

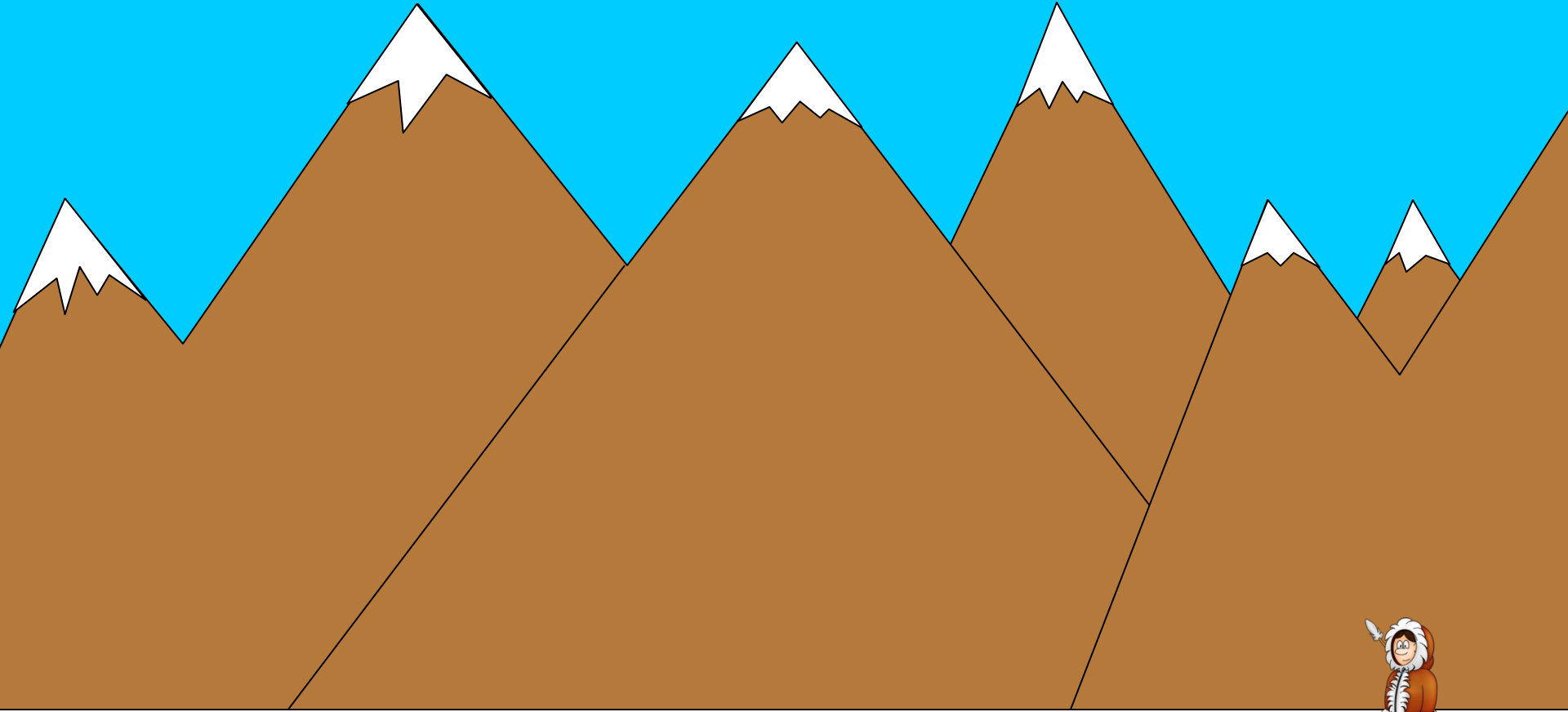


Alfred  
Wegener



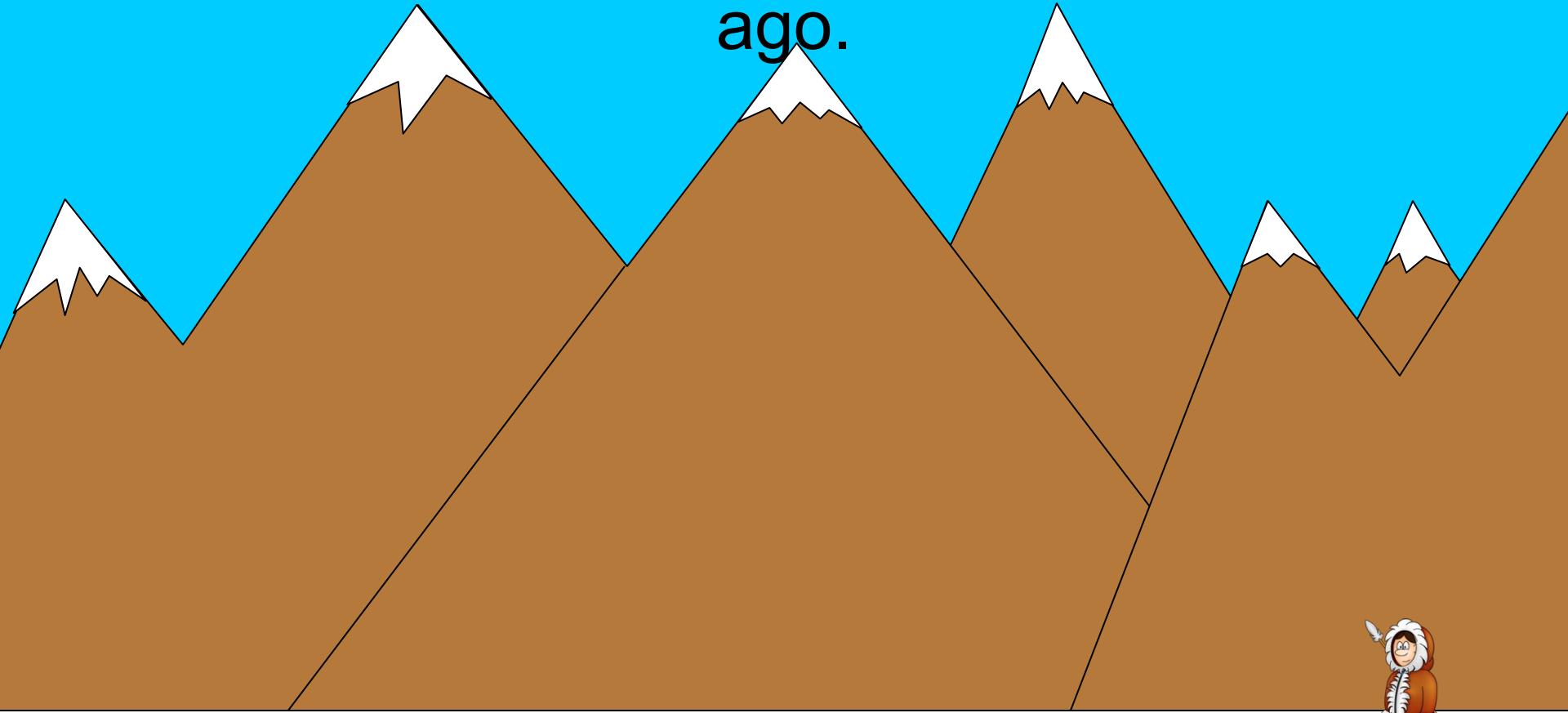
# Continental Drift

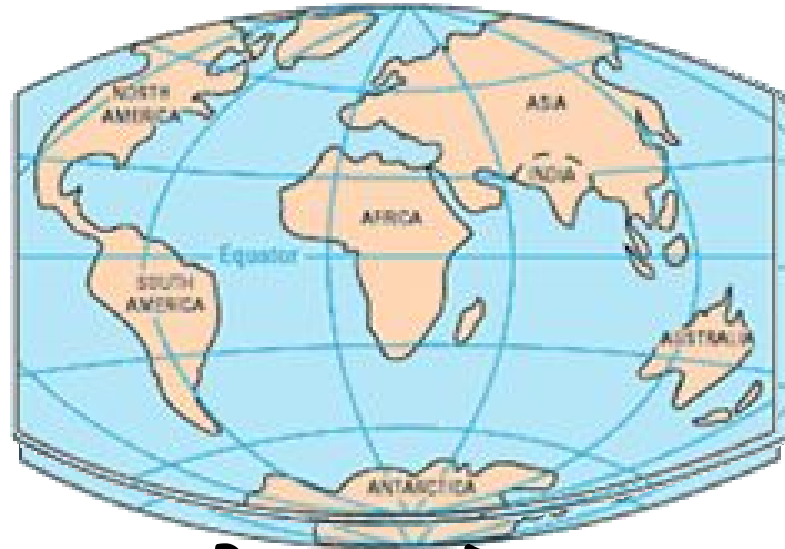
The idea that the world's land masses are slowly moving over time



# Pangaea

The supercontinent made of all continents that existed millions of years ago.





Present Day  
Cretaceous Age  
135 mya



# Alfred's Evidences

## 1. Geometric Evidence



# Alfred's Evidences

## 1. Geometric Evidence

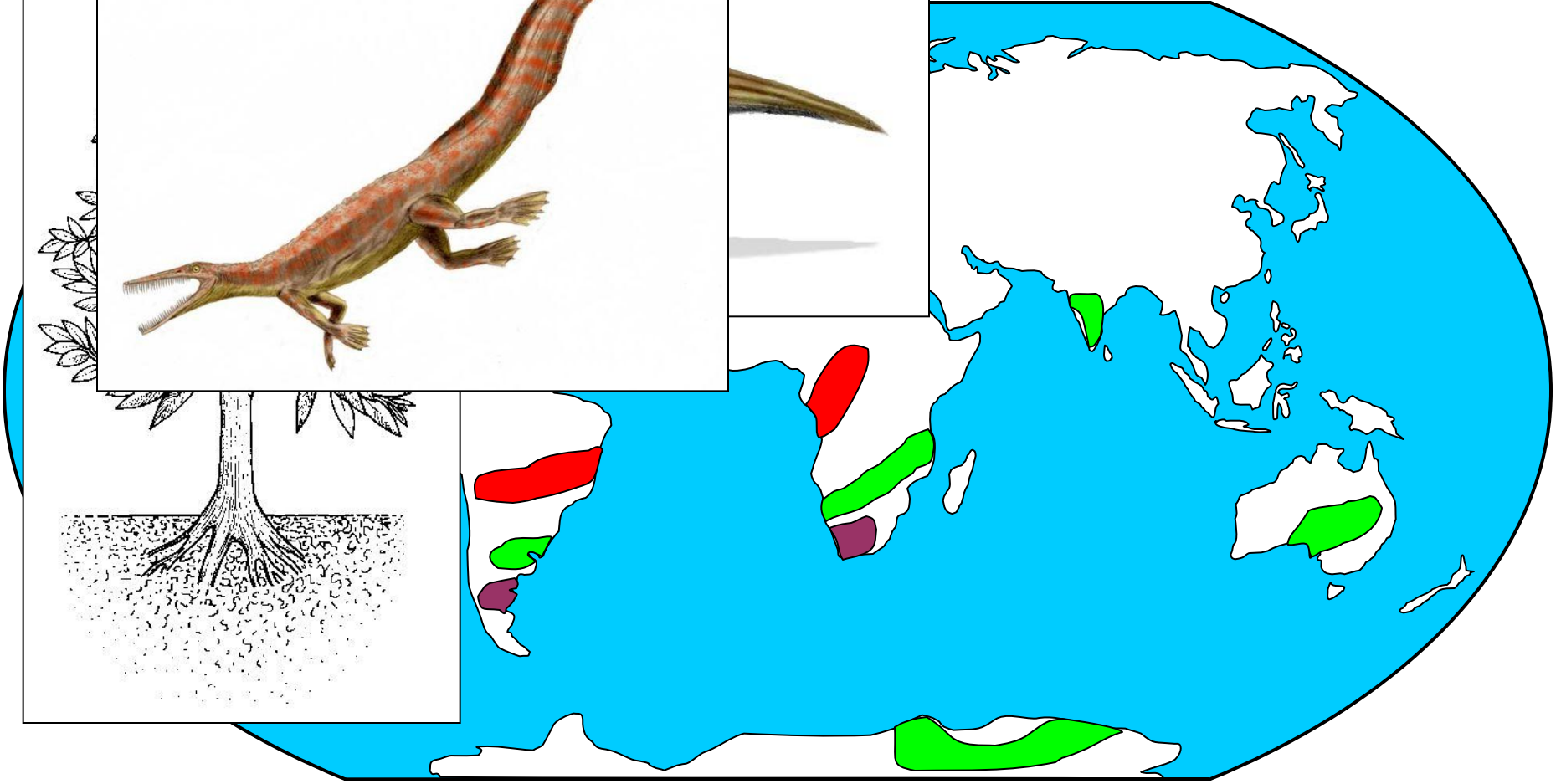
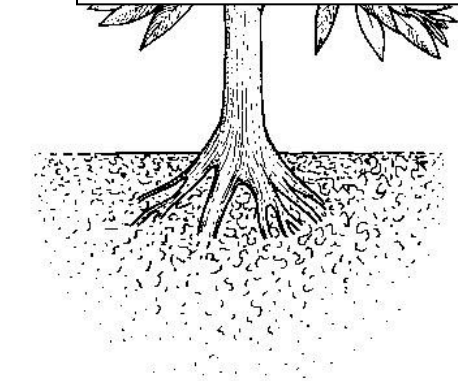
The continents appear  
to fit together like  
pieces of a puzzle





Mesosaurus


Cynognathus

Platanus



 Distribution of Cynognathus

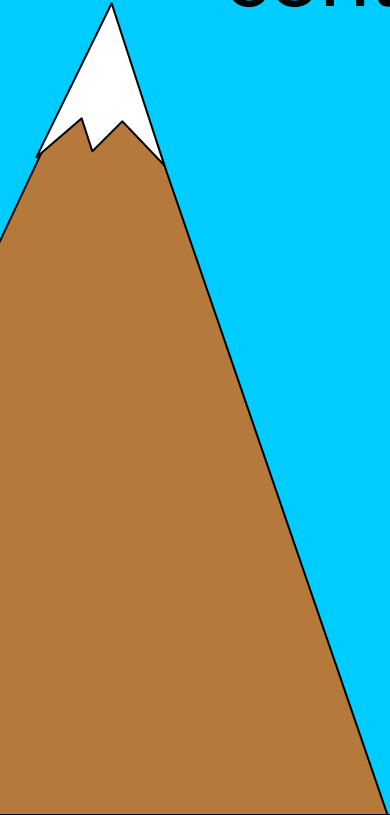
 Distribution of Platanus

 Distribution of Mesosaurus

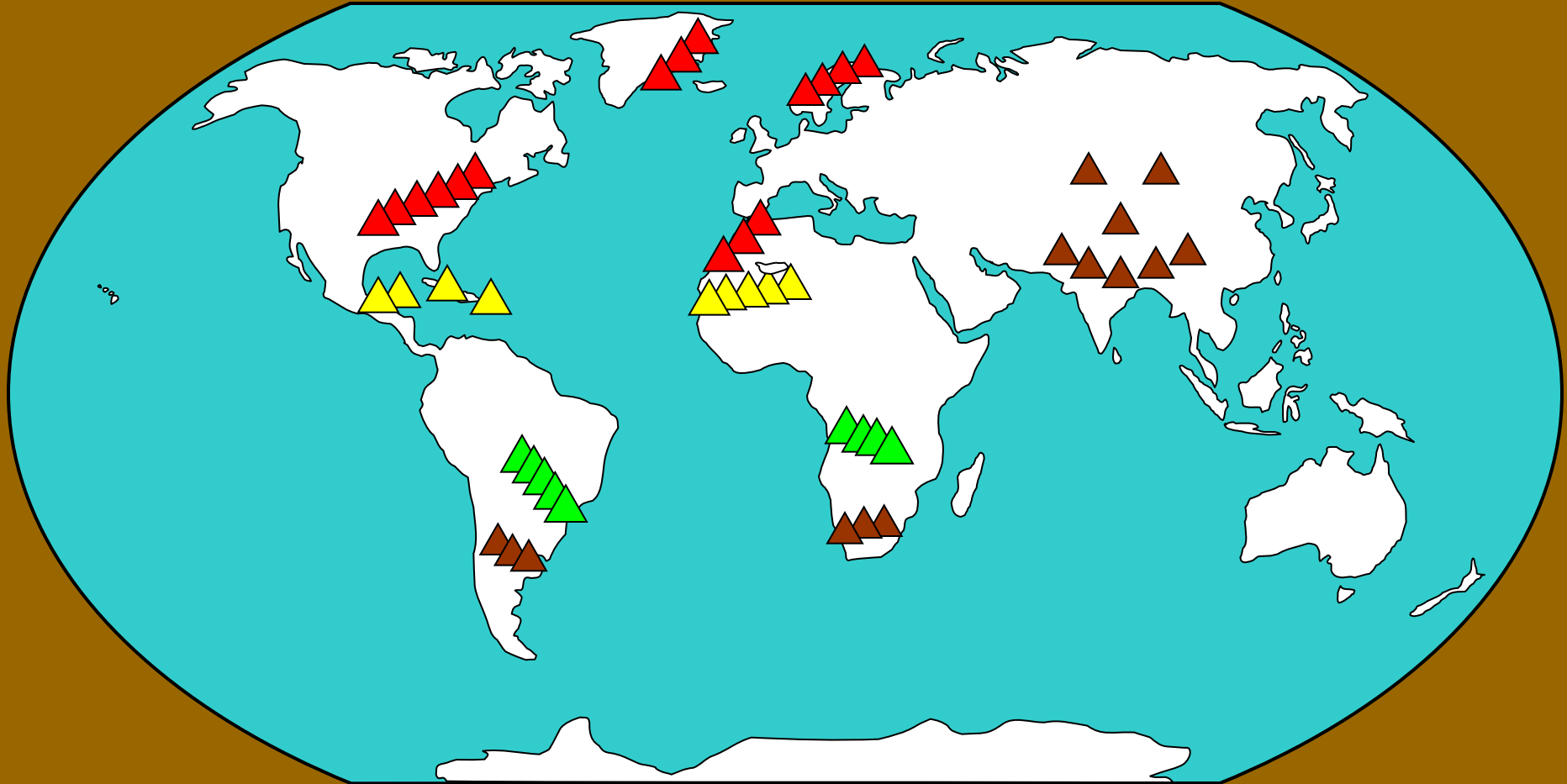


## 2. Fossil Evidence

Fossils of some species are only found on the matching coastlines of continents now separated by oceans



# 3. Mountain Evidence



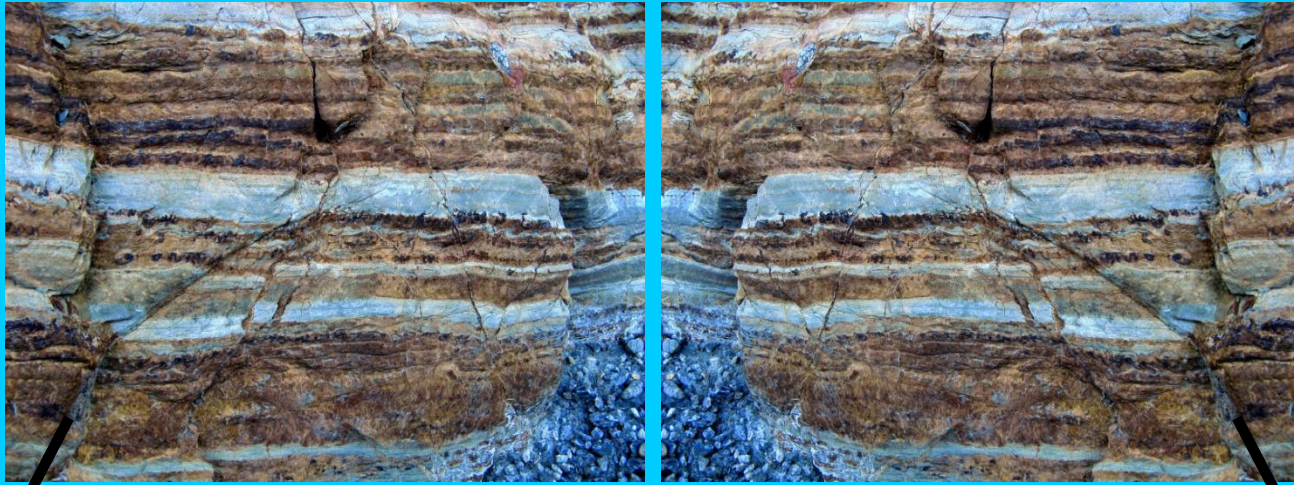
# 3. Mountain Evidence



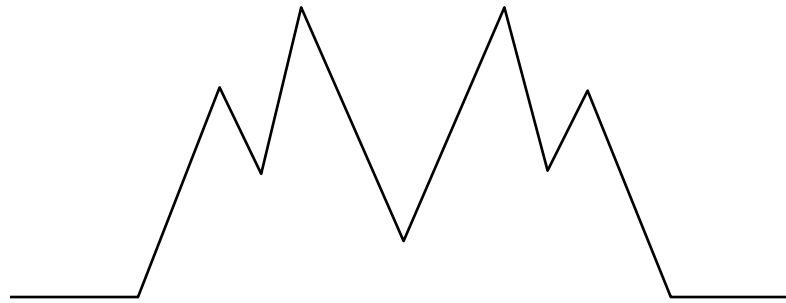
*I never re  
liked hi  
anyways*

*ny*

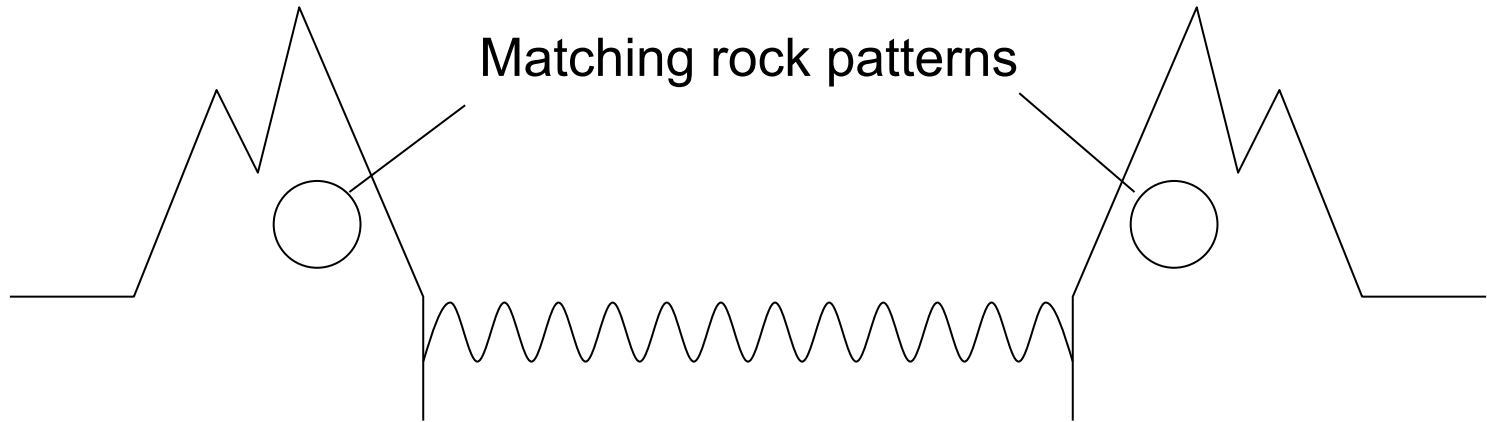
# 3. Mountain Evidence



Mountain ranges end on one coastline and pick back up on another. The rock patterns of these mountains match up.



**Before**

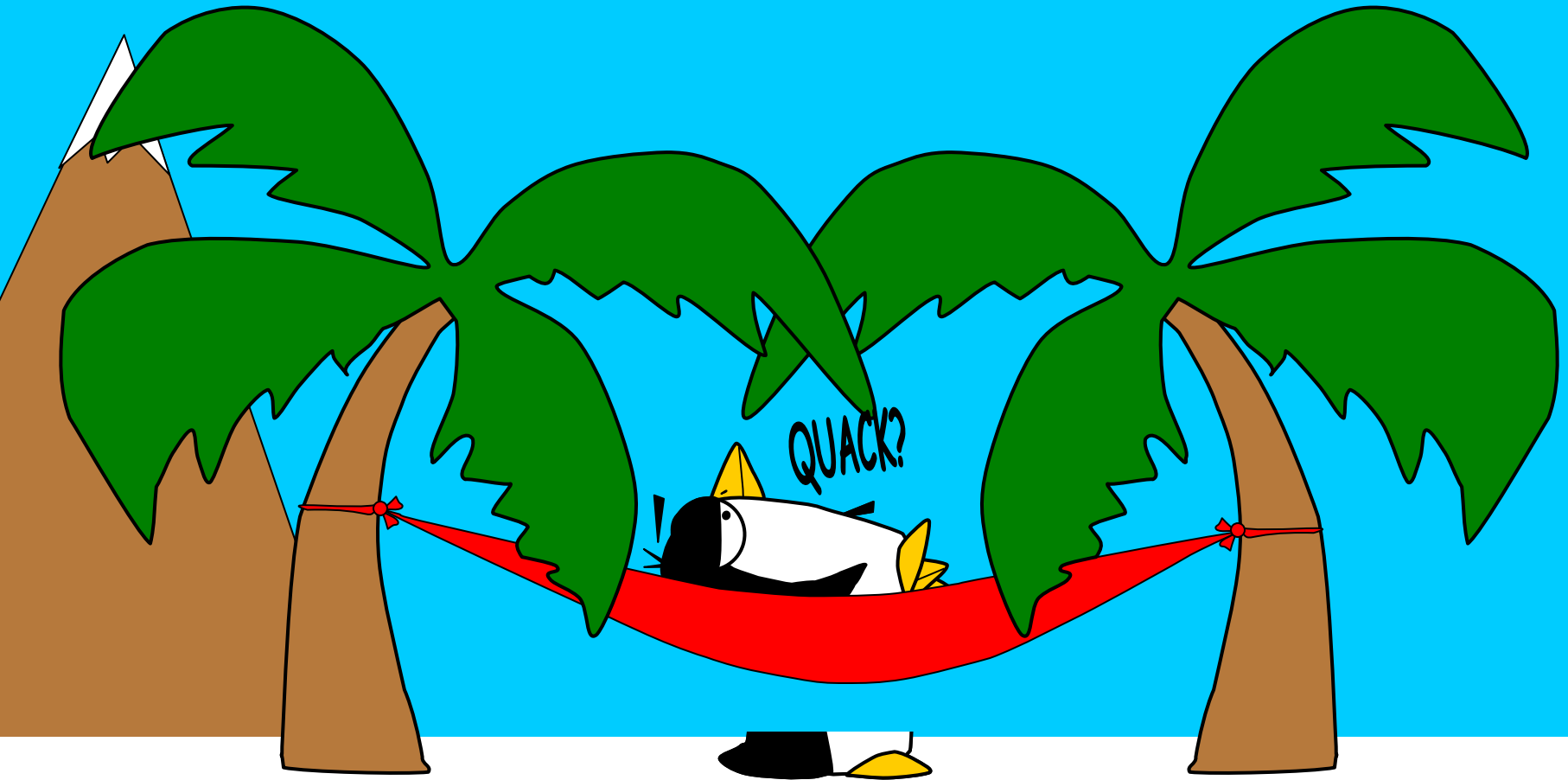


**Matching rock patterns**

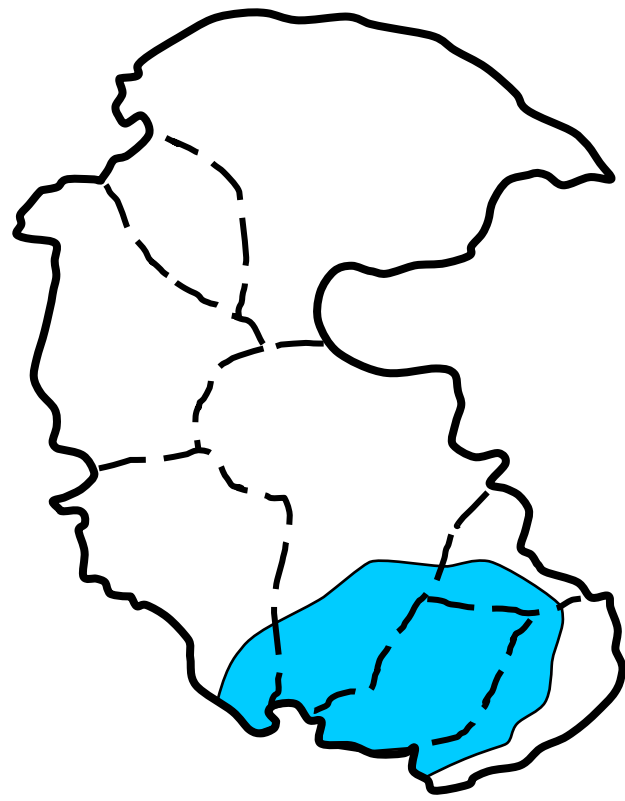
**After**

# 4. Climate Evidence

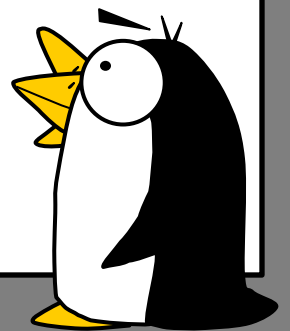
Deposits of coal prove that *tropical plants* used to grow in *cold areas* like Antarctica . . .



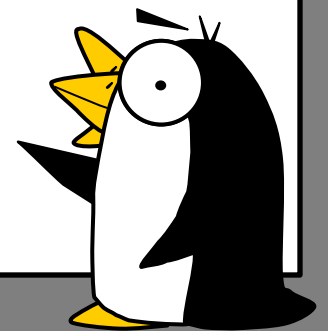
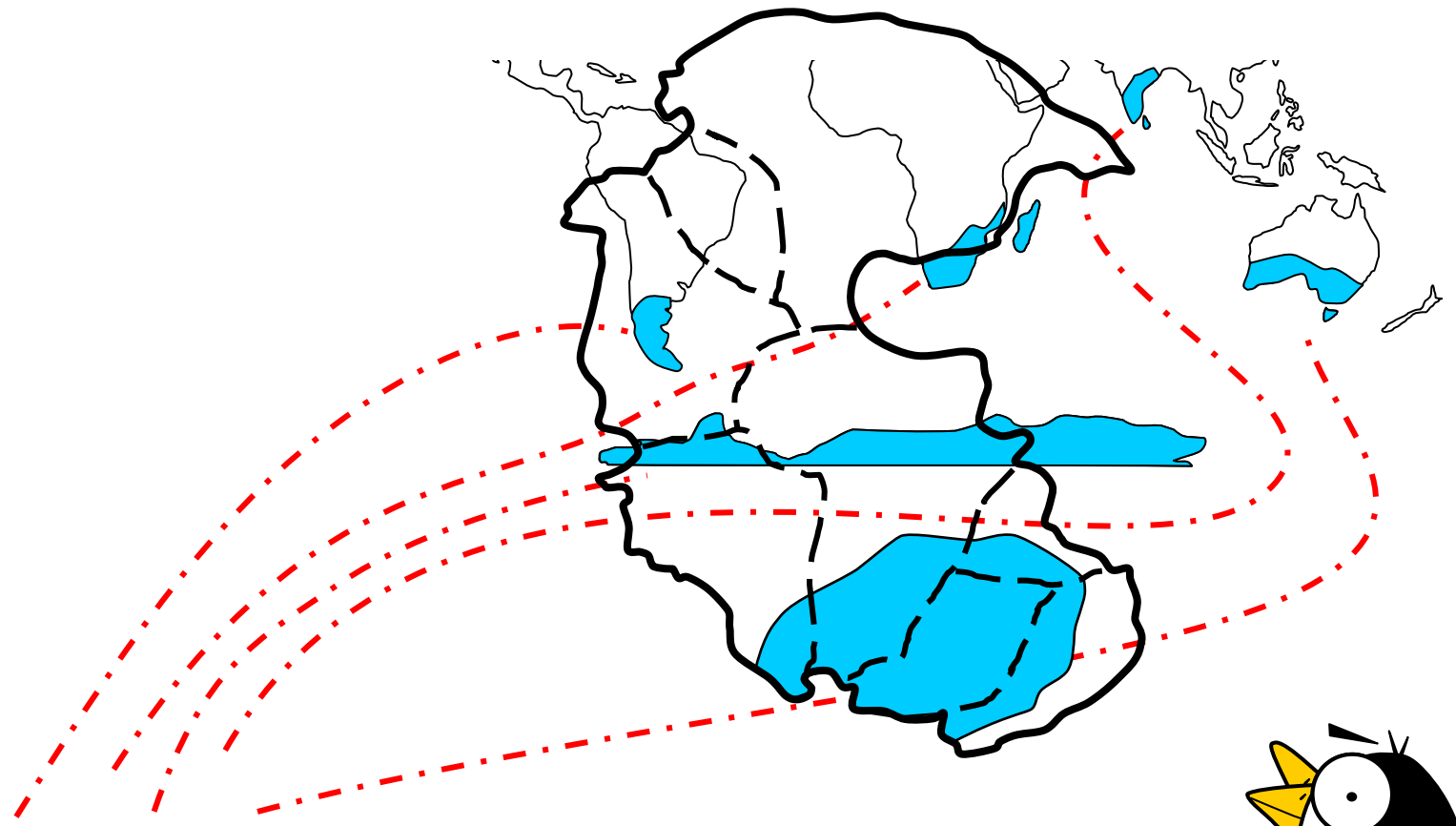
. . . and evidence of past glaciers is found in places that are too hot today.



Pangaea



. . . and evidence of past glaciers is found in places that are too hot today.





# Alfred's Evidences

1. Geometric Evidence
2. Fossil Evidence
3. Mountain Evidence
4. Climate Evidence



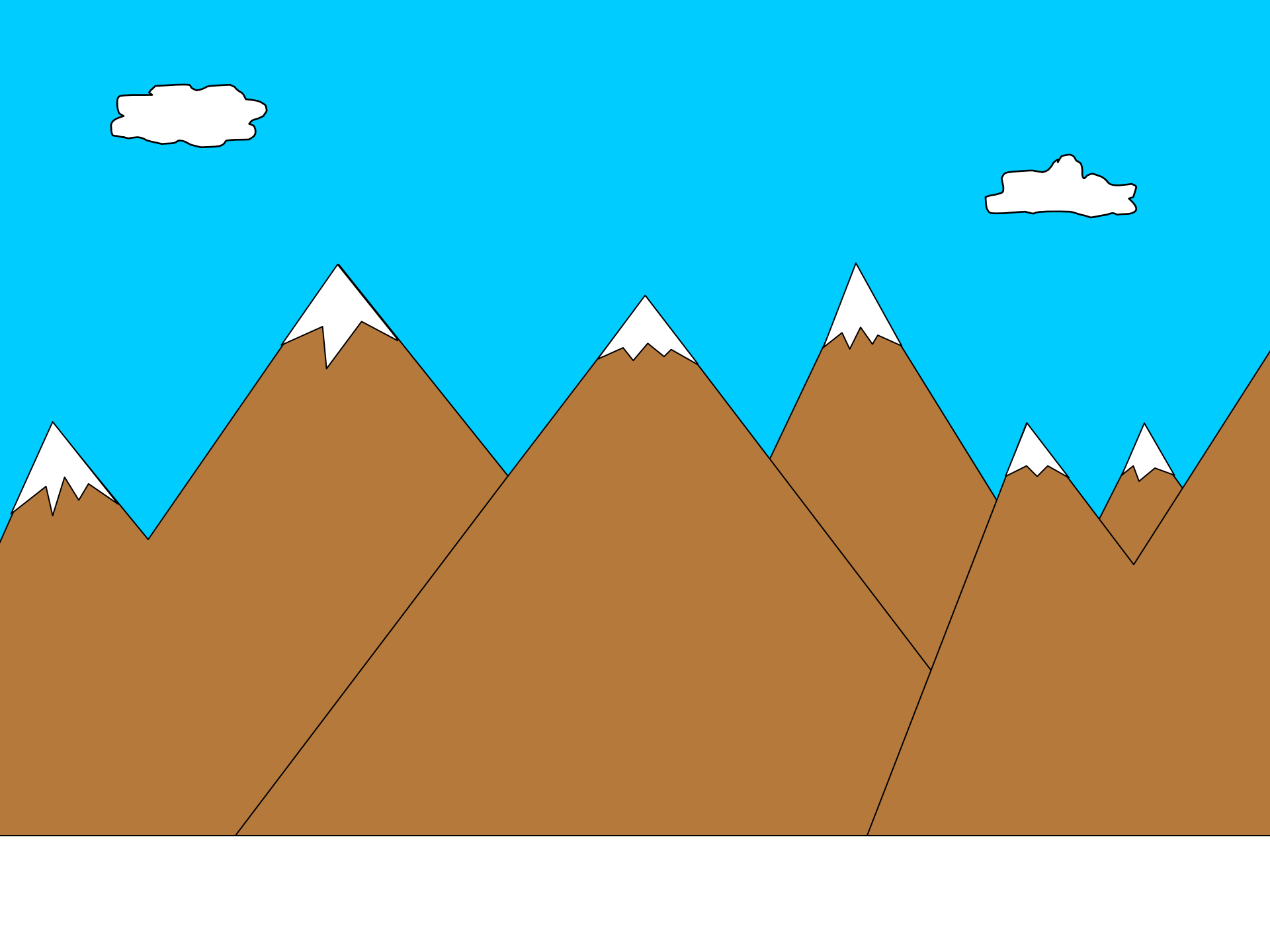
REJ  
ECT  
ED.

# The problem

Despite all of his evidence, Wegener could not explain what happened.

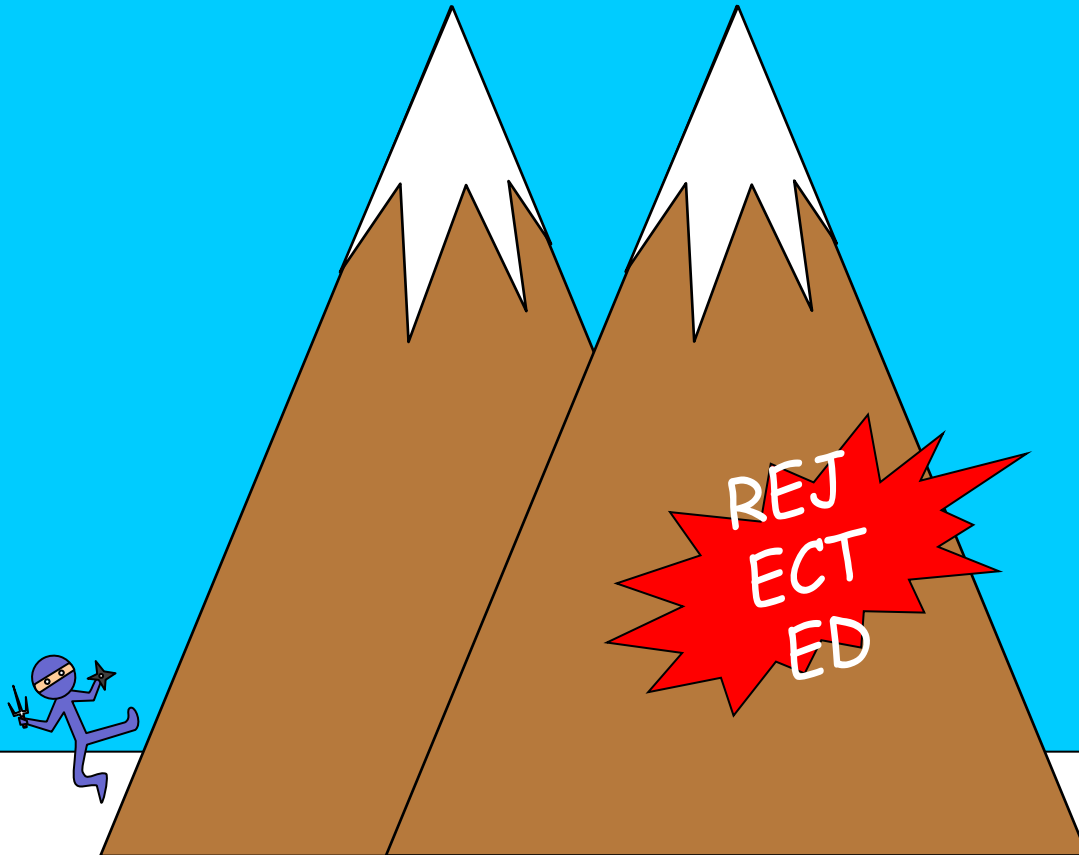
*To Be  
Continued...*

ism!



# Recap...

When we last left, poor Alfred's hypothesis of continental drift was being rejected by his fellow scientists



# HYPOTHESIS

VS.

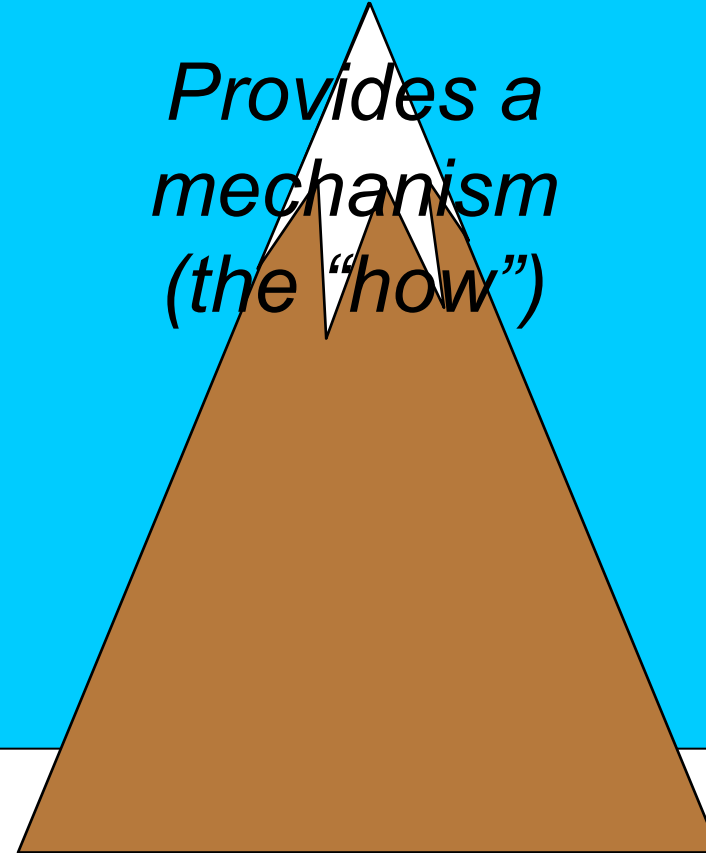
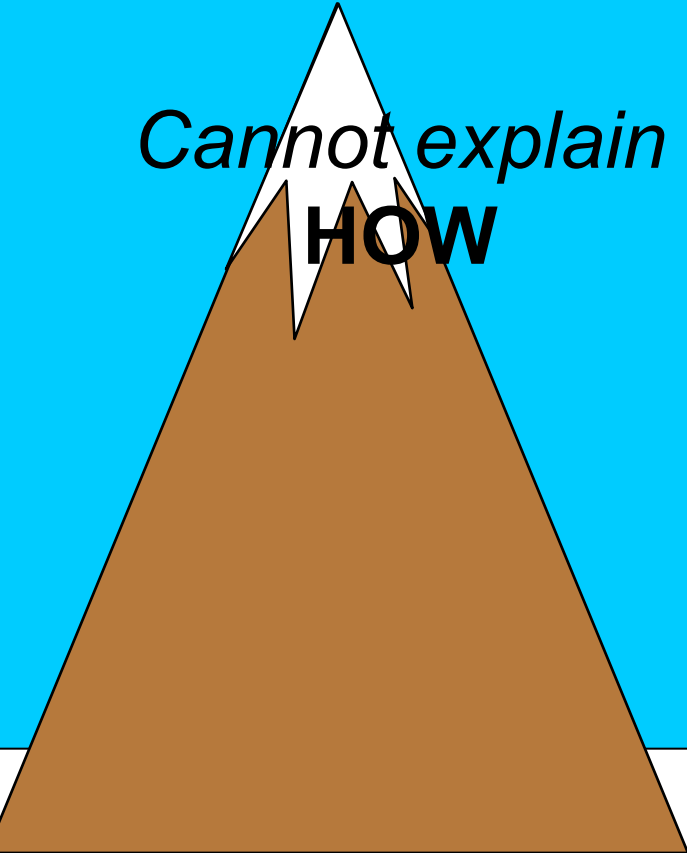
# THEORY

