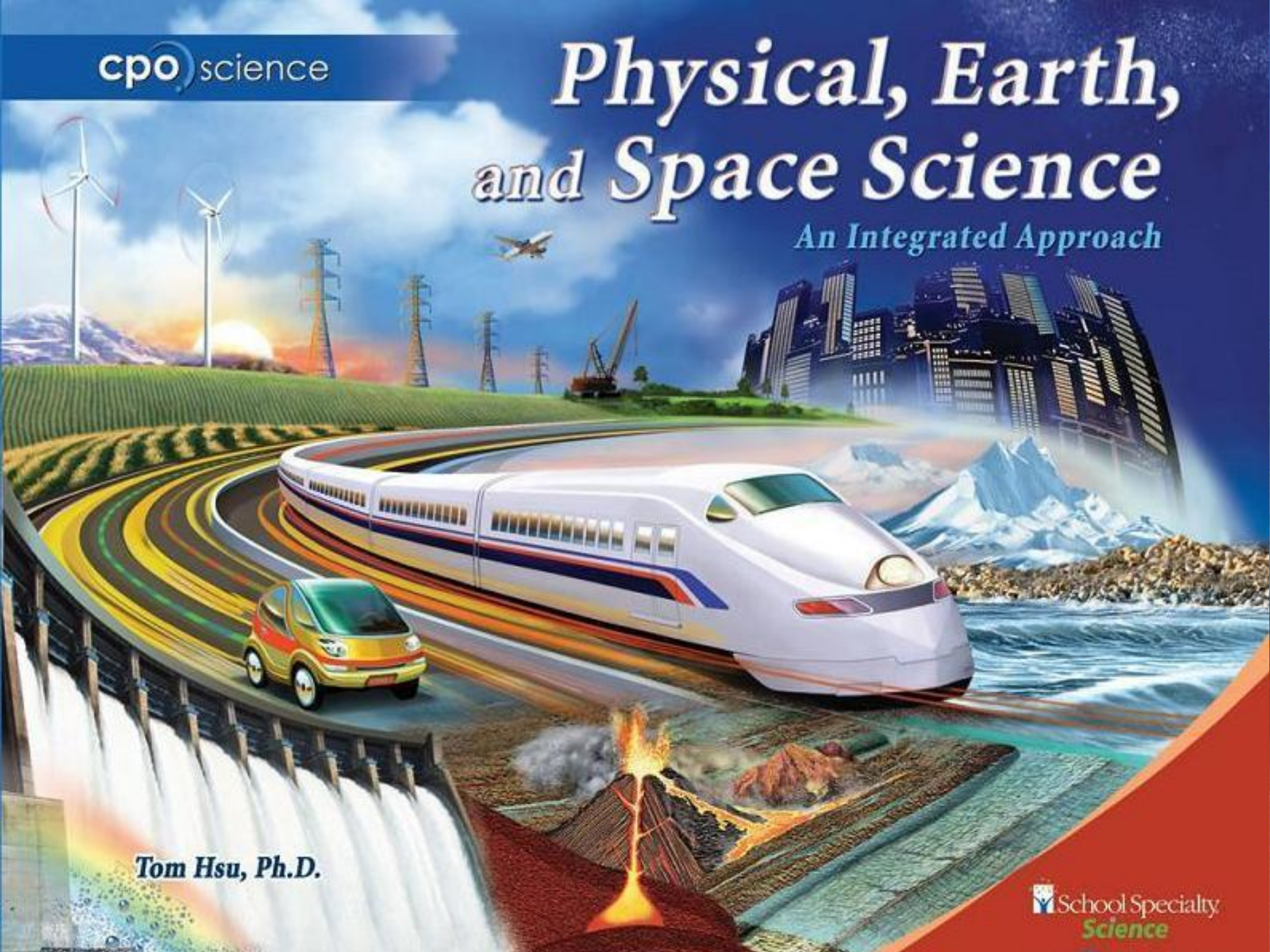
cpo science

Physical, Earth, and Space Science

An Integrated Approach

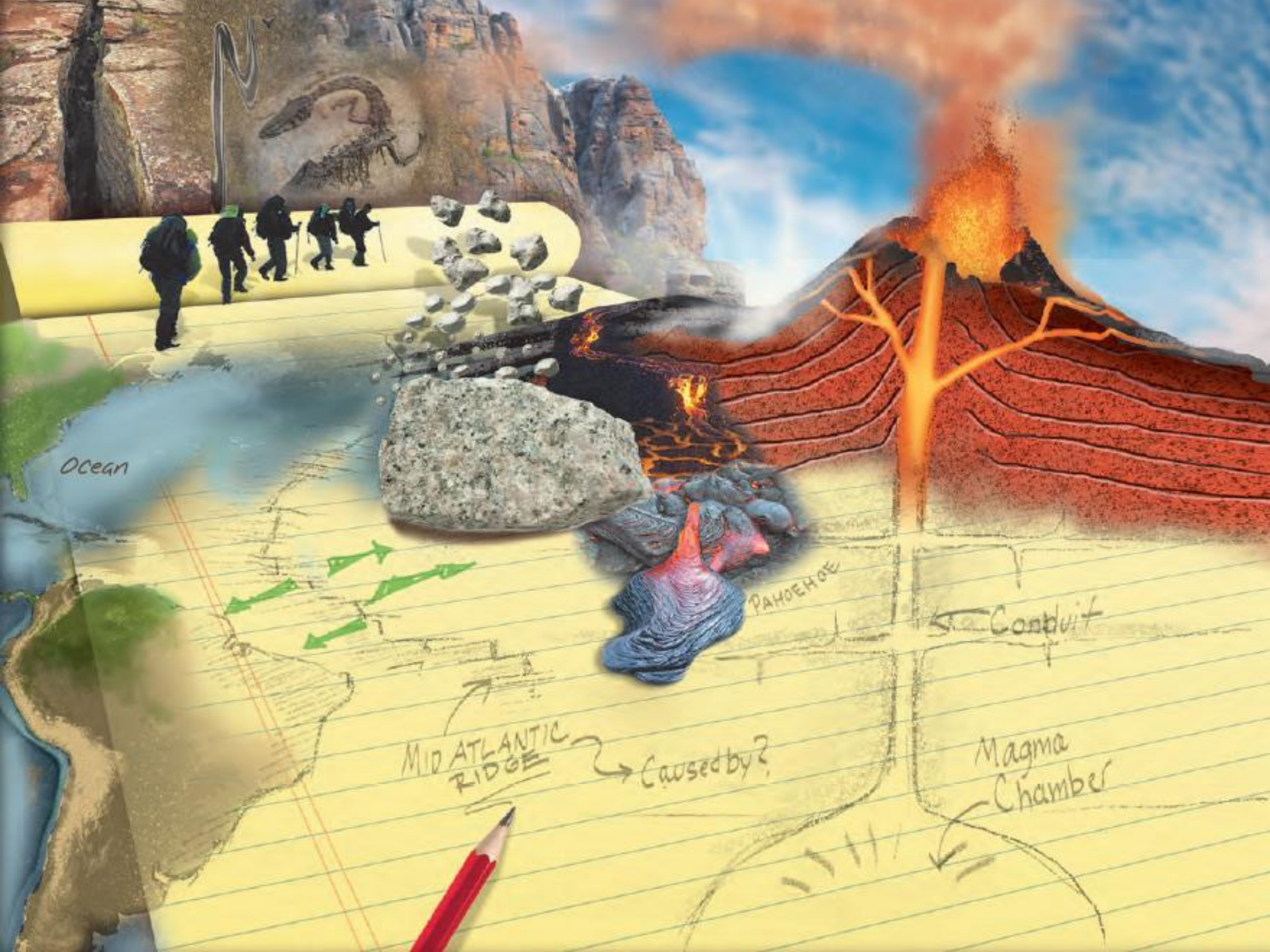


Tom Hsu, Ph.D.

