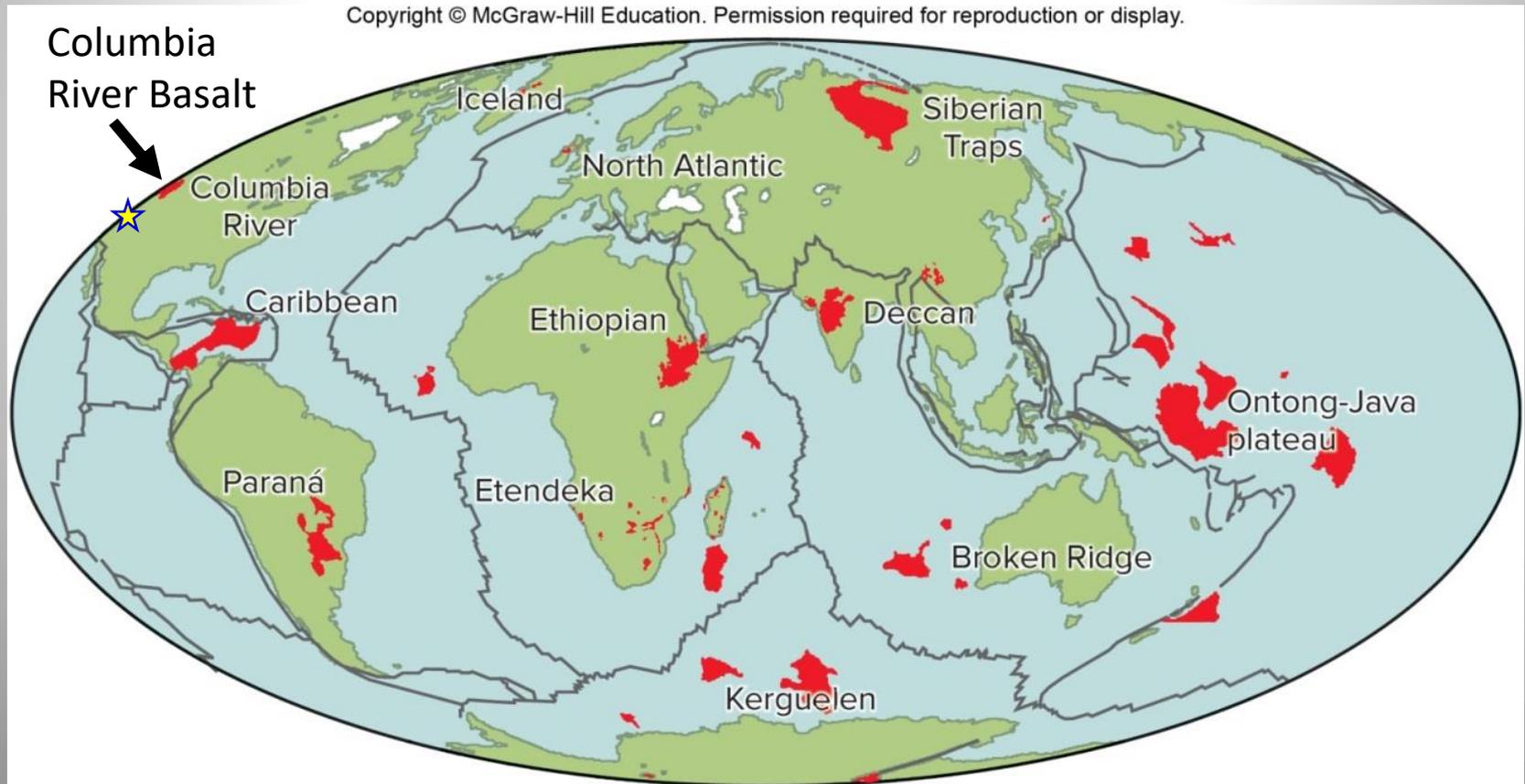
Cinder Cone

Other Volcanic Landforms

Large Igneous Provinces - Lava Plateaus

Massive basalt eruptions formed lava plateaus and elevated atmospheric levels of carbon dioxide 120-80 Myrs ago to produce global “hothouse” conditions

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Other Volcanic Landforms

Lava Plateau

- Hundreds of low viscosity lava (highly fluid) flows stack up on top of each other
- Individual layers of basalt 10-20 meters thick
- Plateau thousands of meters thick
- Form from some of the largest volcanic eruptions

Columbia River
Plateau,
WA & OR



Next Class...

- Lecture: Plate Tectonics & California
 - No additional reading
- Read ahead:
 - LS Chapter 7