*Provides Evidence*

*Provides Evidence*

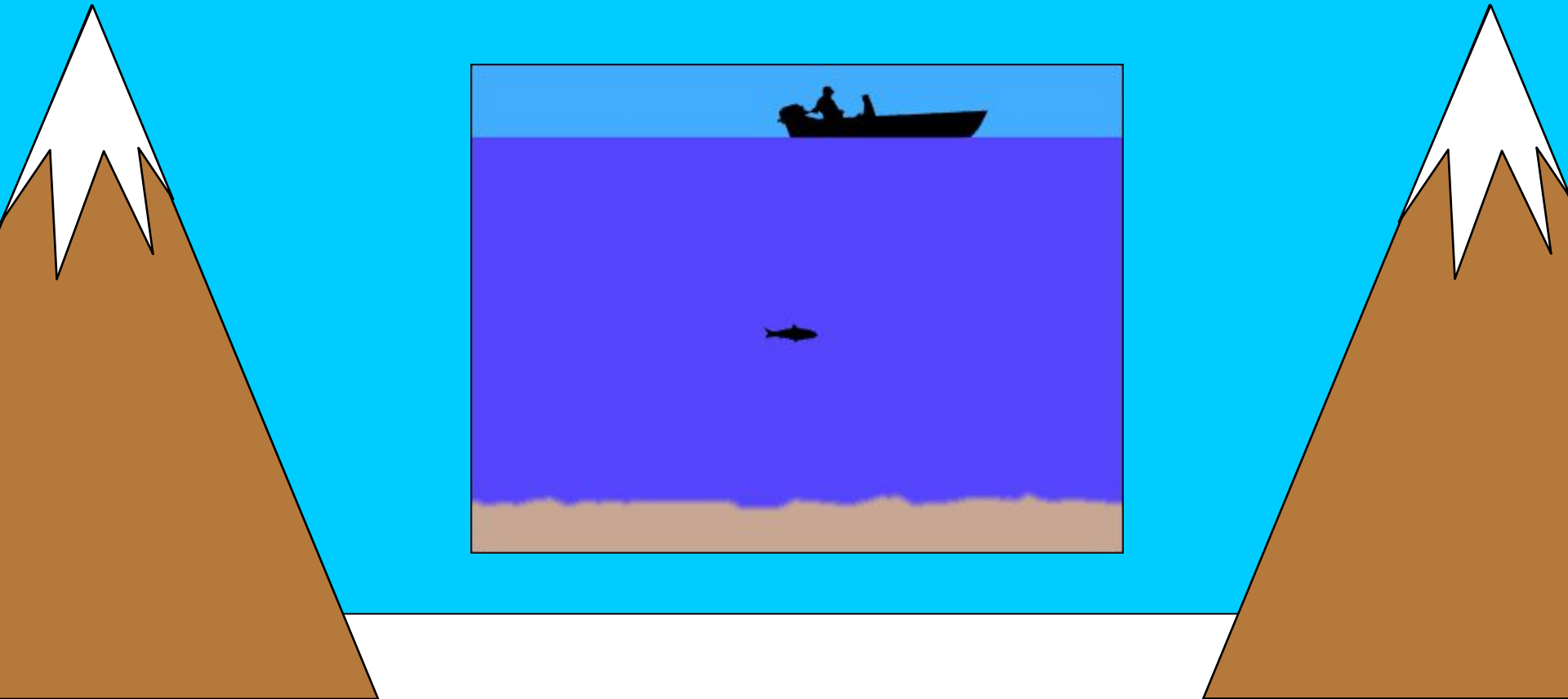
*Cannot explain*  
**HOW**

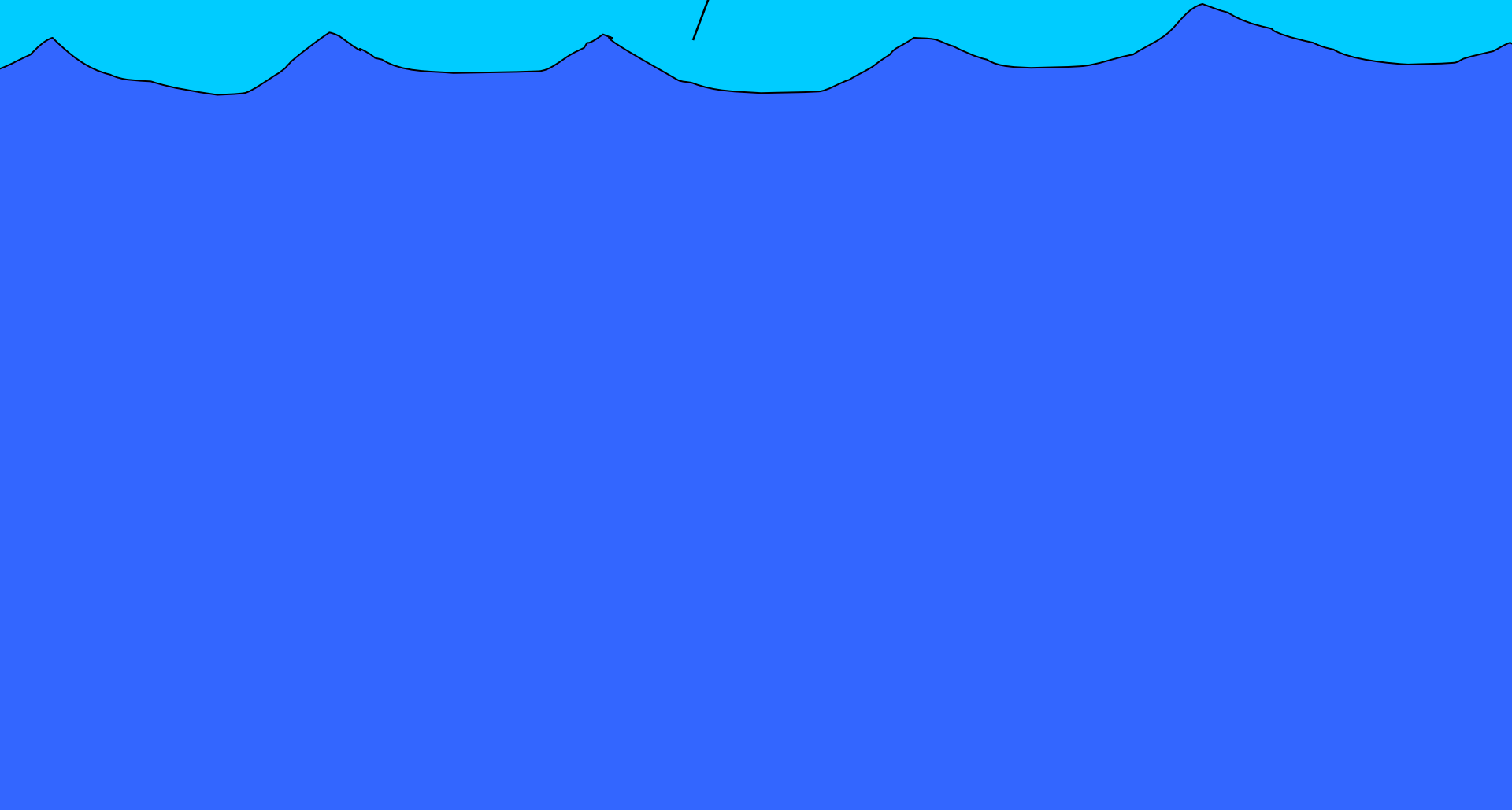
*Provides a  
mechanism  
(the "how")*

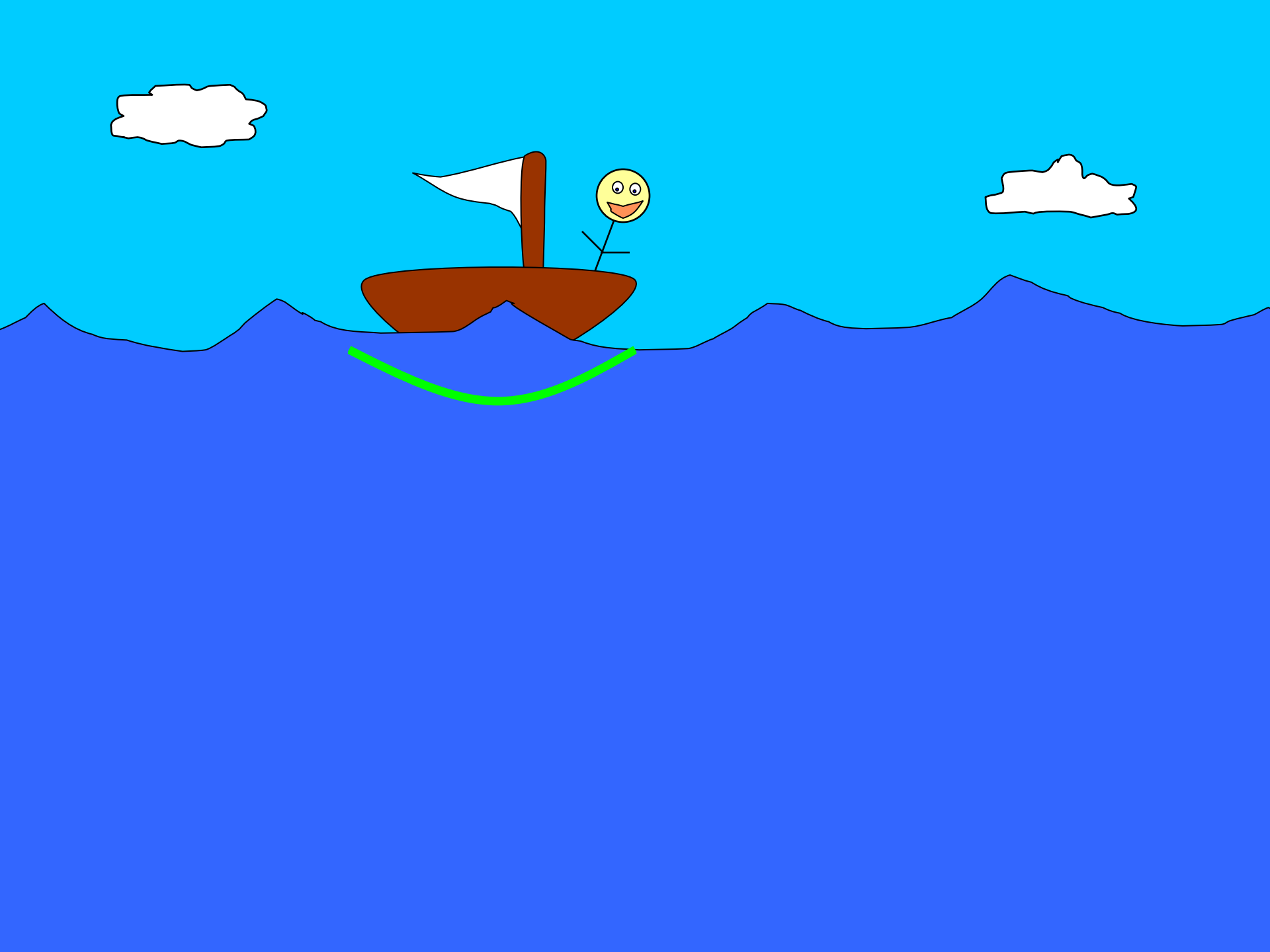


# *World War II*

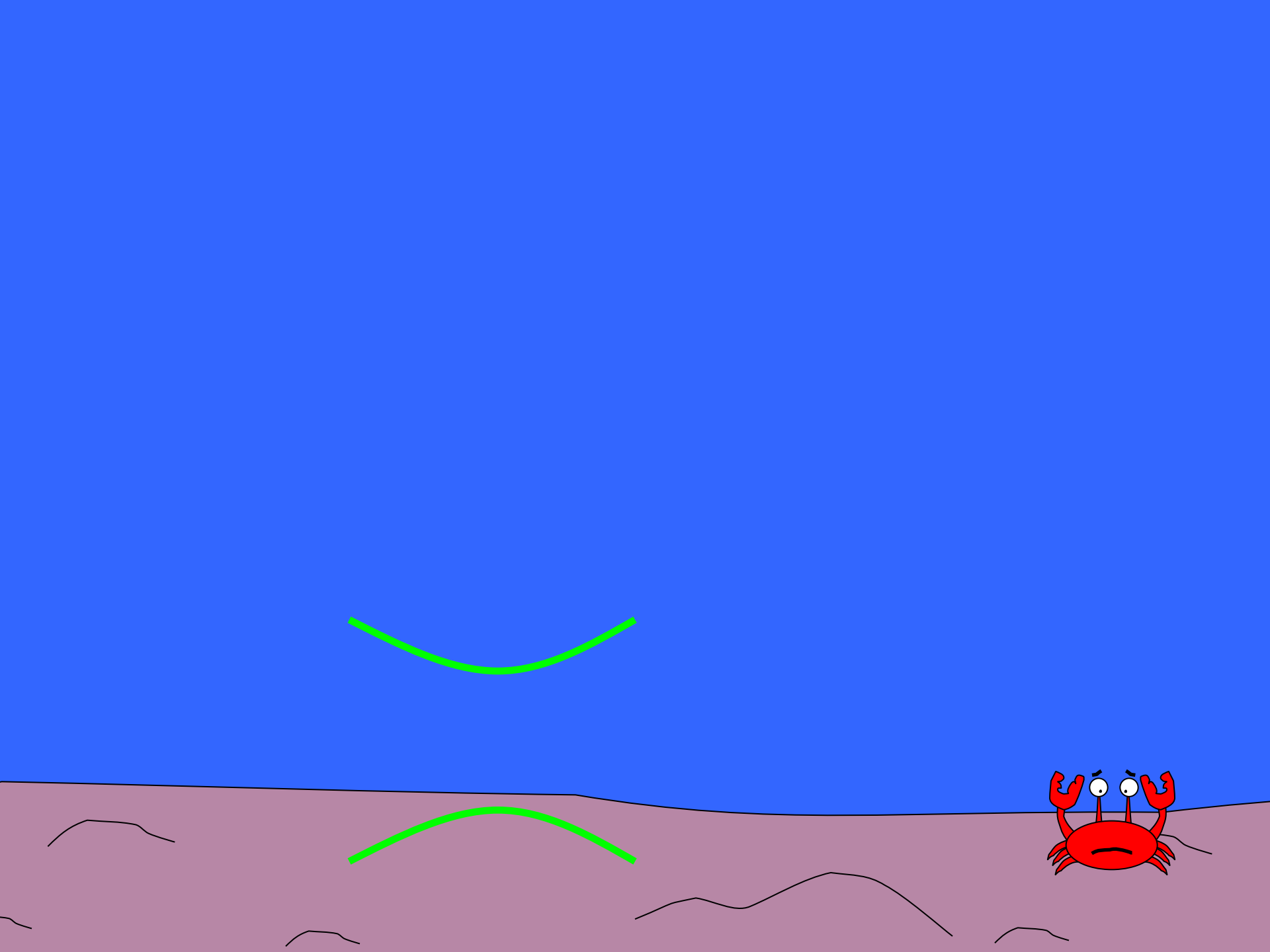
*Sonar – using sound waves to determine  
Finally able to map the ocean floor!  
depths and sizes of objects*

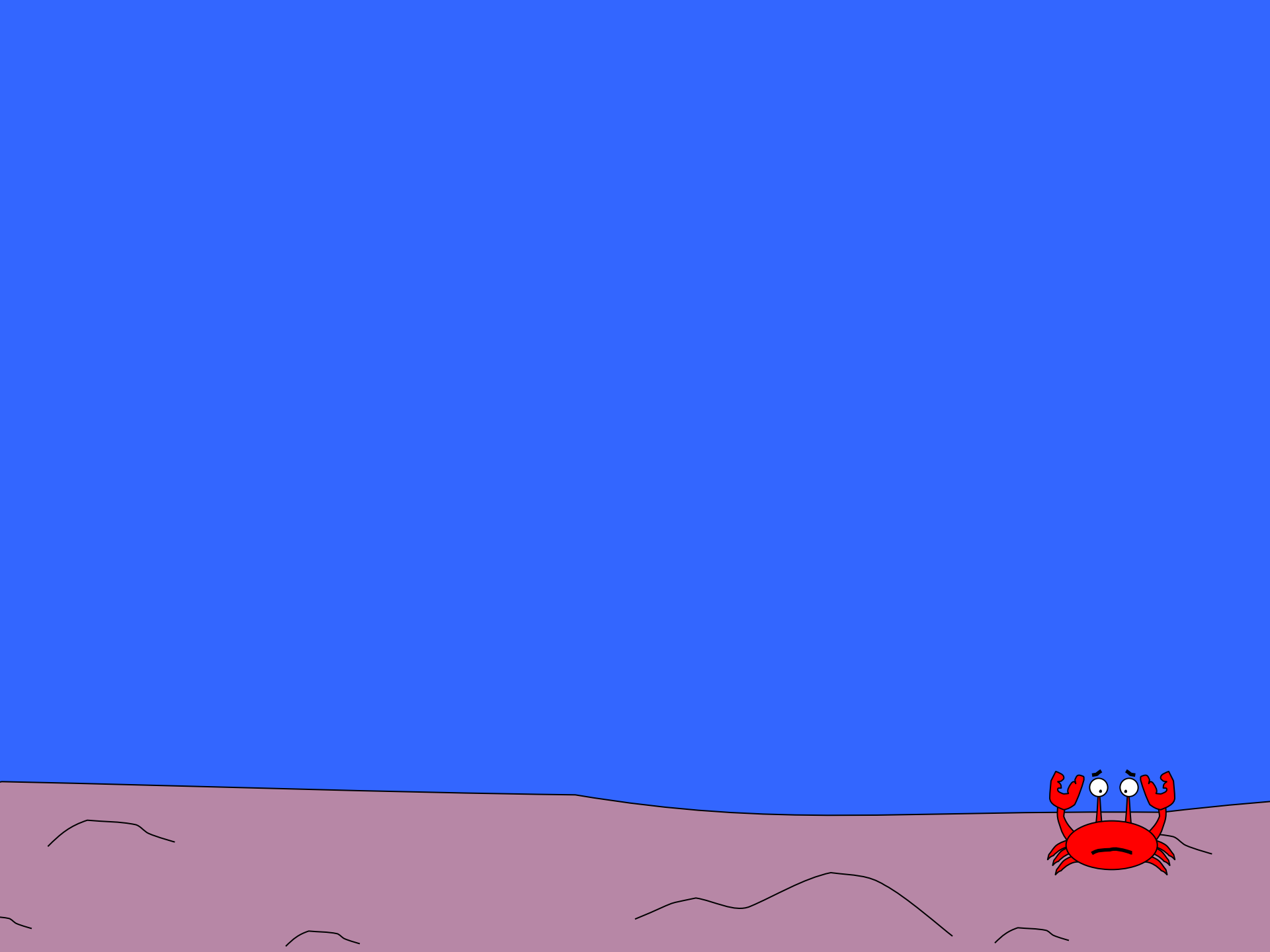


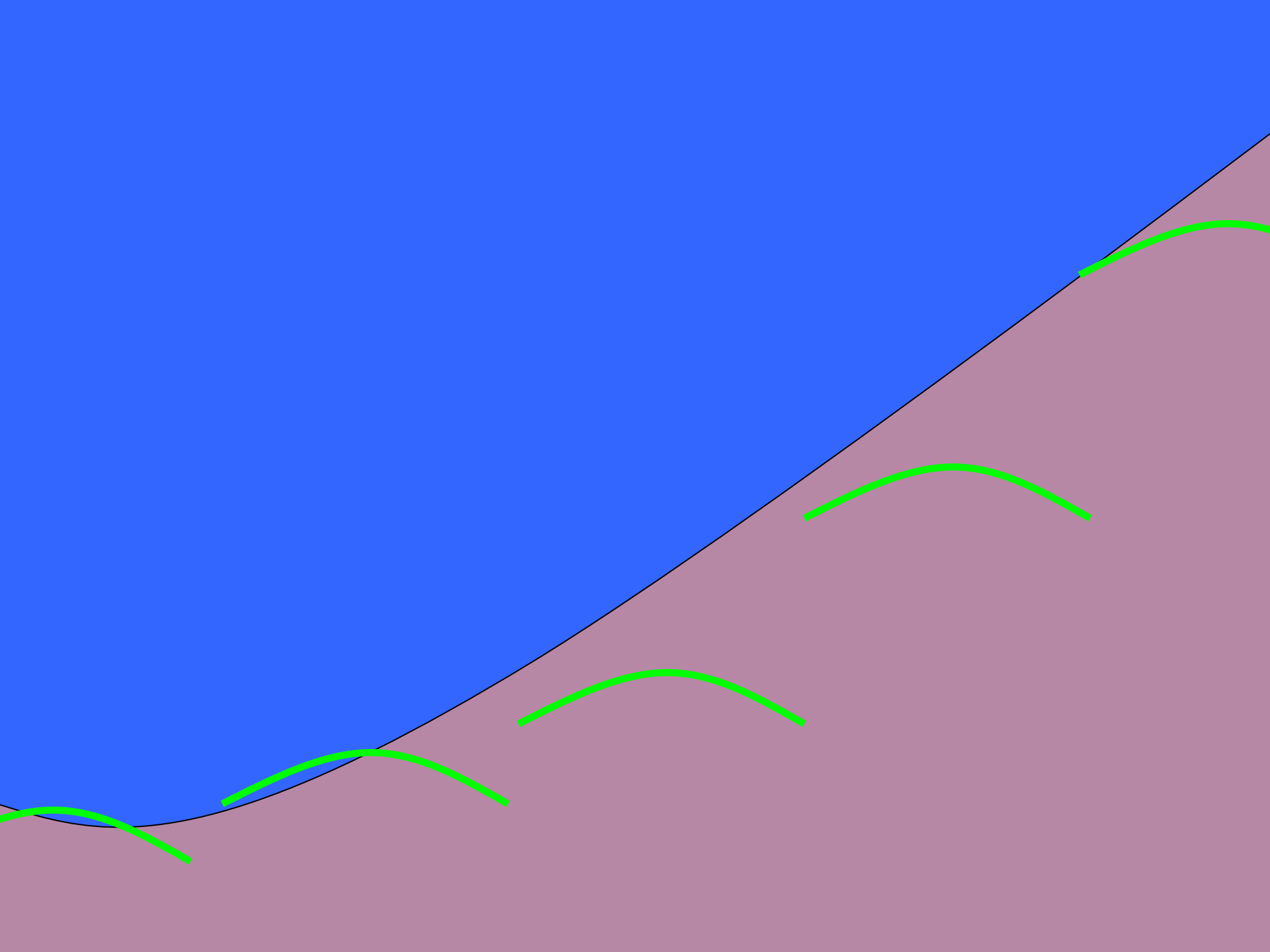


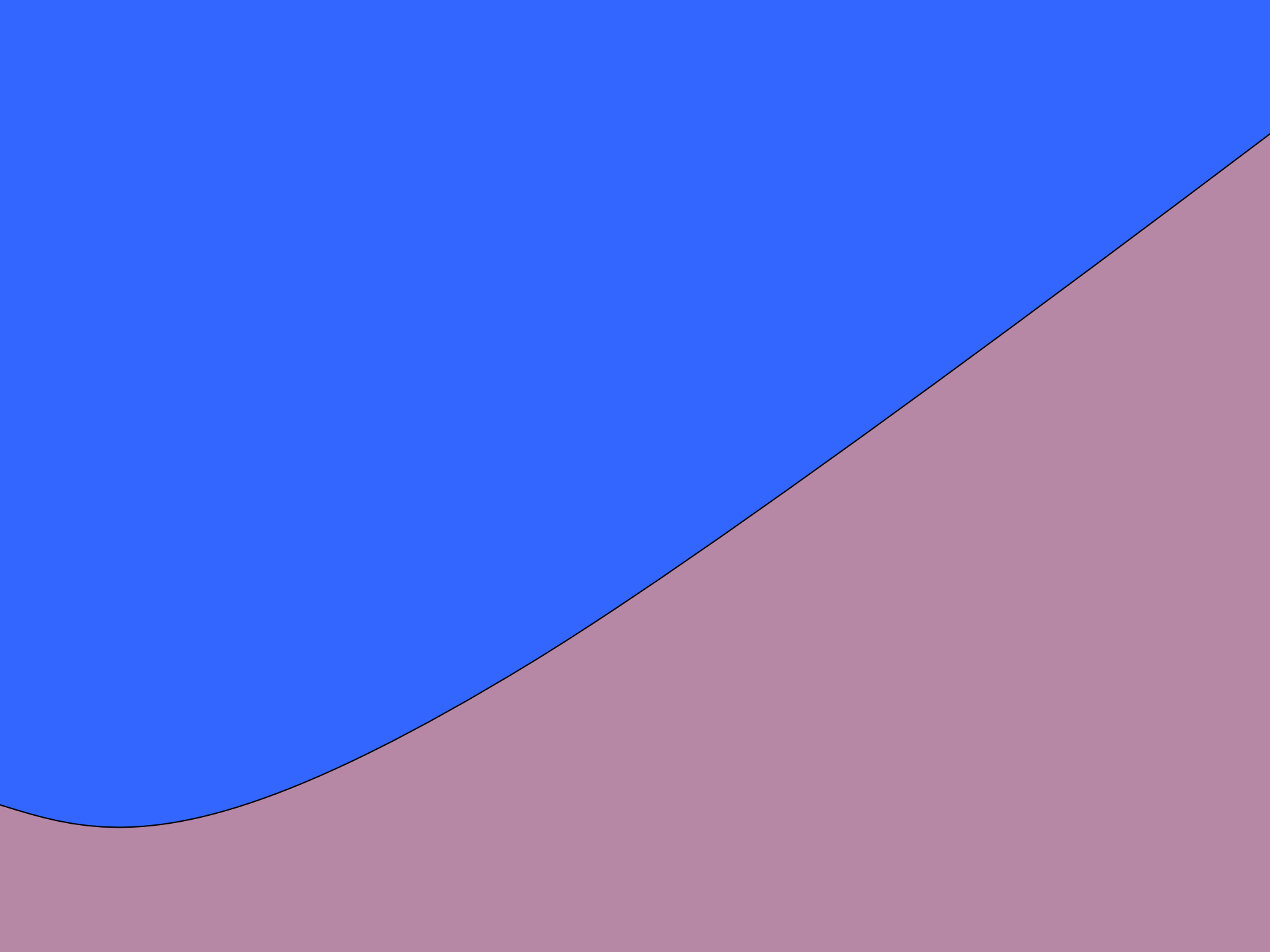


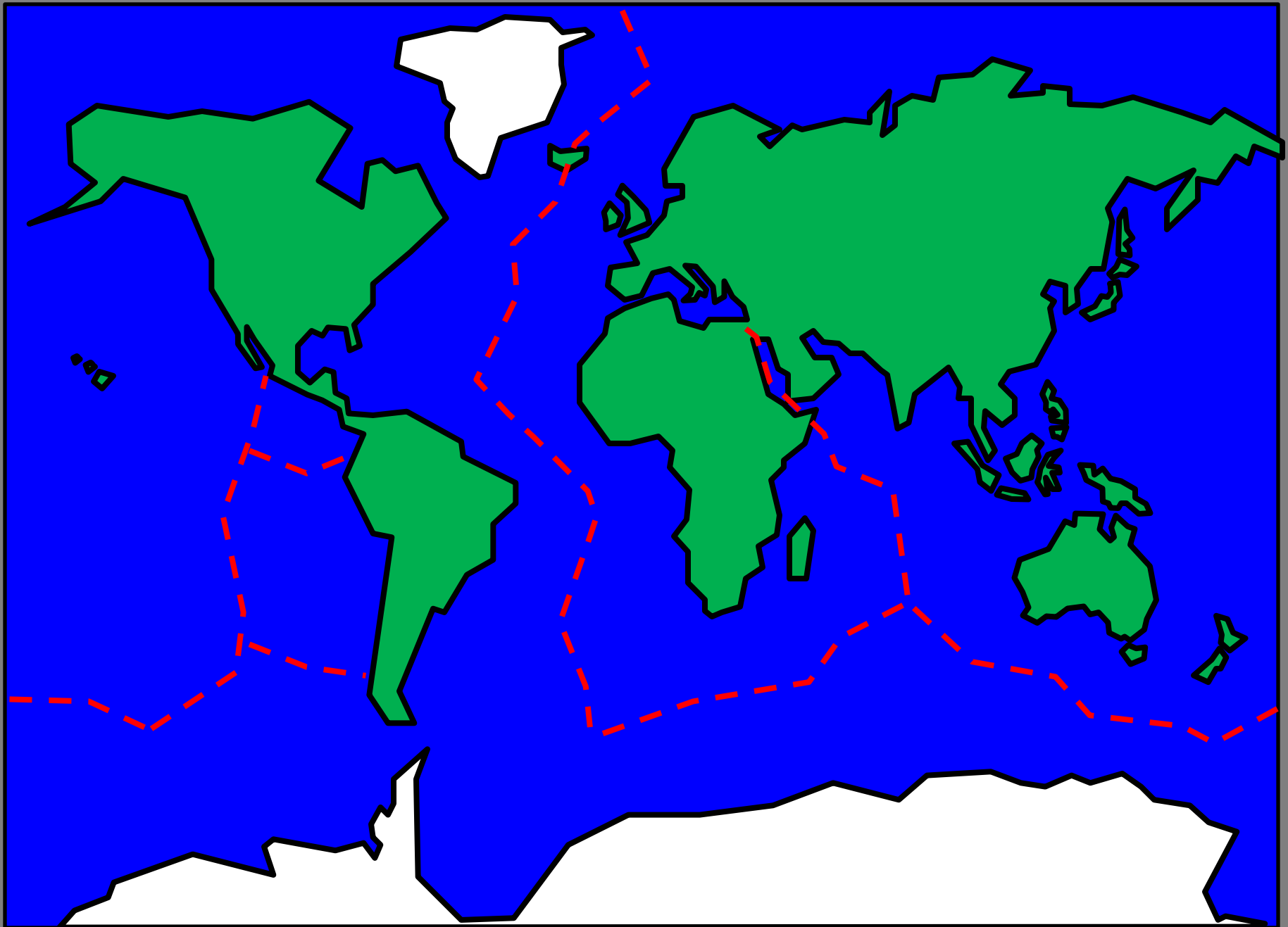






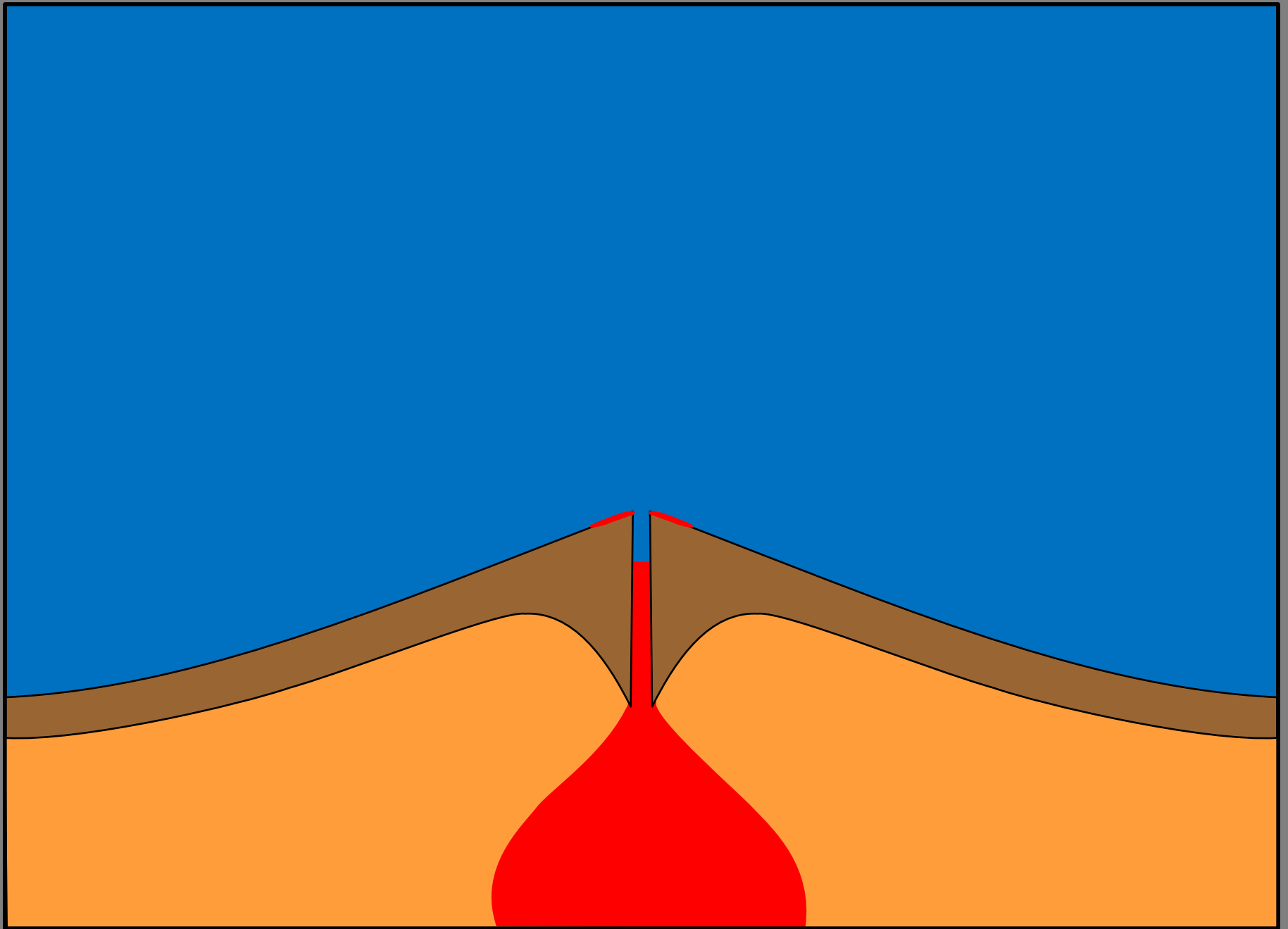




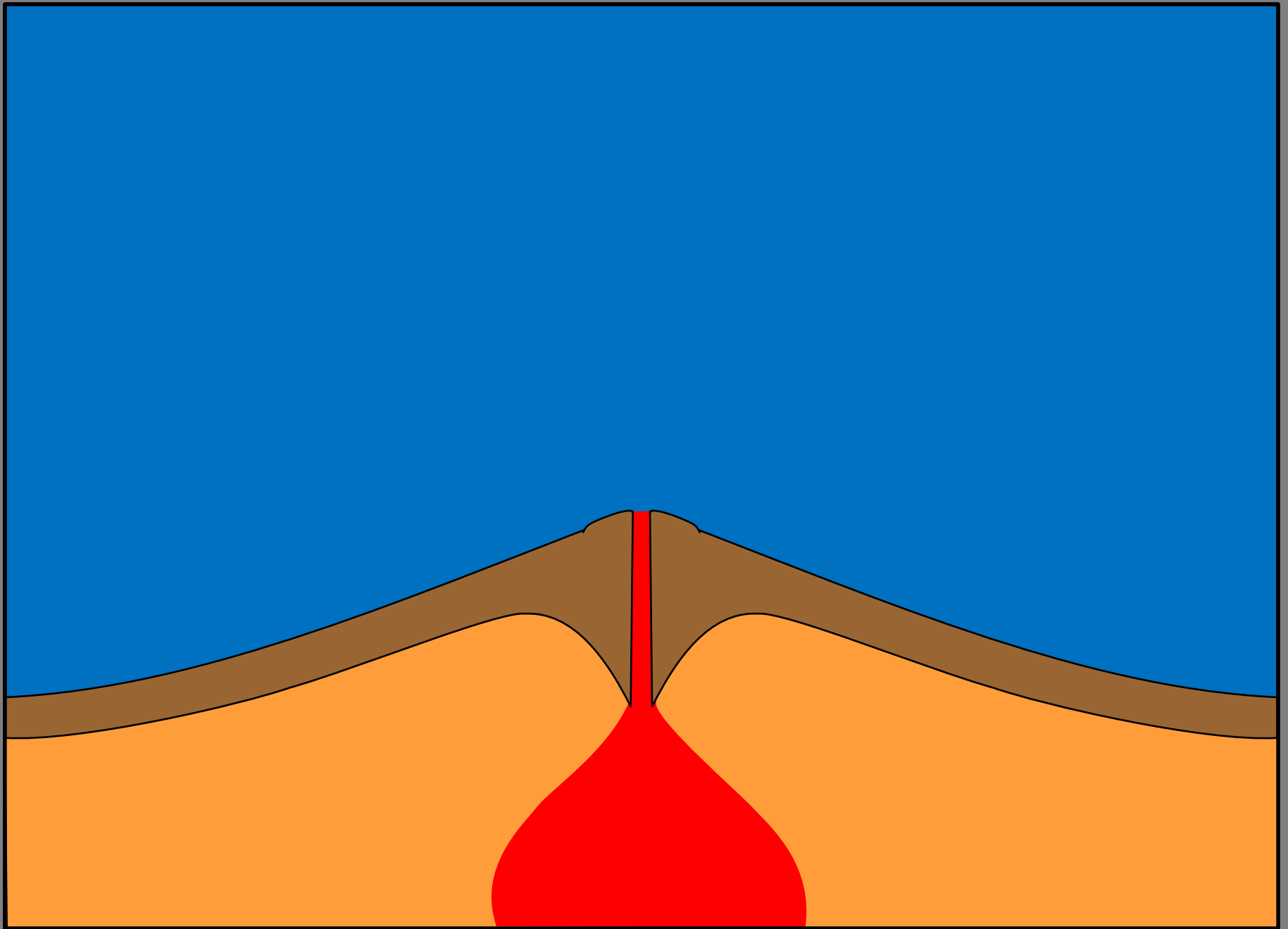


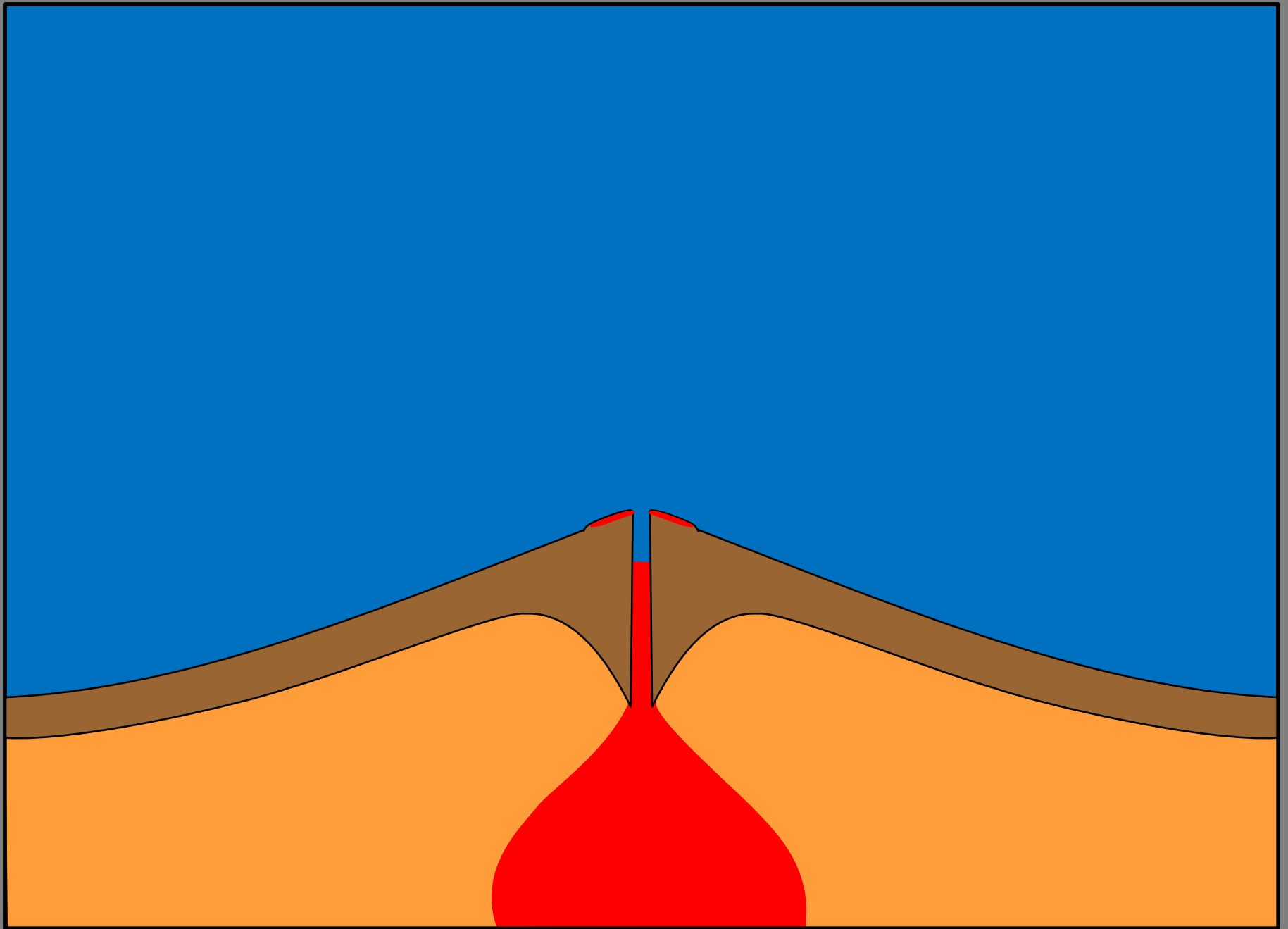


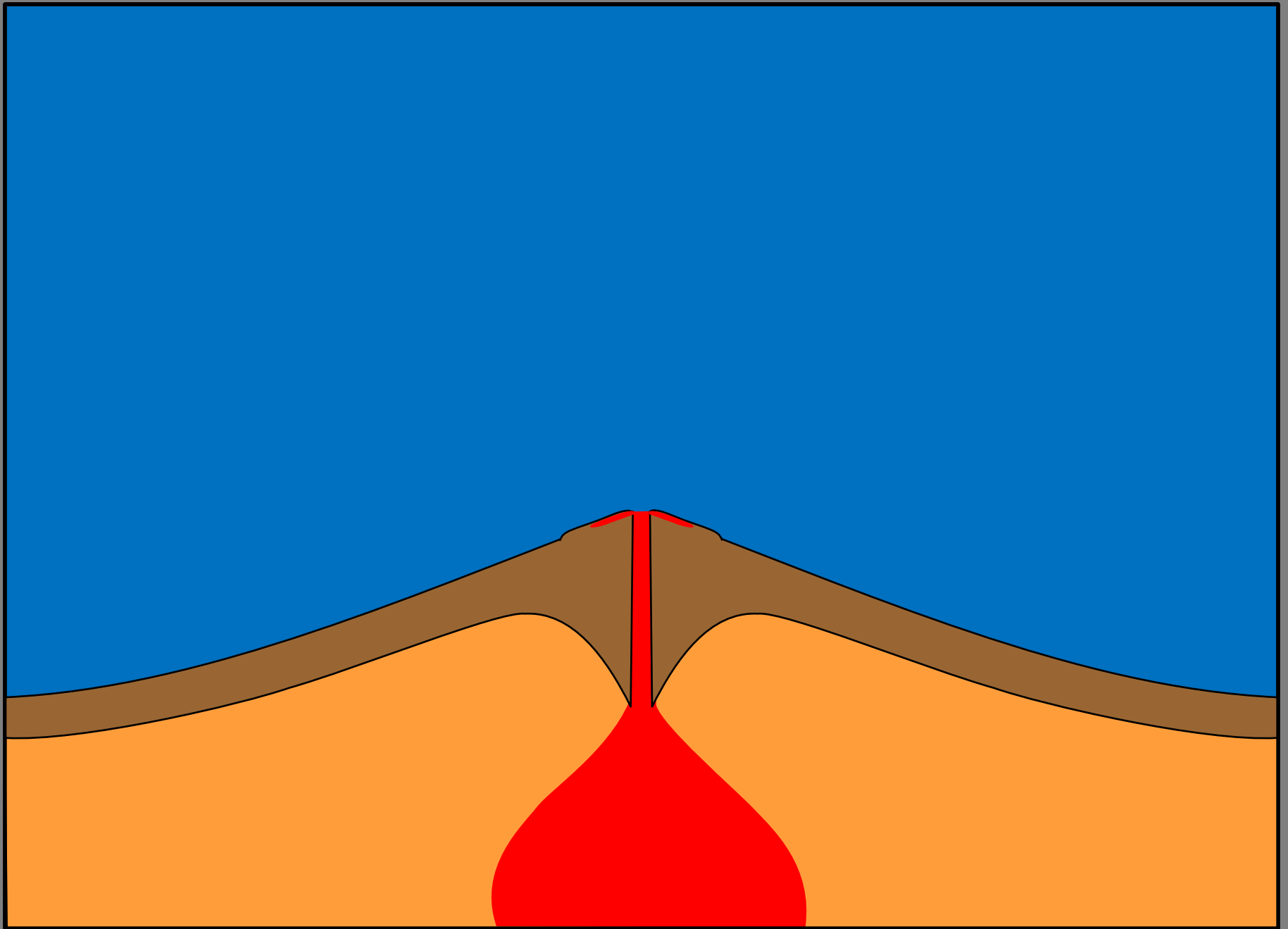






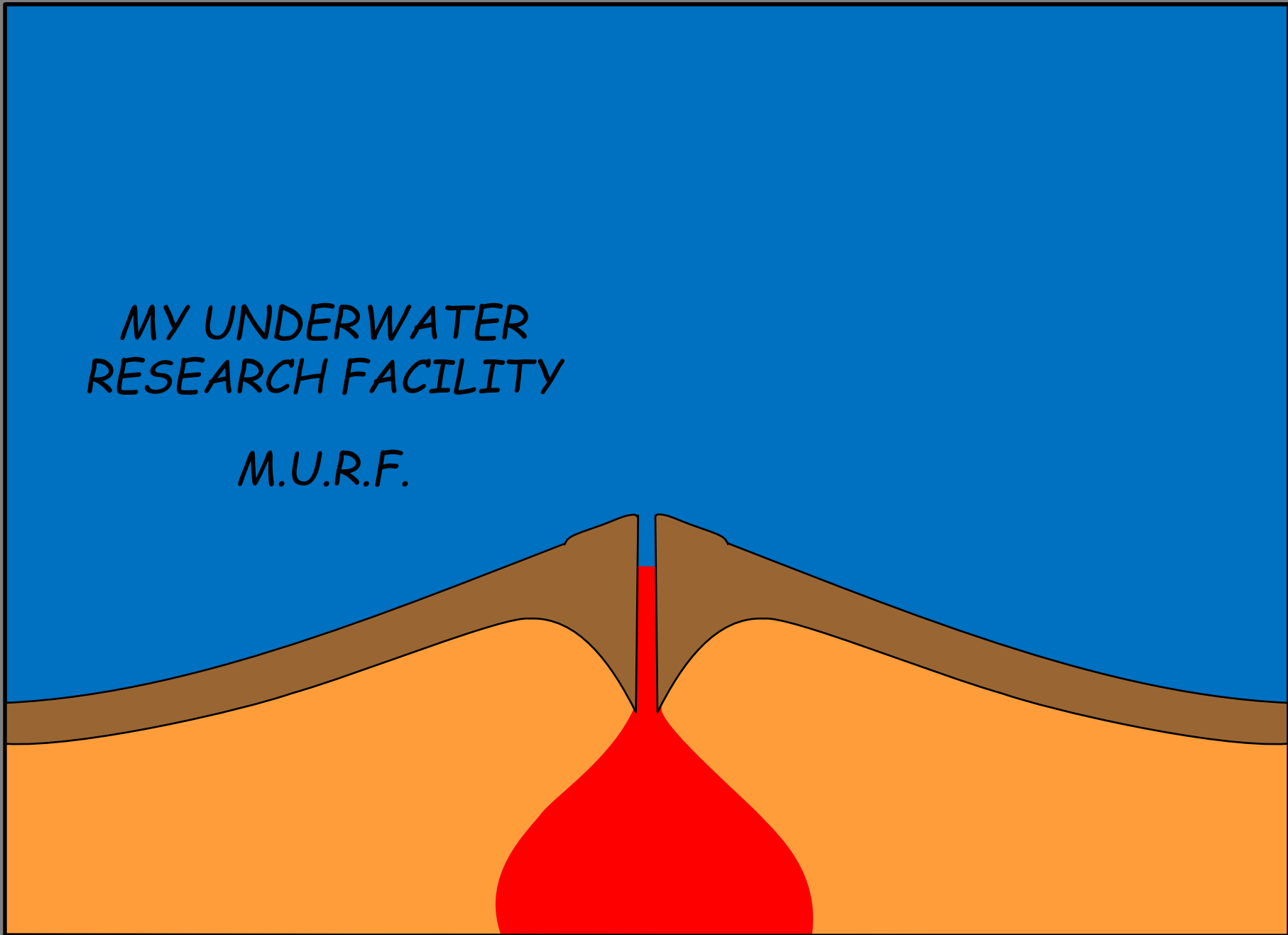






*MY UNDERWATER  
RESEARCH FACILITY*

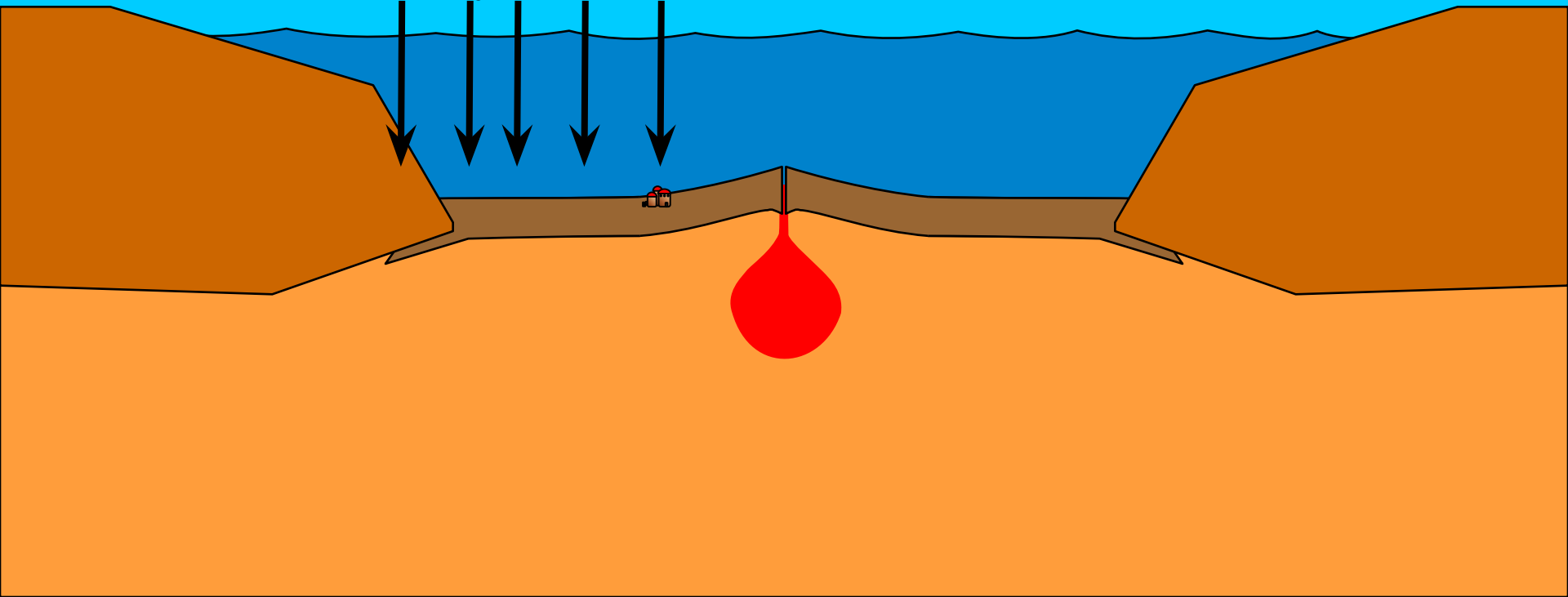
*M.U.R.F.*



# Seafloor Spreading

The seafloor slowly grows outward from mid-ocean ridges as new crust is formed, pushing the continents along for the ride. This is the **MECHANISM** of continental drift!