School Specialty Science

UNIT SIX: Earth's Structure

- Chapter 18 Earth's History and Rocks
- Chapter 19 Changing Earth
- Chapter 20 Earthquakes and Volcanoes


Ocean
PAHOEHOE
Conduit
MID ATLANTIC RIDGE
Caused by?
Magma Chamber

Chapter Twenty: Earthquakes and Volcanoes

- 20.1 Earthquakes
- 20.2 Volcanoes
- 20.3 Igneous Rocks

20.2 Learning Goals

- Identify locations where volcanoes are most likely to form.
- Explain the factors involved in volcanic eruptions.
- Evaluate the features of different types of volcanoes.

Investigation 20B

Volcanoes

- ***Key Question:***
  How are volcanoes and plate boundaries related?

Table I: Examples of volcanoes and VEI ratings

VEI	Plume height	Volume (m^3)	Average time interval between eruptions	Example
0	<100 m	≥ 1000	one day	Kilauea
1	100-1000 m	≥ 10,000	one day	Stromboli
2	1-5 km	≥ 1,000,000	one week	Galeras, 1992
3	3-15 km	≥ 10,000,000	one year	Ruiz, 1985
4	10-25 km	≥ 100,000,000	≥ 10 years	Galunggung, 1982
5	> 25 km	≥ 1,000,000,000	≥ 100 years	Mount St. Helens, 1981
6	> 25 km	≥ 10,000,000,000	≥ 100 years	Krakatoa, 1883
7	> 25 km	≥ 100,000,000,000	≥ 1,000 years	Tambora, 1815
8	> 25 km	≥ 1,000,000,000,000	≥ 10,000 years	Toba, 71,000 years ago

20.2 Where you find volcanoes

- ***A *volcano* is a site where melted rock and other materials from Earth's mantle are released.**
- ***Mount St. Helens is a type of volcano called a composite volcano (also known as a stratovolcano).**

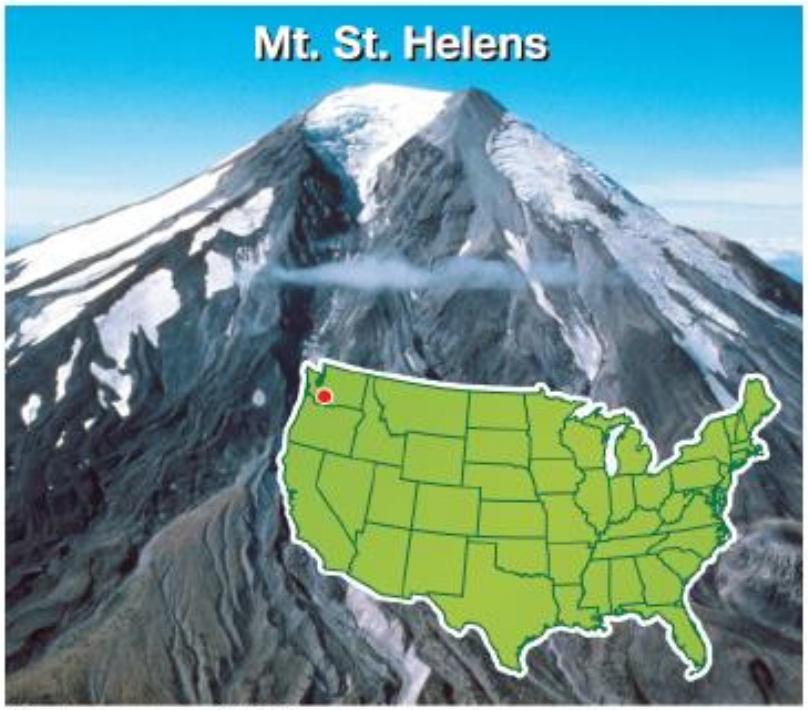


Photo courtesy of USGS

20.2 Where you find volcanoes

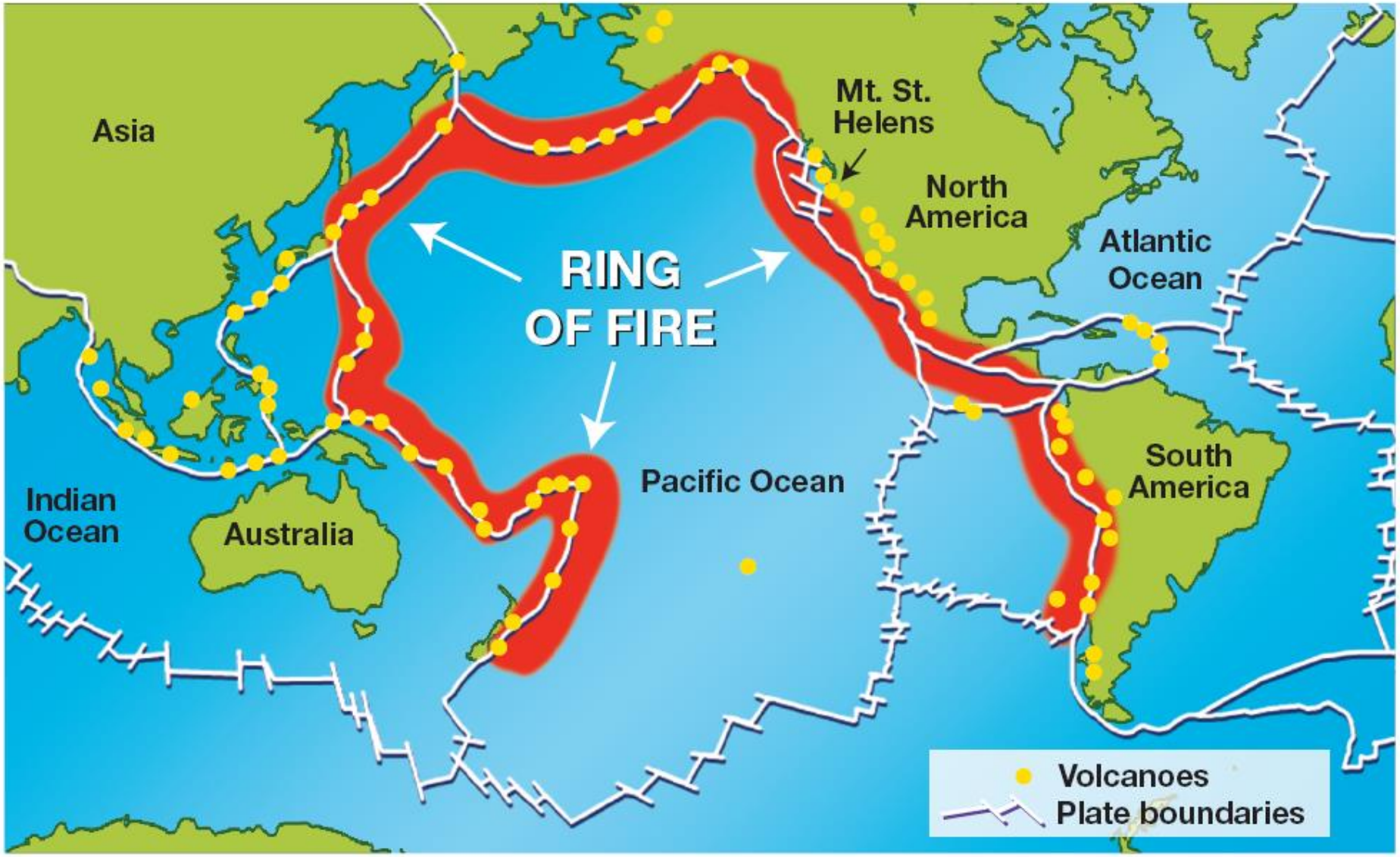
- *About half of the active surface volcanoes on Earth occur along the shores of the Pacific Ocean.
- *This region is called the “Ring of Fire.”