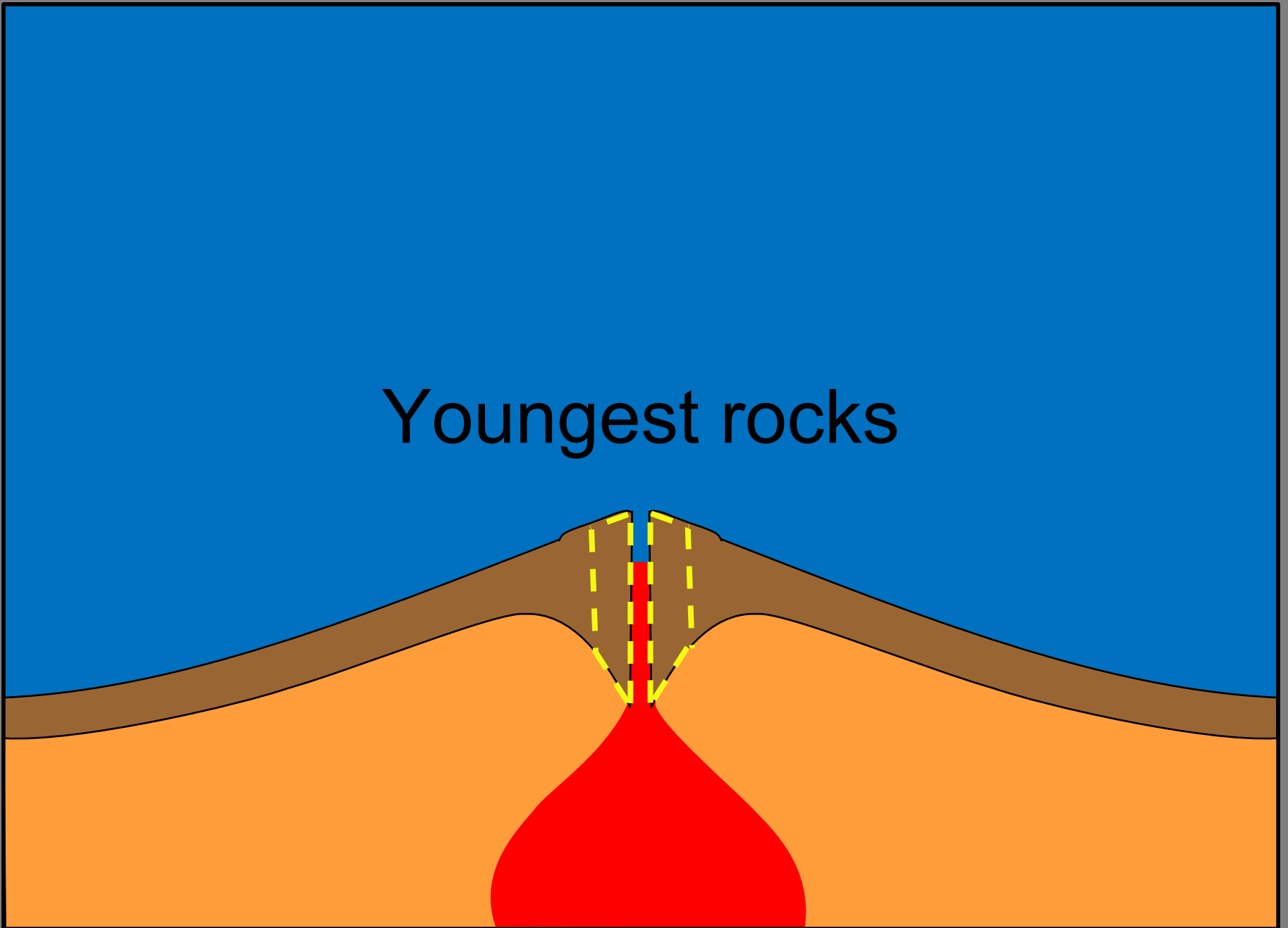
20 million years later  
15 million years later  
10 million years later  
5 million years later  
Present Day



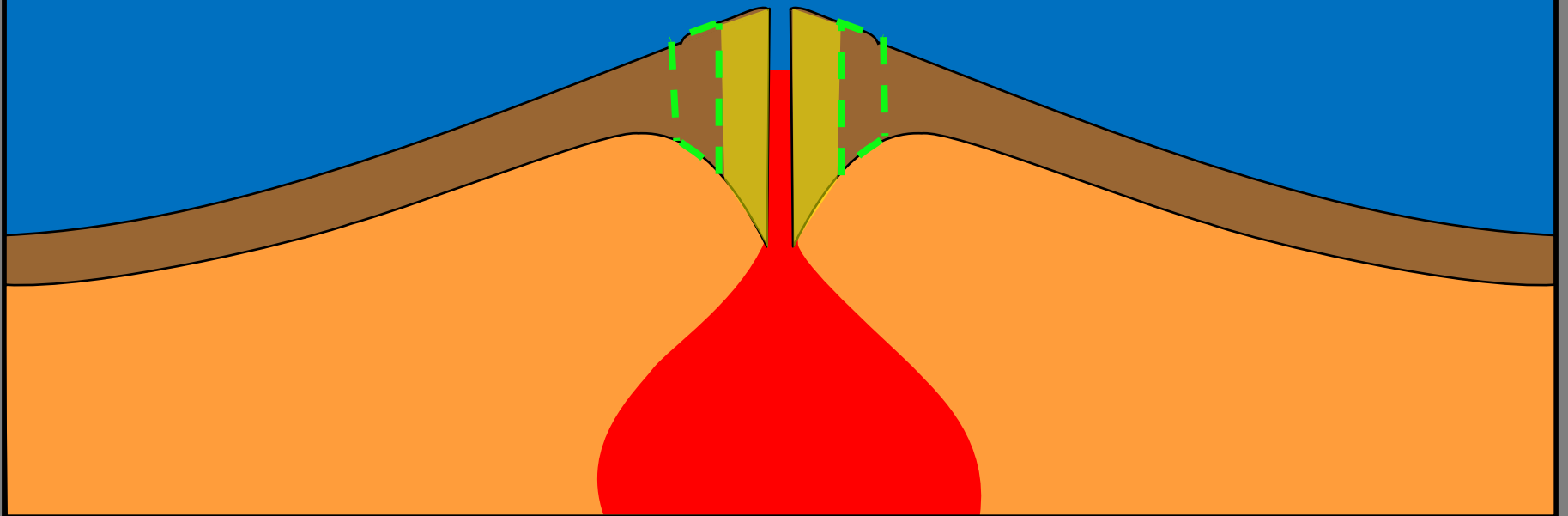
Somewhere in  
Greenland...



Youngest rocks

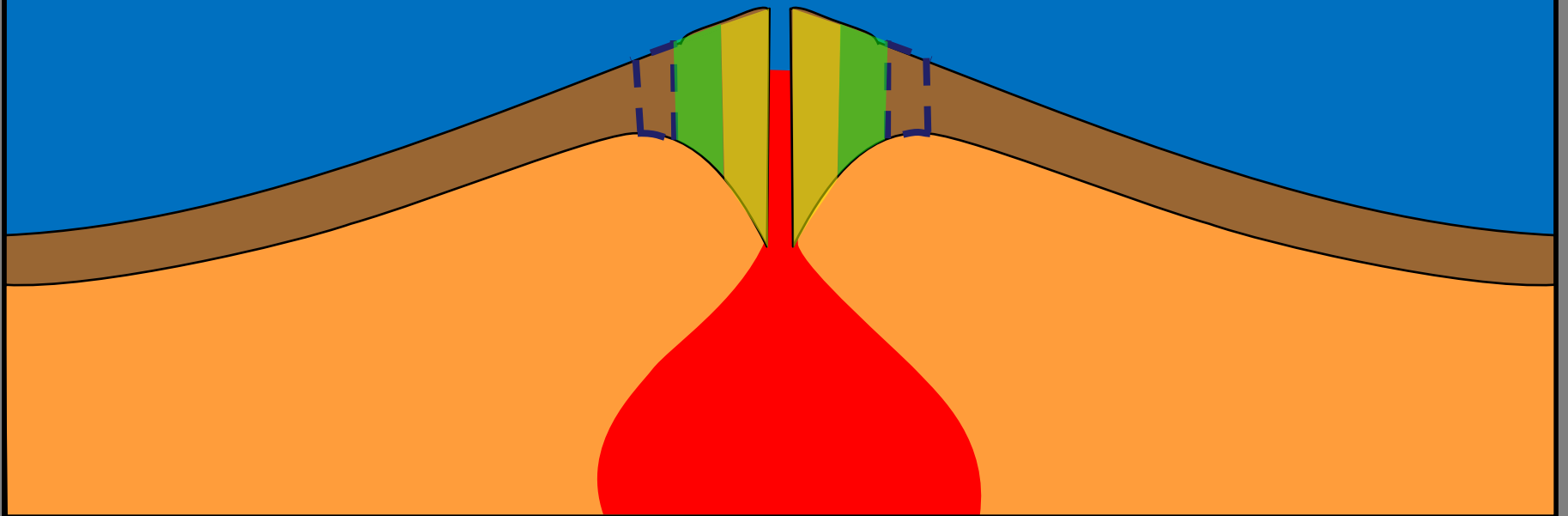


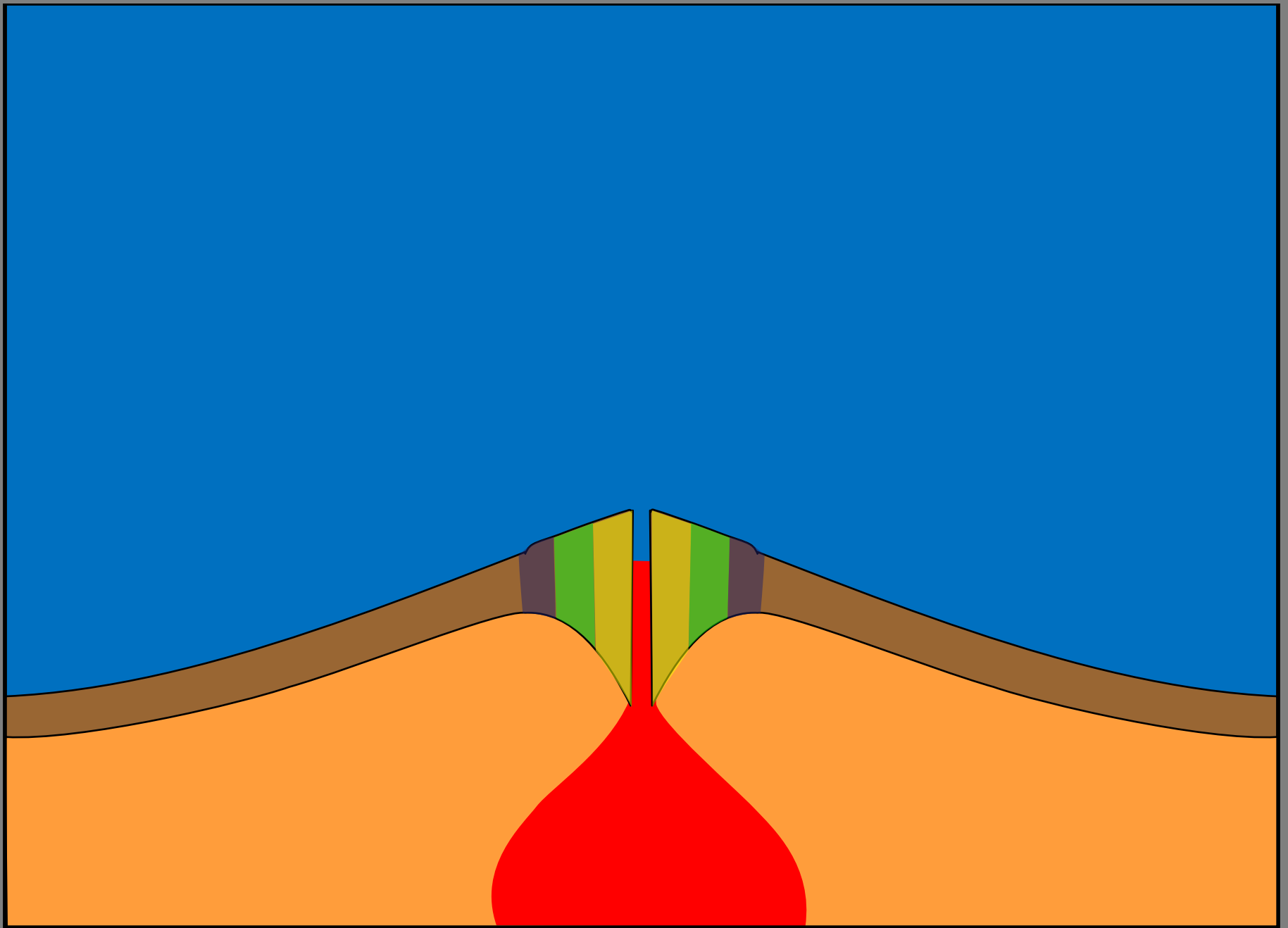
Next Youngest rocks

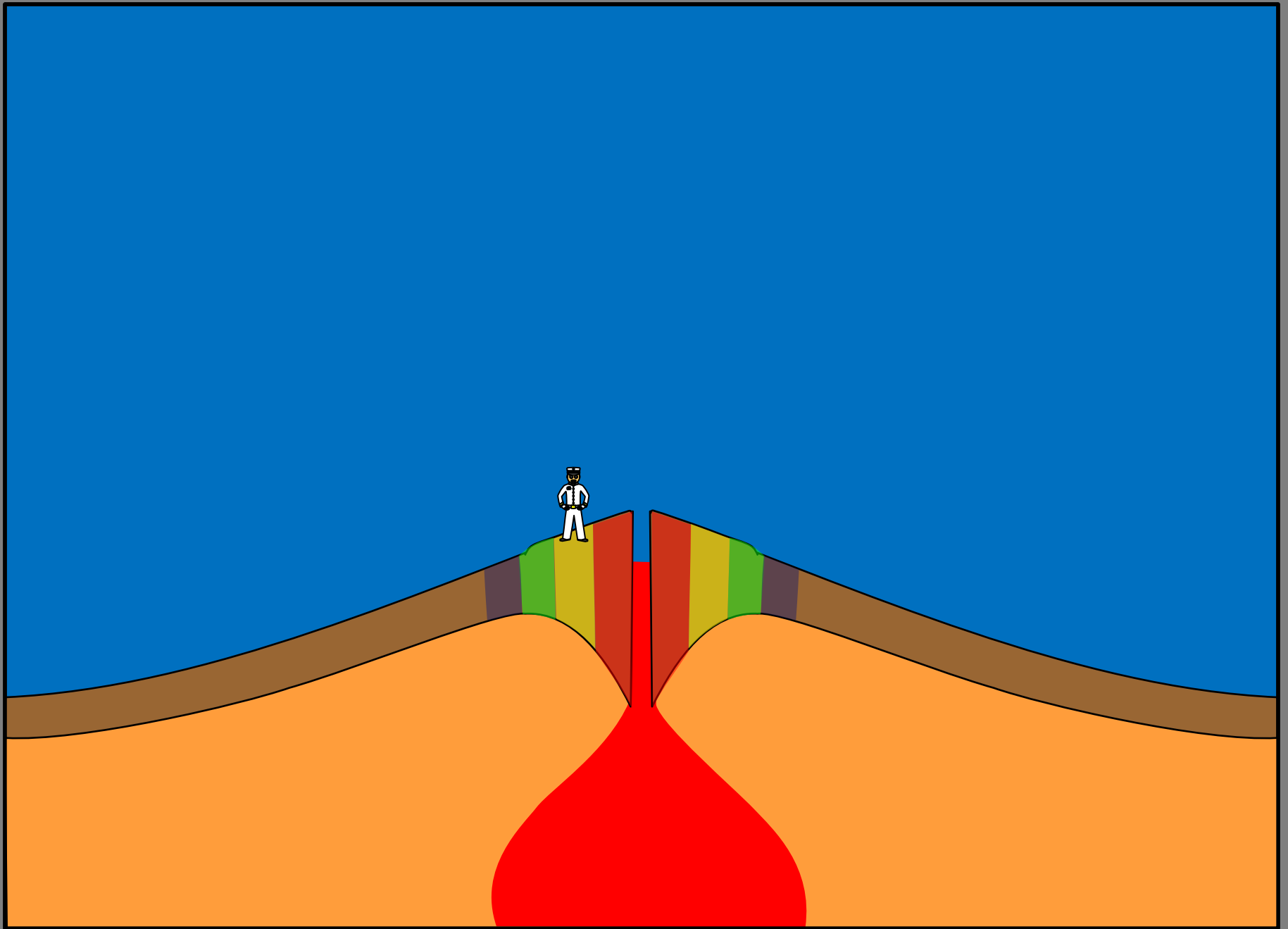


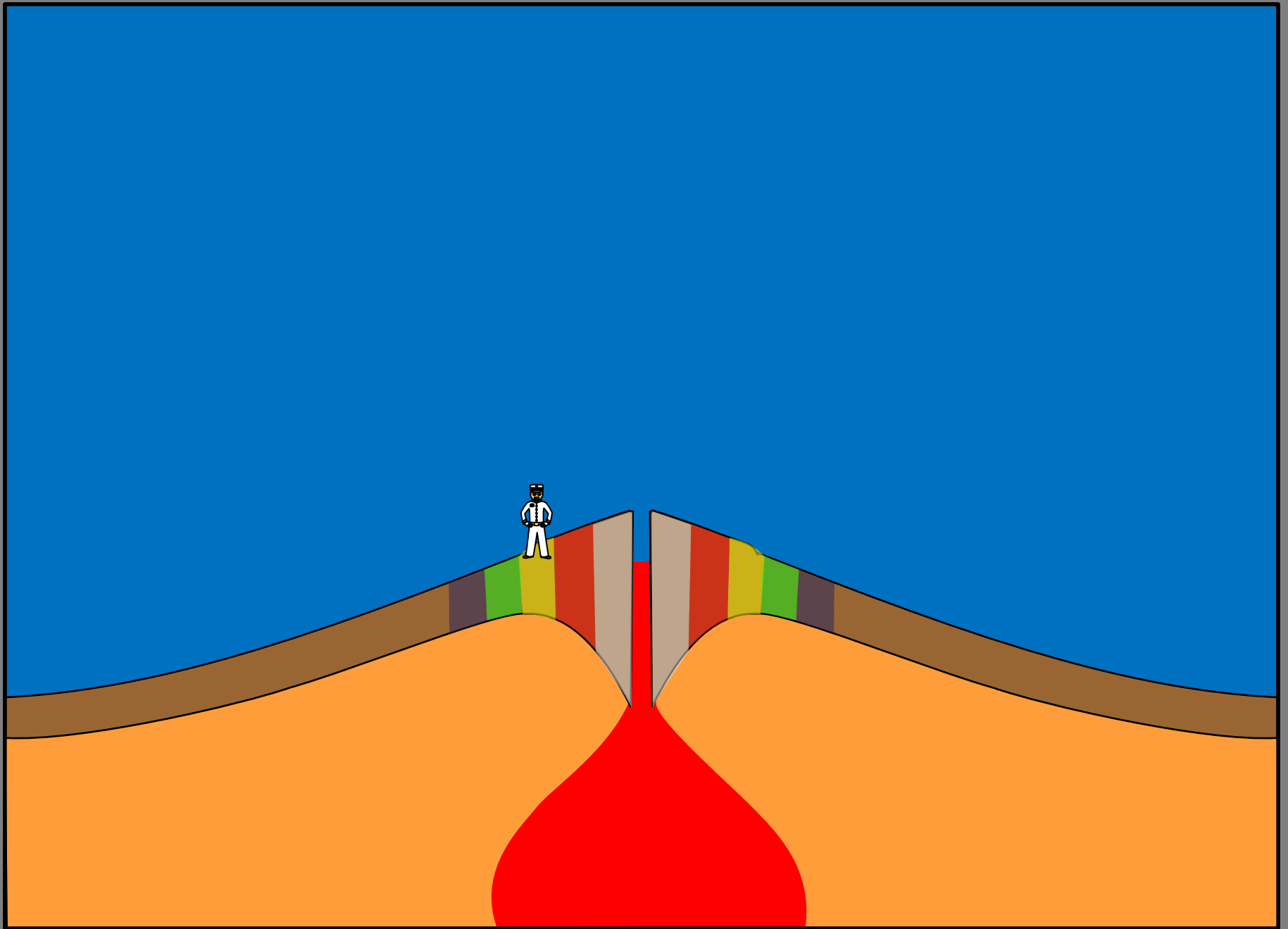


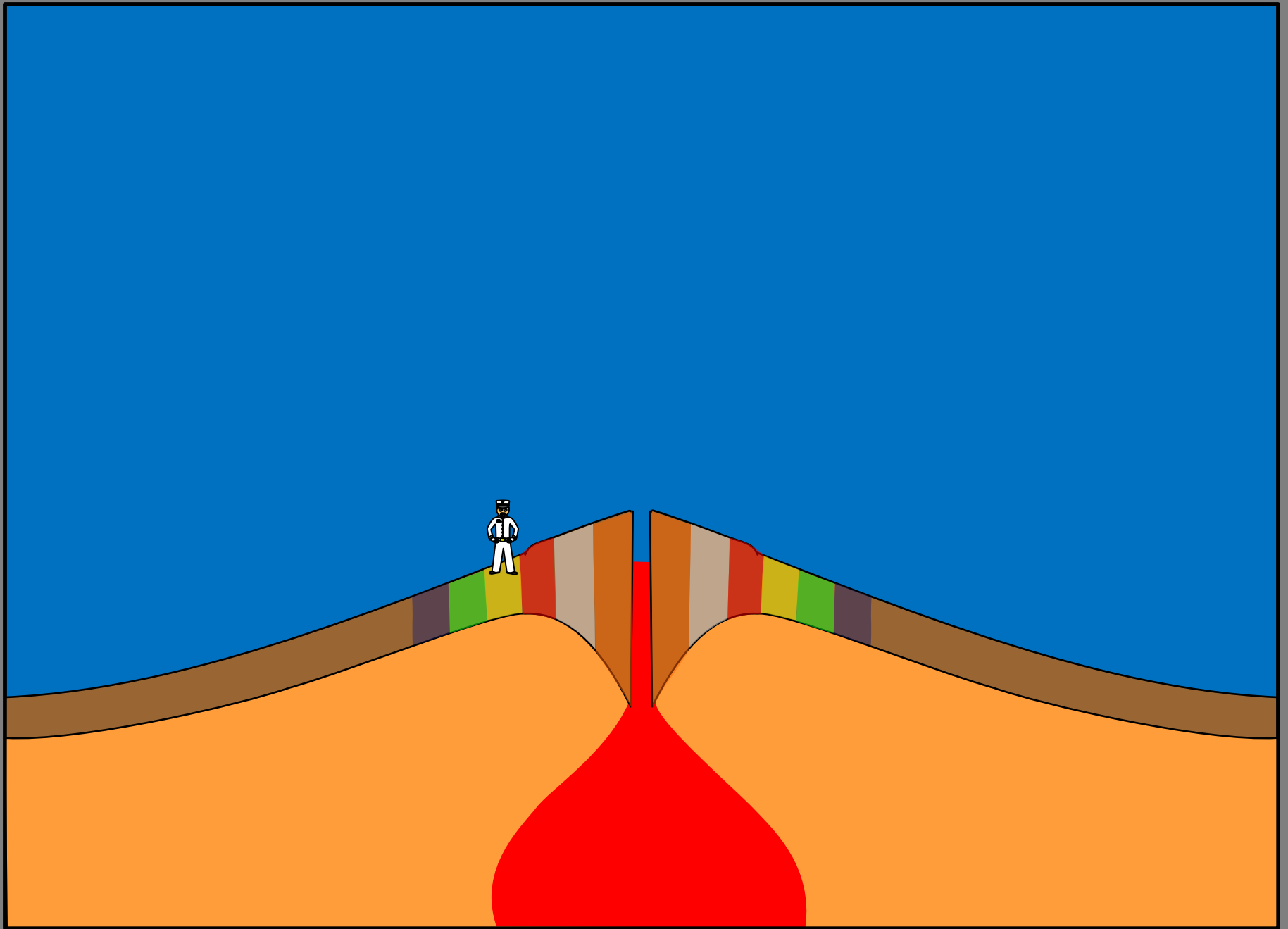
Next Youngest rocks

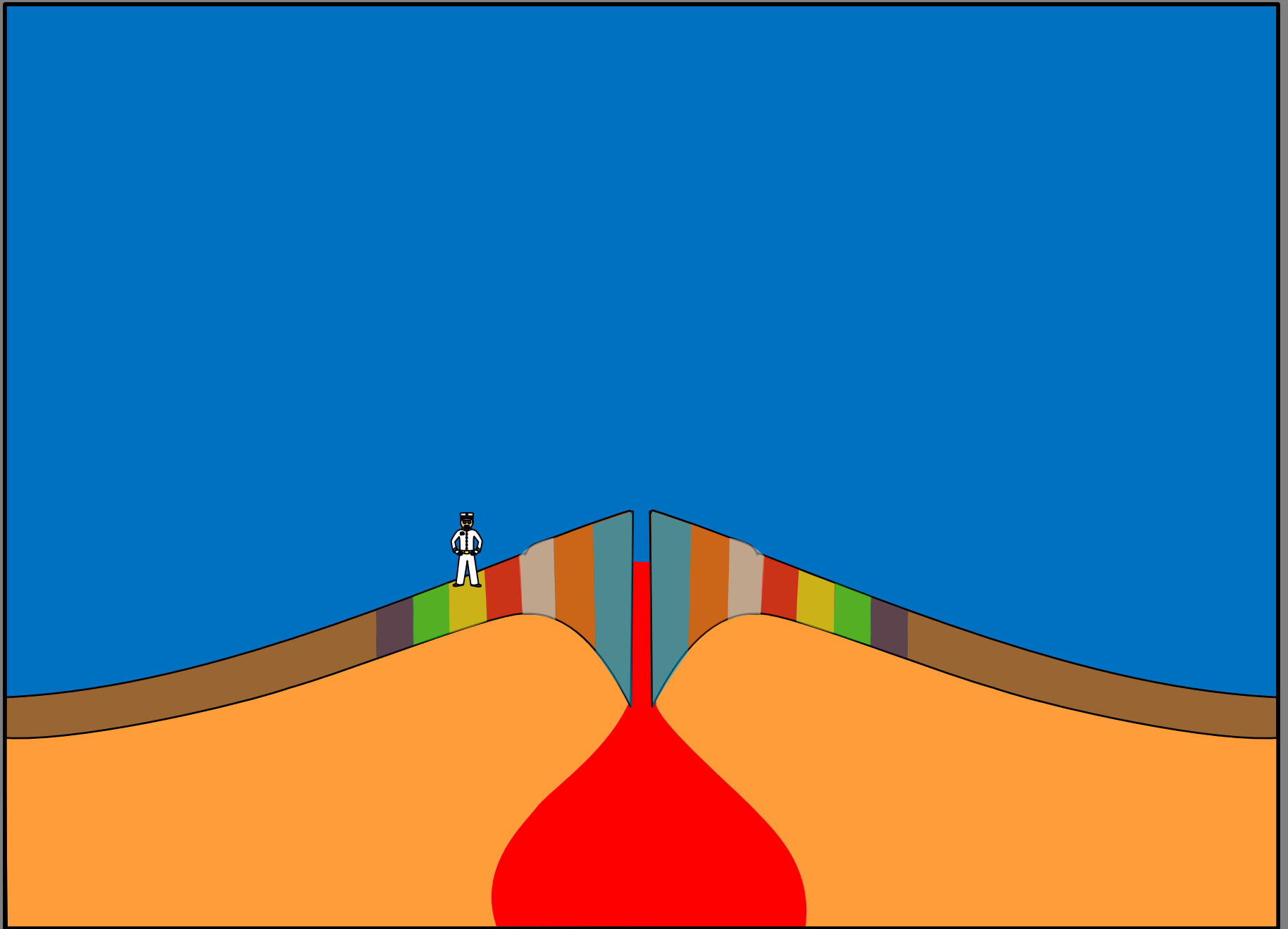


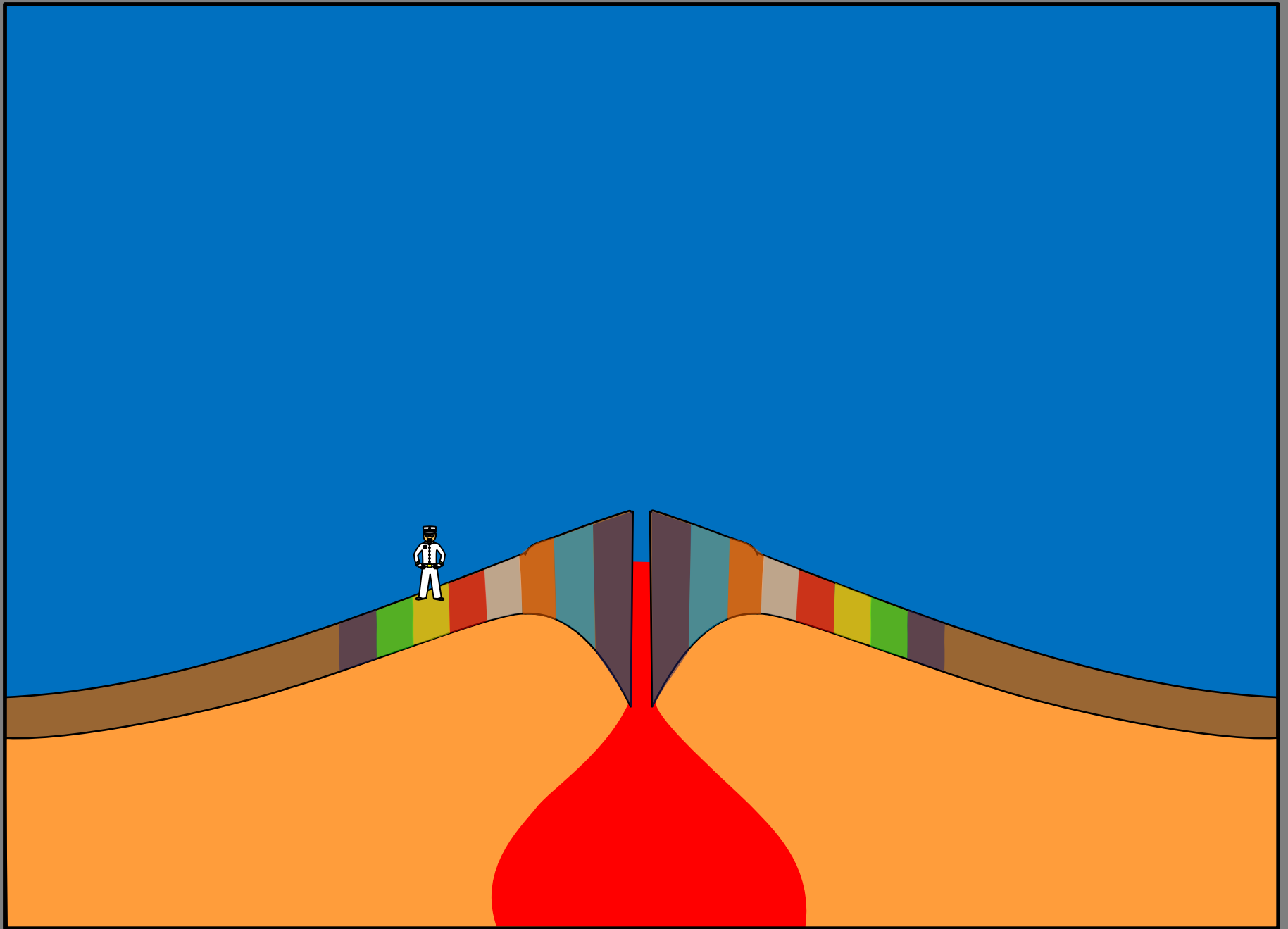


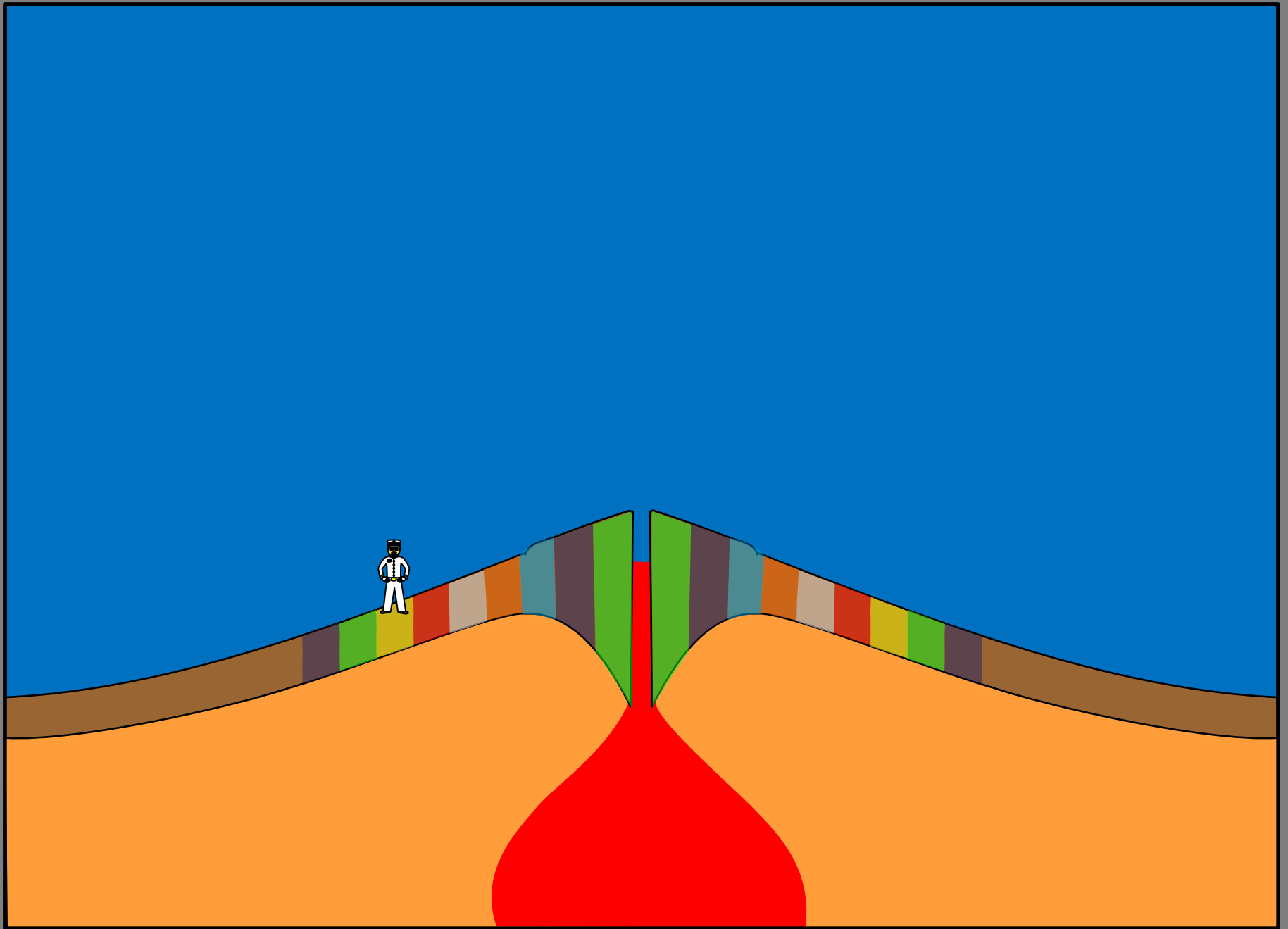




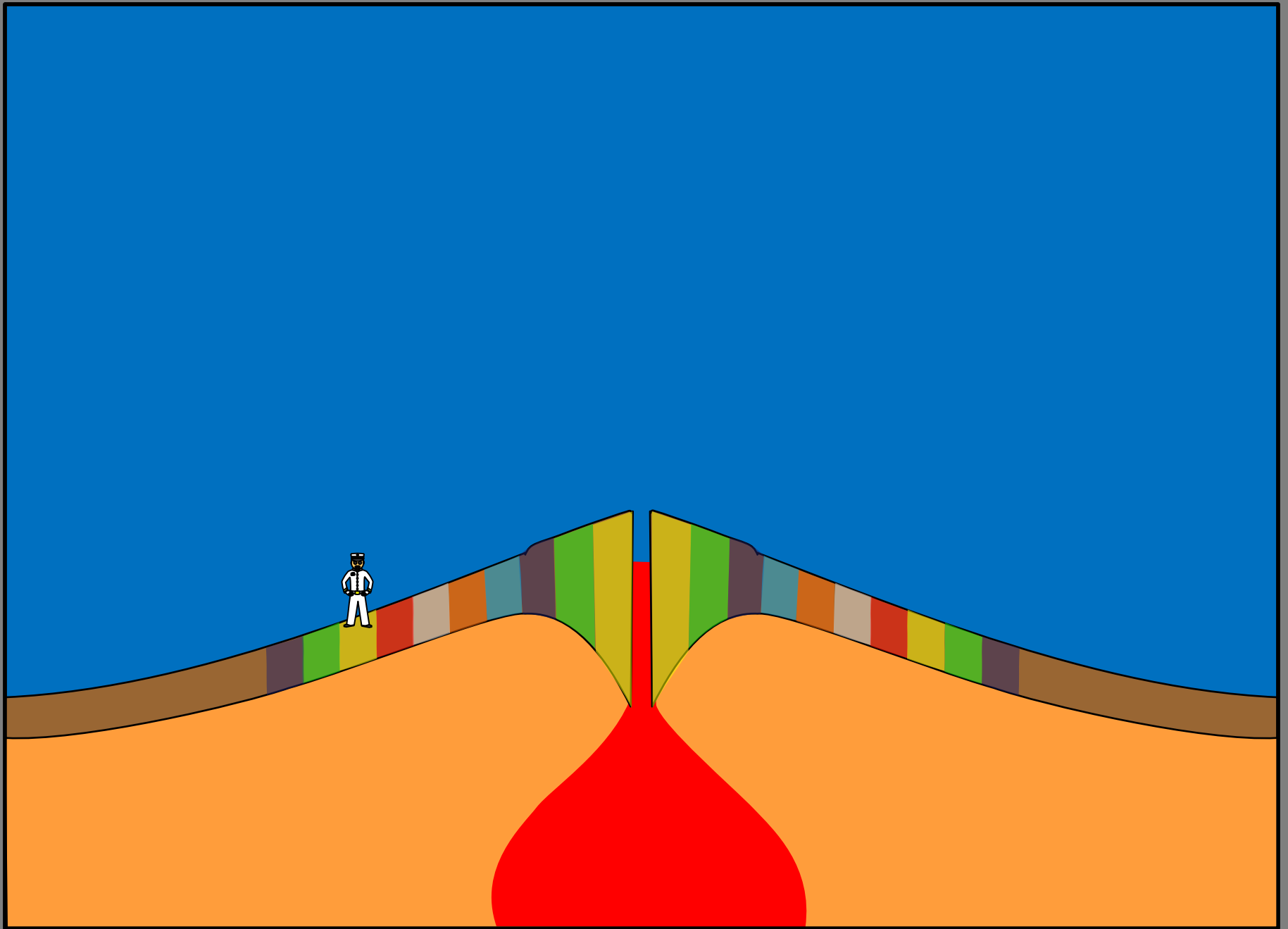


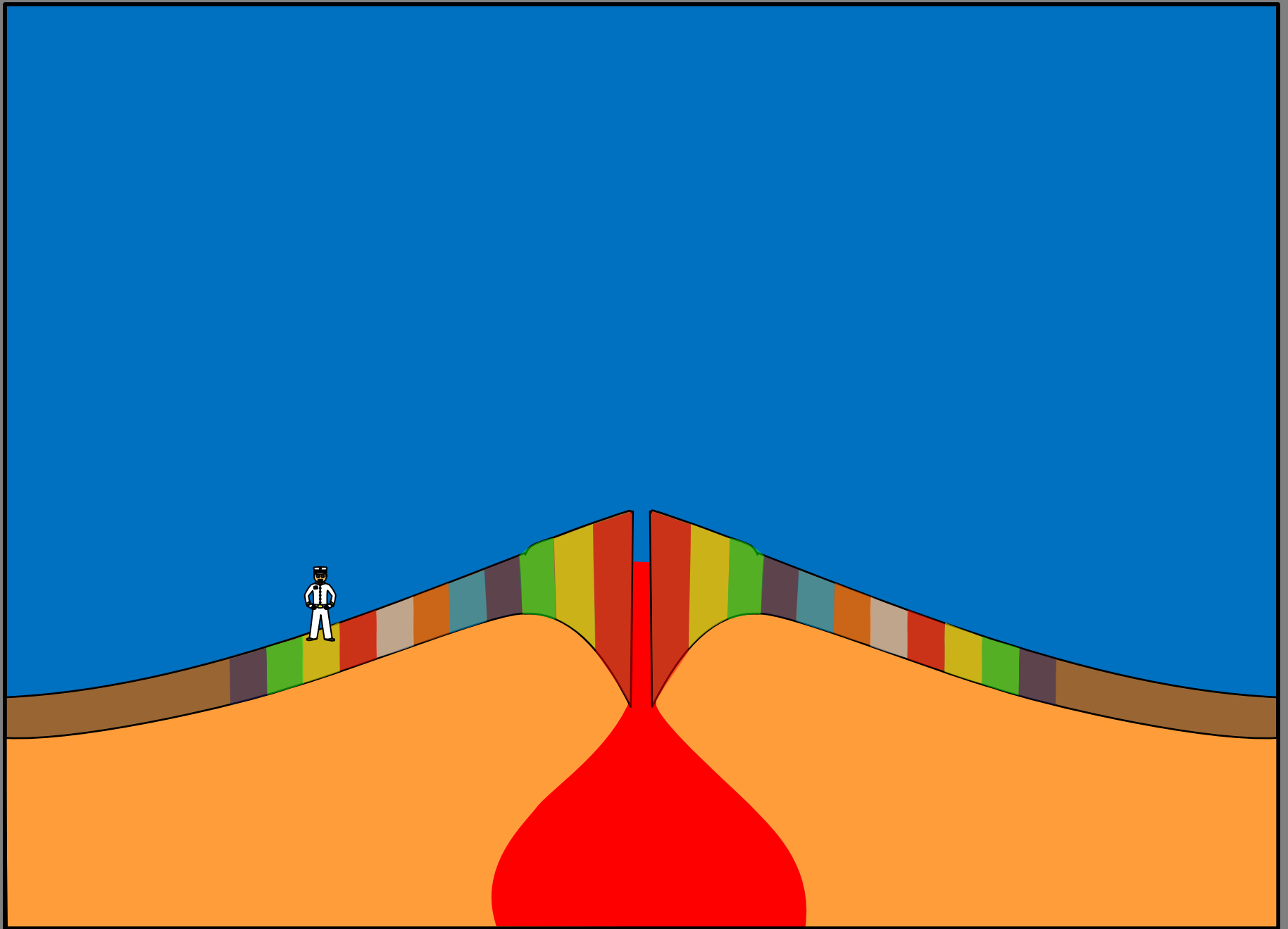


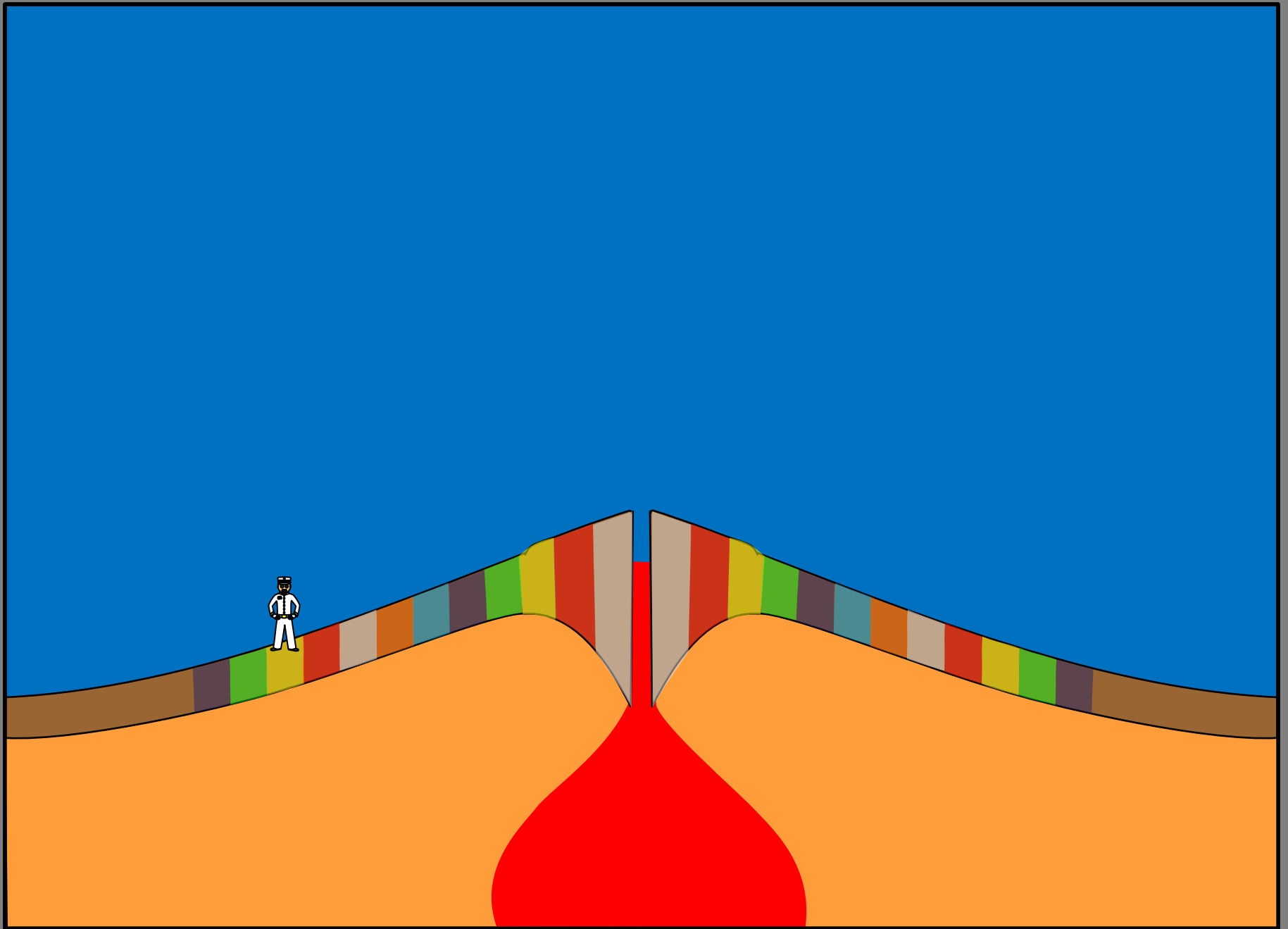


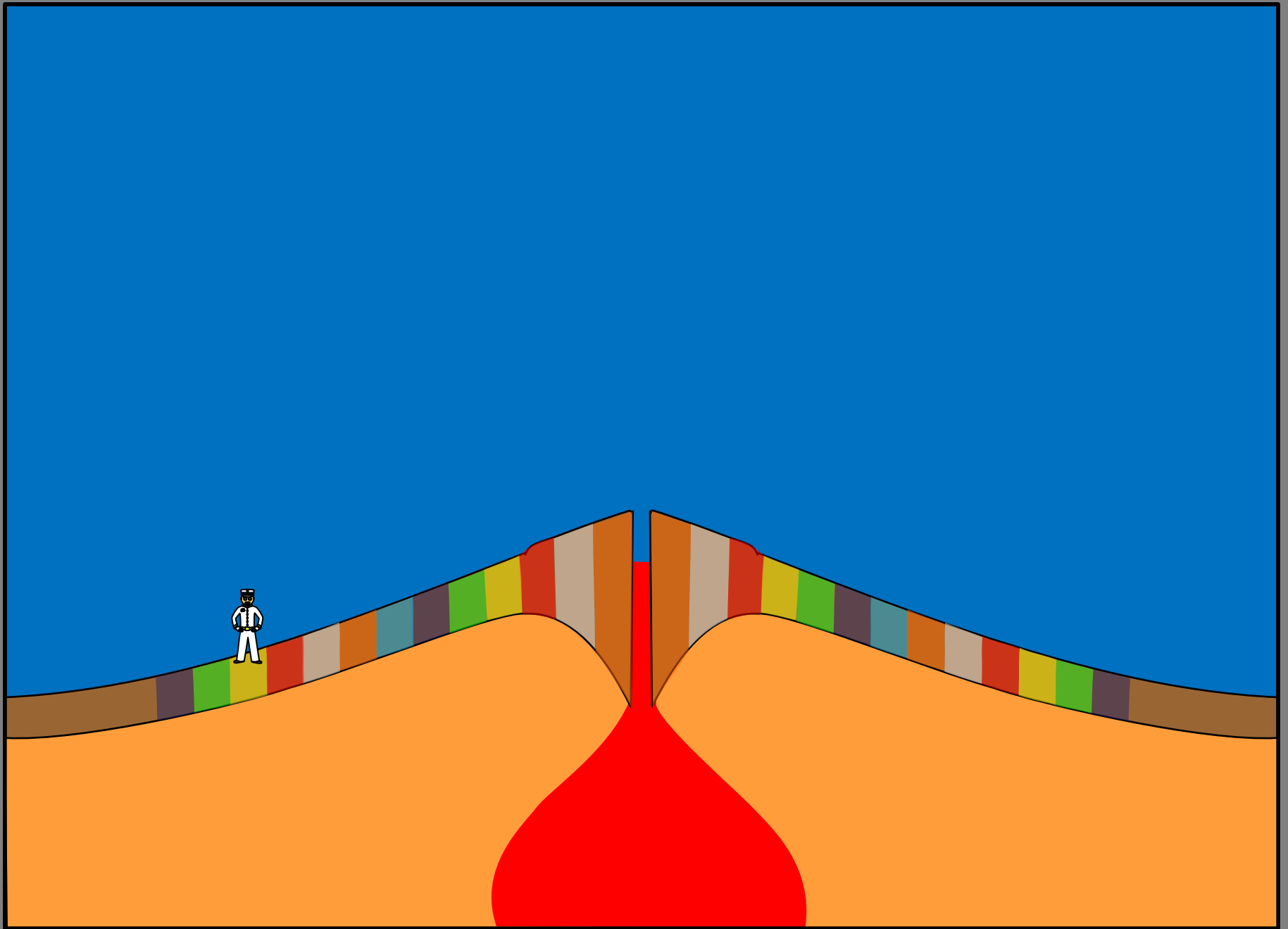


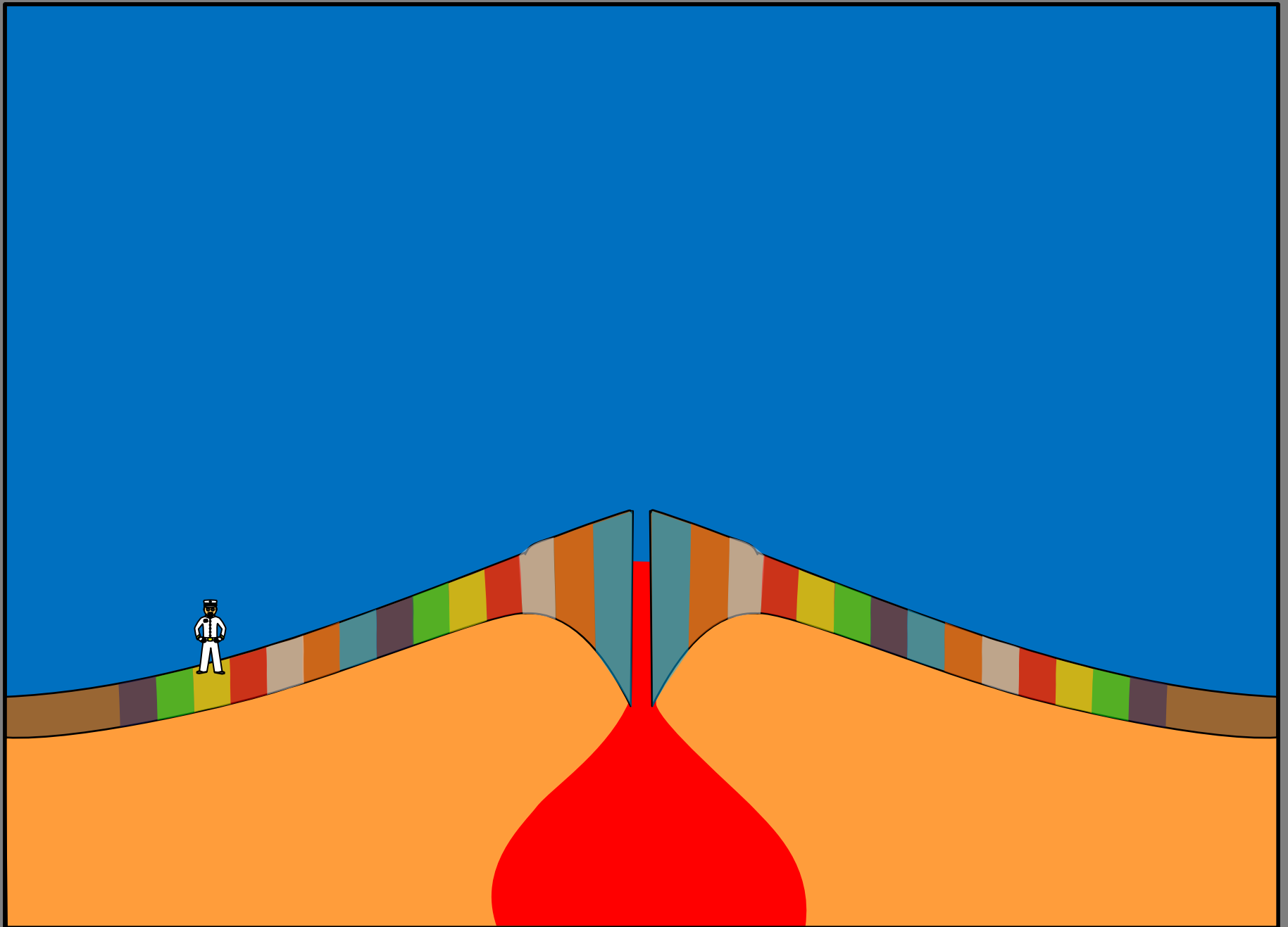


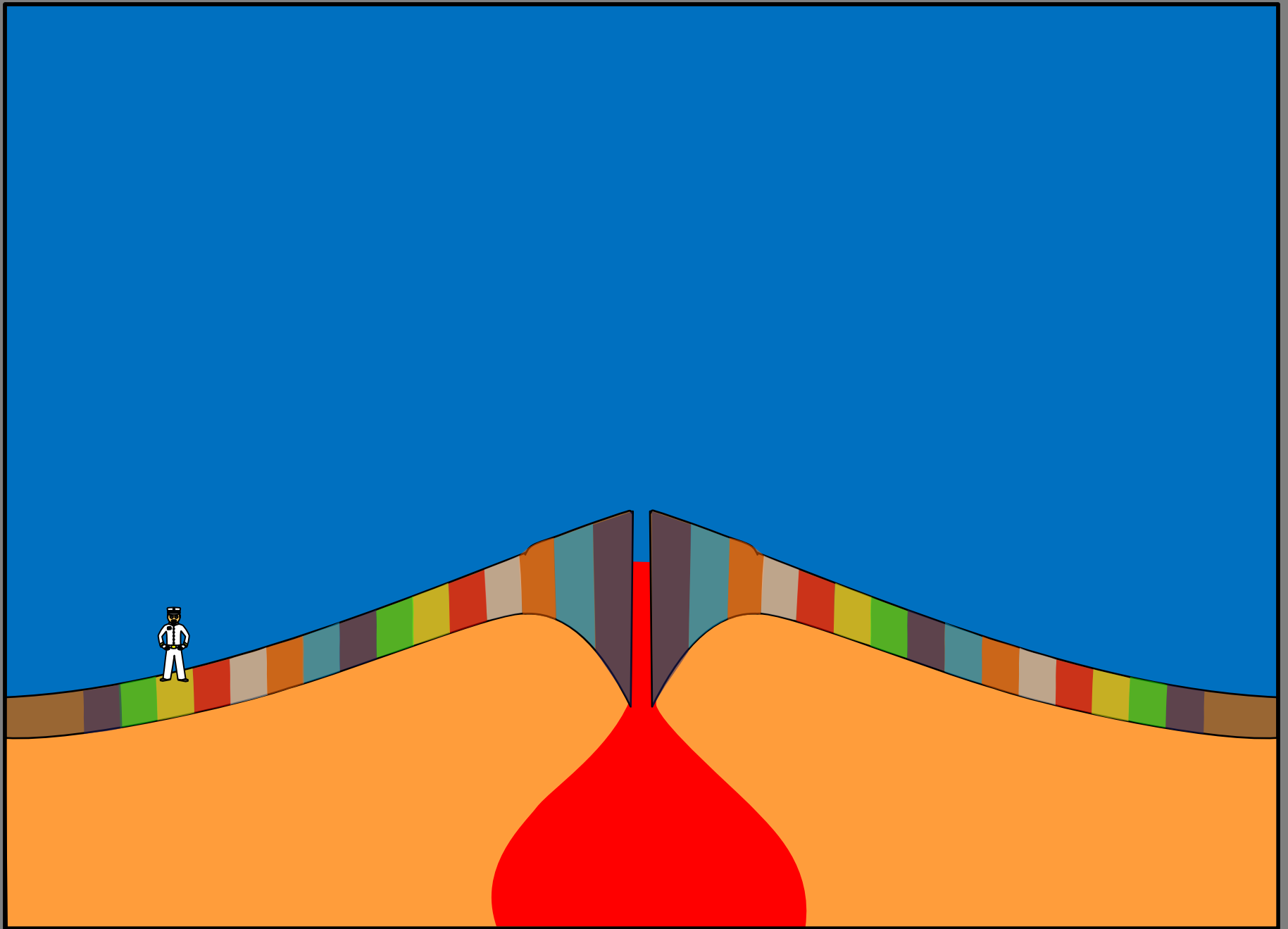


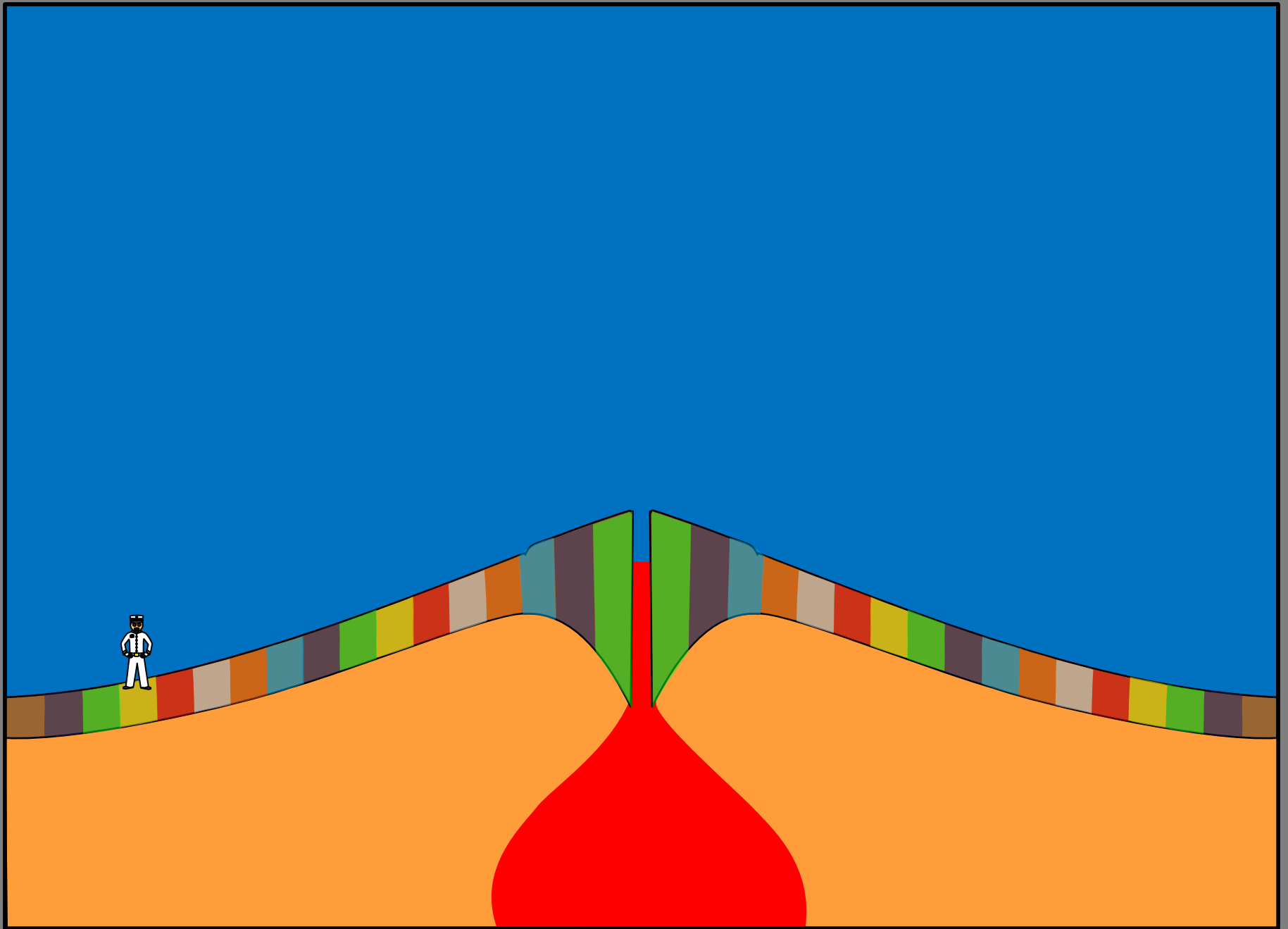


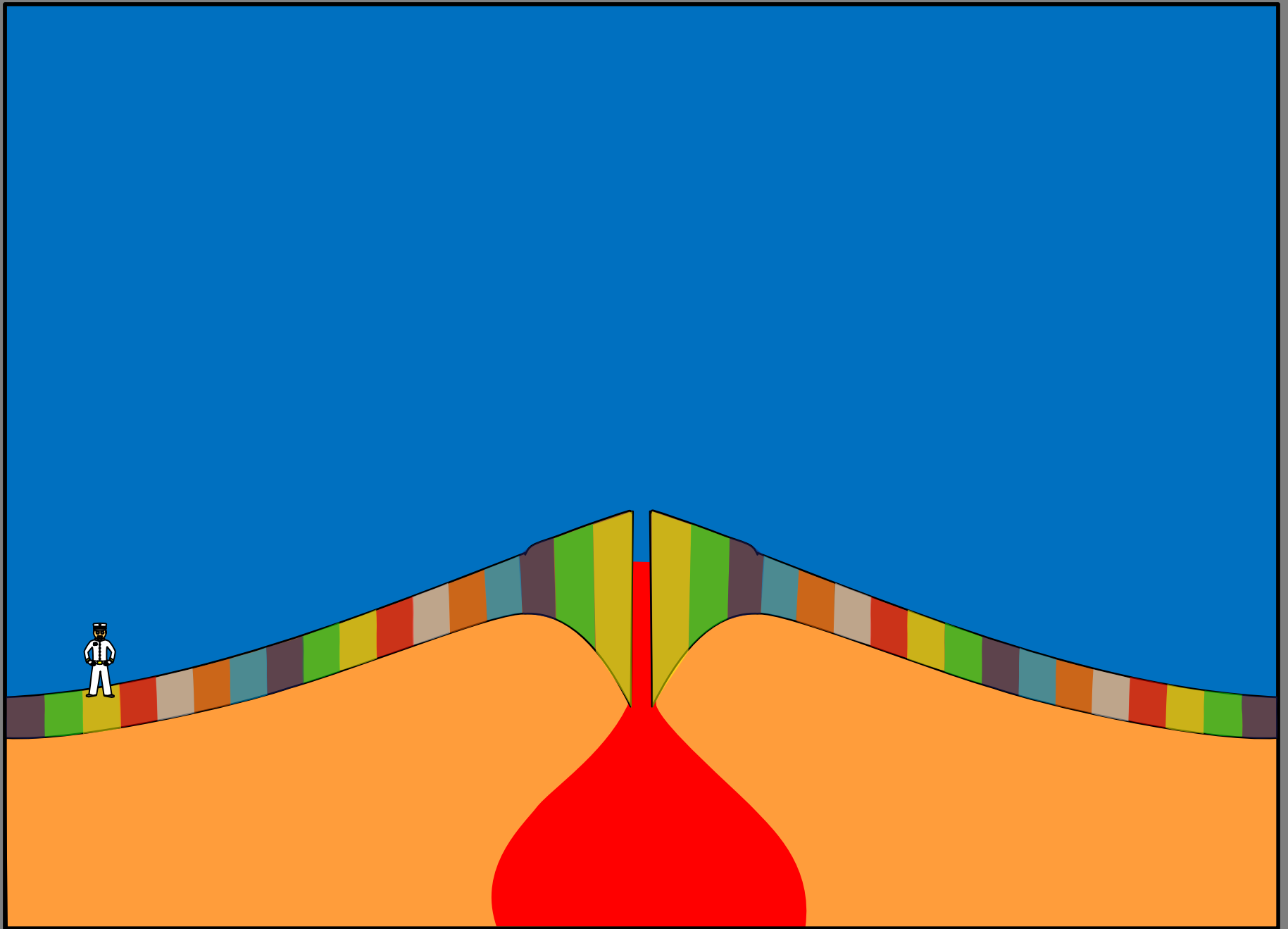




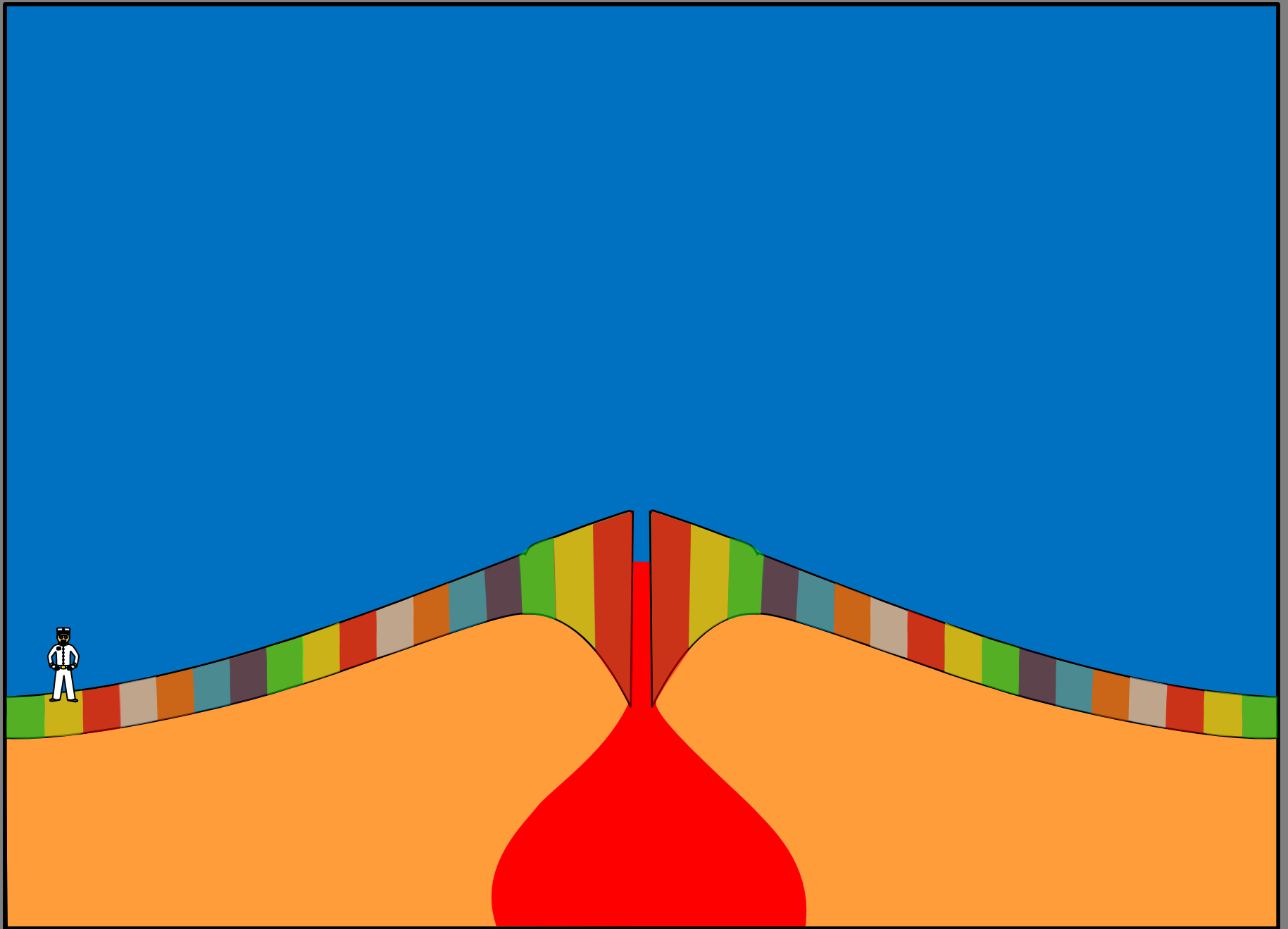


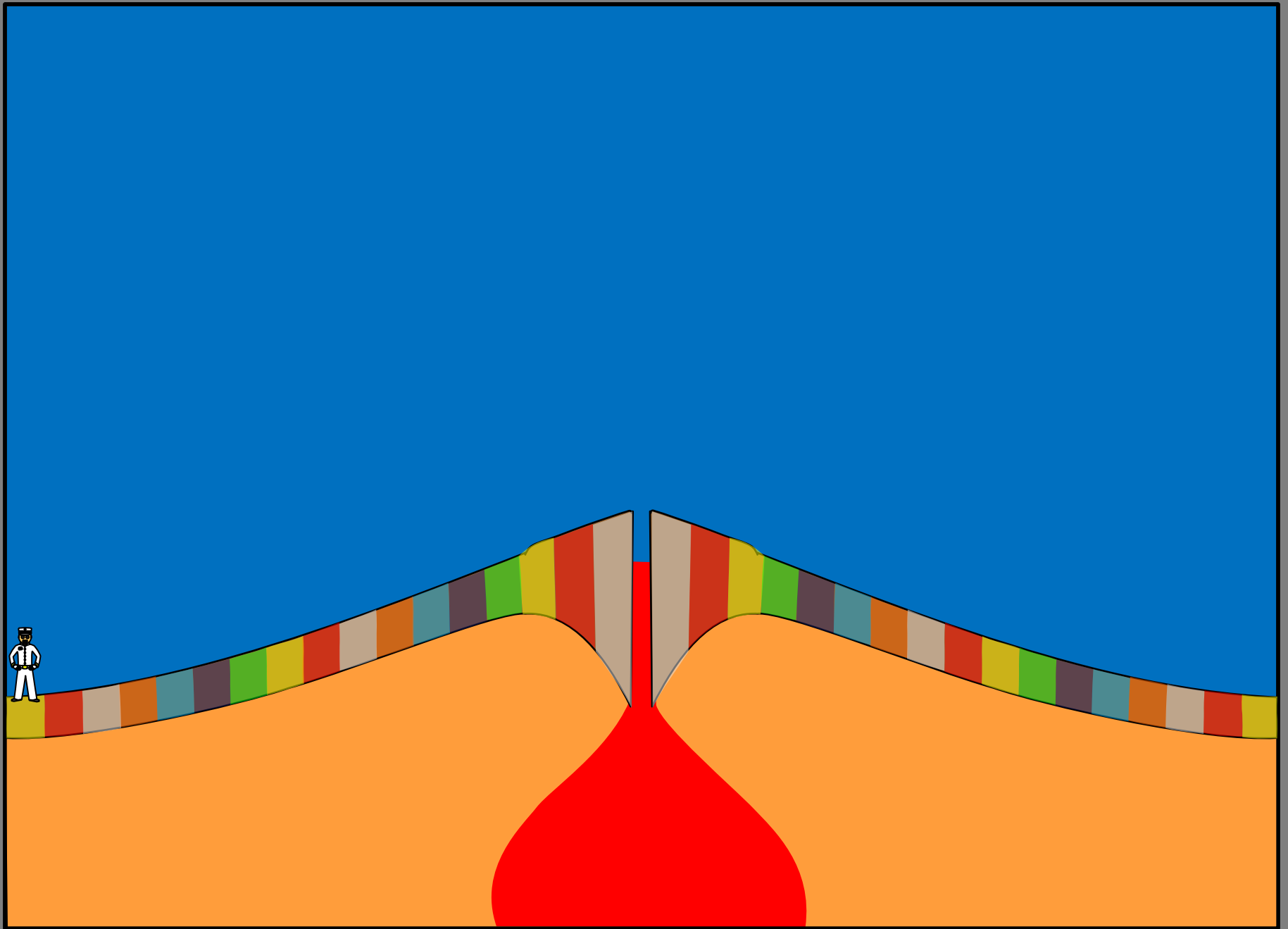


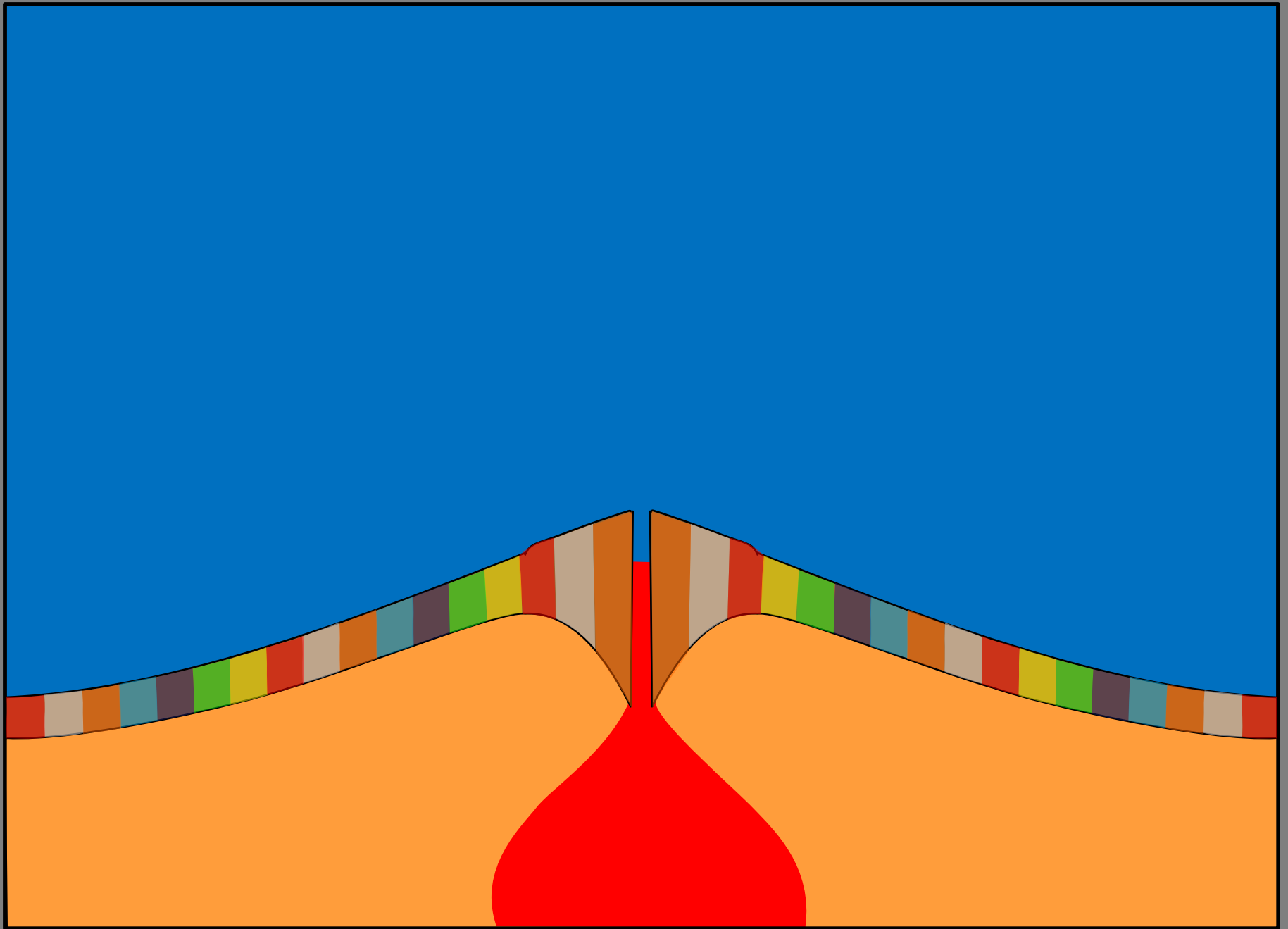


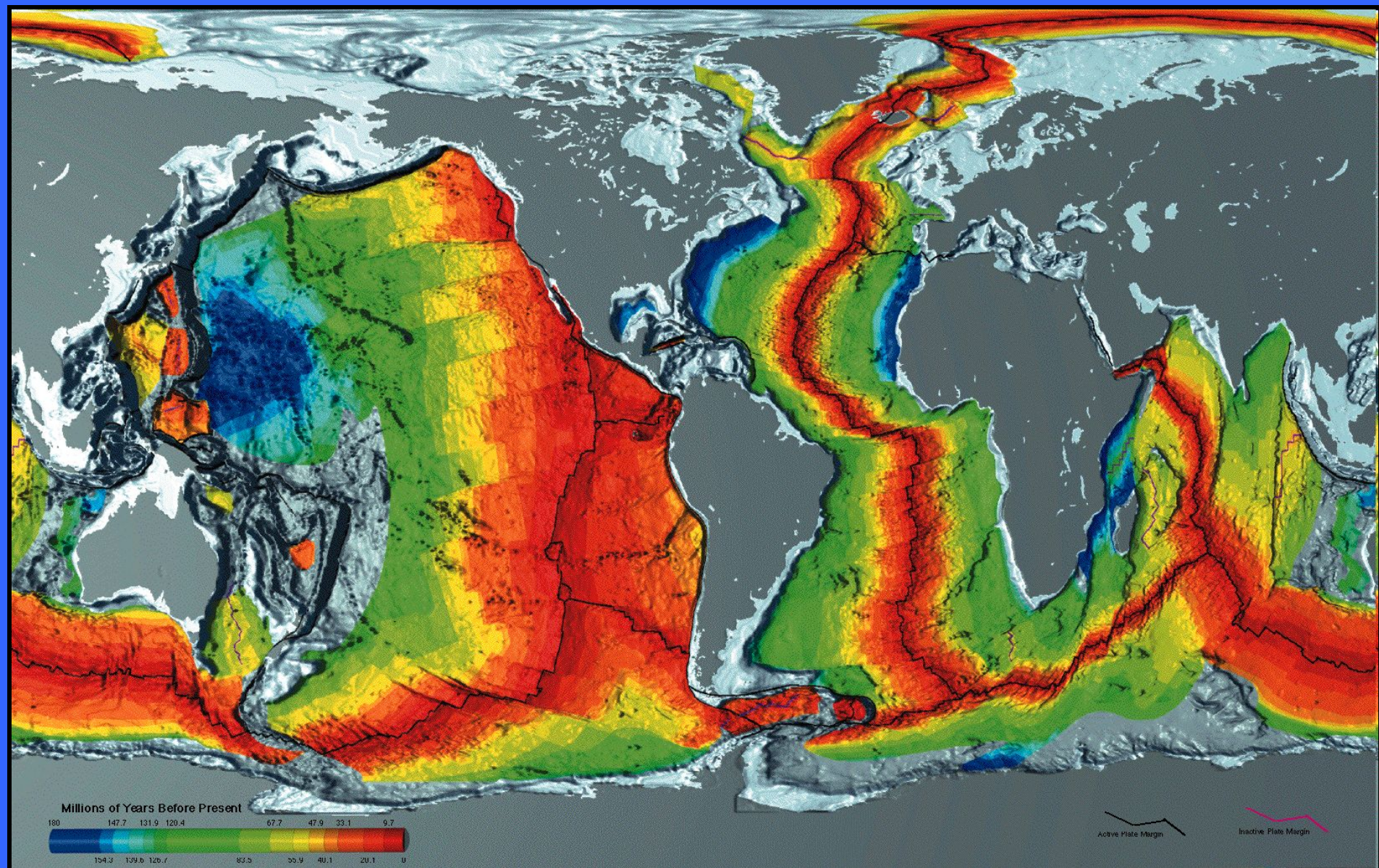


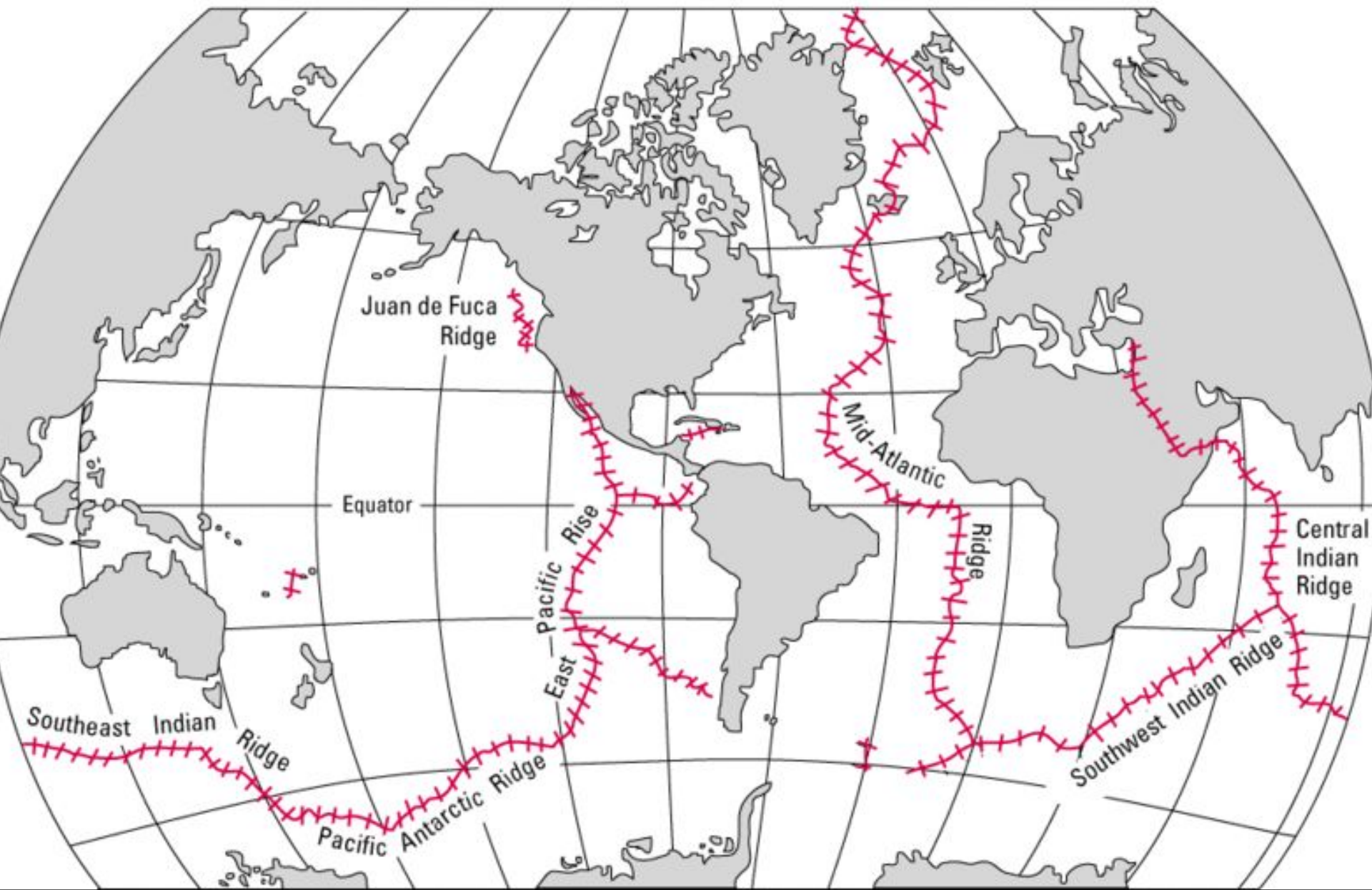


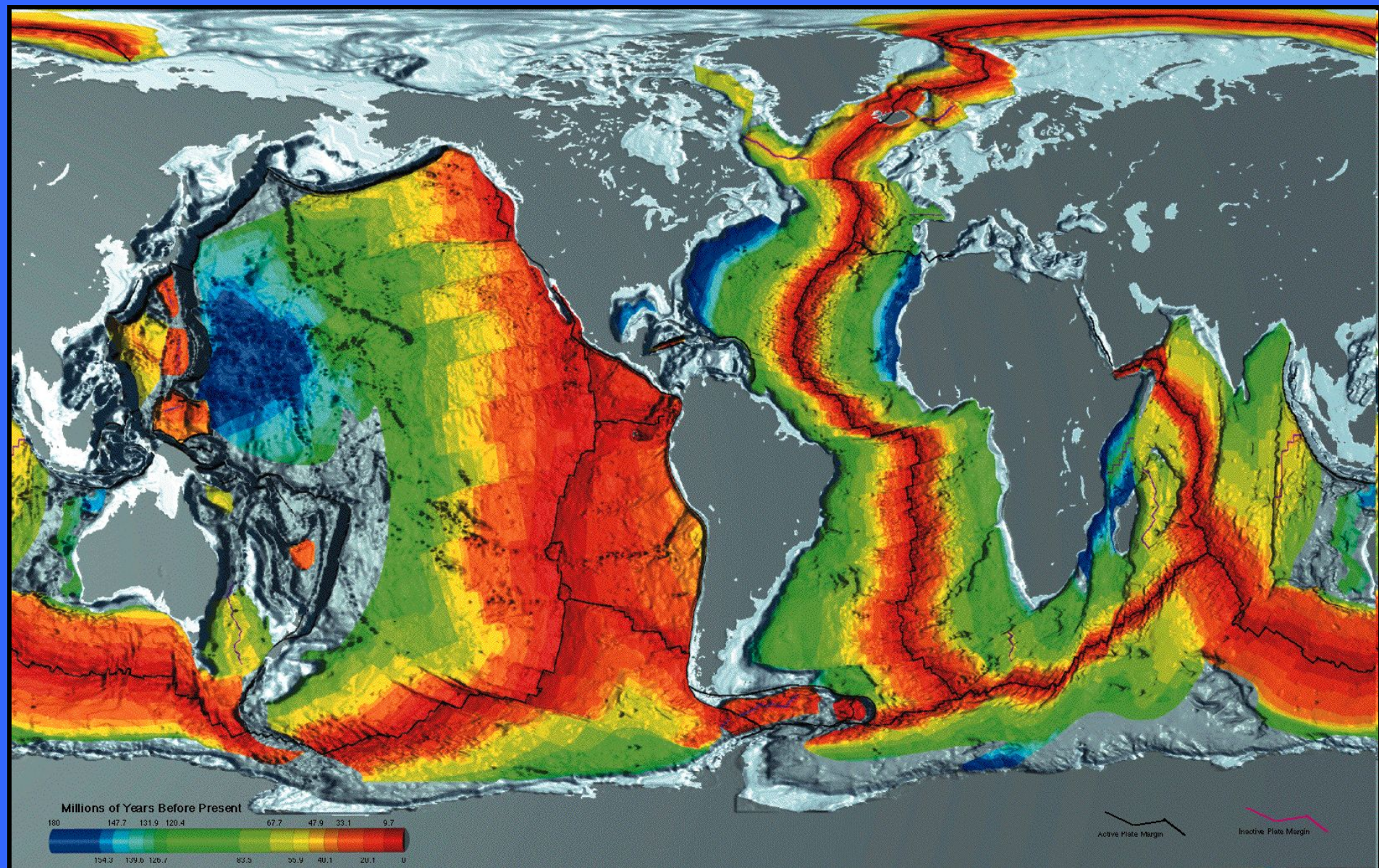






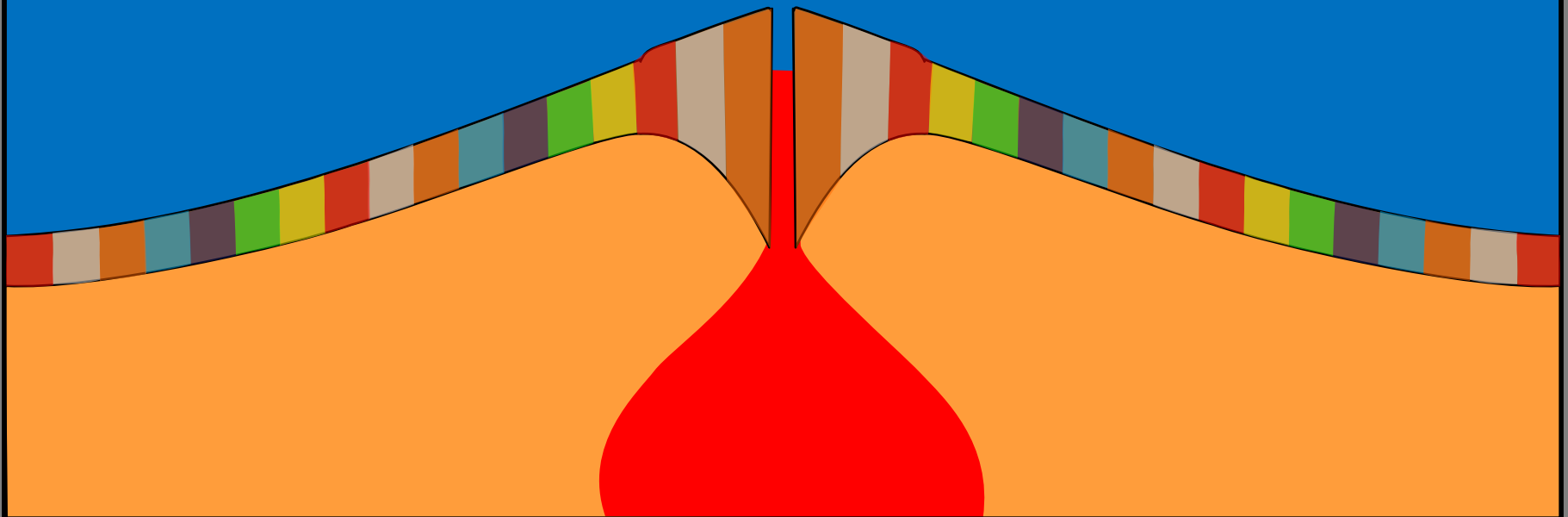


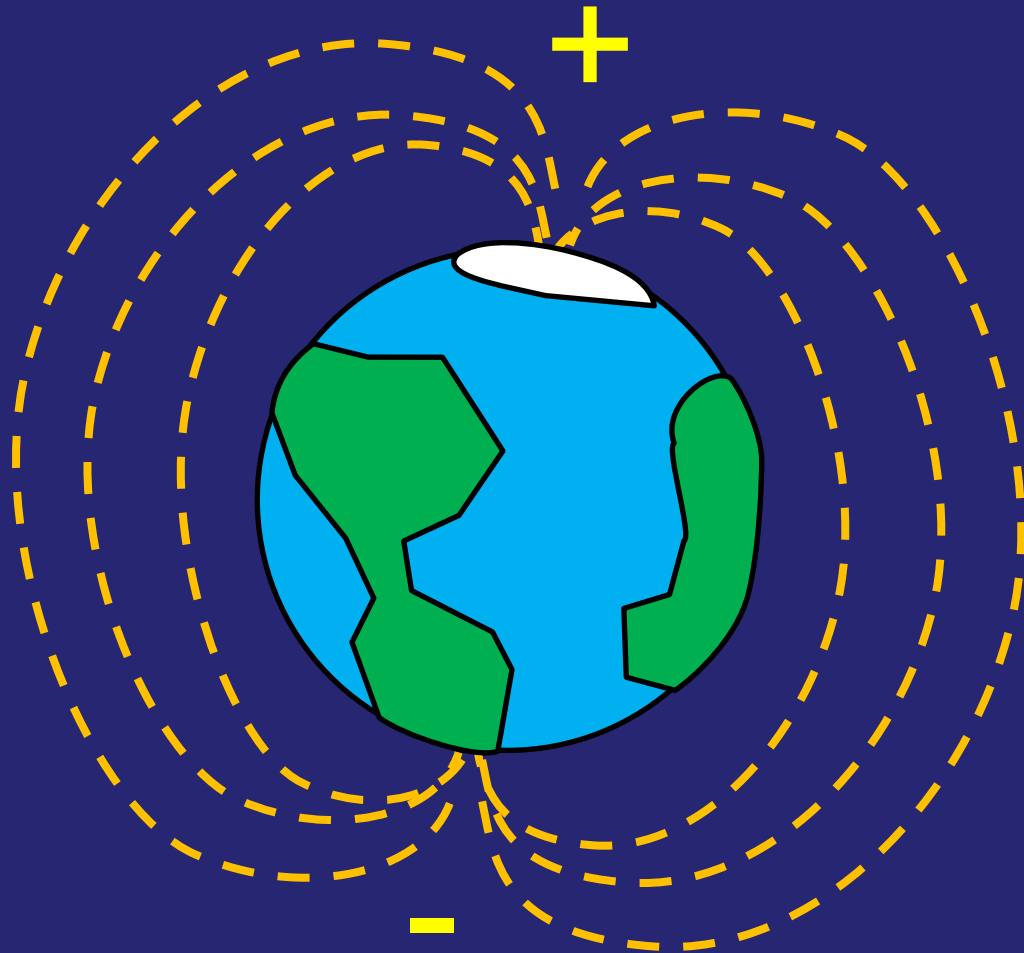
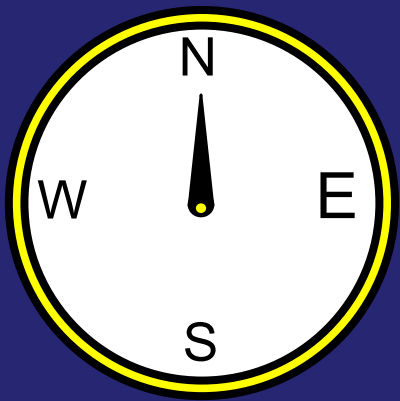




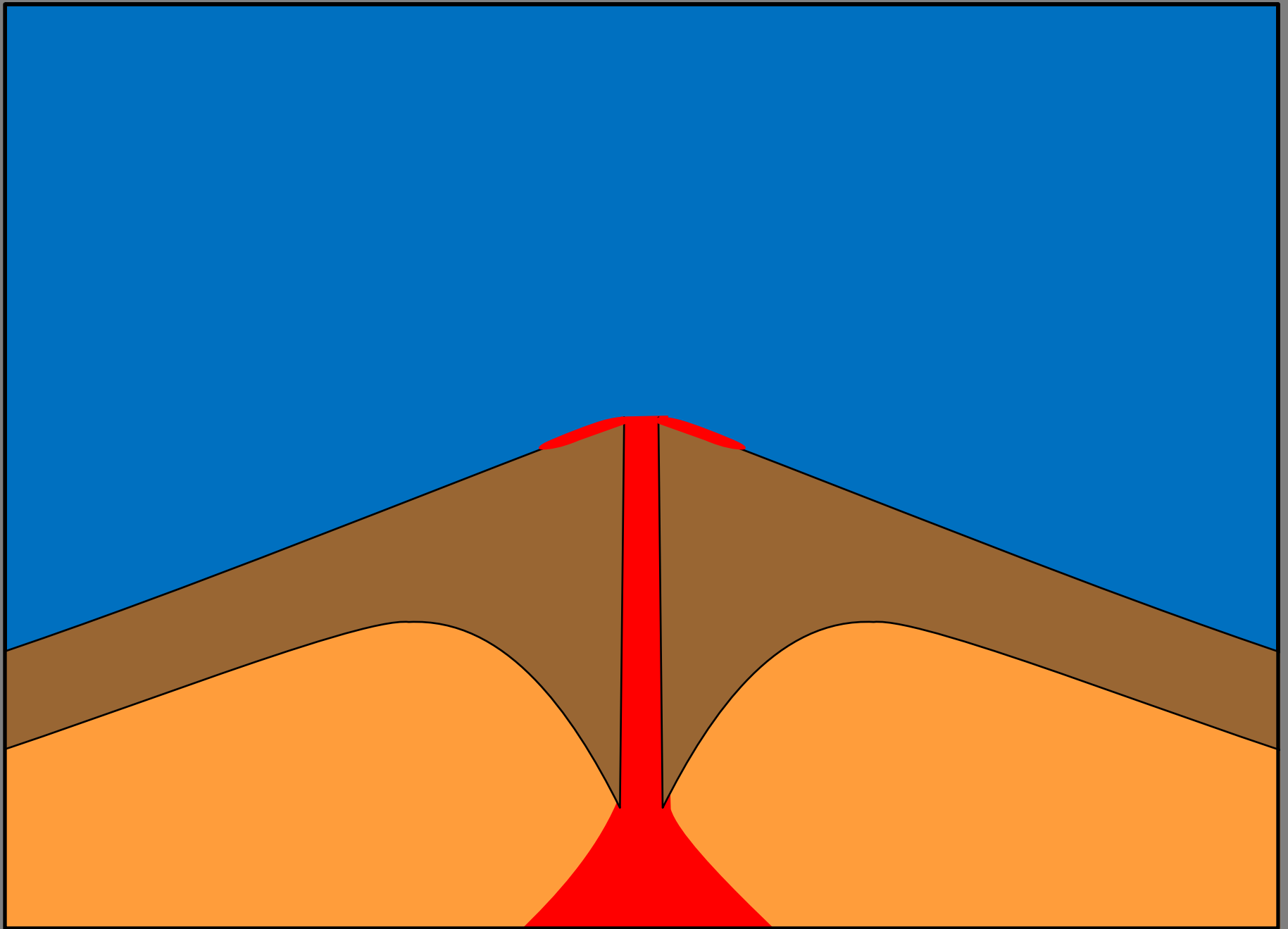
# Evidence of the Age of the Ocean Floor