What is the Ring of Fire?

20.2 Where you find volcanoes

- *The **Ring of Fire** is found where the oceanic crust of the Pacific Plate is subducting under nearby plates.
- *Most volcanoes are located along plate boundaries.
- *Volcanoes, like those in Hawaii are also present along divergent boundaries and within plates.

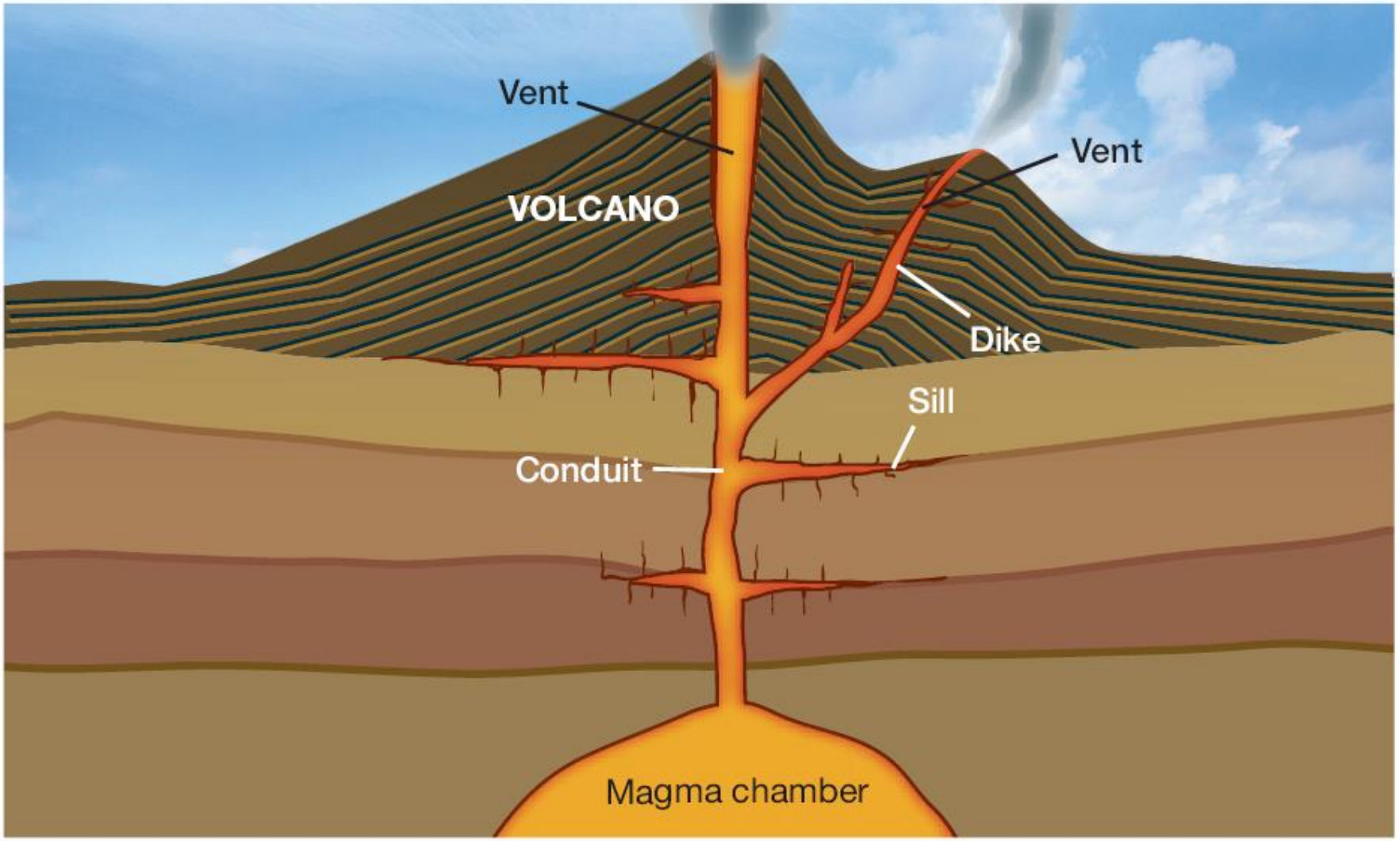
Ring of Fire


Asia
Mt. St. Helens
North America
Atlantic Ocean
RING OF FIRE
Pacific Ocean
South America
Indian Ocean
Australia
Volcanoes
Plate boundaries

20.2 What is a volcano?

- *During an eruption, melted rock called *magma* leaves the *magma chamber* and moves up the *conduit*. The magma leaves the conduit at the *vent*.
- *Magma is called *lava* after it leaves the vent.