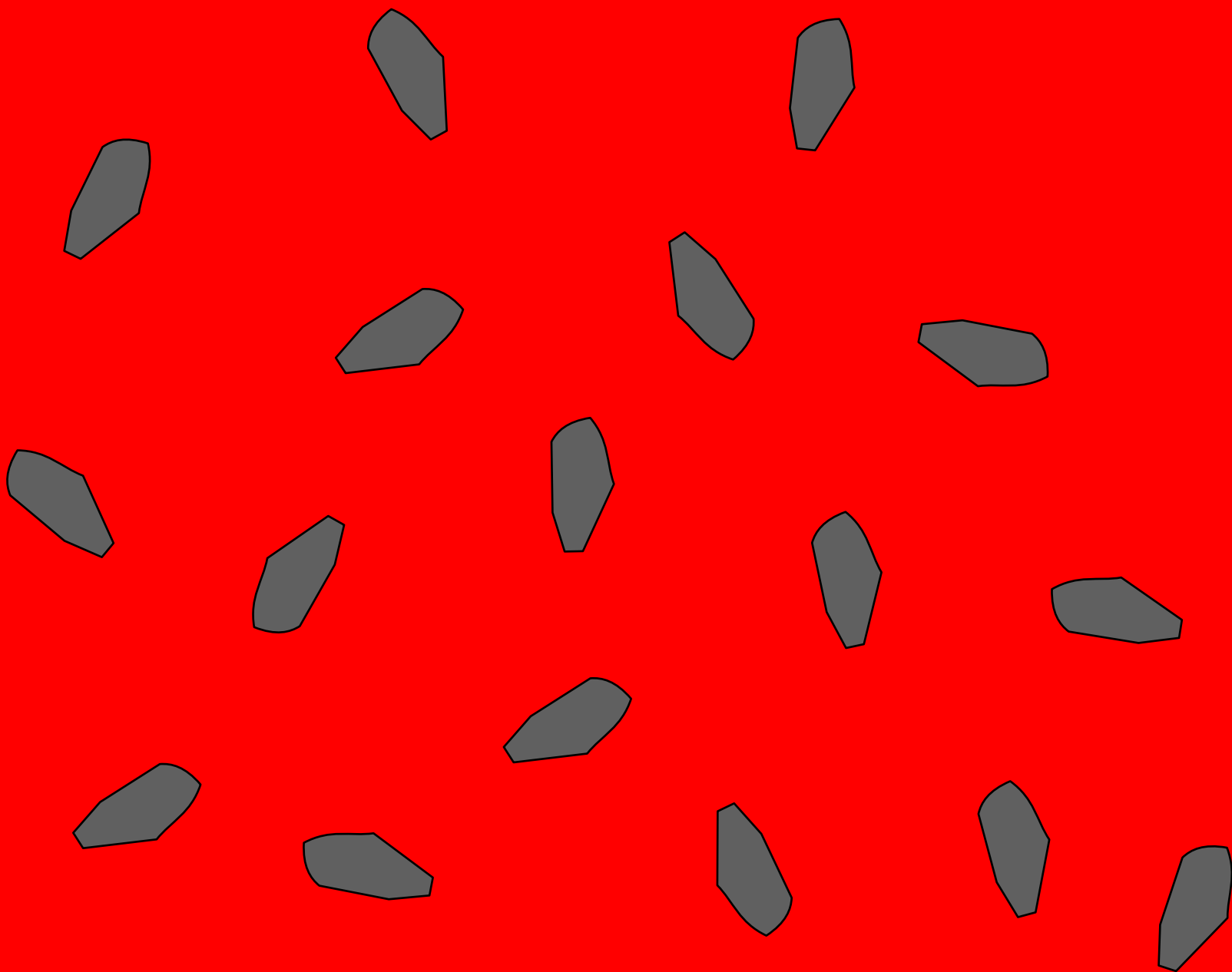
The fact that rocks get older at equal rates the farther away you get from a mid-ocean ridge is evidence of seafloor spreading

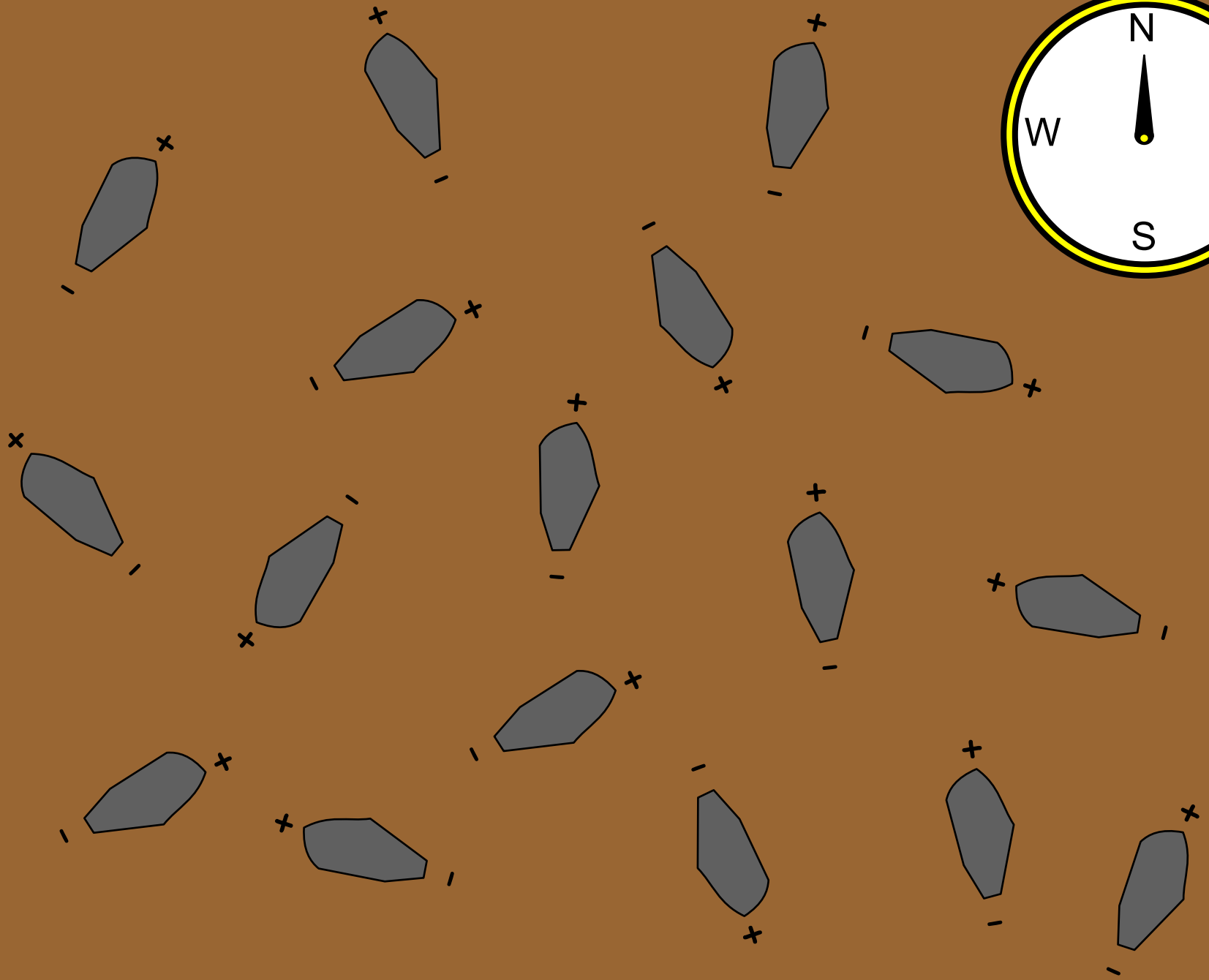
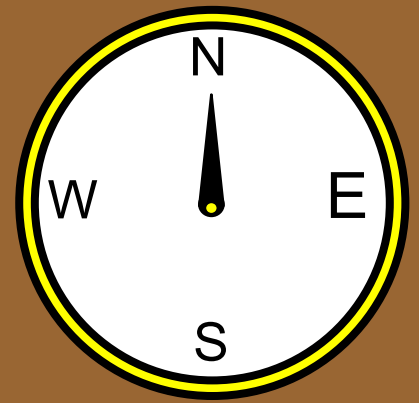


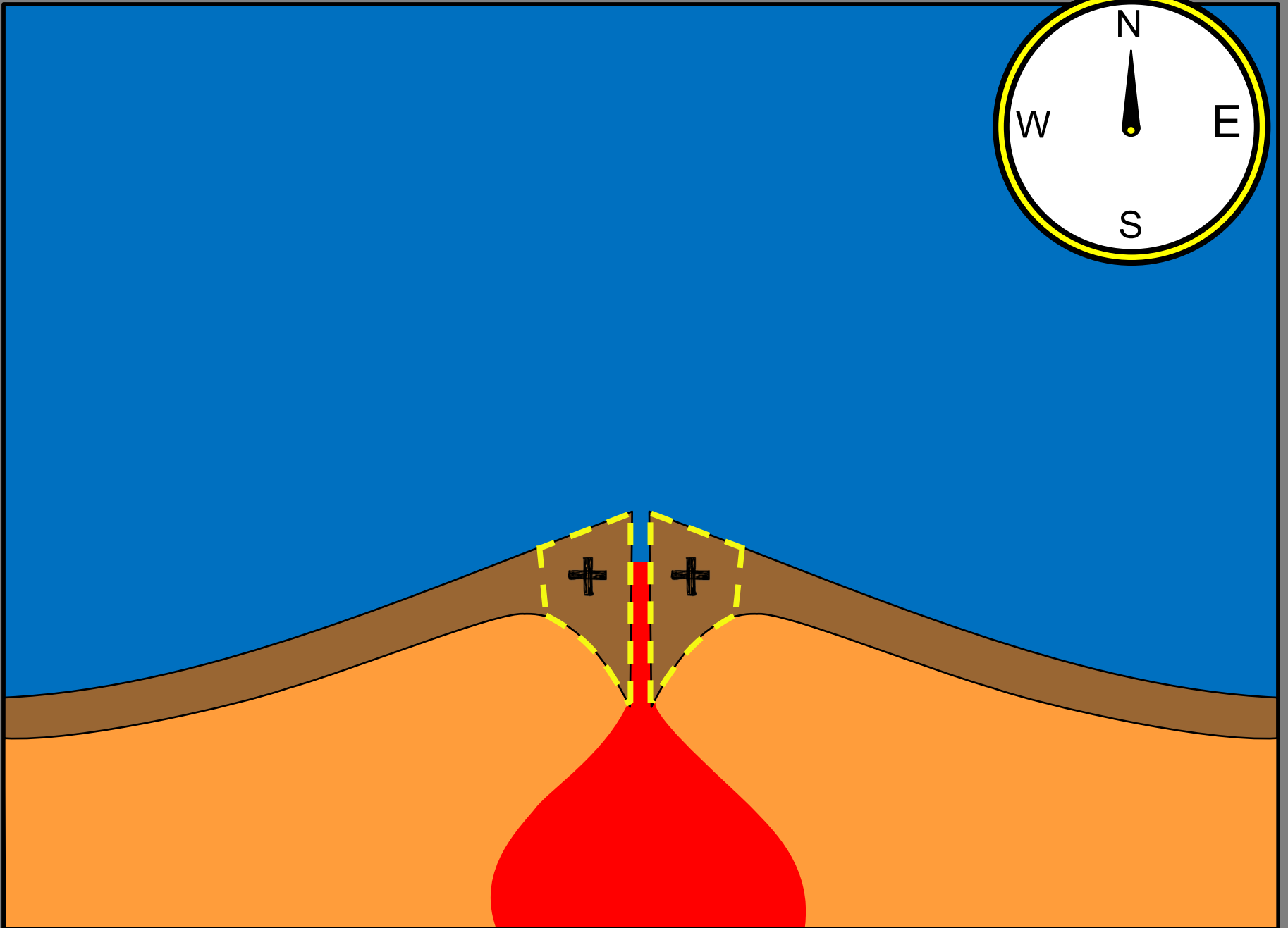
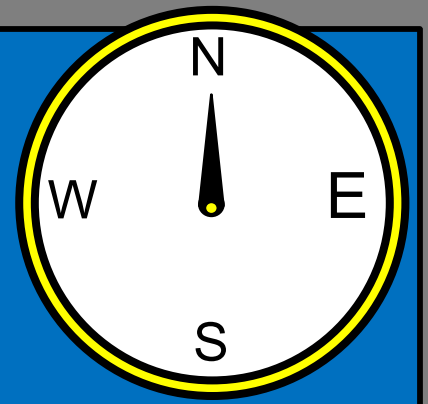


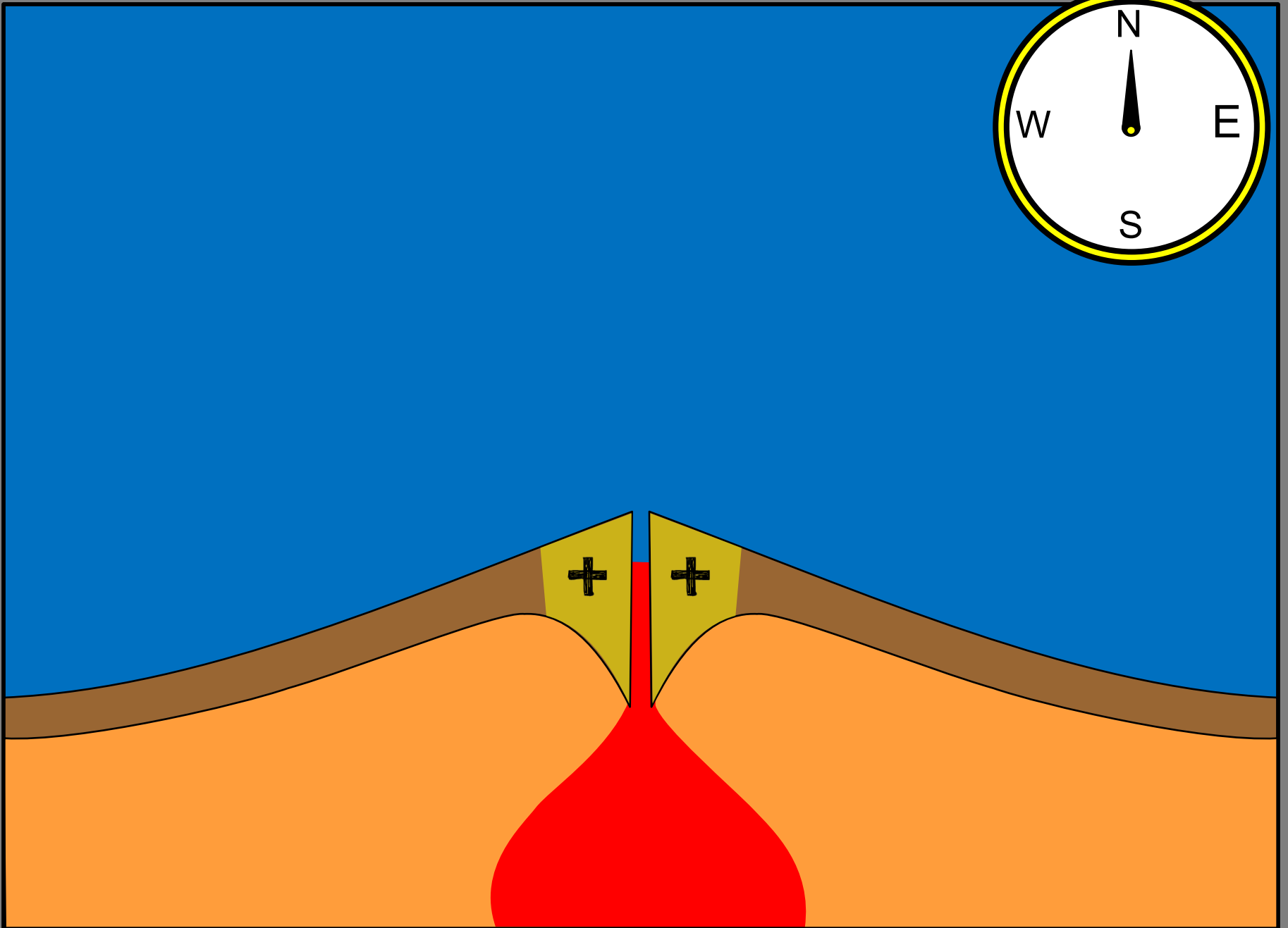
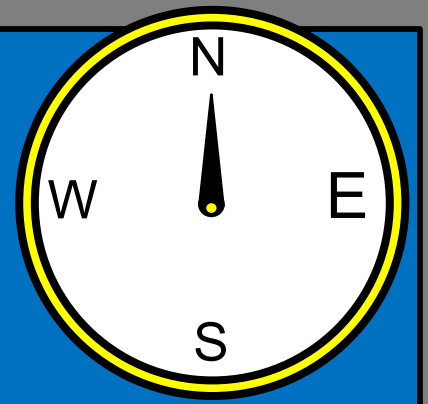


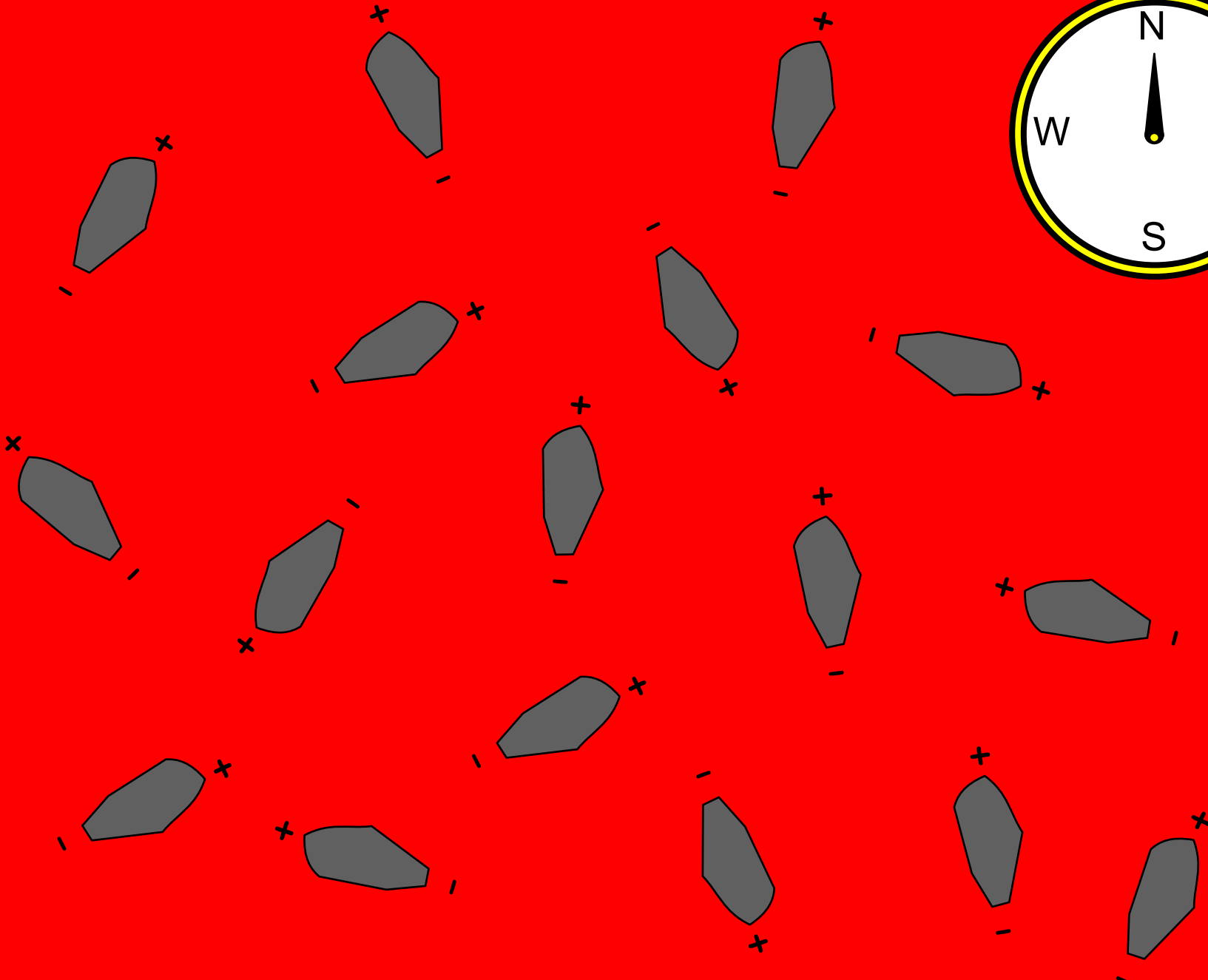
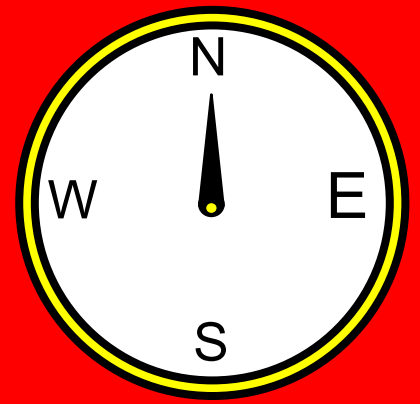


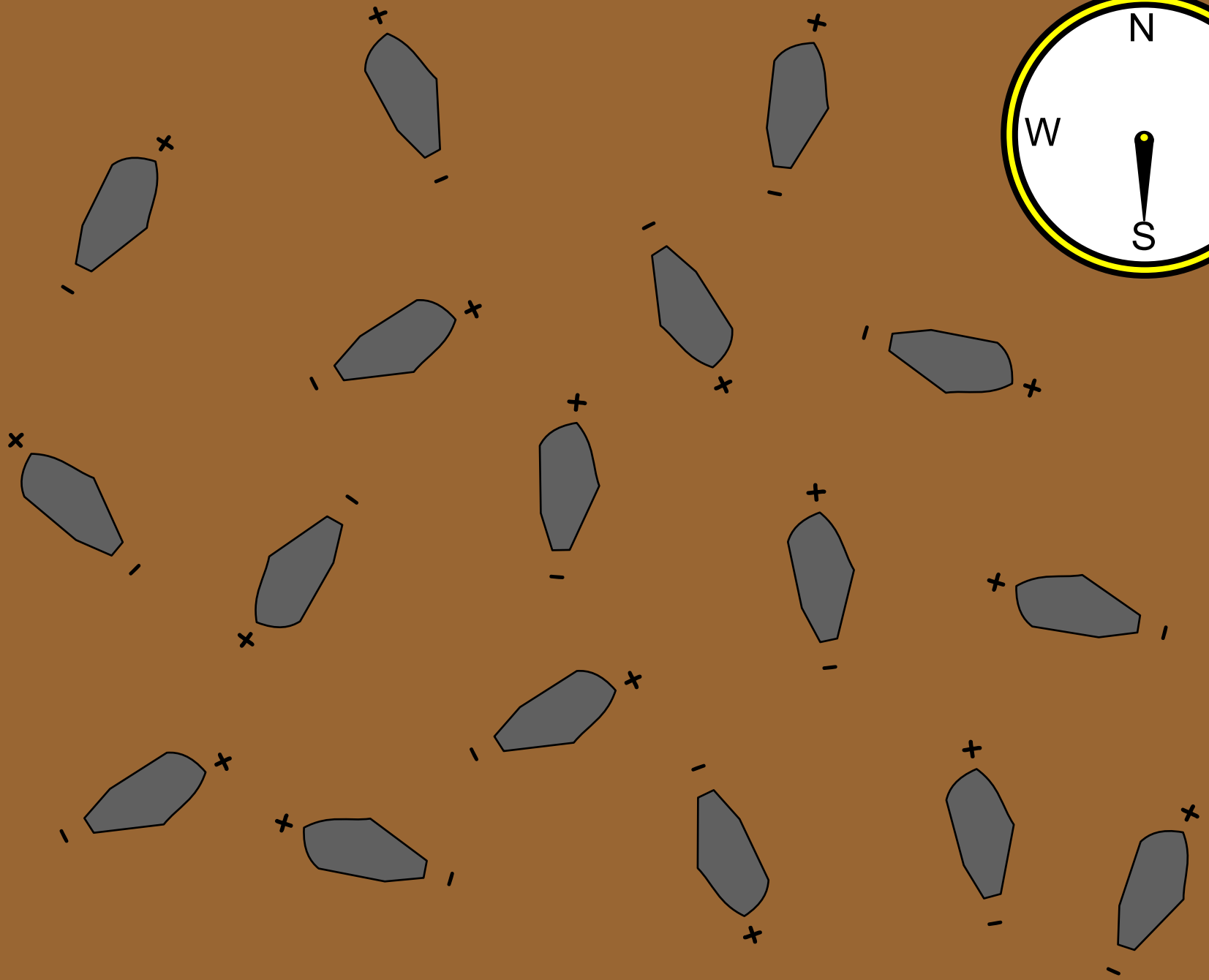
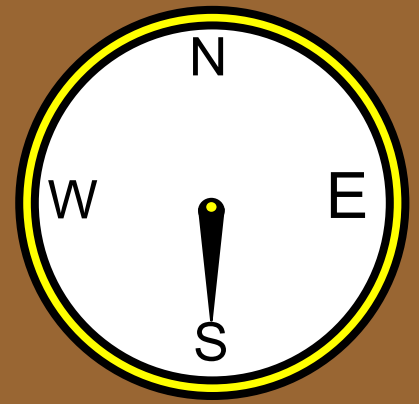


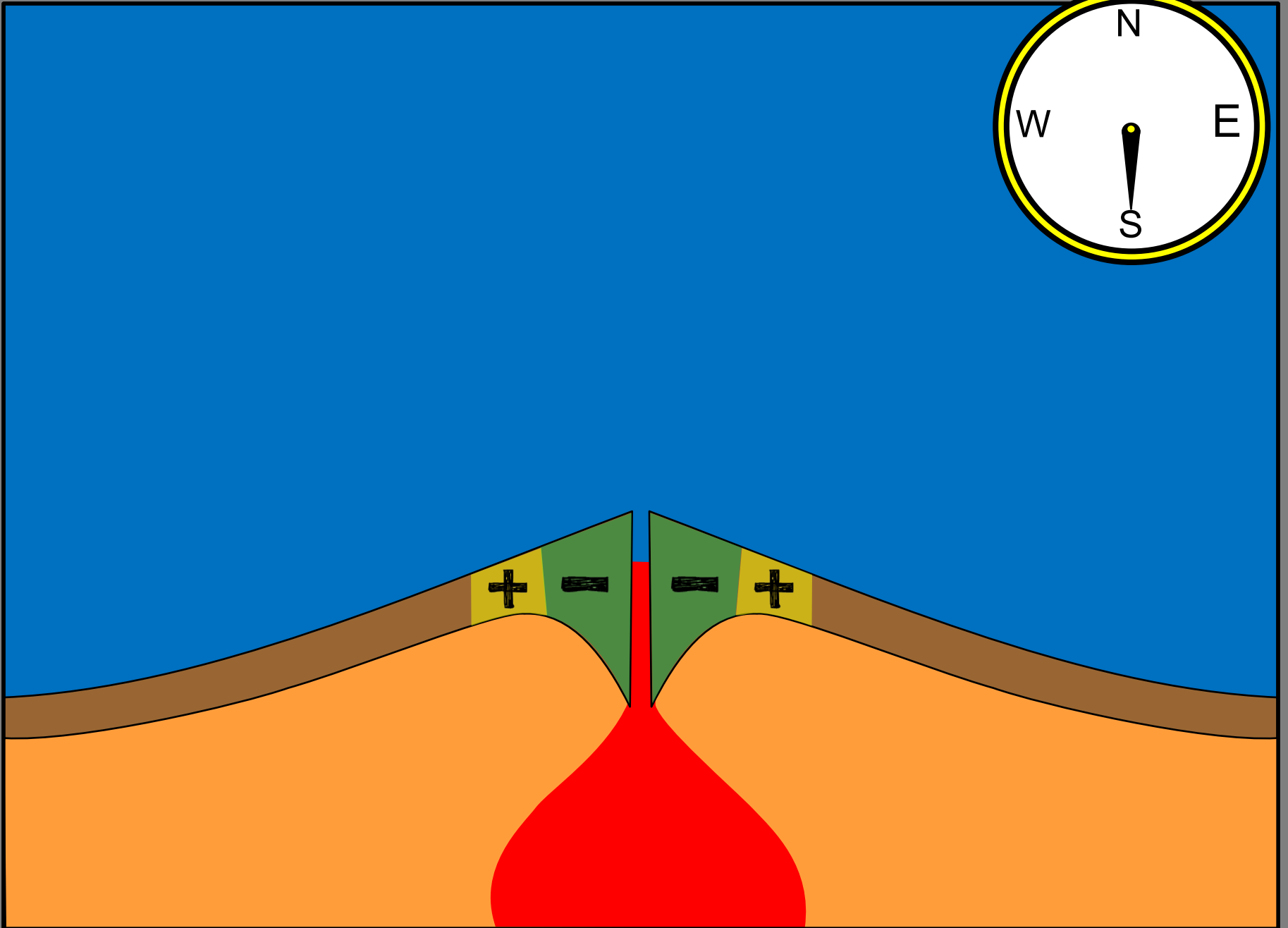
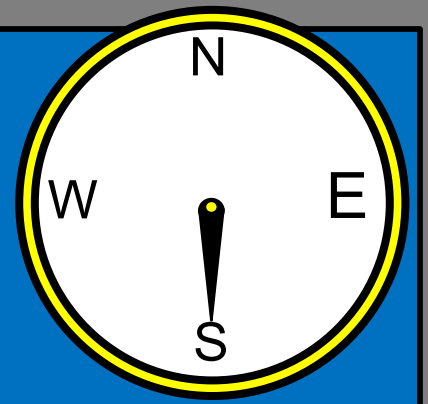




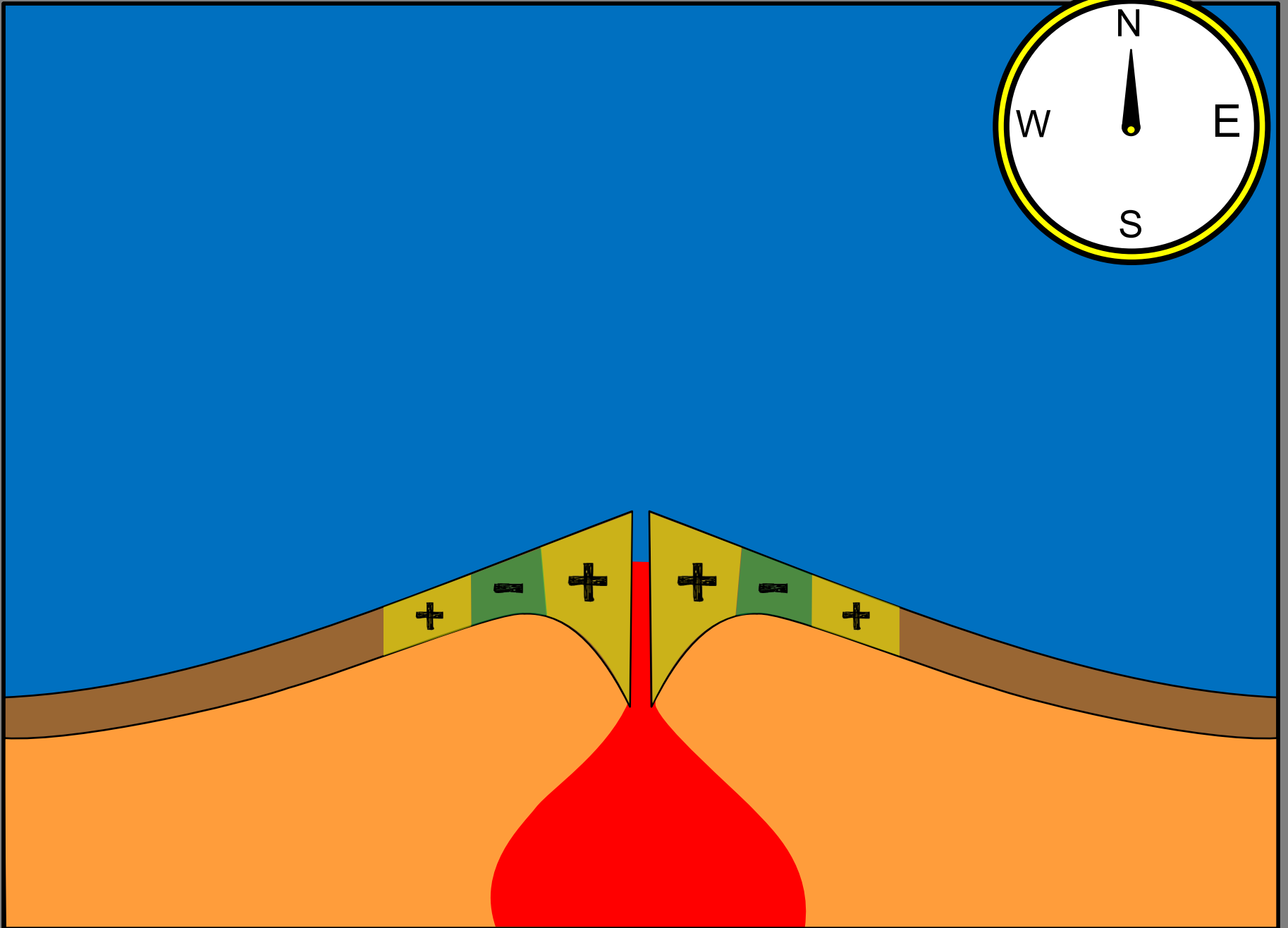
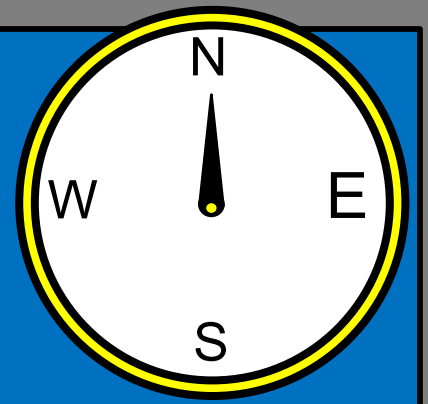


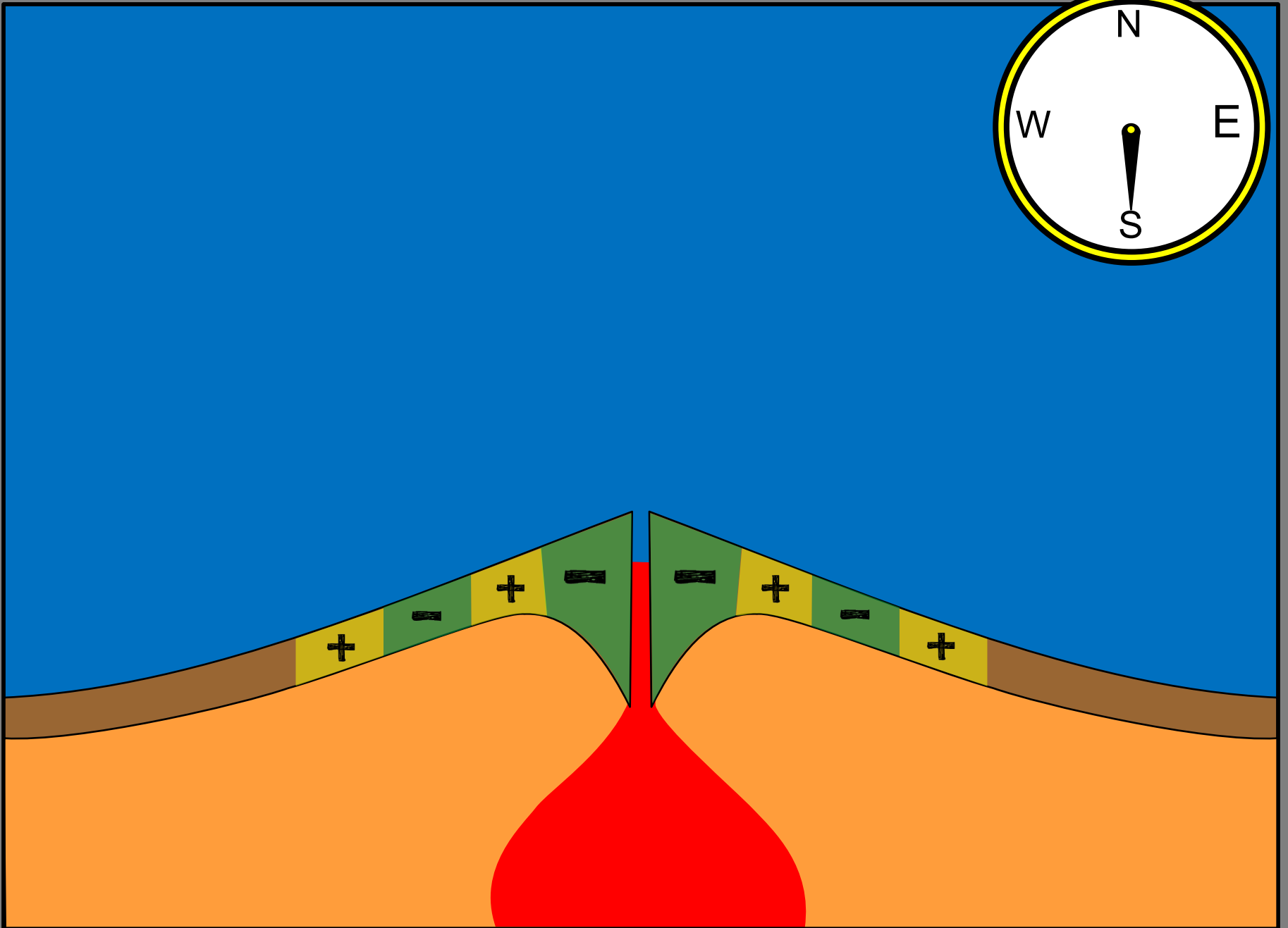
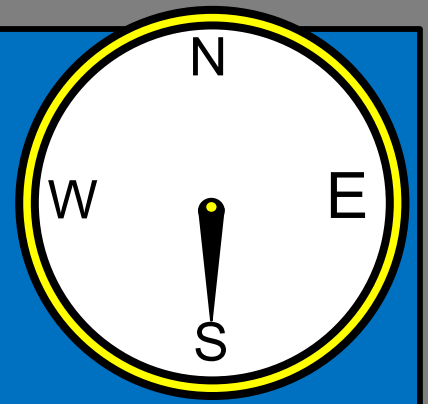


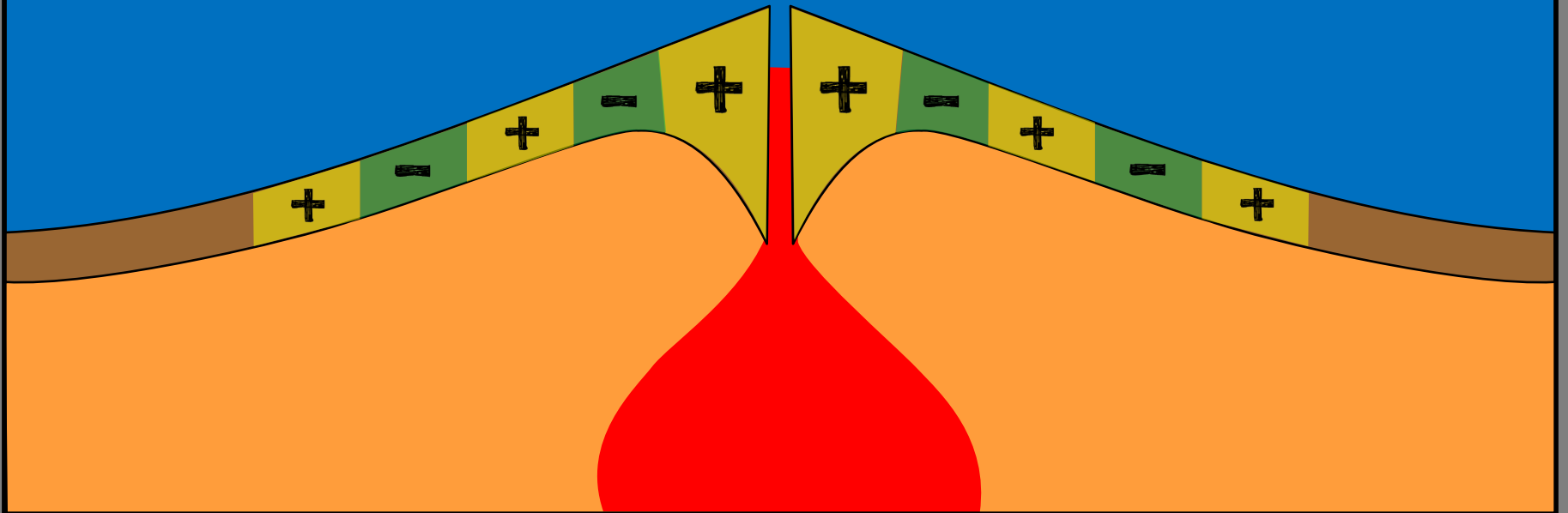
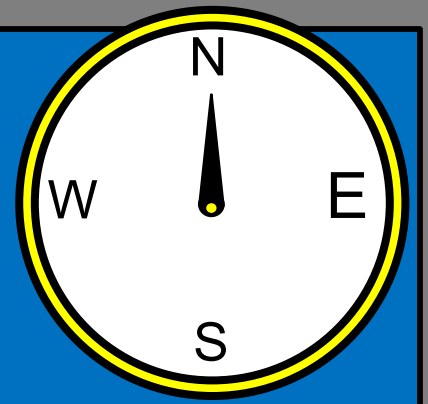


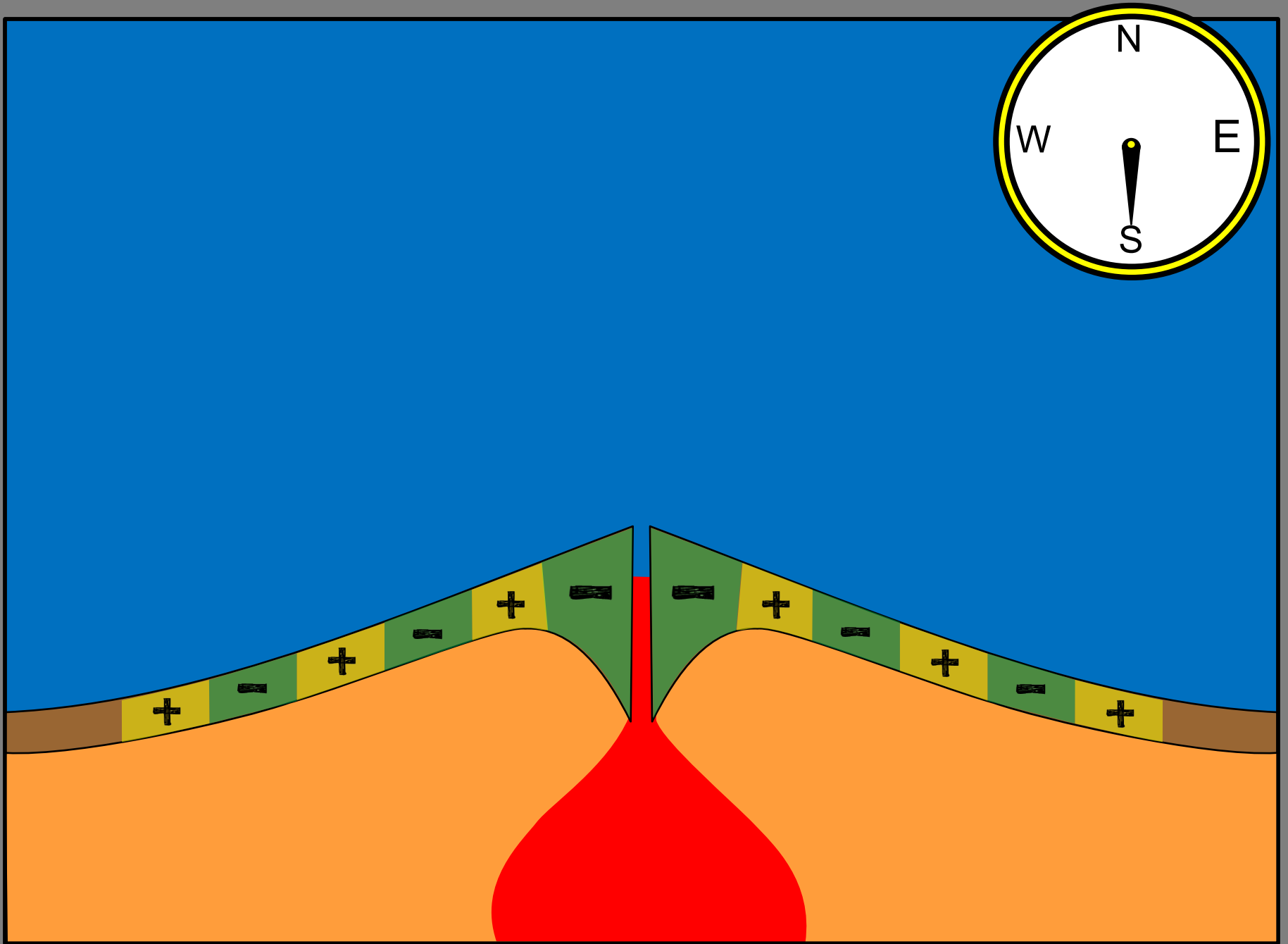


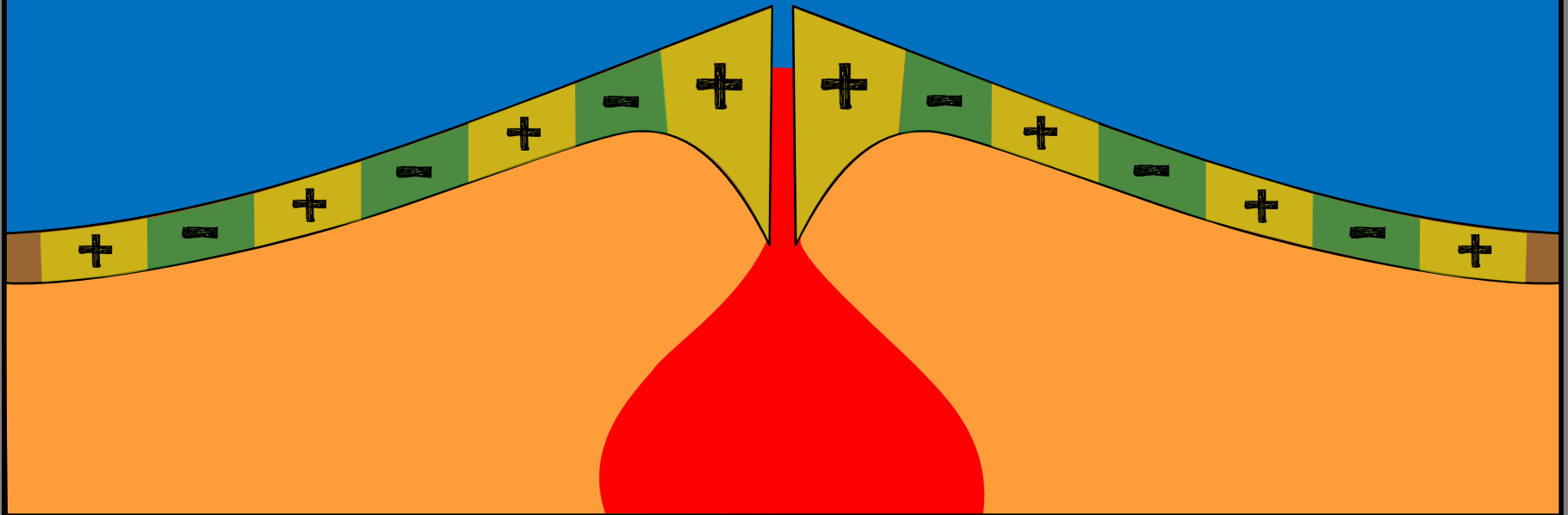
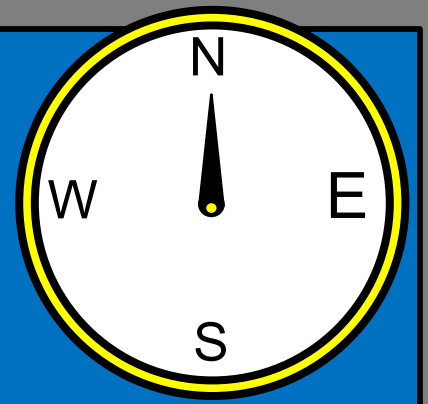


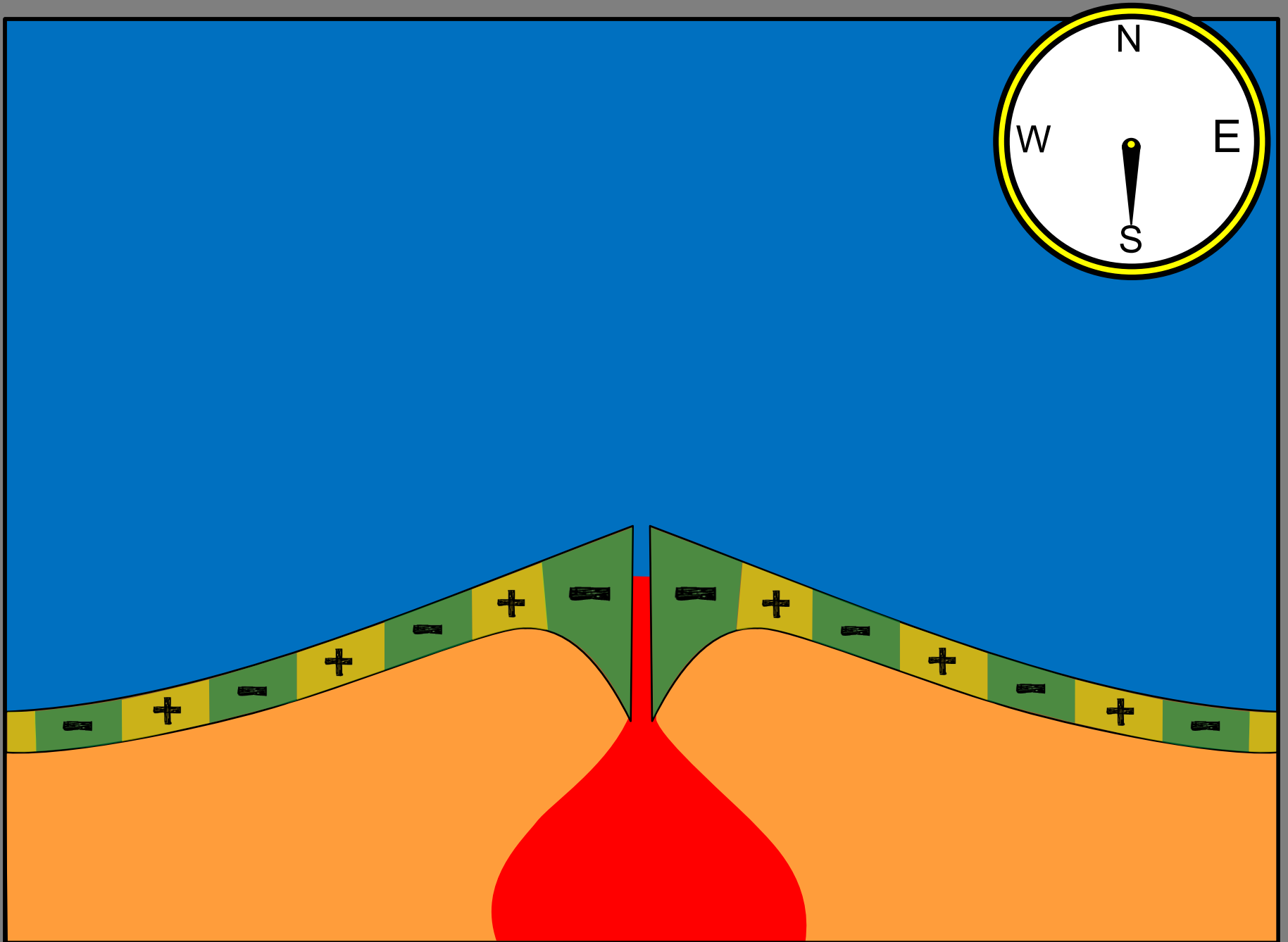


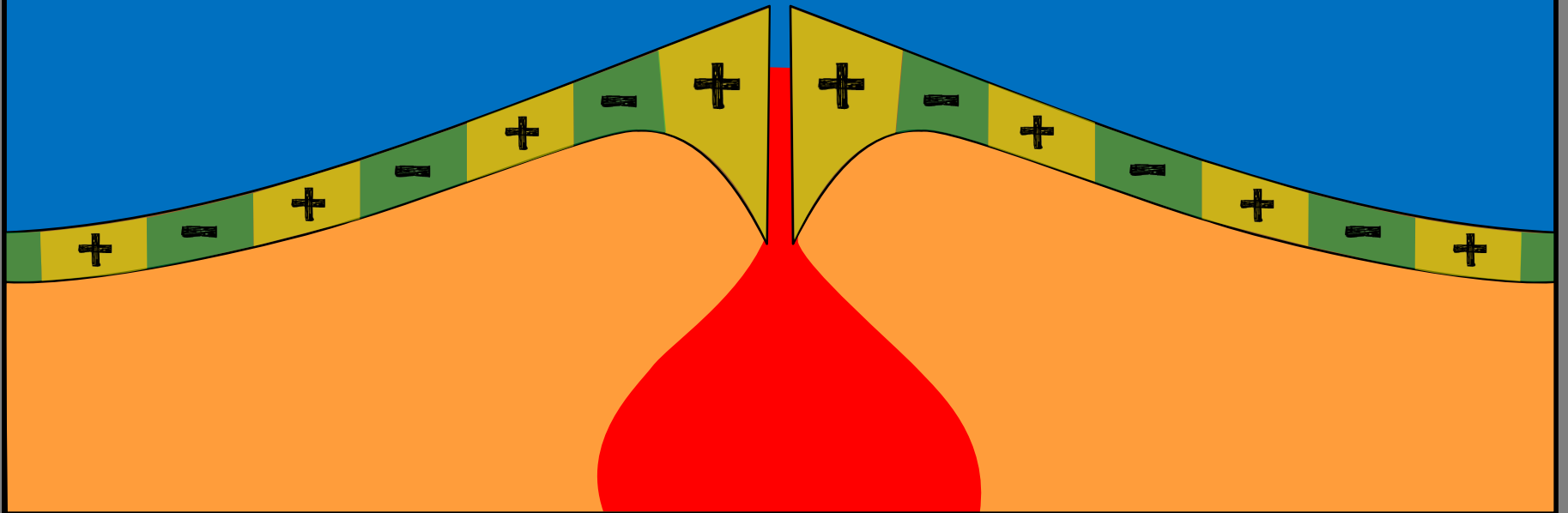
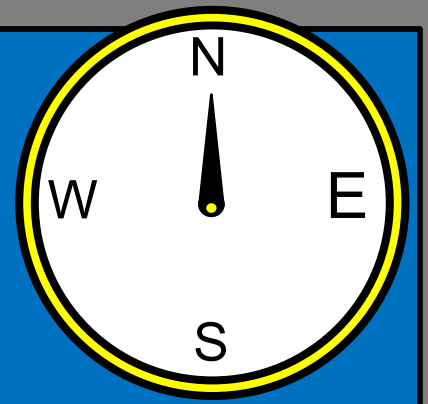






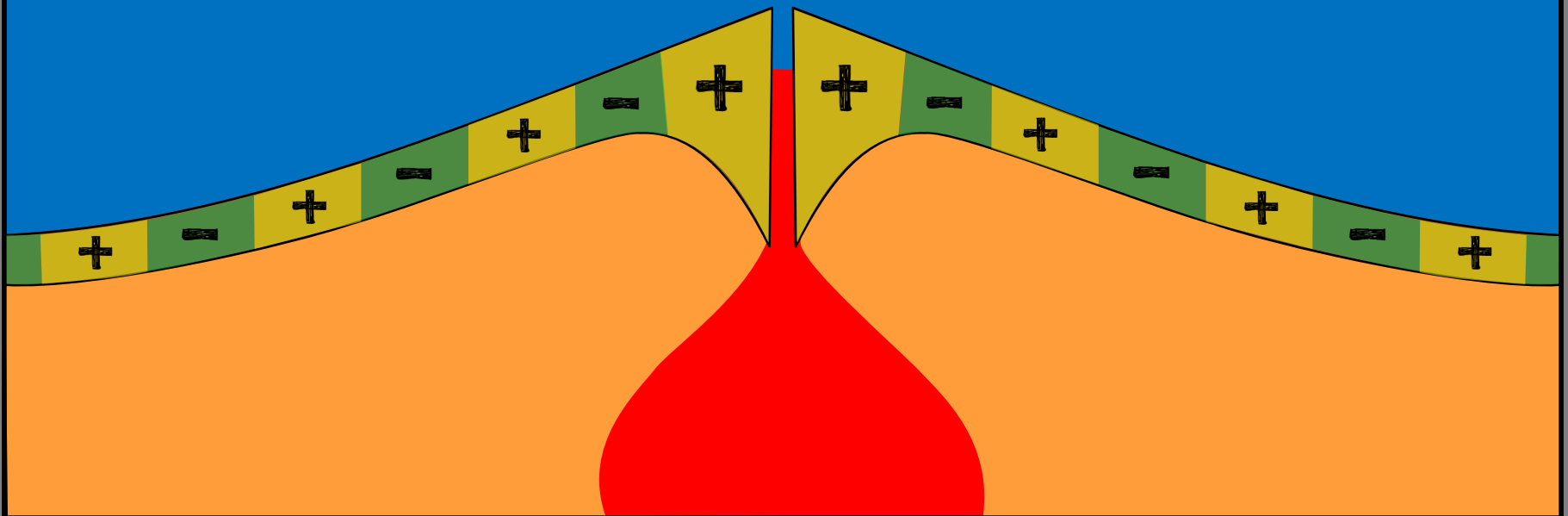






## Evidence of Sea Floor Spreading

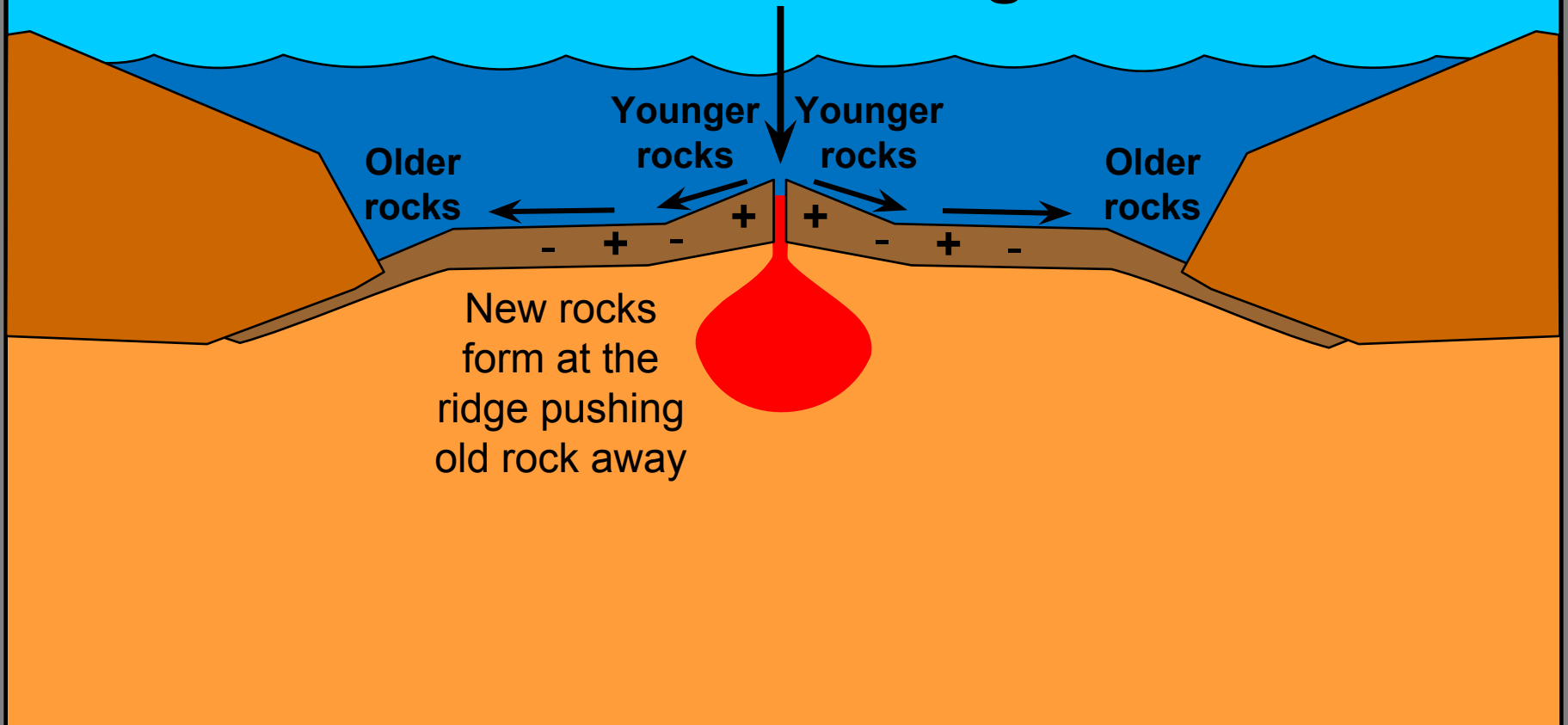
The fact that magnetic stripes on the ocean floor are identical on both sides of a mid-ocean ridge is evidence of sea floor spreading



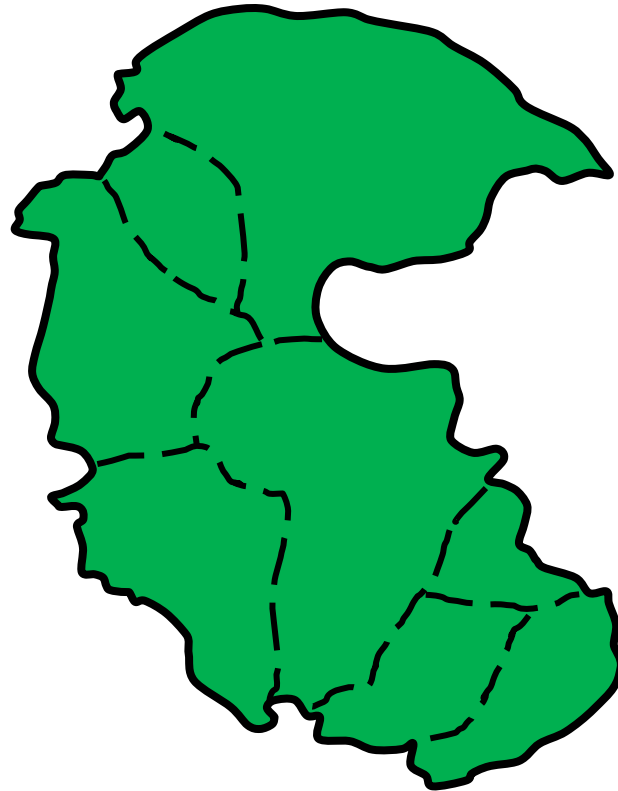


Let's draw a diagram

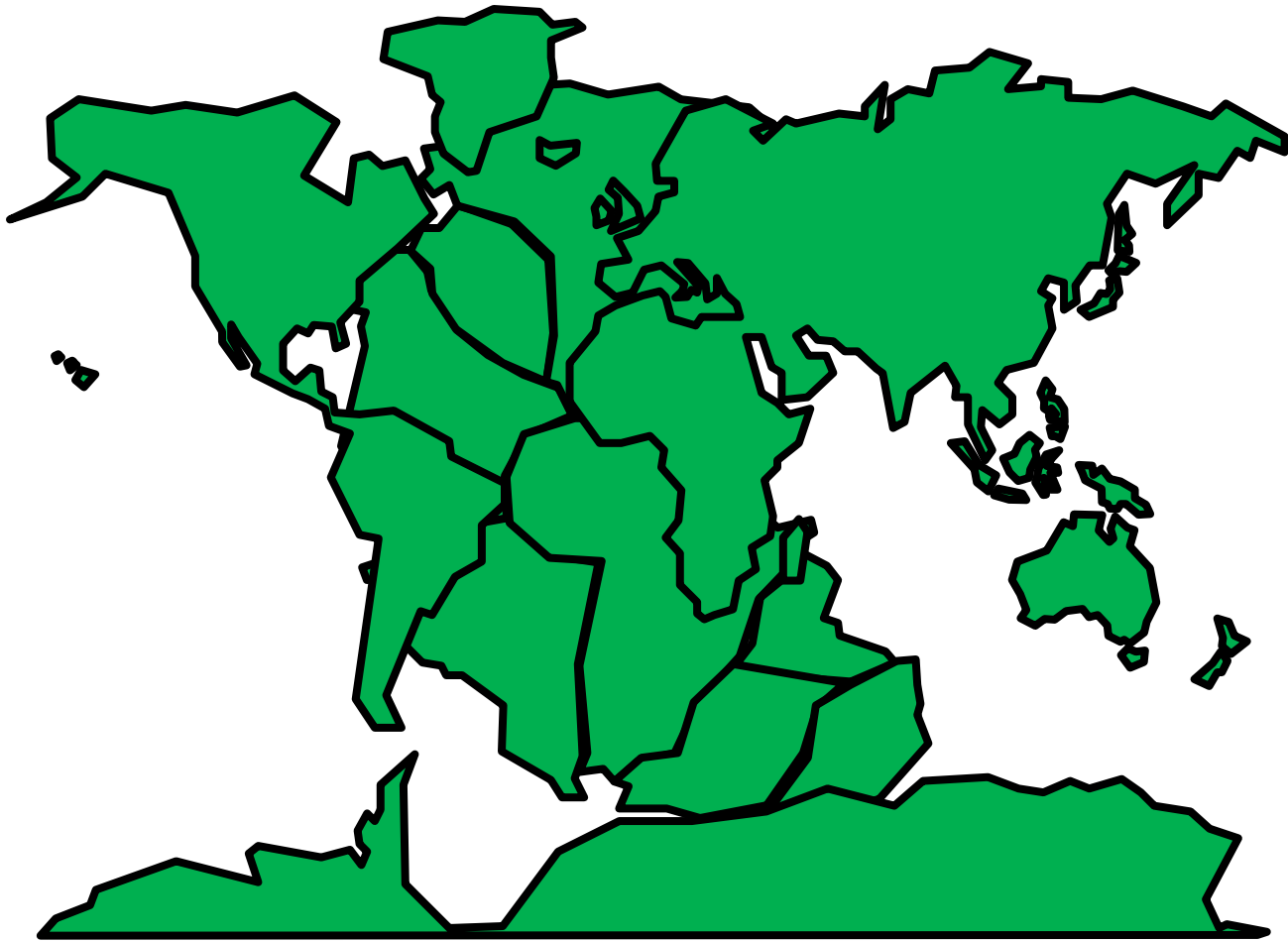
## Mid-Ocean Ridge



# Quiz Time



# Quiz Time



# Quiz Time

## Alfred's Evidences

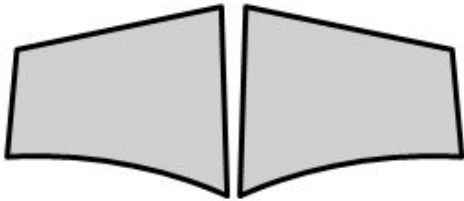
1. Geometric Evidence
2. Fossil Evidence
3. Mountain Evidence
4. Climate Evidence

# Quiz Time

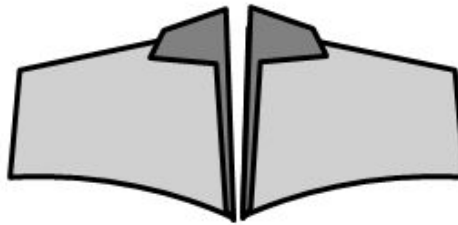
Why was Alfred Wegener not accepted in his time?

# Quiz Time

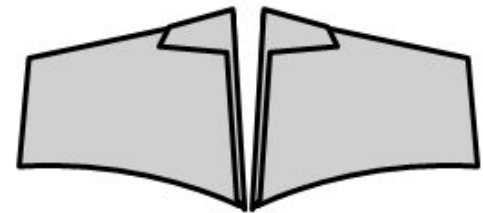
A Ocean floor at a mid-ocean ridge



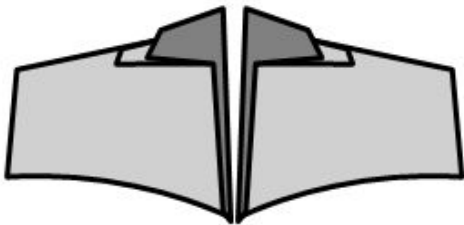
B Magma rises up from Earth's mantle



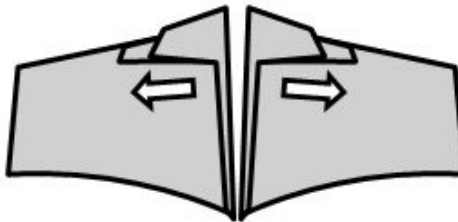
C Magma cools and turns into new rock



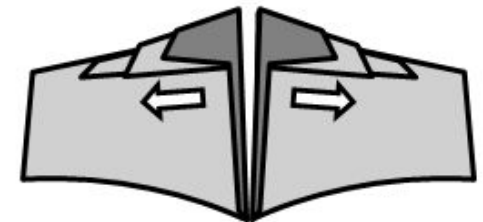
D More magma rises up from Earth's mantle



E New rock forms, pushing the old rock out of the way



F Process continues as the ocean floor slowly gets wider



# Quiz Time

What is the mechanism of continental drift?

# Quiz Time

Who came up with the mechanism of continental drift?



# Quiz Time

Where does seafloor spreading take place?

Quiz Time

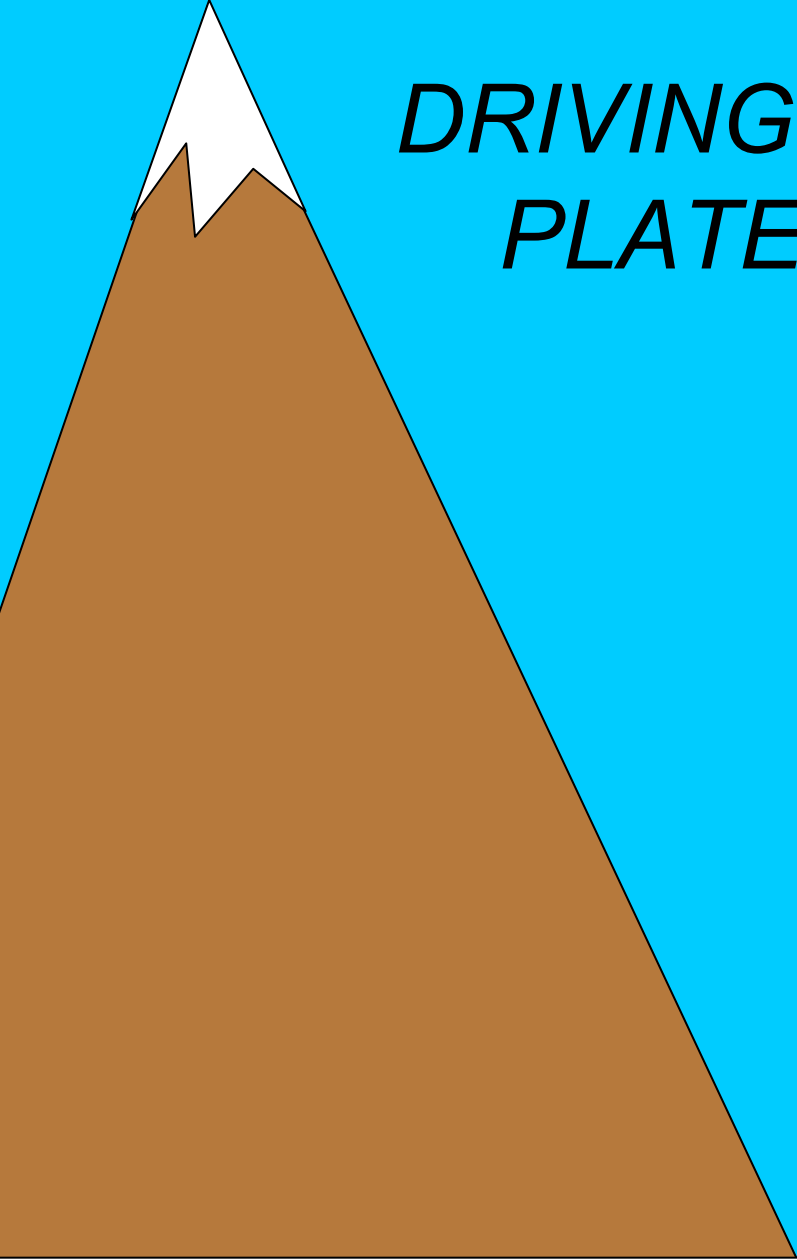
Seafloor spreading what

causes the

What evidence of seafloor

spreading?

*To Be  
Continued...*

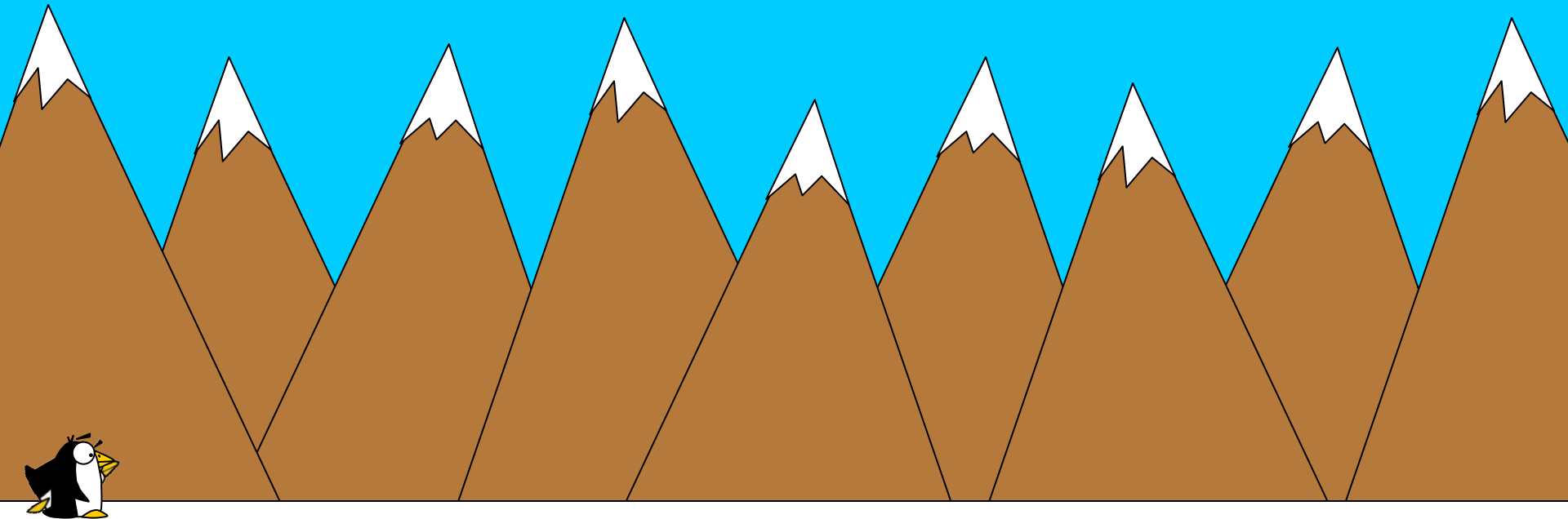


# *DRIVING FORCES OF PLATE Movement*

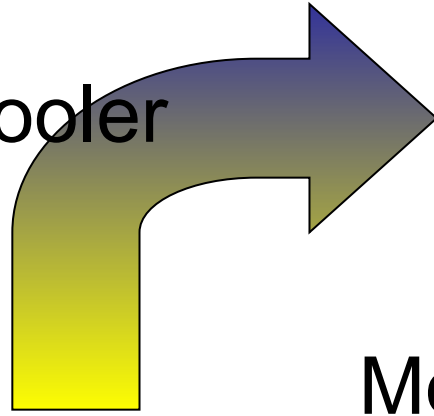
# Convection

Cycle where substances rise and fall because of changes in temperature and density.

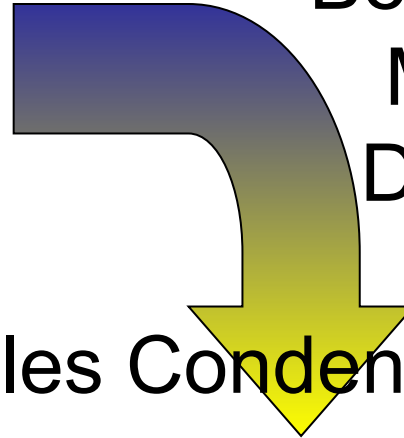
Examples: magma, water,  
air



Gets Cooler

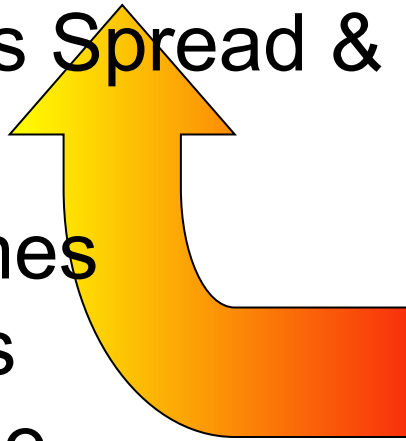


Becomes  
More  
Dense



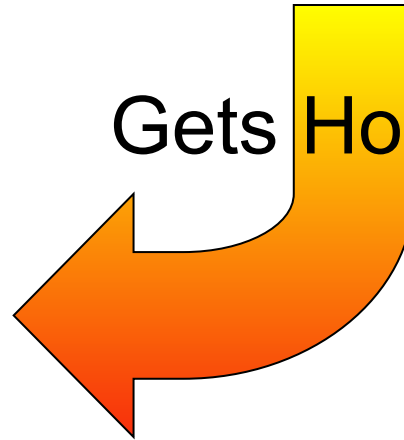
Molecules Condense & Sink

Molecules Spread & Rise

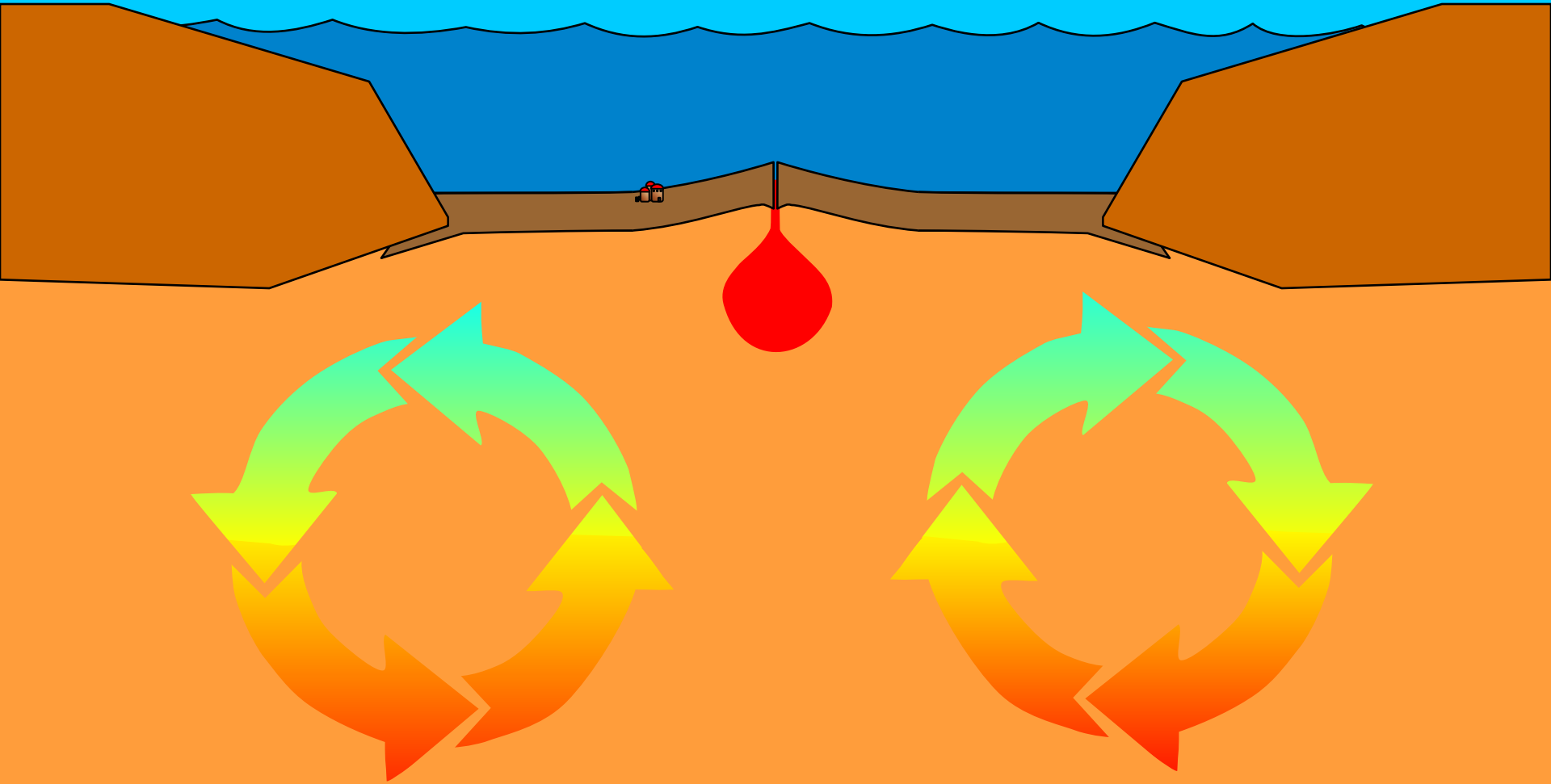


Becomes  
Less  
Dense

Gets Hotter



Convection moves the plates by rolling them along like a conveyor belt



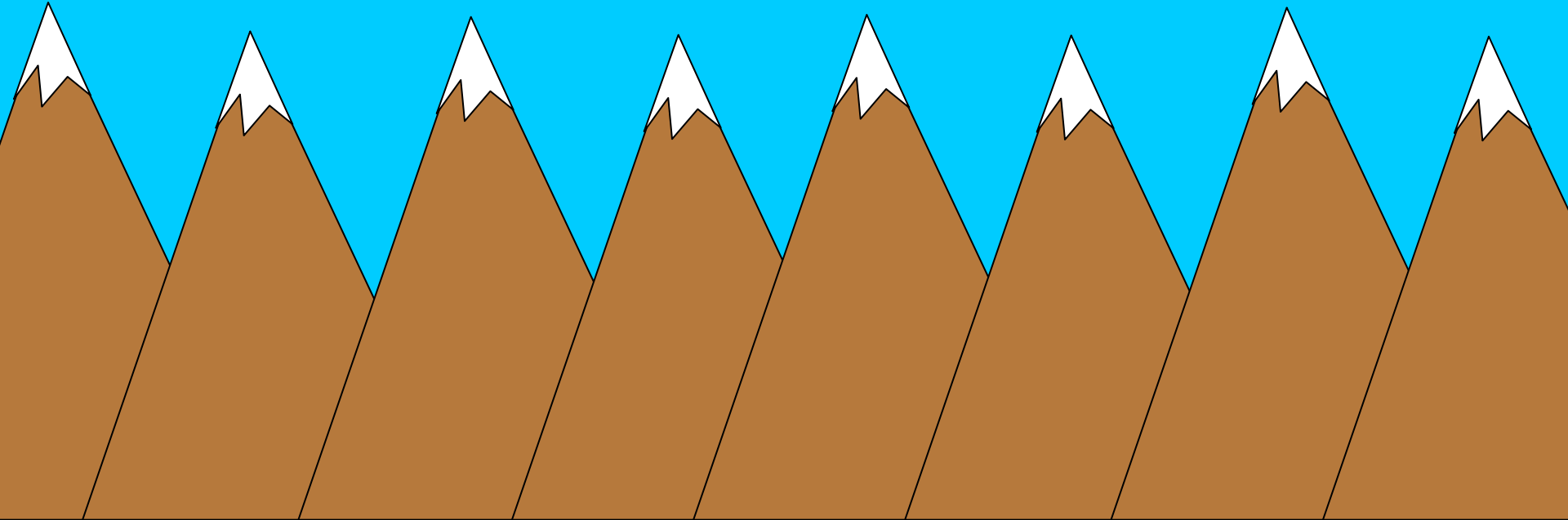
# *DRIVING FORCES OF PLATE Movement*

*1. Convection*

A diagram featuring a brown mountain with a white peak on a blue background. The text '1. Convection' is on the left and 'DRIVING FORCES OF PLATE Movement' is on the right.

# Gravity

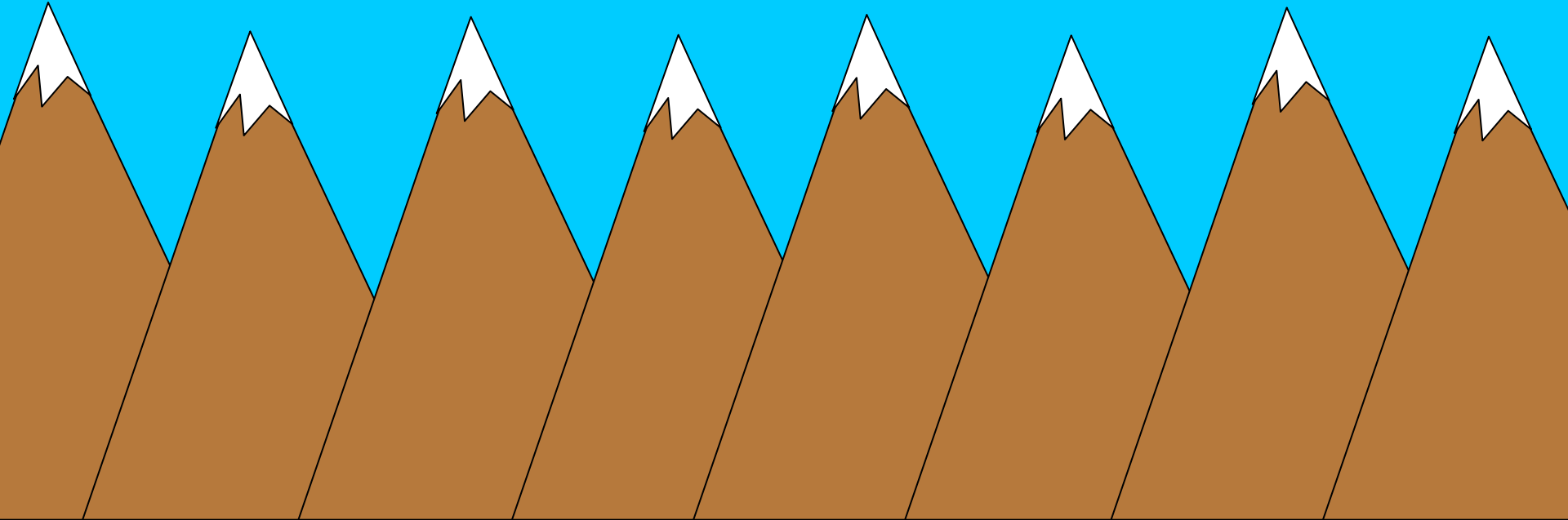
Force that pulls objects towards the Earth



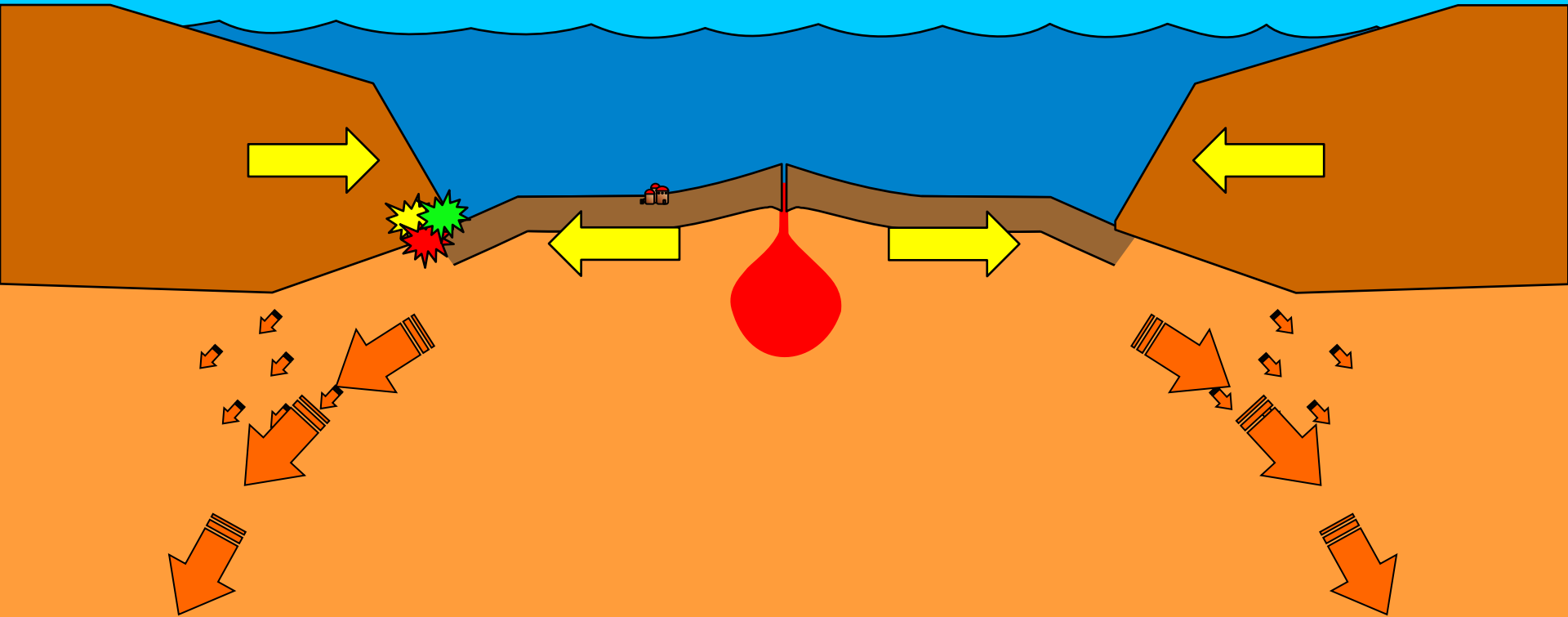


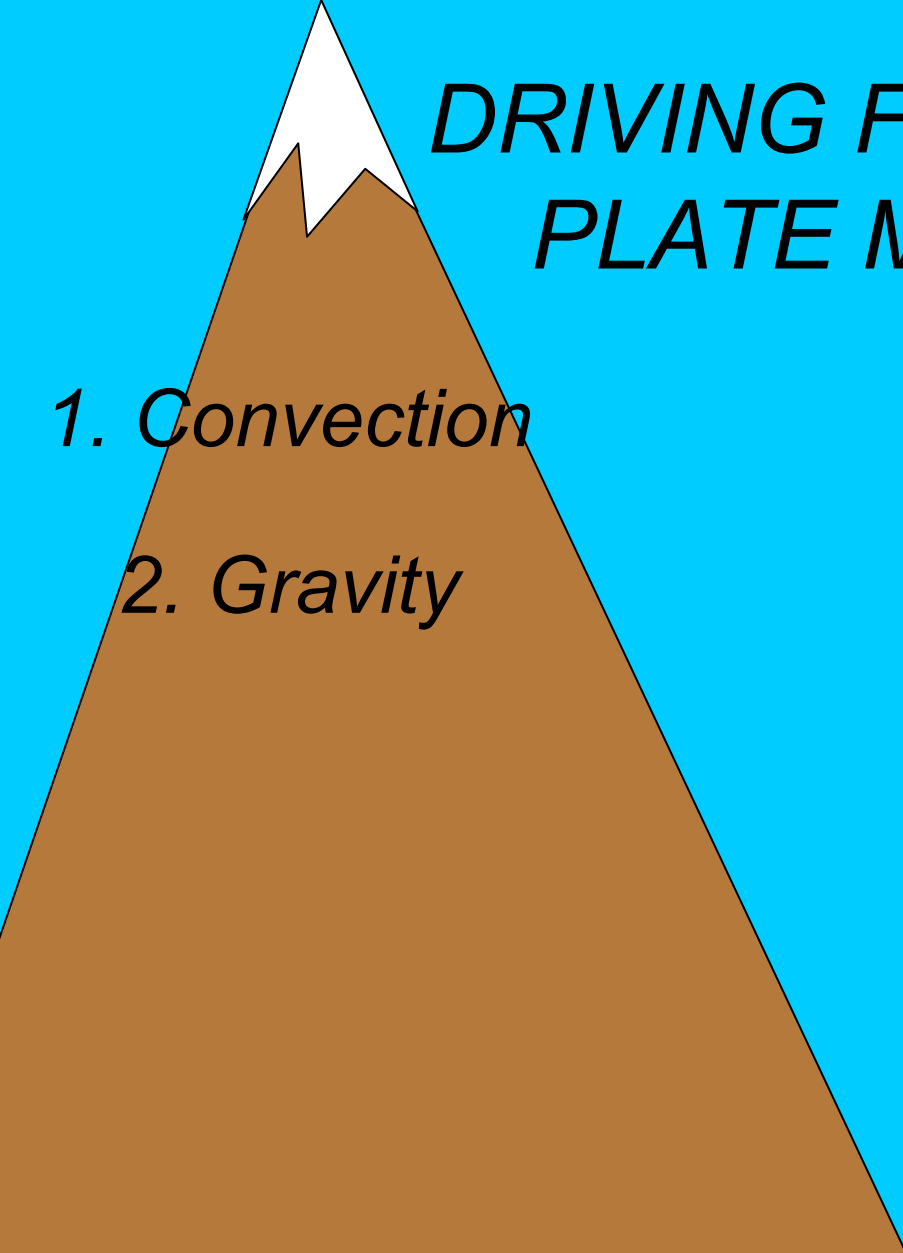
# Gravity

Force that pulls objects towards the Earth



# Gravity moves plates by pulling them down at subduction zones





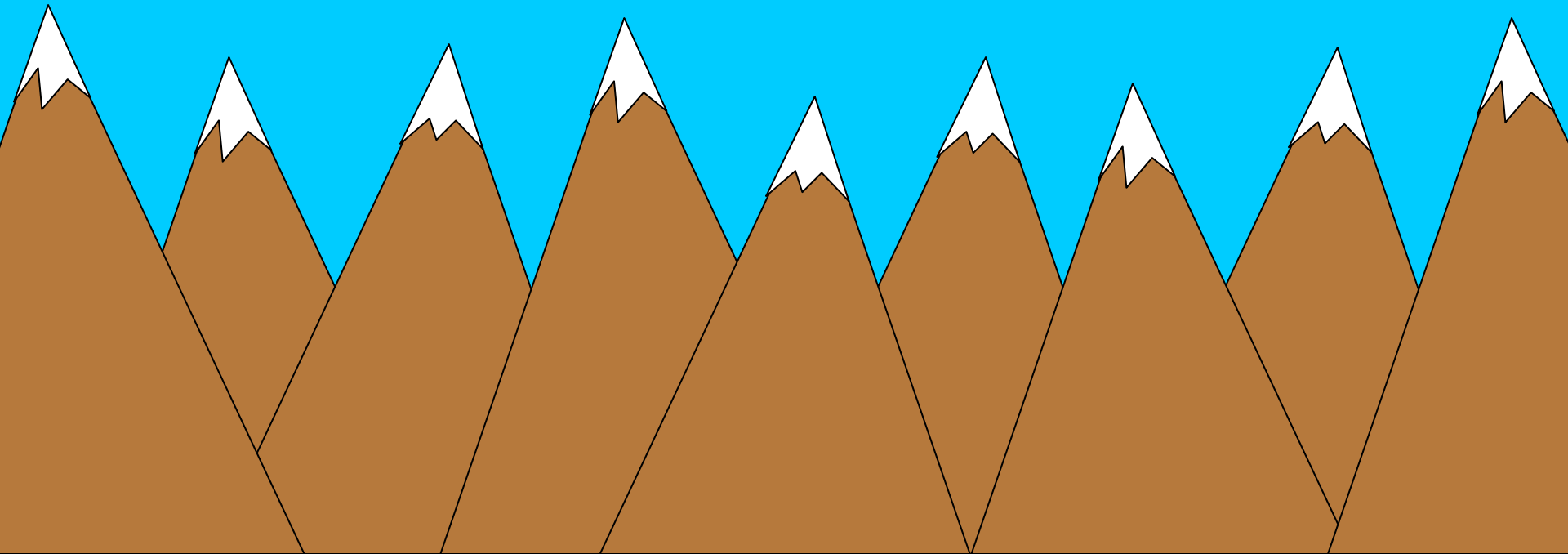
# *DRIVING FORCES OF PLATE Movement*

*1. Convection*

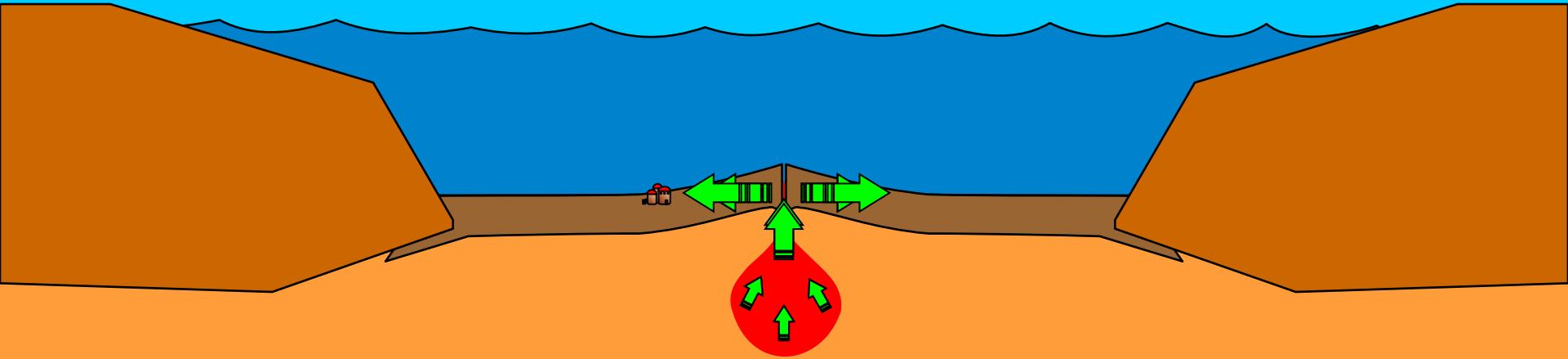
*2. Gravity*

# Pressure

Force that pushes outward  
against the space around it



Pressure moves the plates as rising magma pushes at the mid-ocean ridge.