Parts of a Volcano

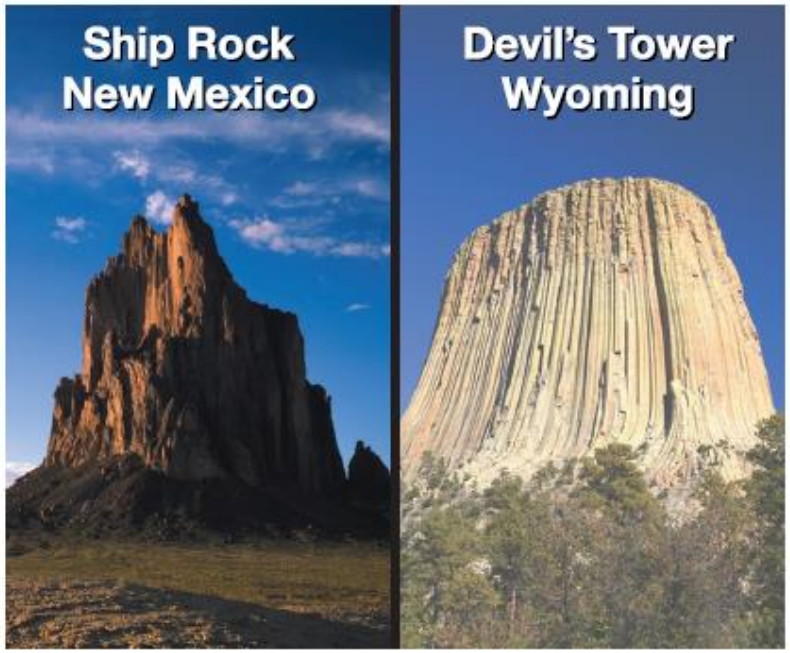


20.2 The life of a volcano

- *An *active* volcano is the most vigorous kind of volcano.
- *Active volcanoes are erupting or have erupted recently, and are expected to erupt again in the near future.
- *A *dormant* volcano is a quiet volcano.
- *Dormant volcanoes are not active now, but may become active again in the future.

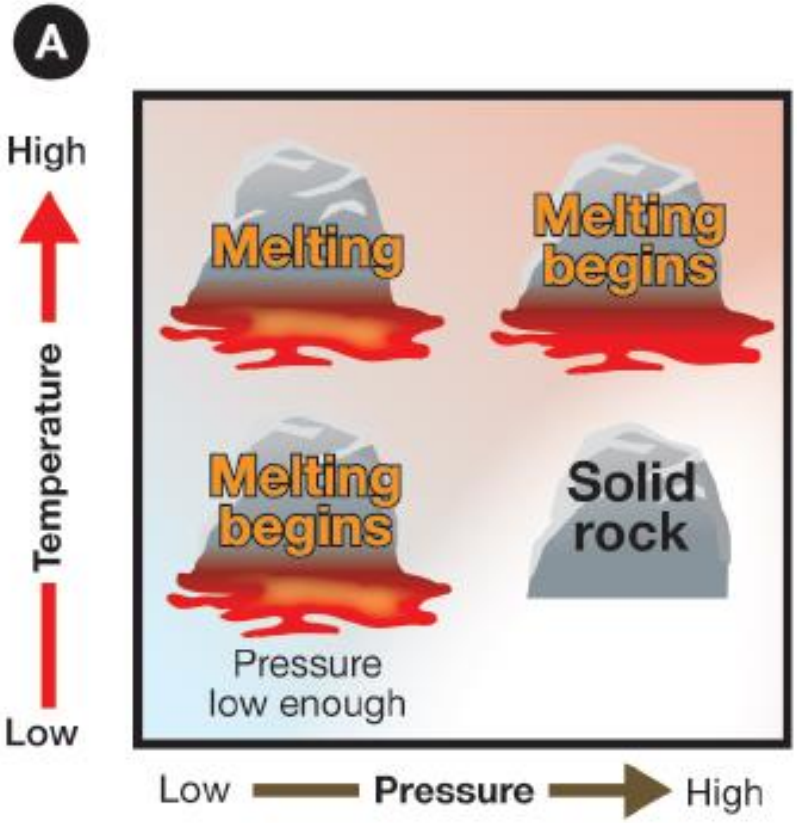
20.2 The life of a volcano

- ***Devil's Tower and Ship Rock are examples of *extinct* volcanic "necks."**



As the volcano erodes, a core of solid magma gets exposed by erosion.

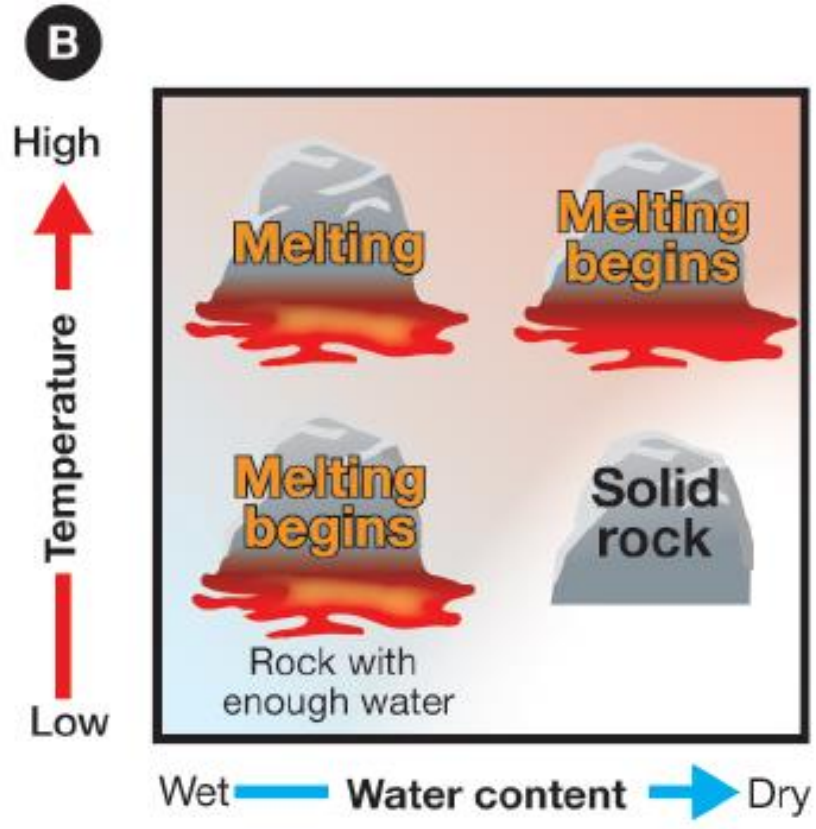
20.2 What makes magma?



- There are two ways to make rock melt.
- One way is to reduce the pressure.

20.2 What makes magma?

- The other way is to mix water with the hot rock.
- The conditions needed to melt rock are very special and exist inside our planet.