*DRIVING FORCE*

Let's...

*Draw a  
diagram!*

Str

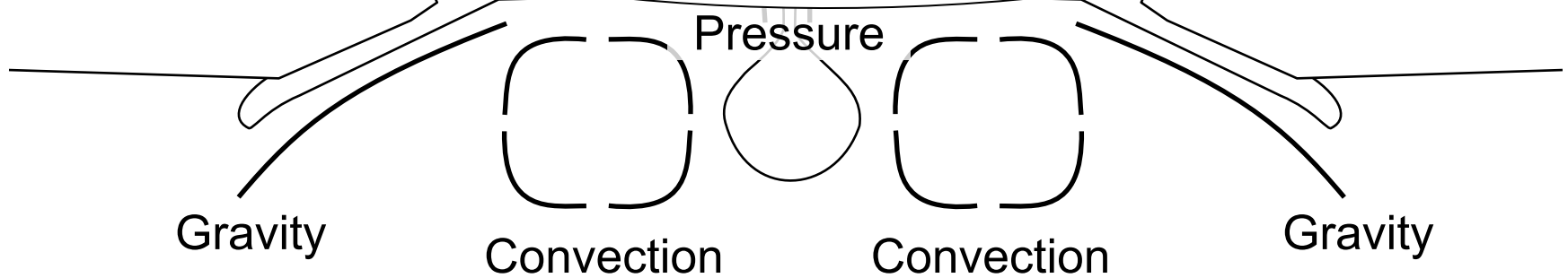
Still strong →

*2. Gravity*

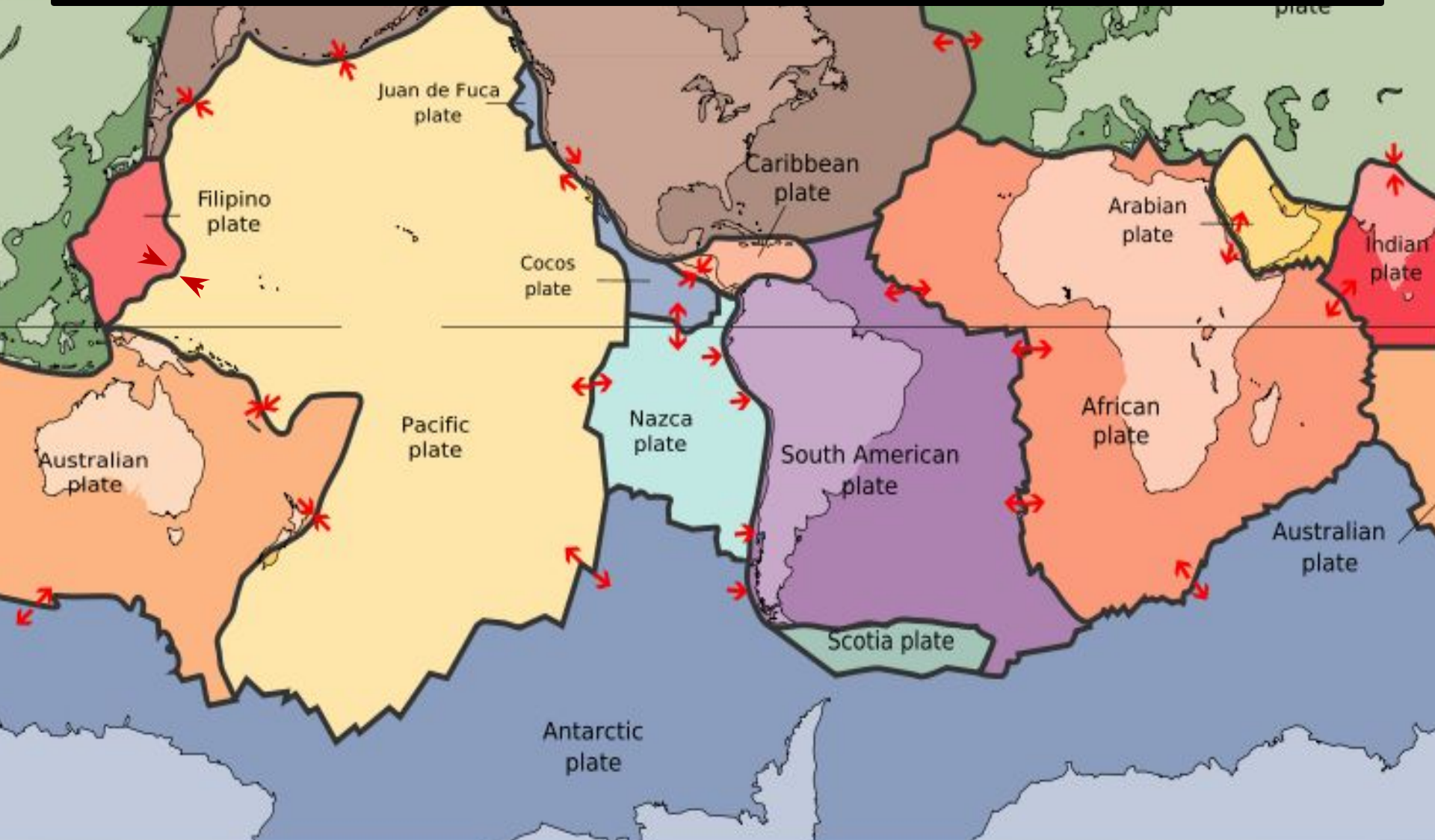
Kind of weak →

*3. Pressure*

Finally, we're ready  
to learn about...  
***PLATE TECTONICS!***



Earth's outer shell is broken up into chunks called "Plates"

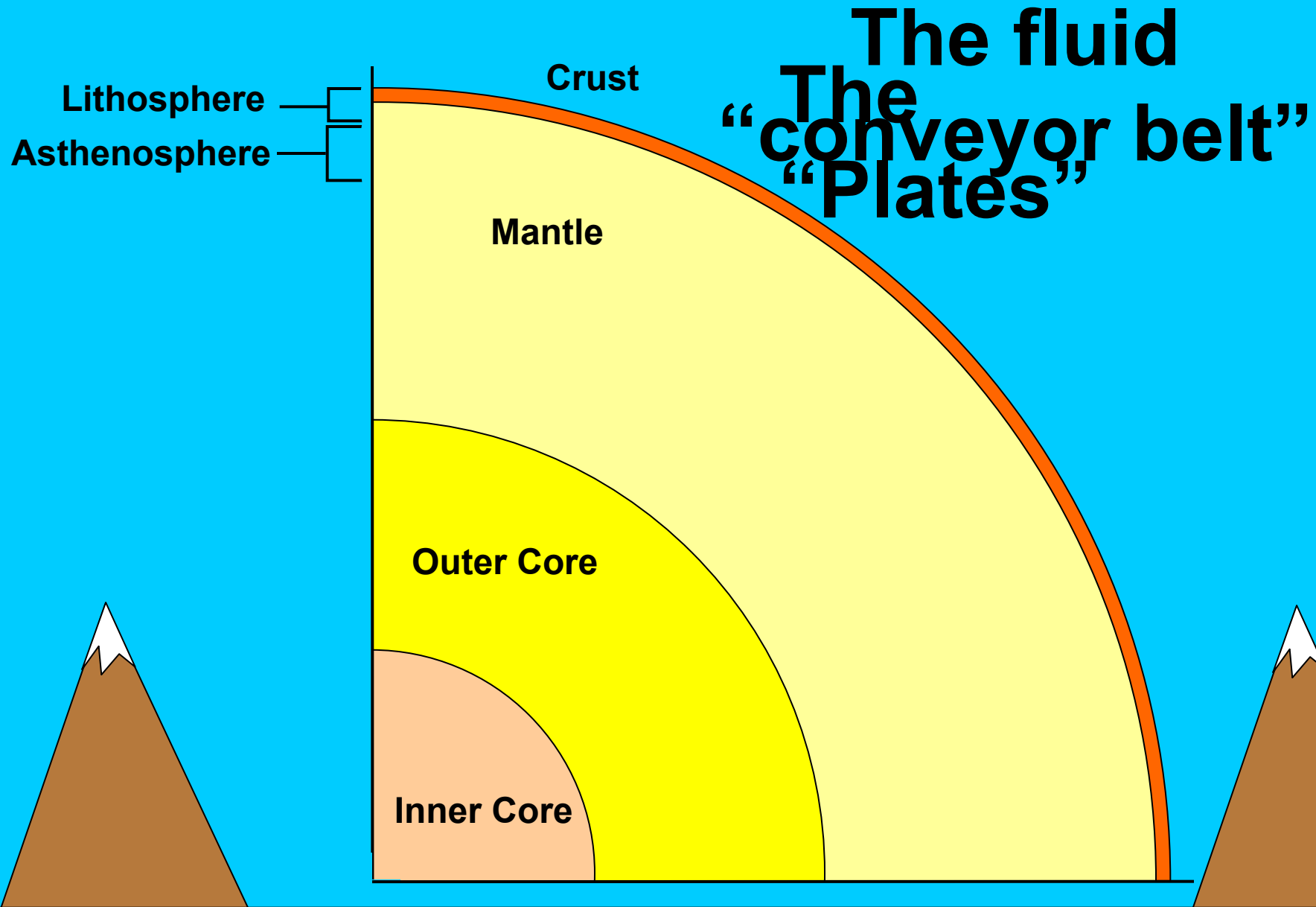


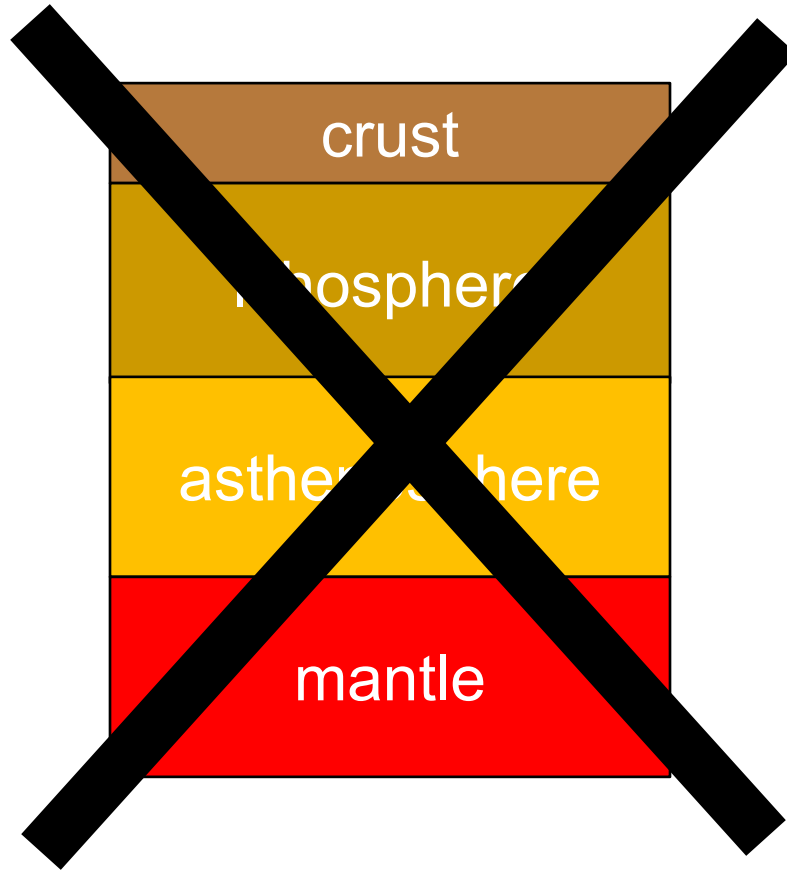


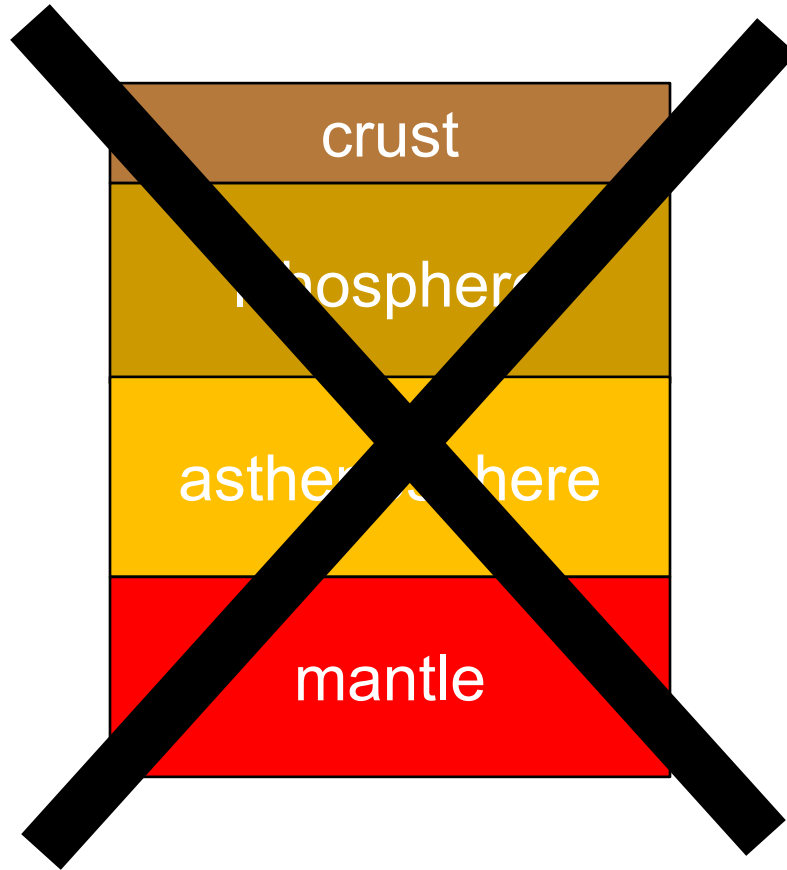
# Plate Tectonics

The theory describing how Earth's plates move and what happens when they interact with each other.









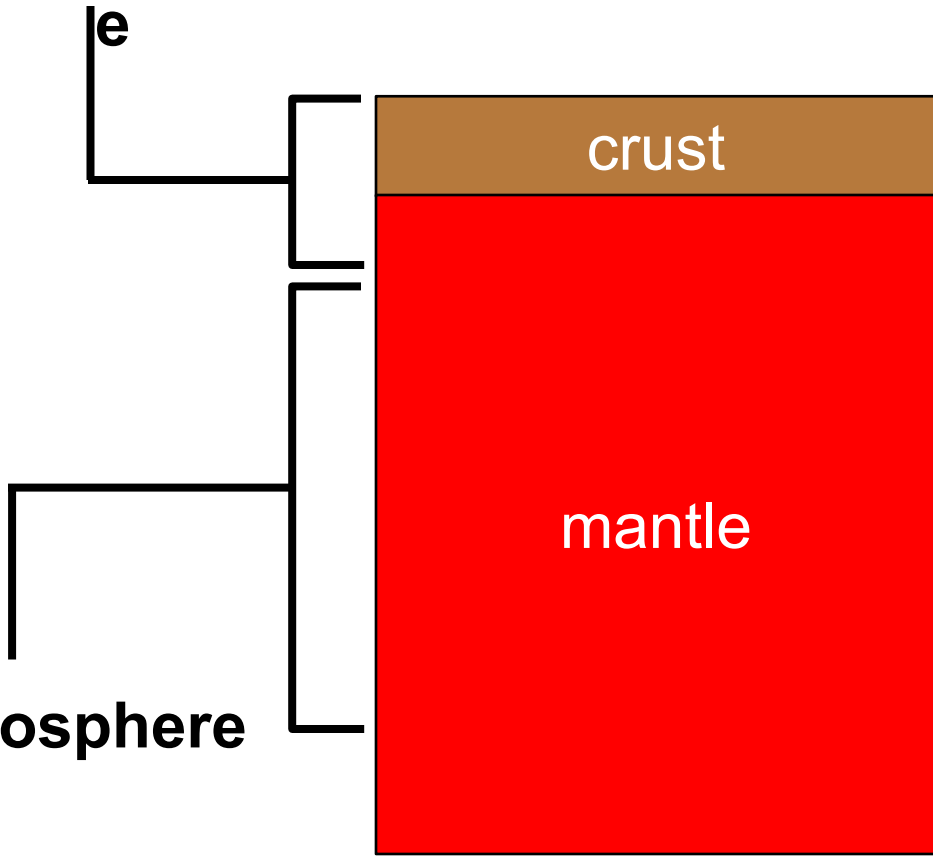
**Lithosphere**

**e**

**crust**

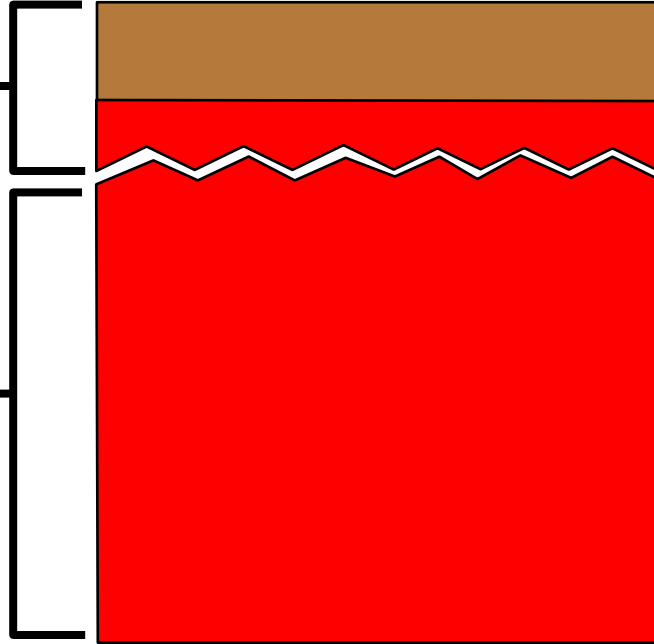
**mantle**

**Asthenosphere**

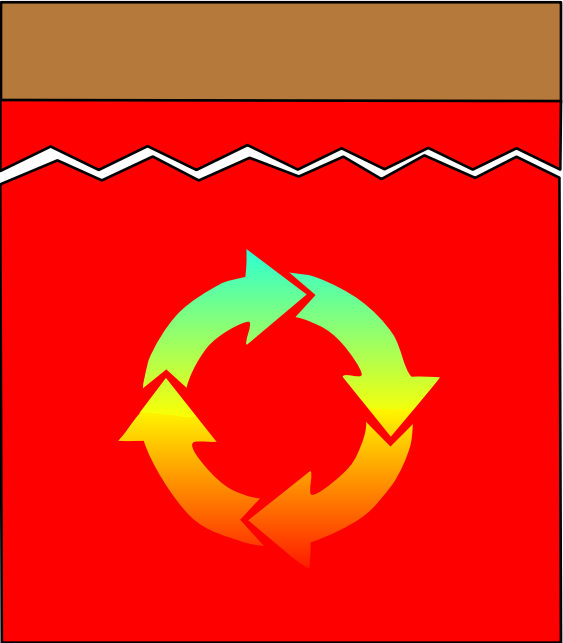


**Lithosphere**

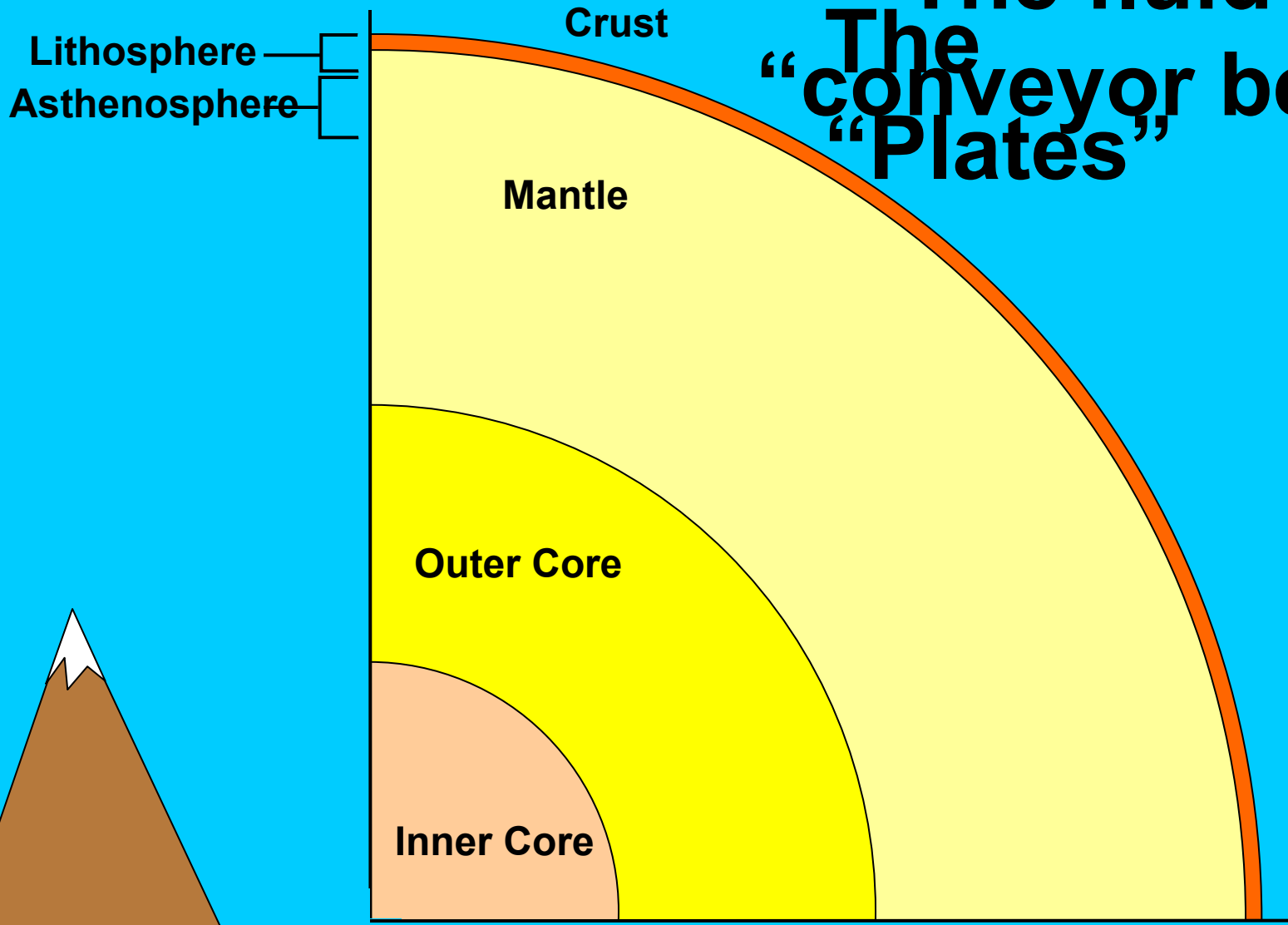
e



**Asthenosphere**



**The fluid  
“conveyor belt”  
“Plates”**

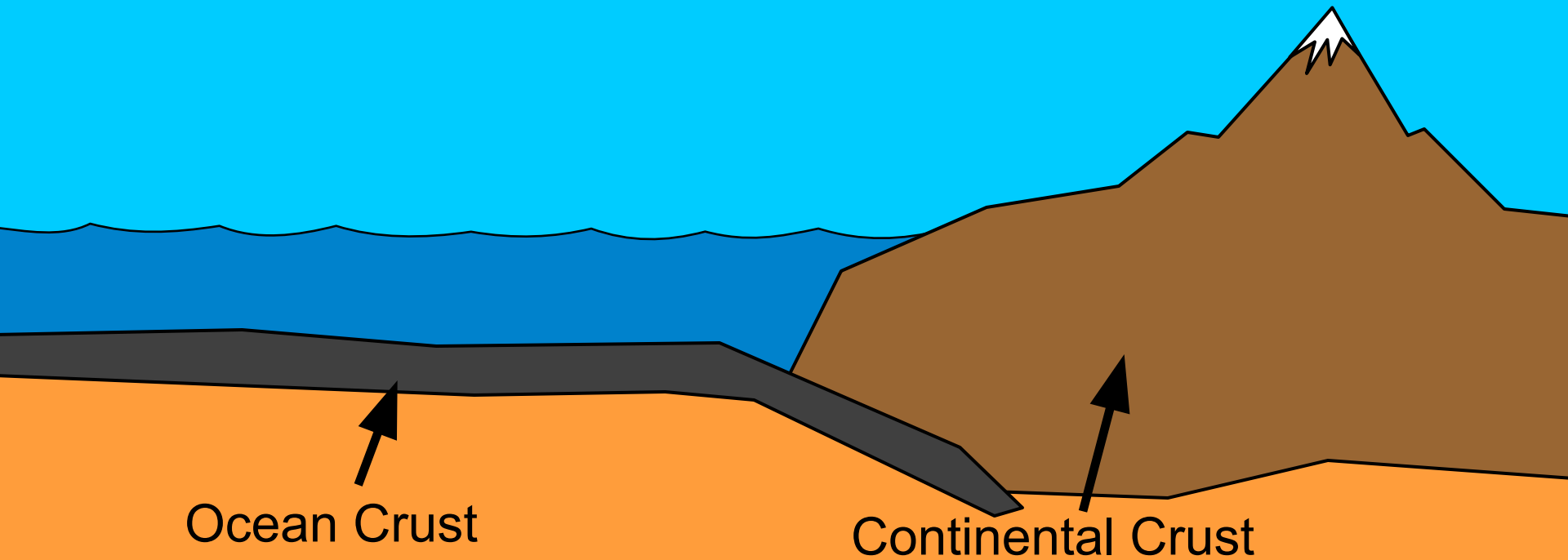




# Two kinds of crust

Ocean Crust

Continental Crust

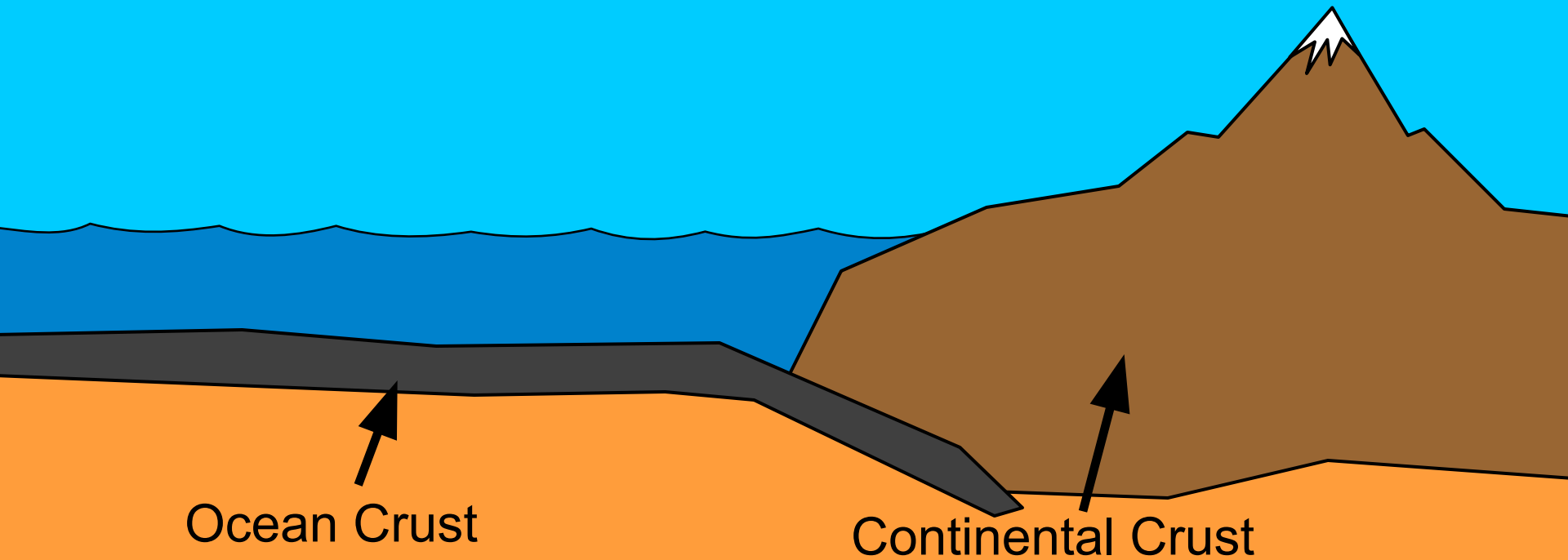


# Ocean Crust

Thinner  
More  
Dense  
Younger

# Continental Crust

Thicker  
Less  
Dense  
Older



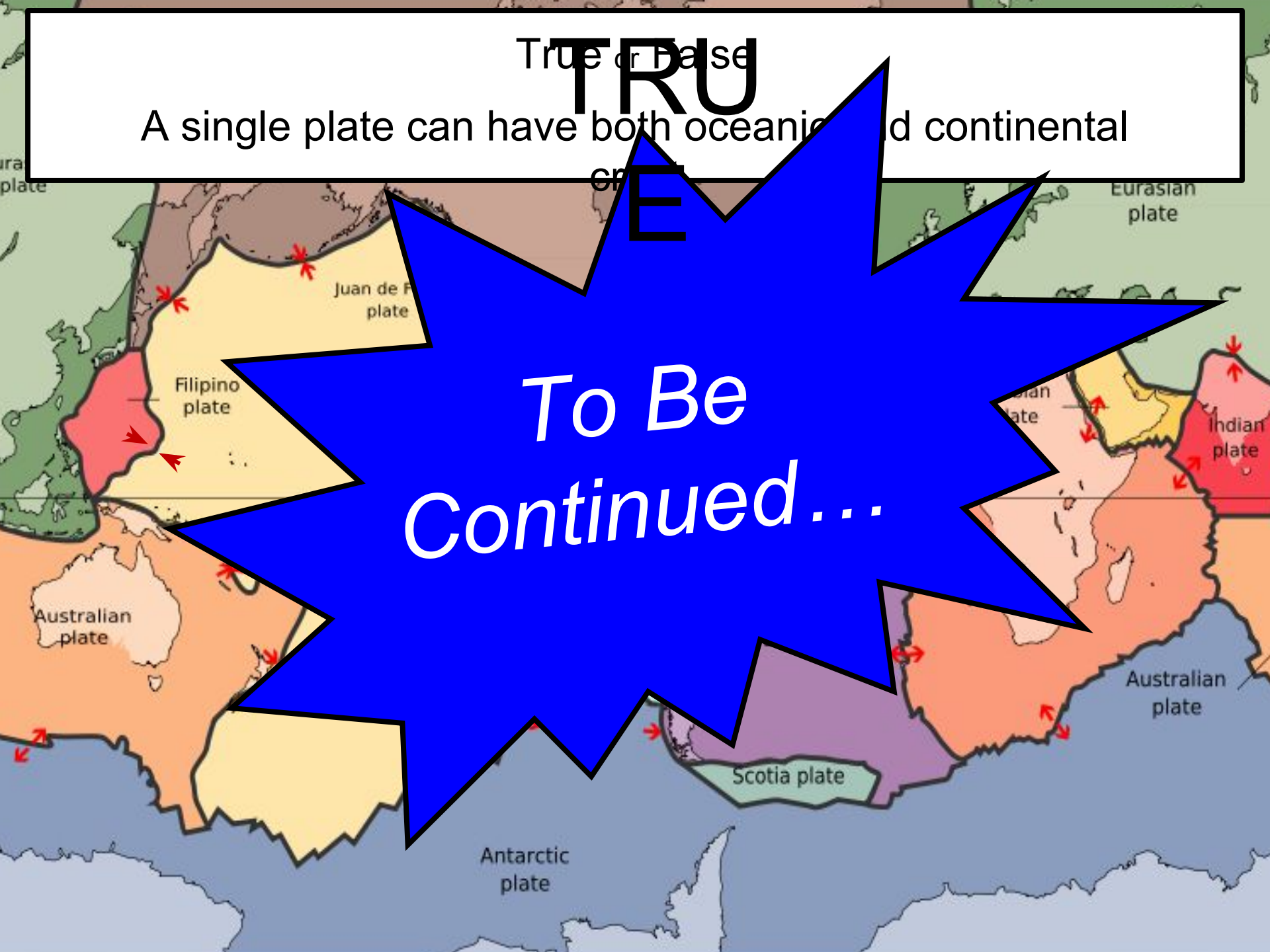
True or False

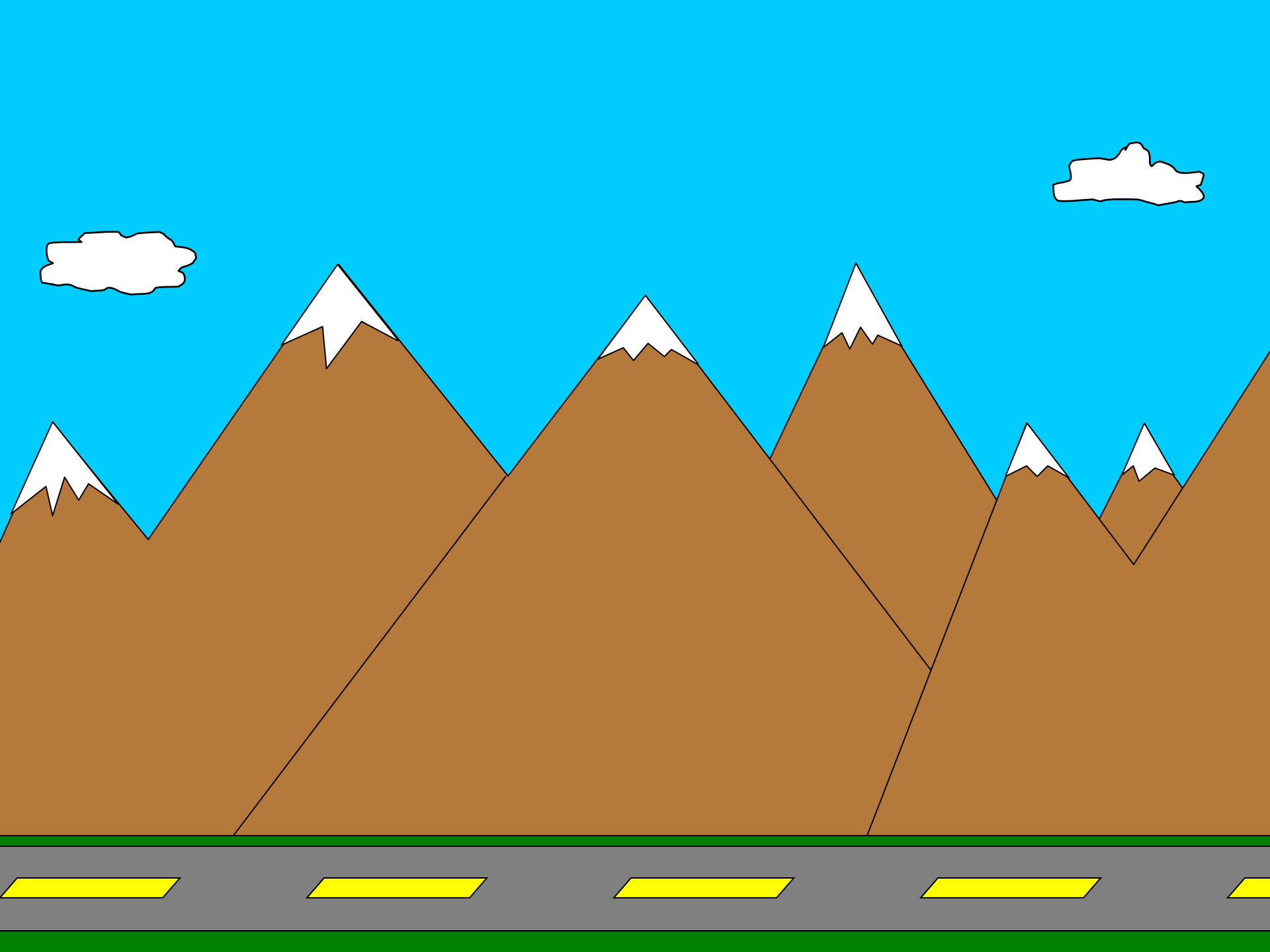
TRUE

A single plate can have both oceanic and continental crust

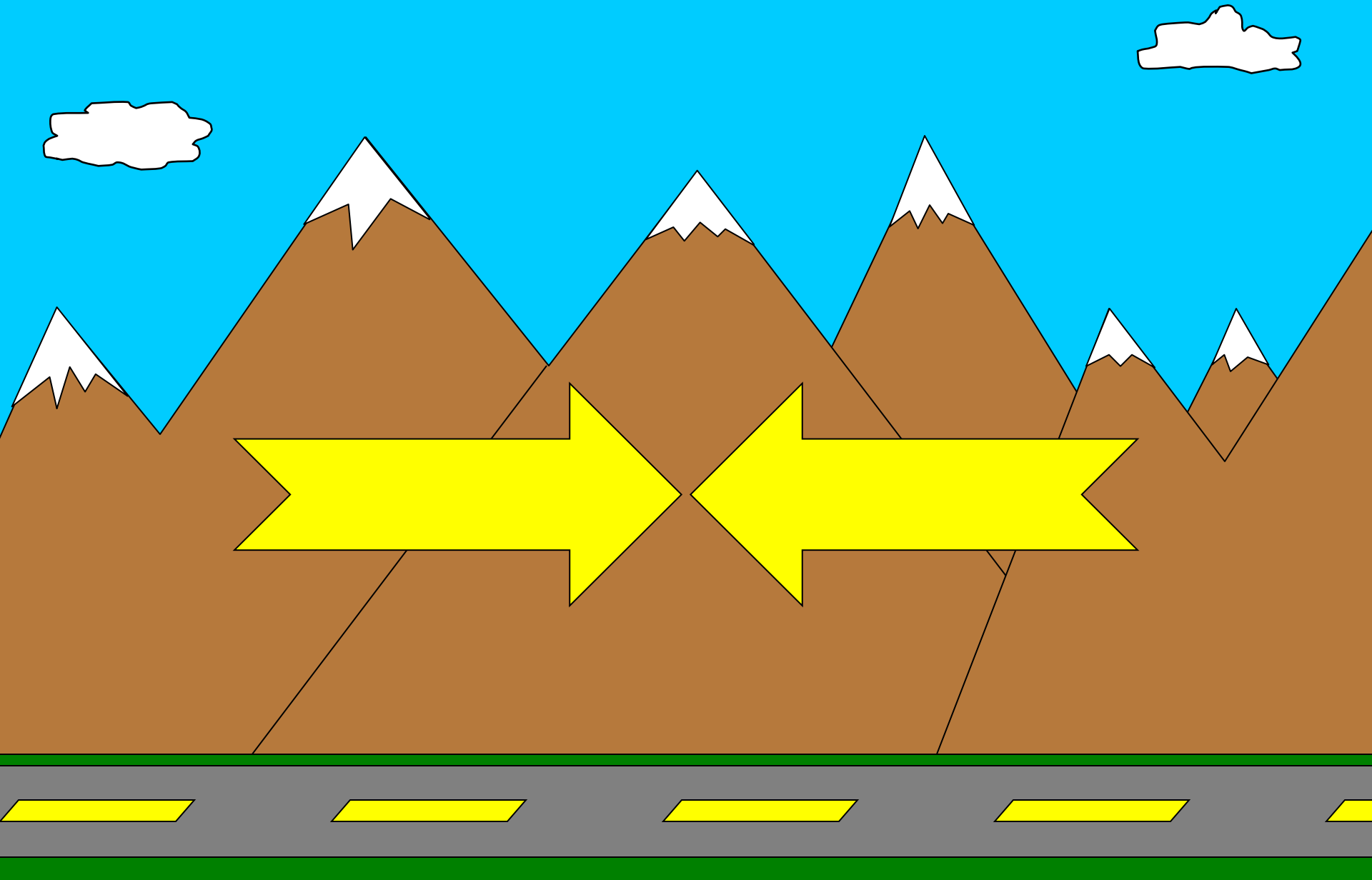
FALSE

To Be Continued...

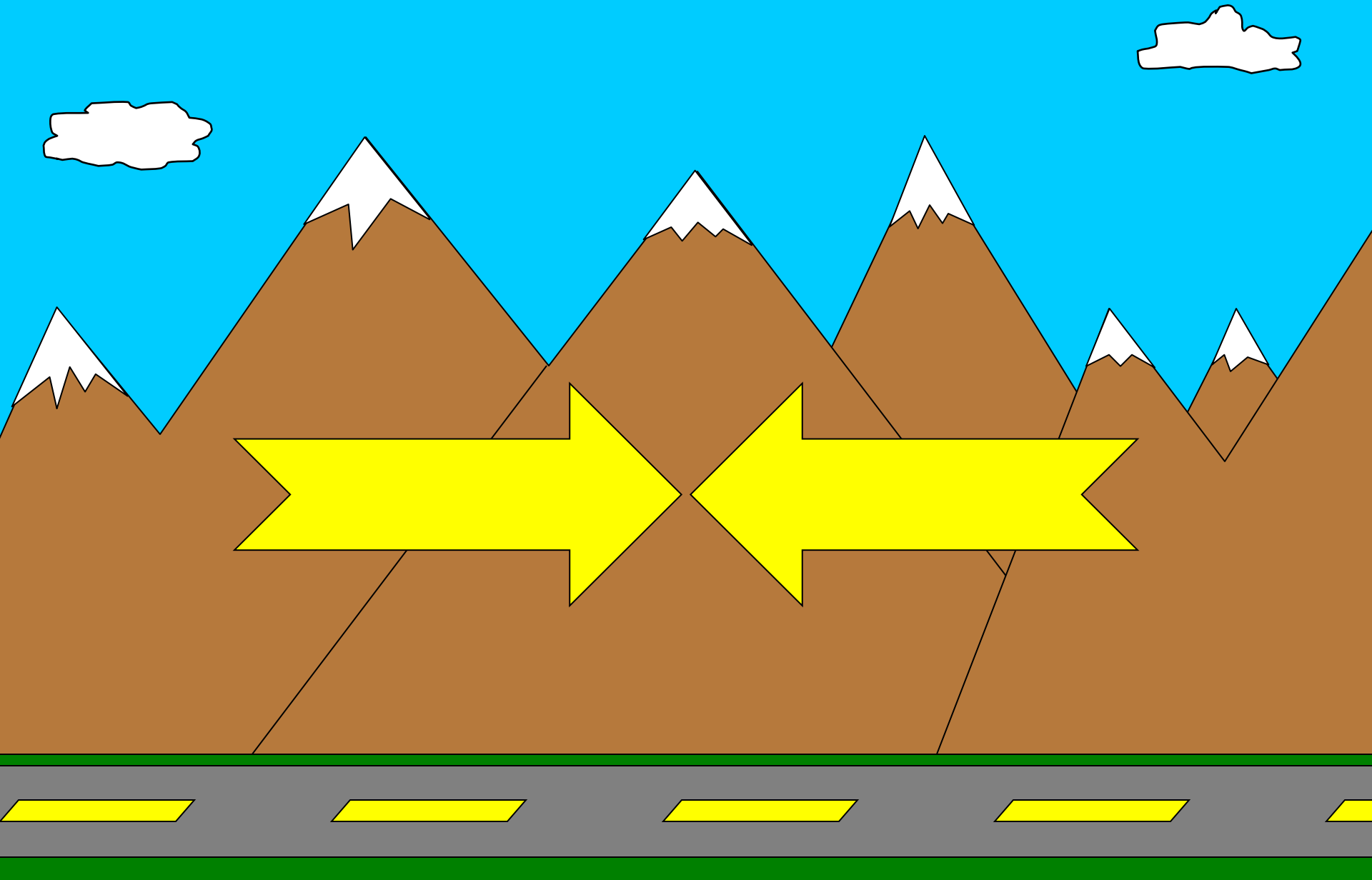




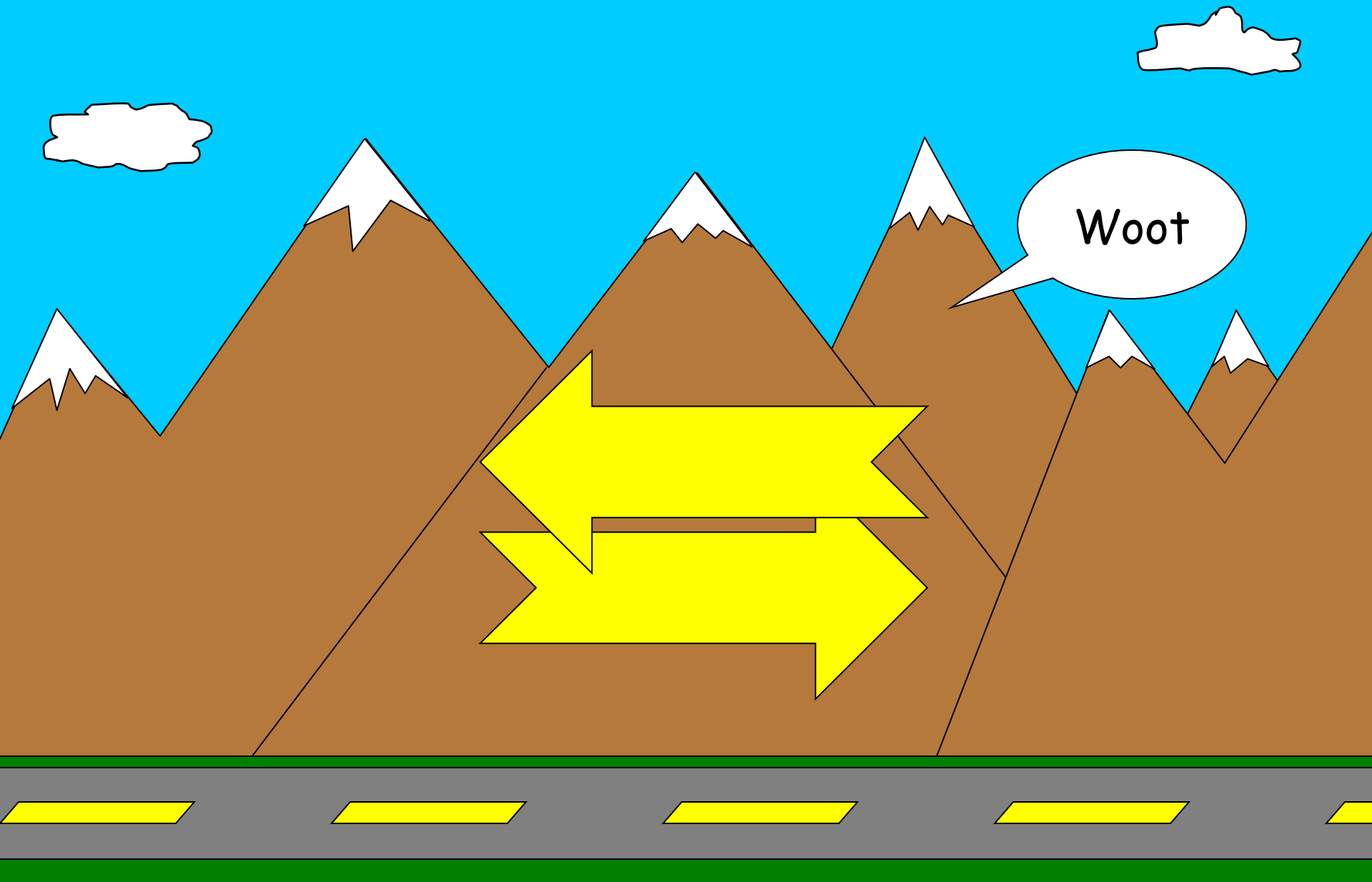
# Three types of plate boundaries



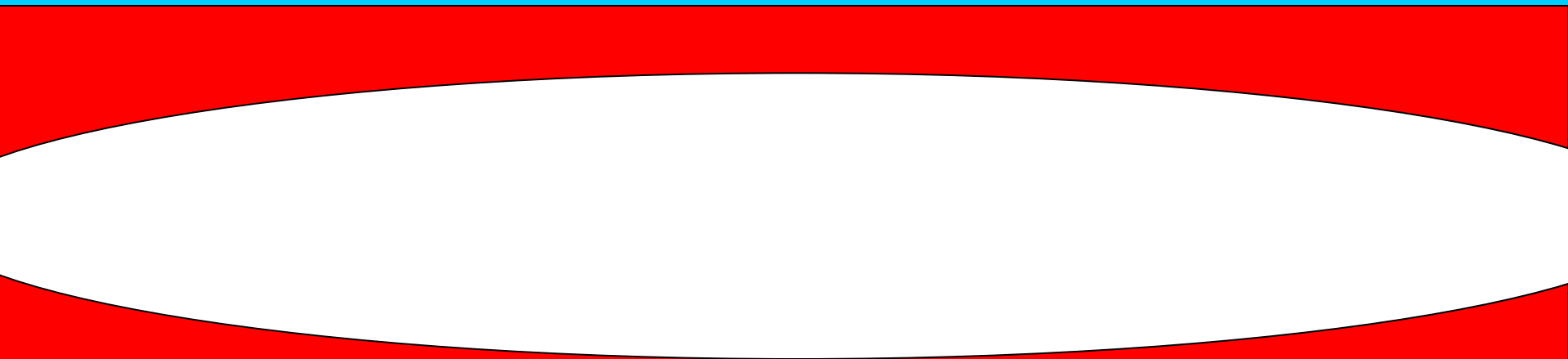
# Three types of plate boundaries



# Three types of plate boundaries



# Convergent





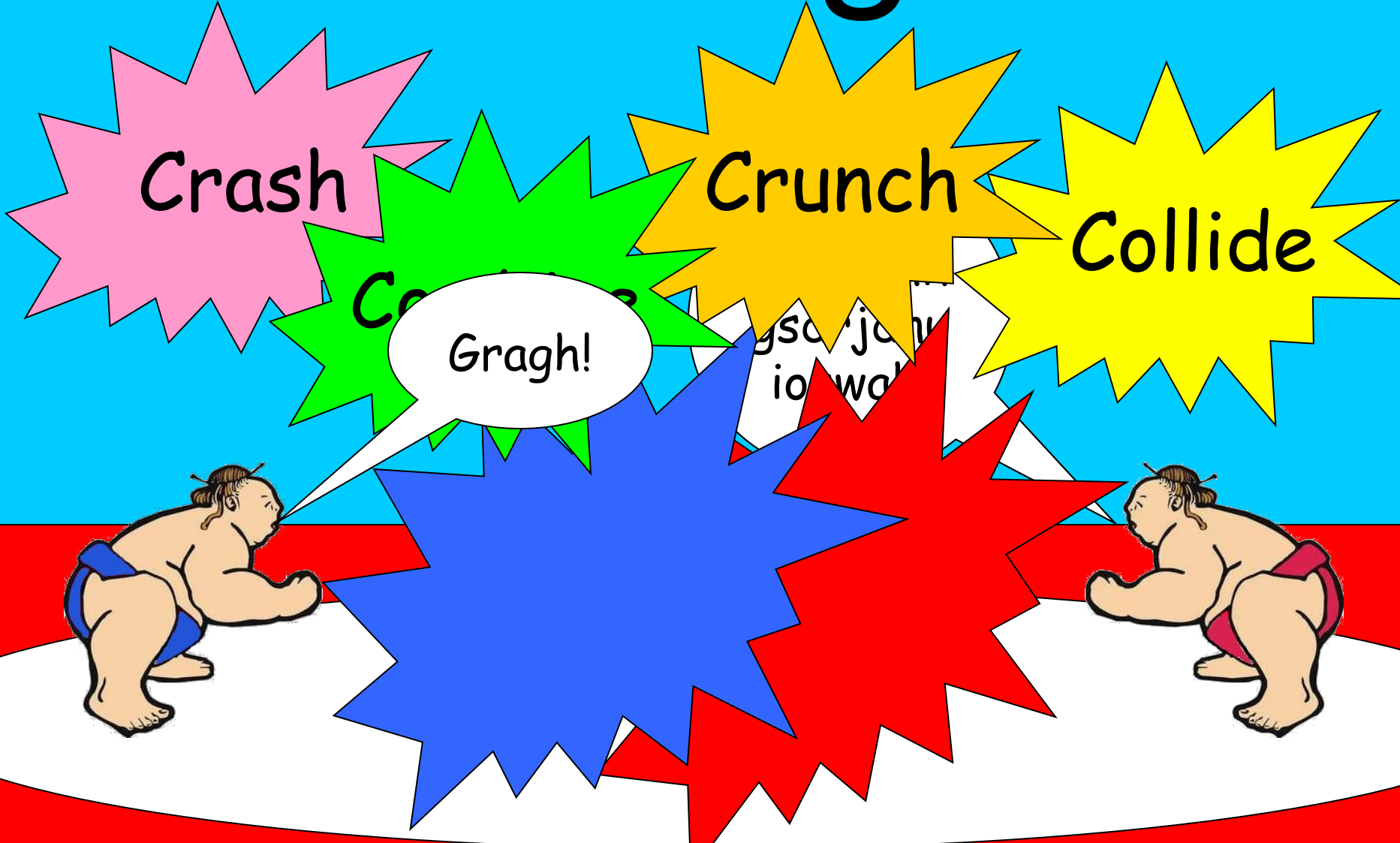
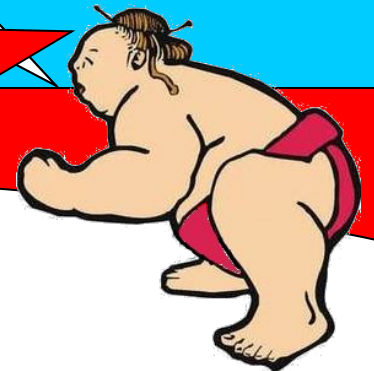
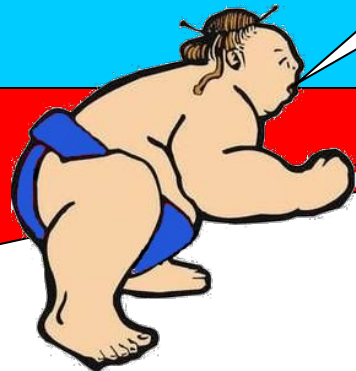
# “C”ostværgse for

Crash

Crunch

Collide

Gragh!