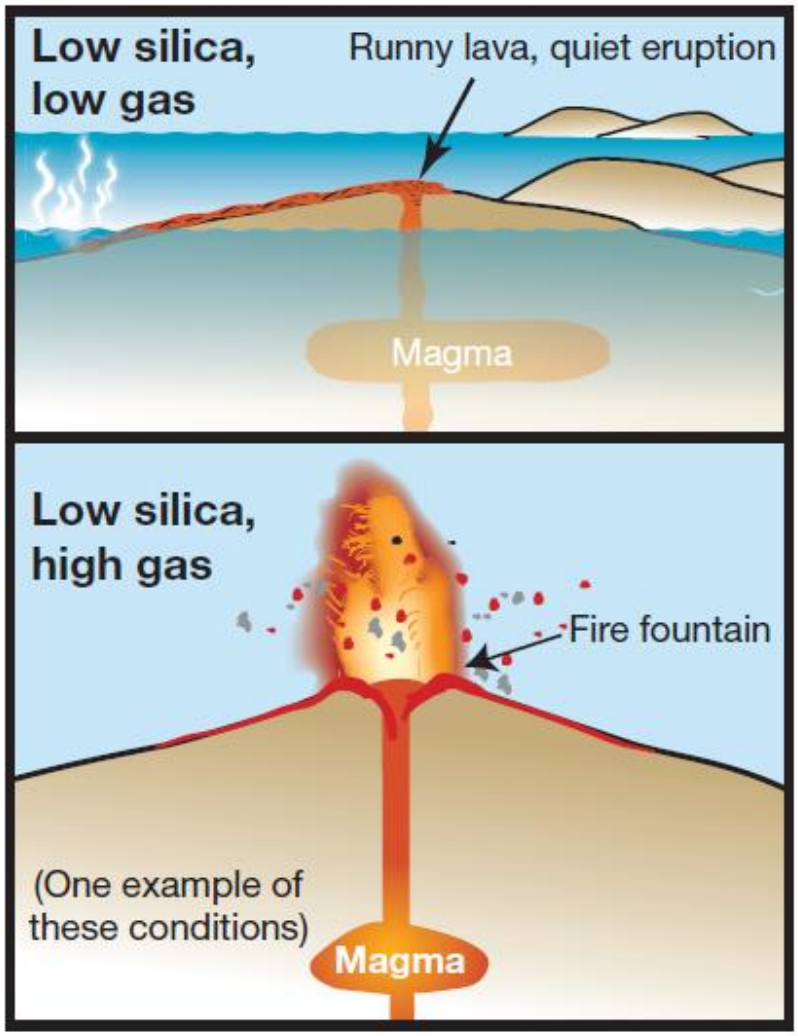


20.2 Volcanoes vary

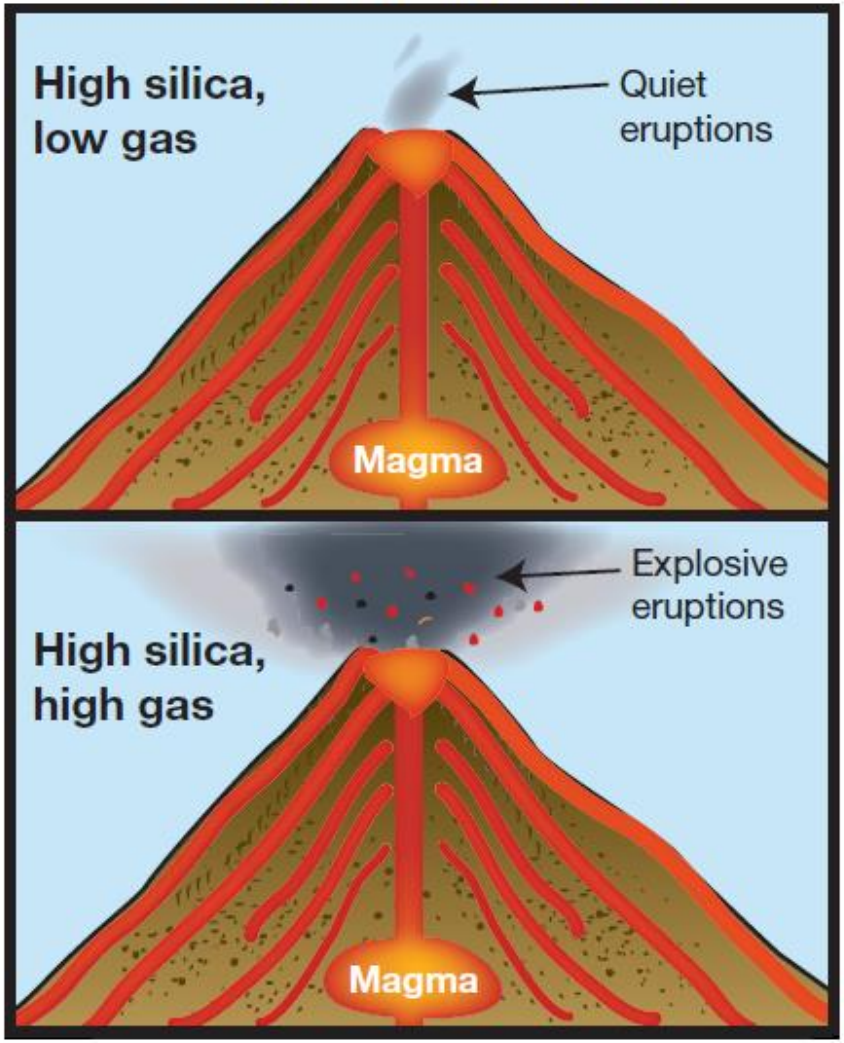
- *The shapes of volcanoes depend on the composition of the magma that formed them.
- *Volcanoes can look like wide, flat mounds (shield volcanoes), like tall cones (composite volcanoes), or like a heap of rock bits (cinder cones).

Types of Volcanoes

Shield Volcanoes



Composite Volcanoes

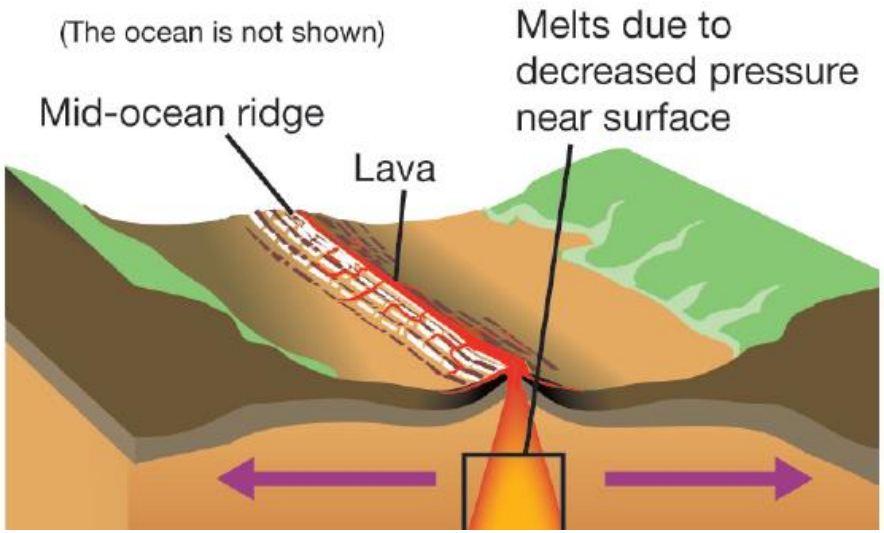


20.2 Volcanoes vary

- **The quantity of dissolved gases affects how explosive the eruption will be.**

		Low Gas	High Gas
Shield Volcanoes	**Low Silica**	Runny magma, like ketchup Quiet eruption, lava flows easily	Runny magma, bubbly Fire fountain, lava flows easily
Composite Volcanoes	**High Silica**	Thick, sticky magma, like taffy Quiet eruption	Thick, sticky magma Explosive eruption

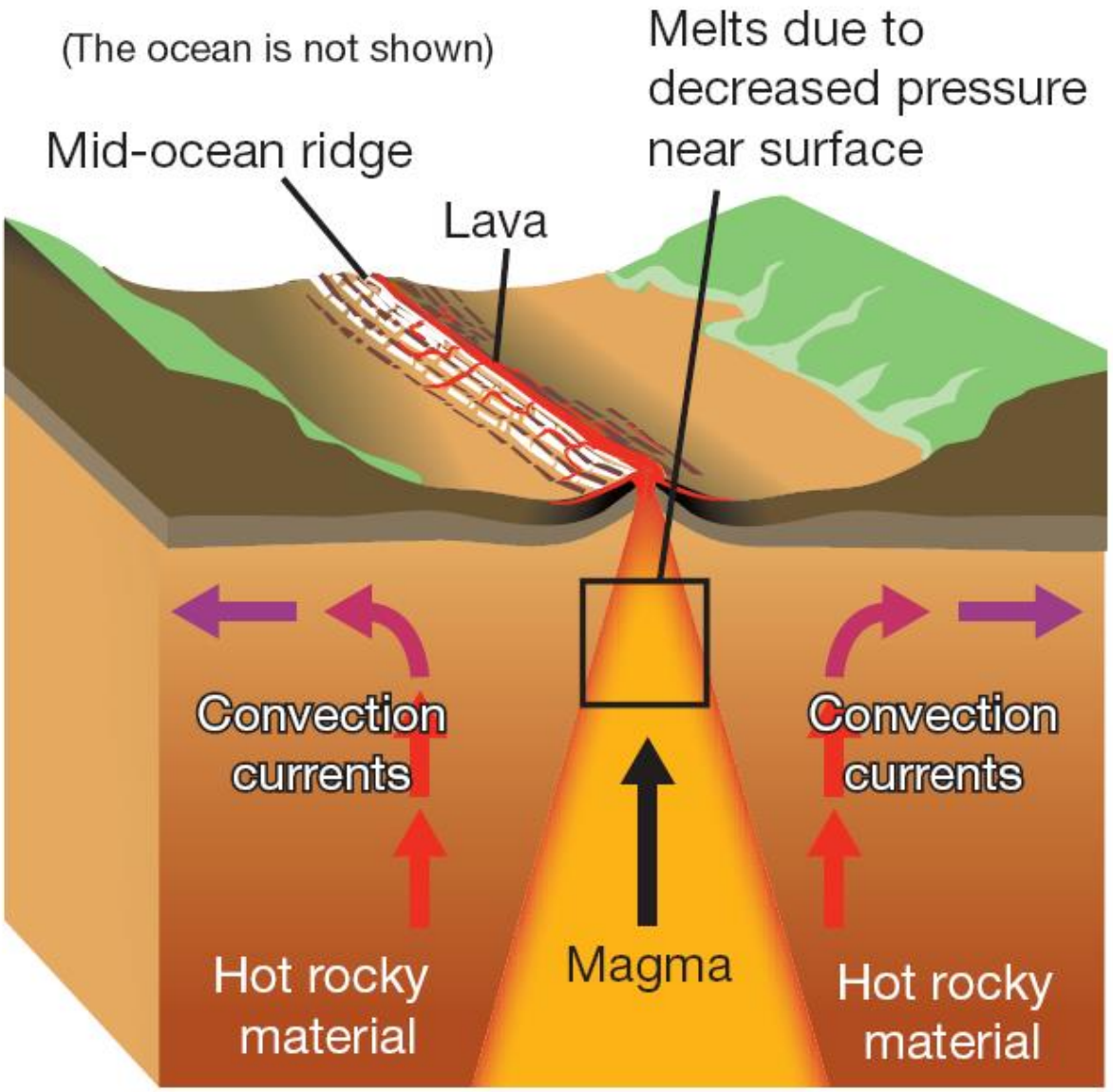
20.2 Volcanoes at divergent boundaries



- *Mid-ocean ridges occur underwater at diverging plate boundaries.
- *When lava oozes out at a mid-ocean ridge, it immediately hits cold seawater, forming a crust.

Can you name an oceanic ridge formed at diverging plates?

Volcanoes at Mid-Ocean Ridges



20.2 Volcanoes at divergent boundaries

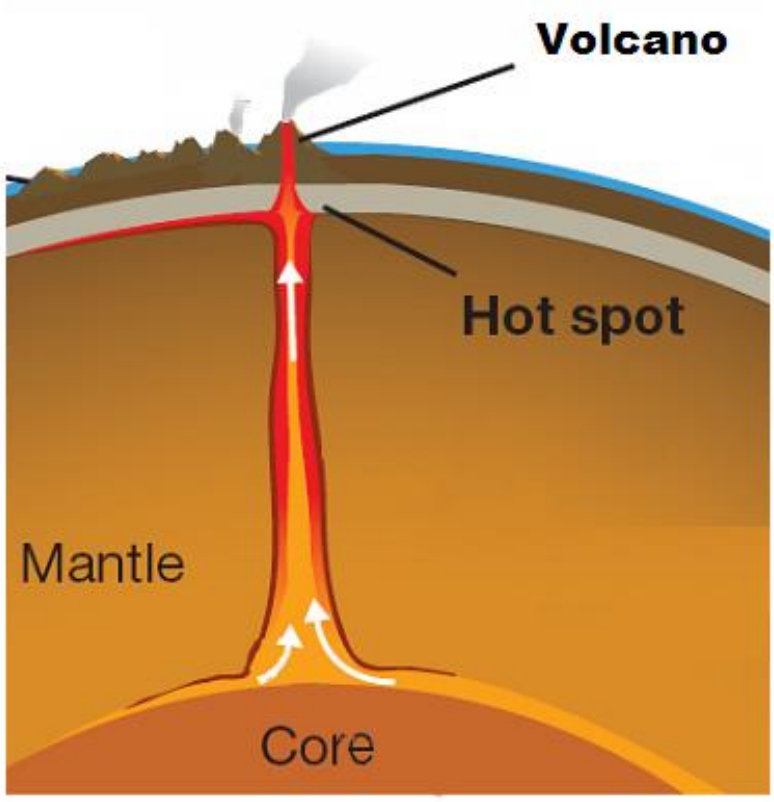
- ***On land, *basaltic lava* flows like spilled syrup.**
- ***Underwater, oozing lava hits cold seawater and air fills a solid lava skin like a balloon.**
- ***When geologists find *pillow lava* on land, they know that there was once a midocean ridge nearby (evidence of sea-floor spreading).**

20.2 Volcanoes at divergent boundaries

- Iceland is separating along the Mid-Atlantic Ridge.
- Similarly, Ethiopia is the site of the East African Rift zone.

Due to the separation of plates at these locations, each is intensely volcanic.

20.2 Volcanic islands chains and mantle plumes



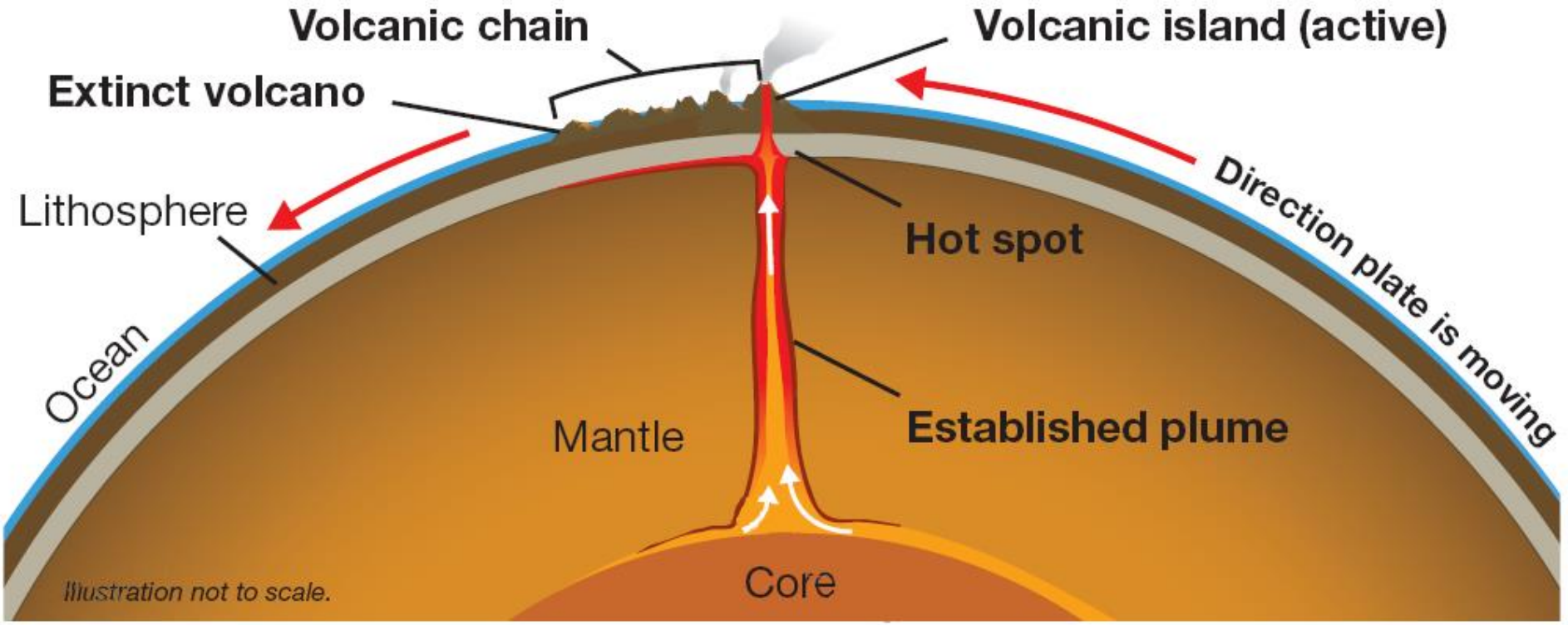
- ***Volcanic islands* form when mantle plumes bring material from deep within the lower mantle under an ocean.**
- ***The top of an active mantle plume is called a *hot spot*.**

20.2 Volcanic chains

Copy all

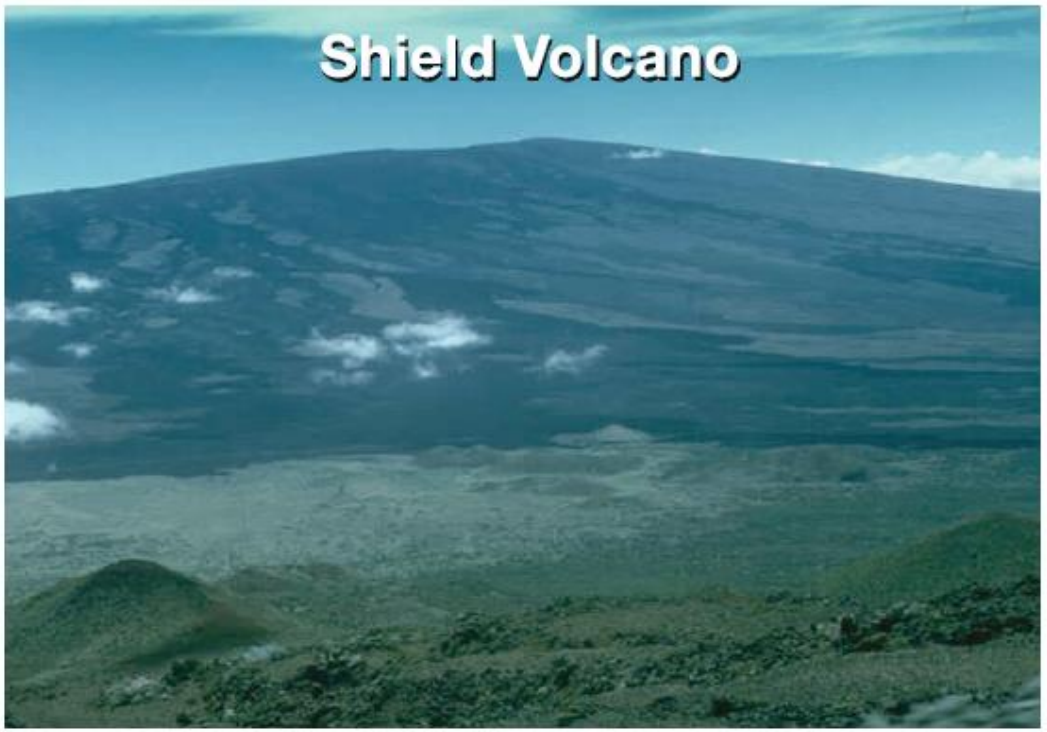
1. As the plate moves, it carries the volcanic island away from the active hot spot.
2. Without the hot spot to supply magma, the volcano becomes extinct.
3. The hot spot begins to form a new volcano beside the old one.
4. The result is a volcanic island chain.

Volcanic Islands

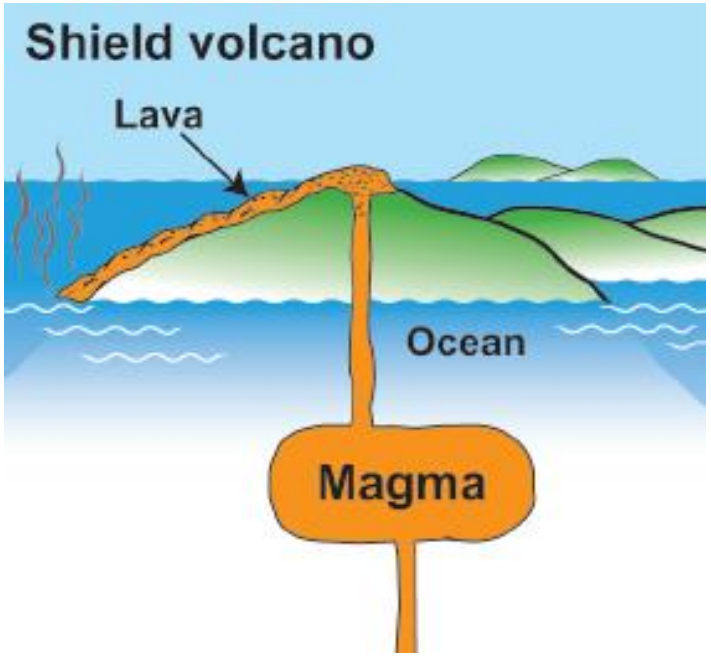


20.2 Shield and composite volcanoes

- ***Low silica magma produces a *shield volcano.***



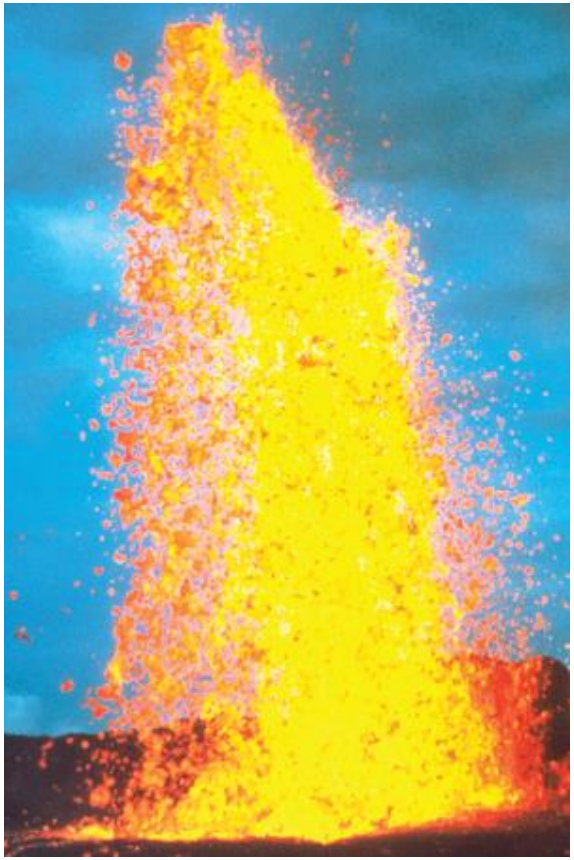
20.2 Shield and composite volcanoes



- *Because low-silica, basaltic magma is runny, it can’t build up a tall, cone-shaped volcano.

12.2 Volcanoes with low silica magma

- When low silica magma has high levels of dissolved gas, gas bubbles out as it reaches the volcano vent.
- The effect is identical to shaking a soda bottle to produce a shower of soda.

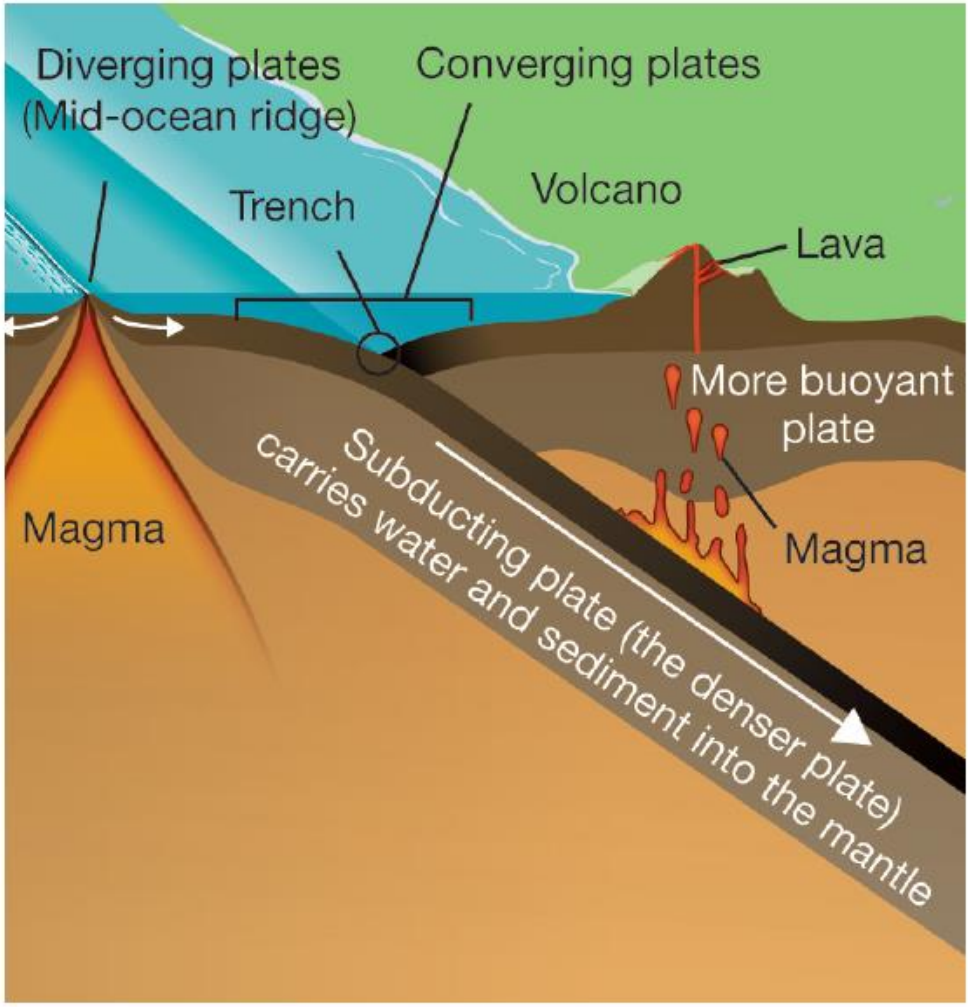


High-gas magma produces a spectacular fire fountain.

20.2 Shield and composite volcanoes

- ***A tall cone, or *composite volcano* is a tall cone formed by layers of lava and ash.**

20.2 Silica rich magma



- During the upward migration, minerals in magma begin to crystallize.
- As the minerals crystallize, the silica increases in concentration.

20.2 Silica rich magma

- **Compare and contrast shield and composite volcanoes using the data below:**

	Shield volcanoes	Composite volcanoes
Volcano shape	Flattened, gradual slopes	Tall, steep slopes
Silica concentration	Silica poor	Silica rich
Magma source	Mantle	Mantle (and melted subducted ocean crust and sediment)
Distance from magma source to volcano on Earth's surface	Short	Long

20.2 Dissolved gas and cinder cones

- *If silica-rich magma contains high levels of dissolved gas, pressure usually builds inside a volcano.

20.2 Dissolved gas and cinder cones

- The lava bits filled with gas bubbles break apart as the dissolved gas expands.
- *The gas-filled fragments cool to produce pumice and ash.

20.2 Cinder cones

- *A cinder cone, a third type of volcano, is not the result of flowing lava.
- *Imagine a volcano that ejects a lot of gas with only small bits of lava.