# Convergent

The plates crash together

Three Kinds:

Forms different  
stuff depending  
on which type of  
collision you  
have

Land

vs

Land

Land

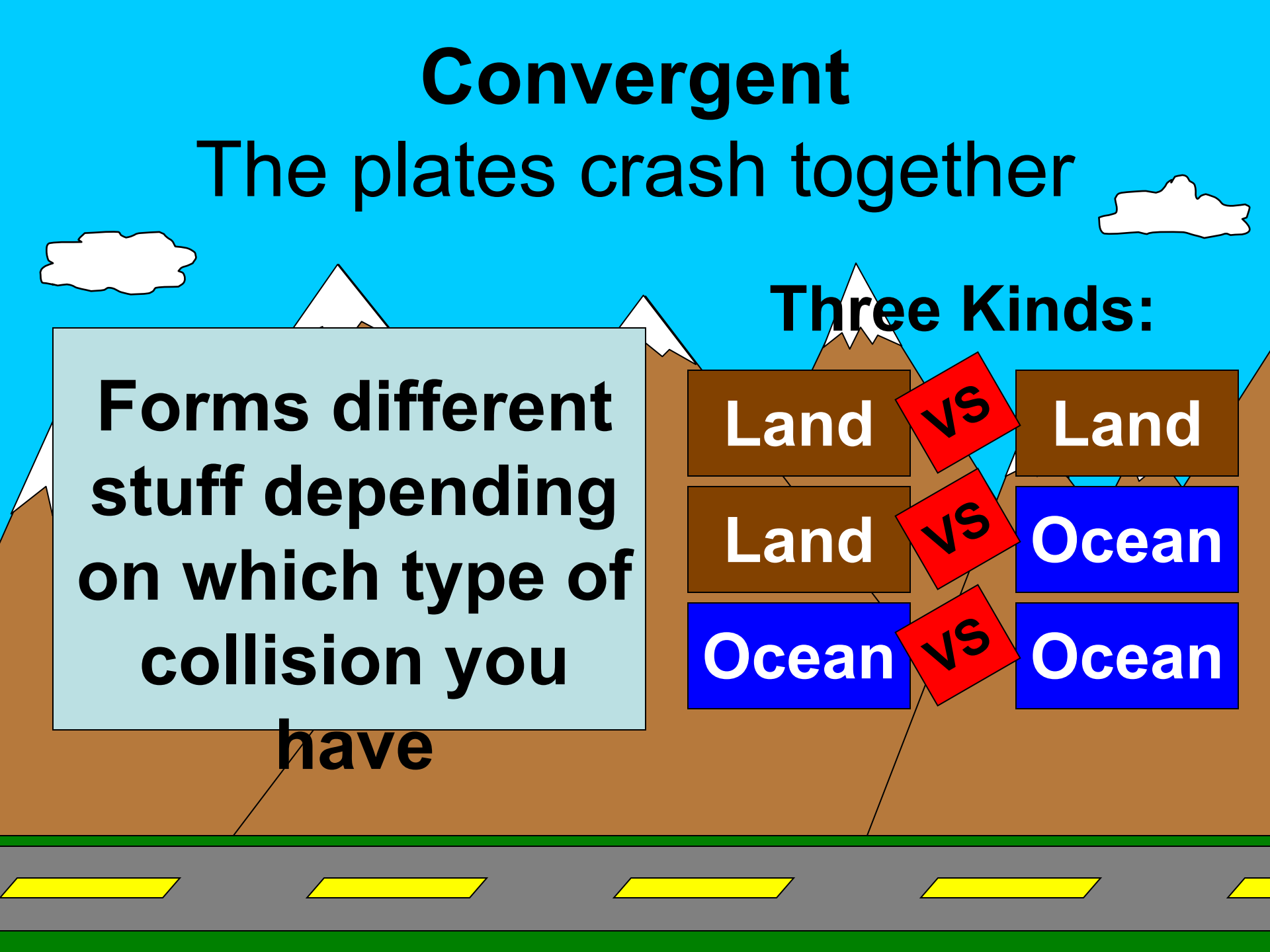
vs

Ocean

Ocean

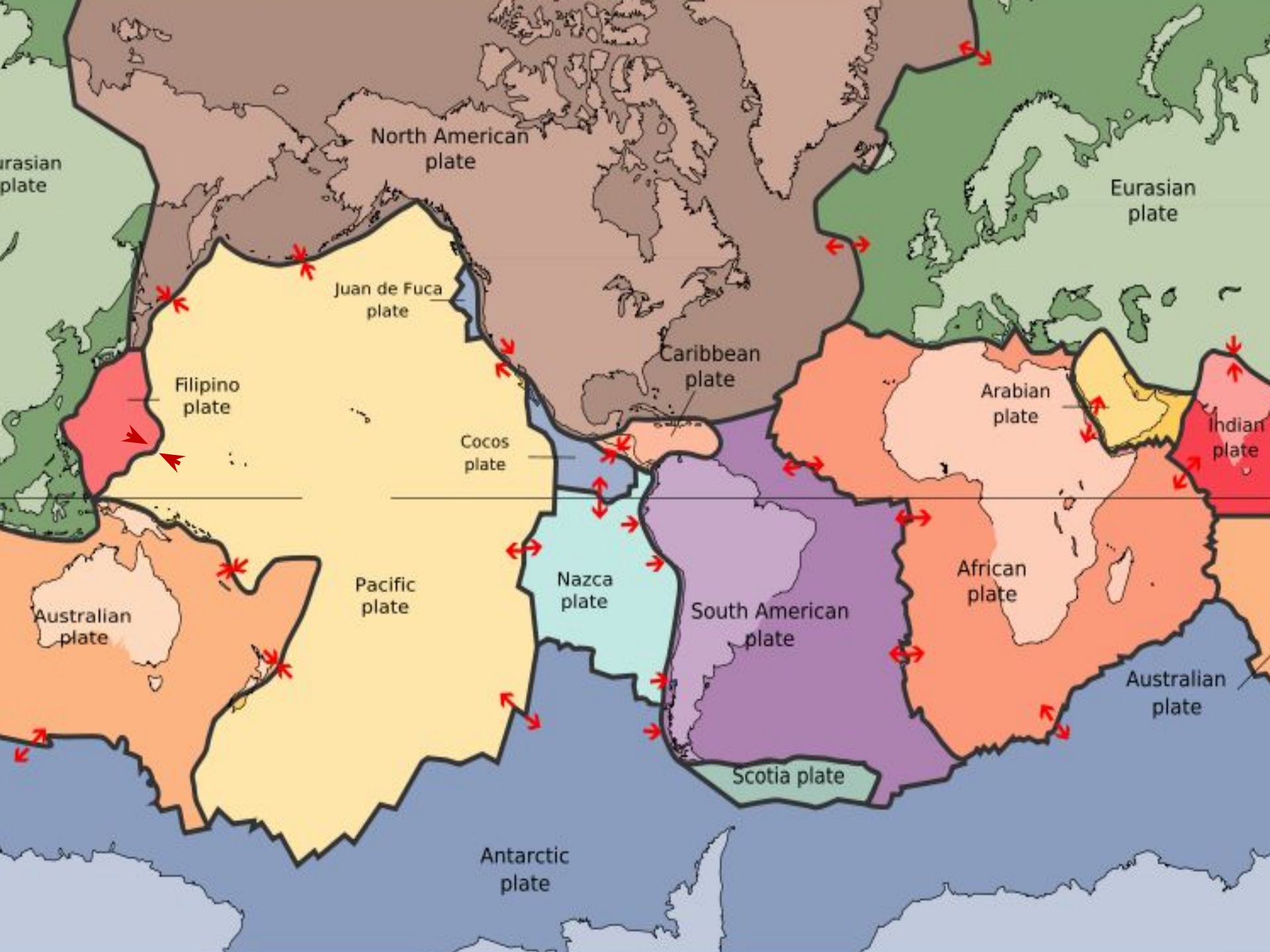
vs

Ocean

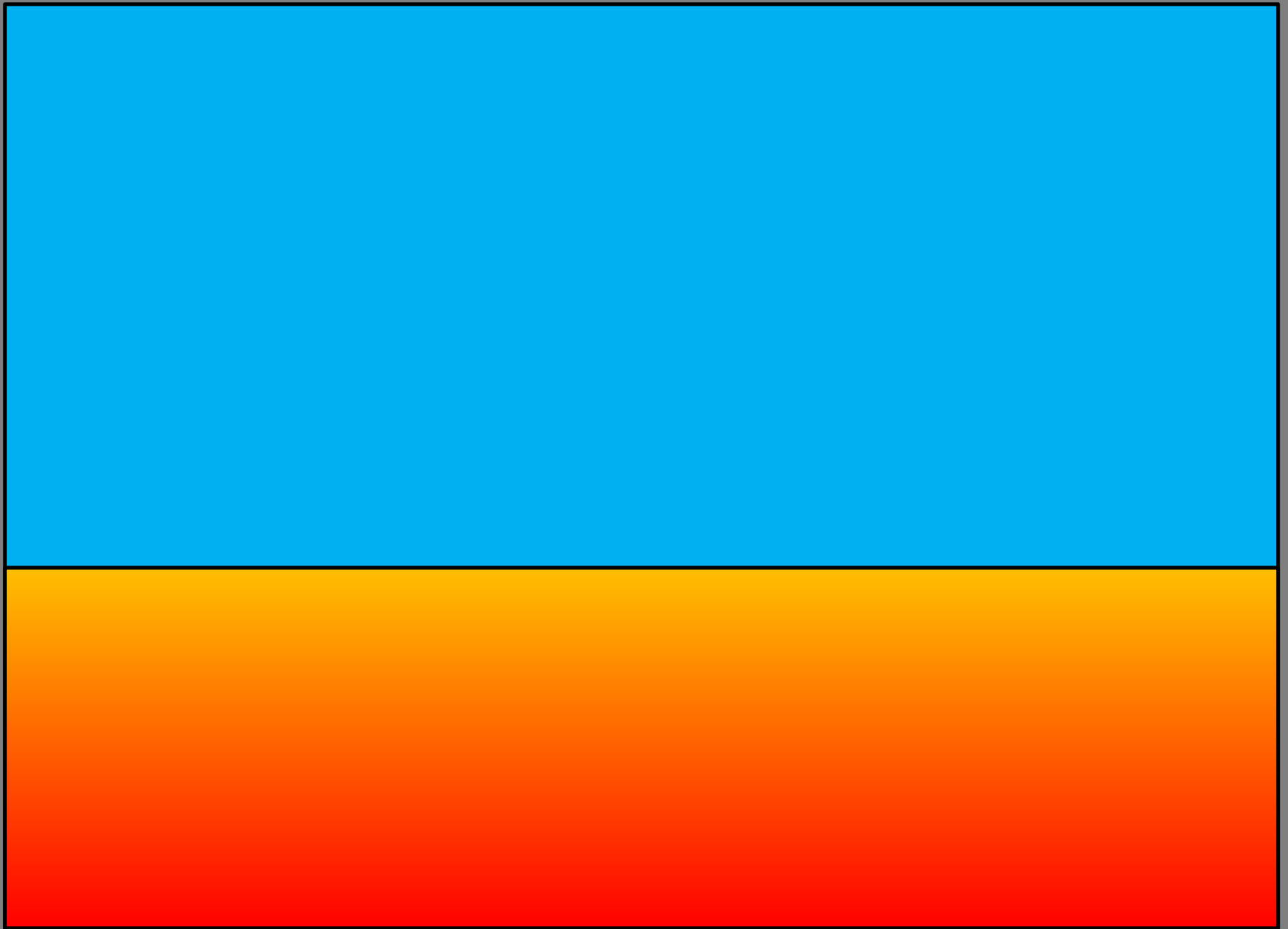


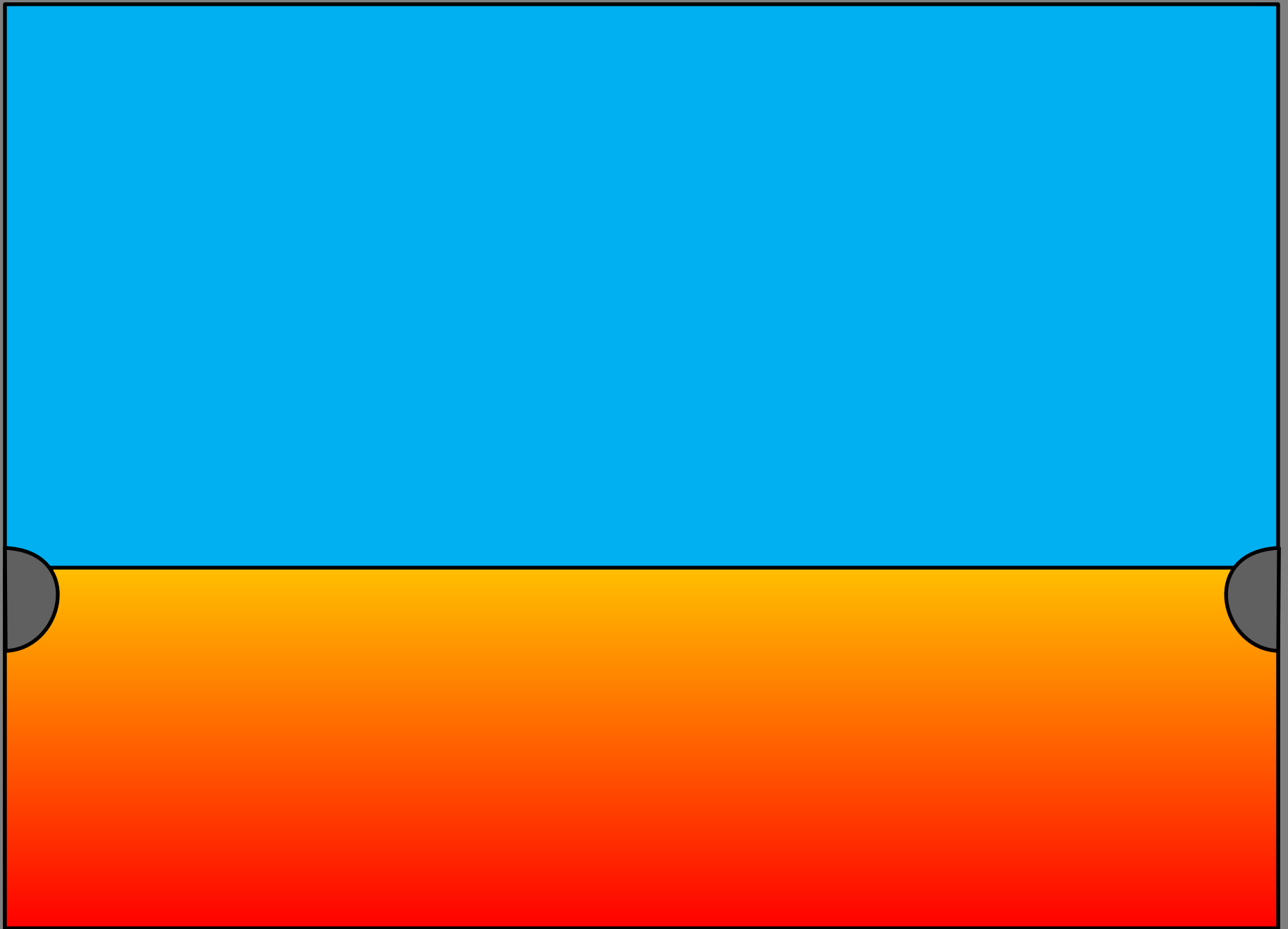
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust		

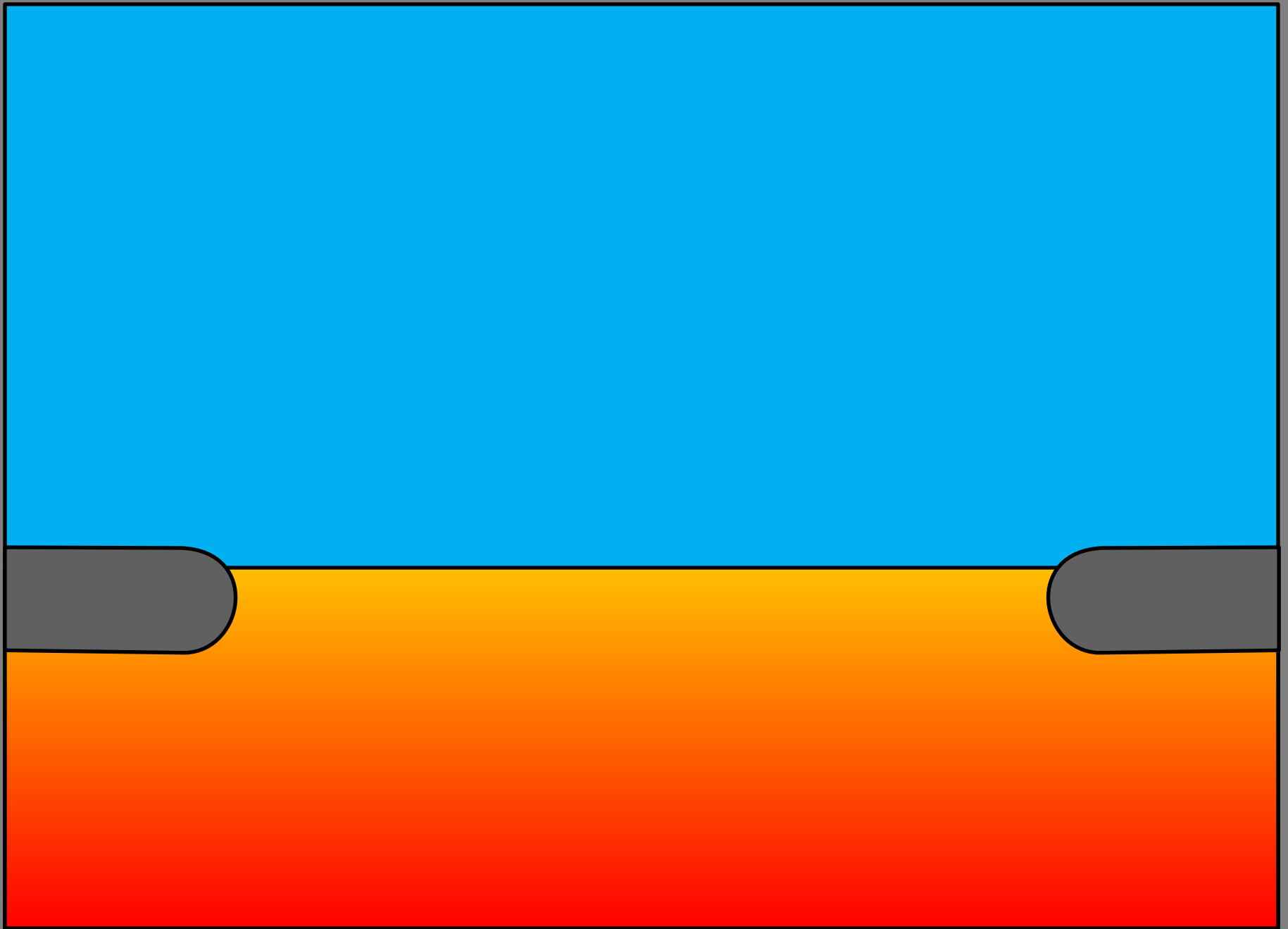
Continental crust collides with continental crust



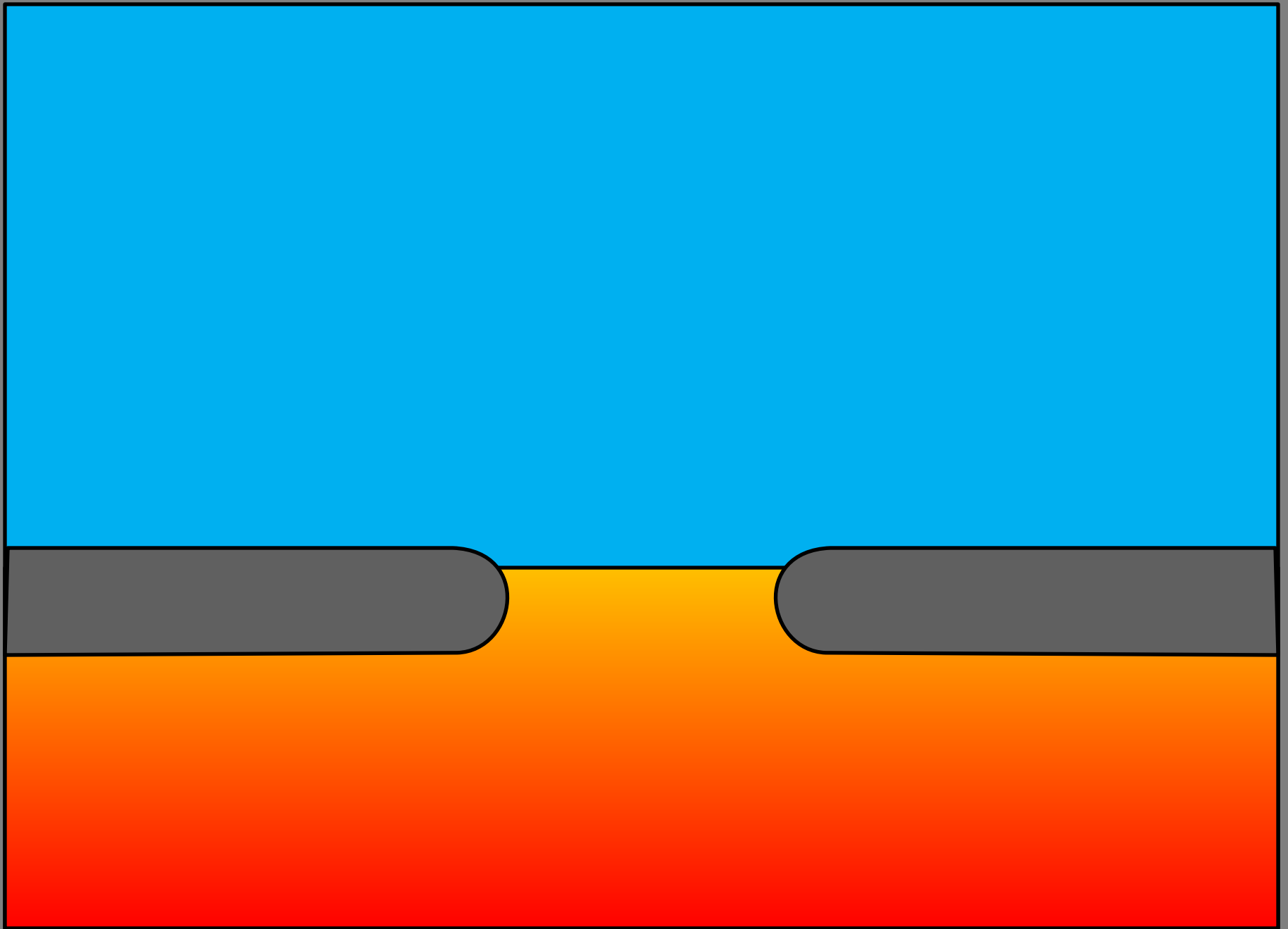
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust		

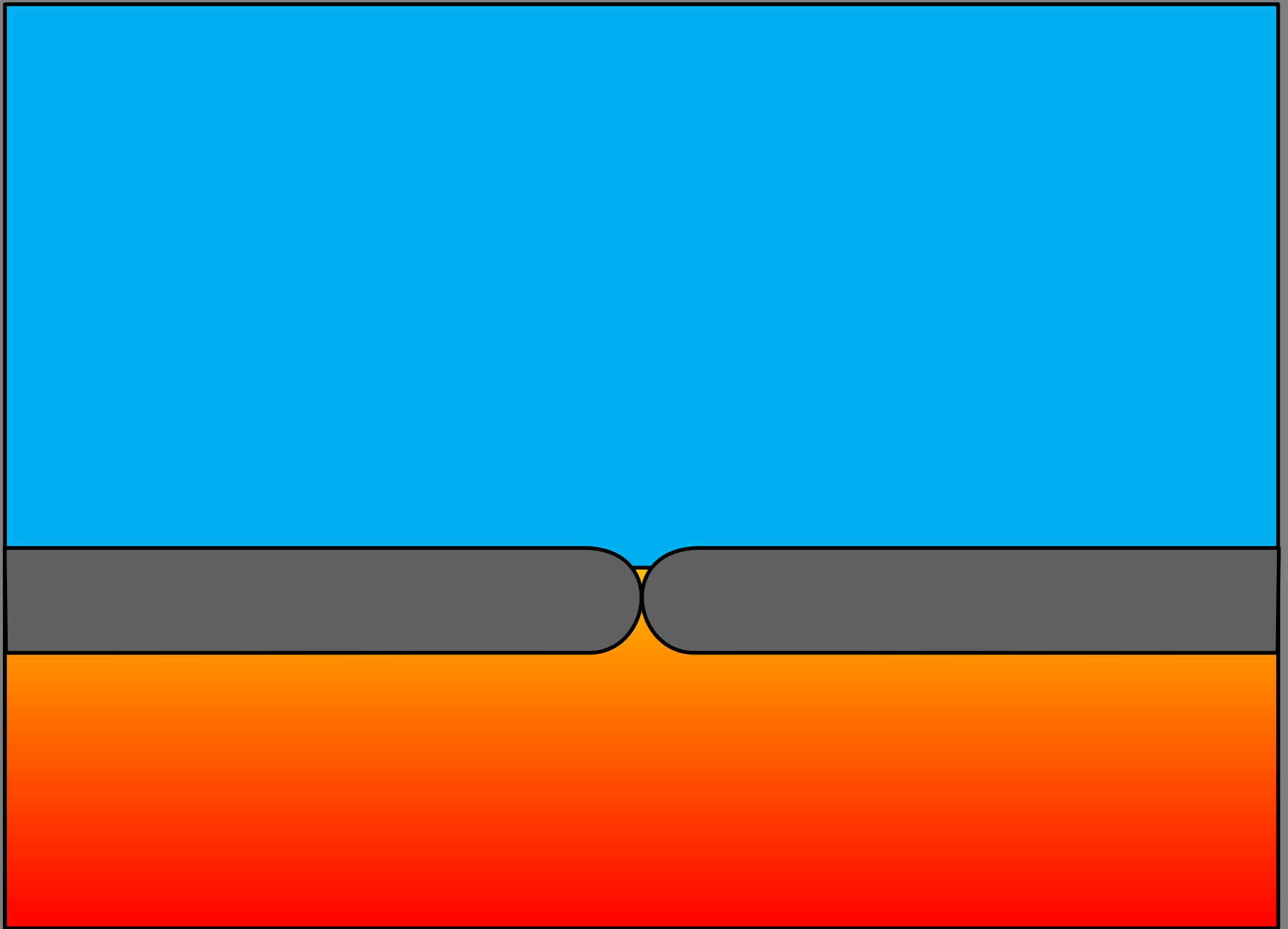


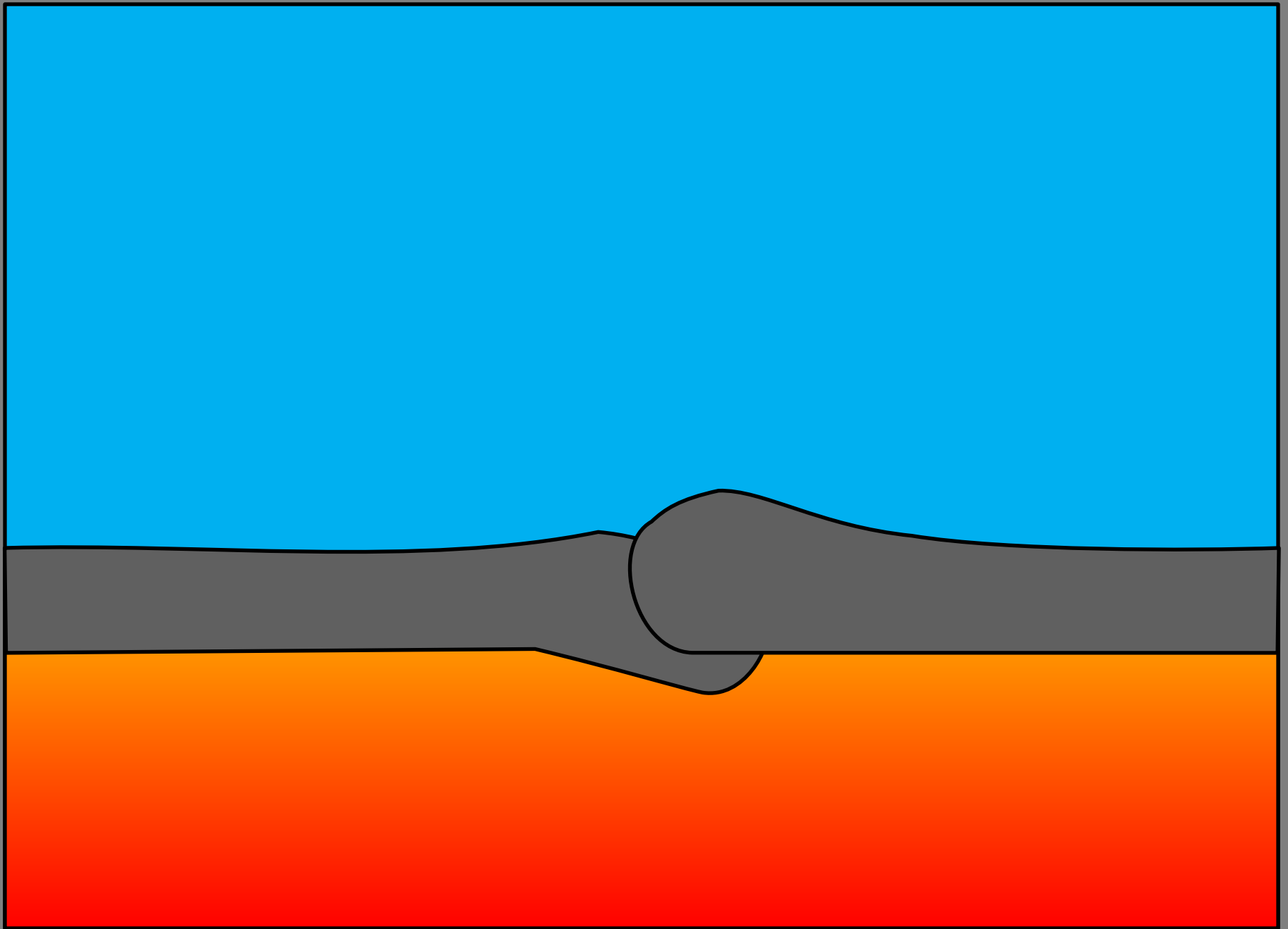


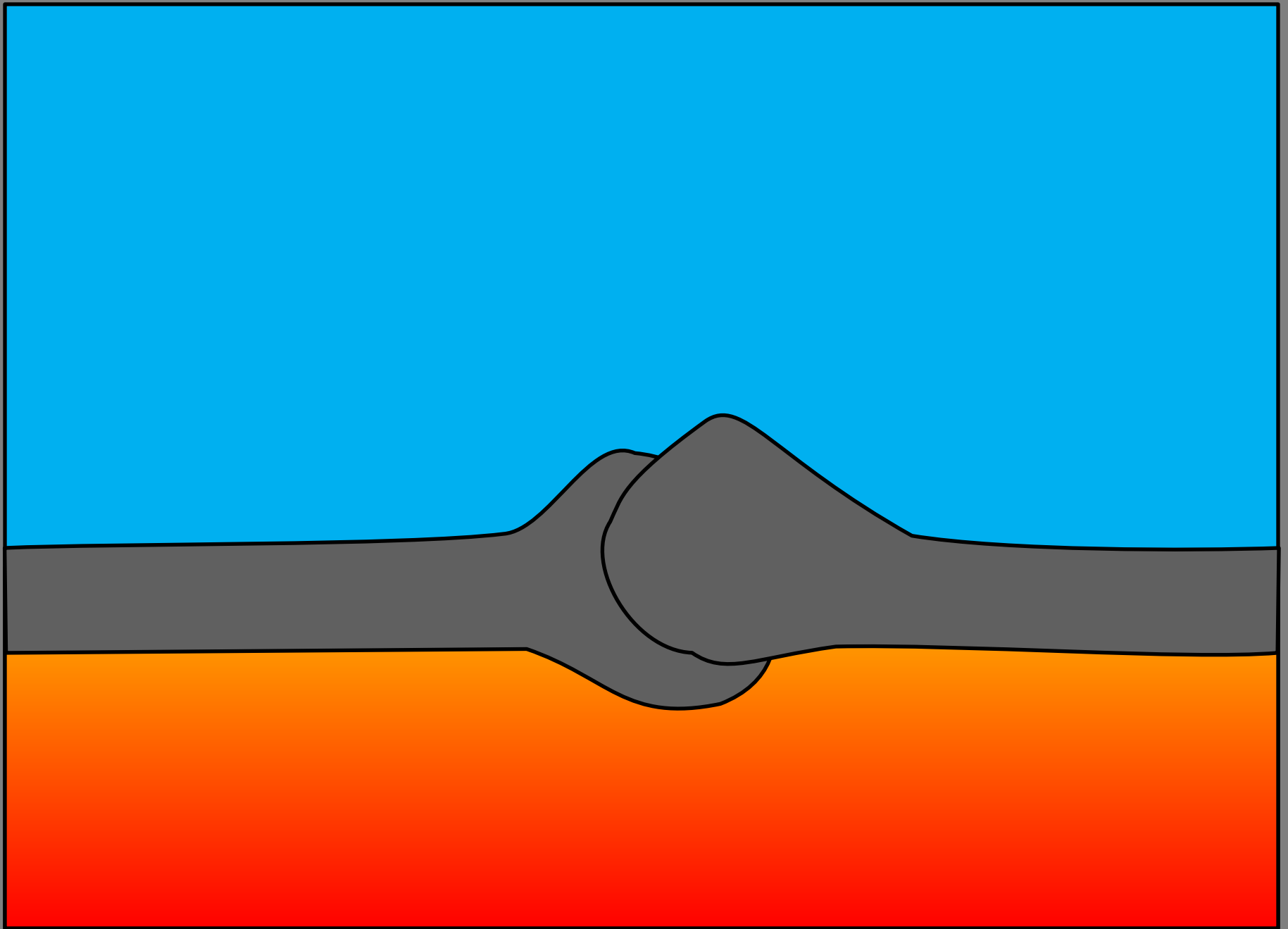


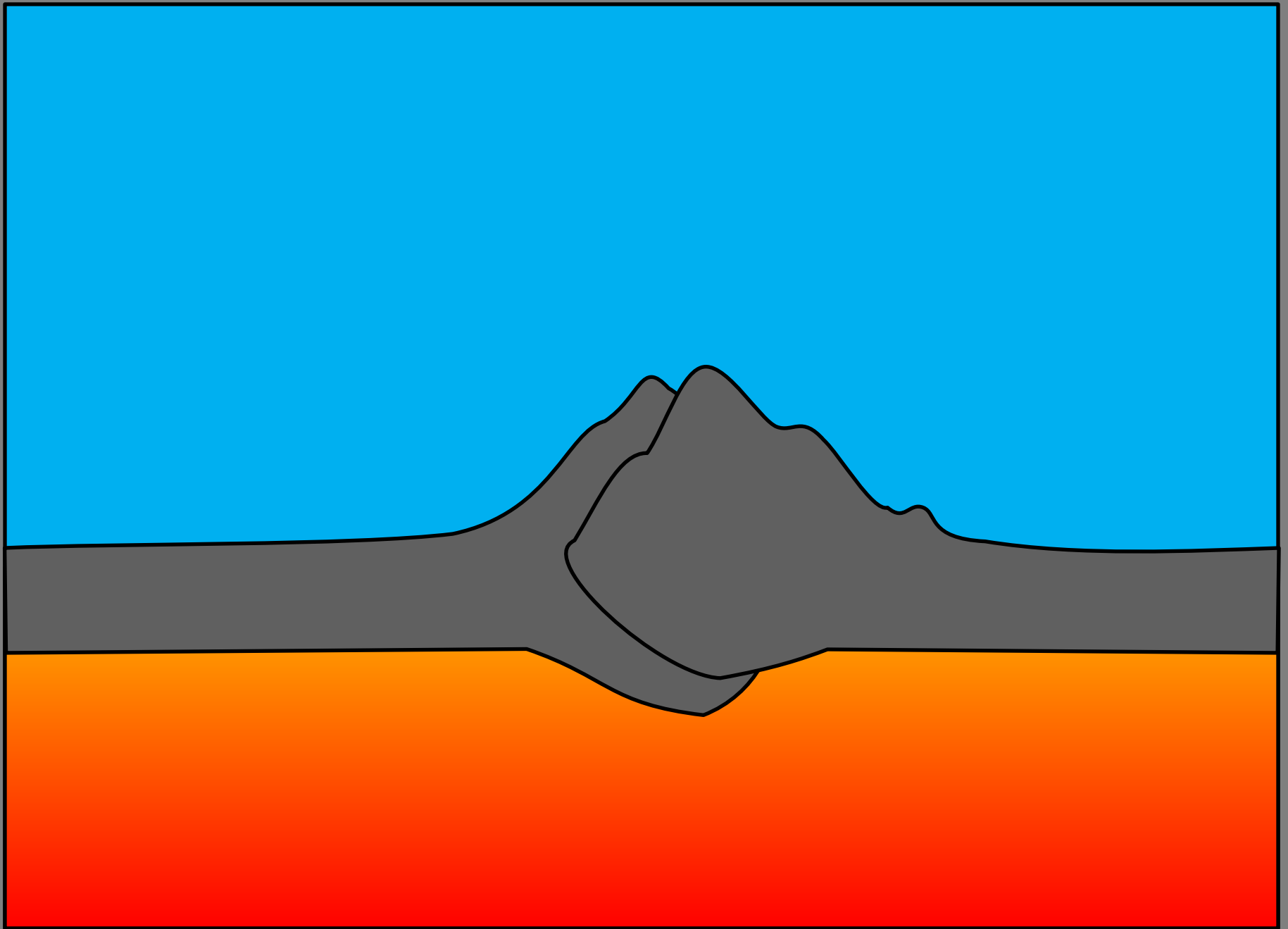


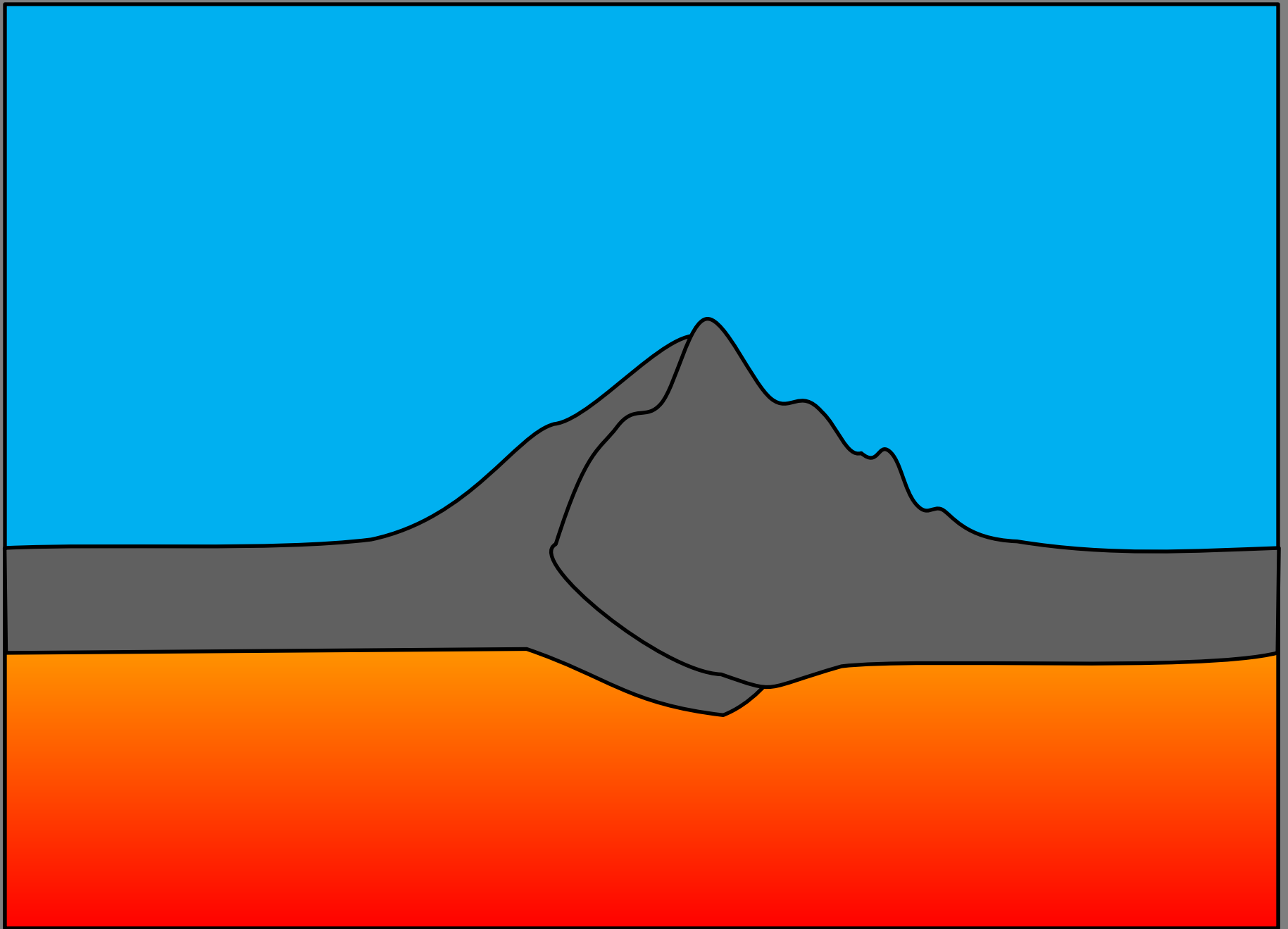




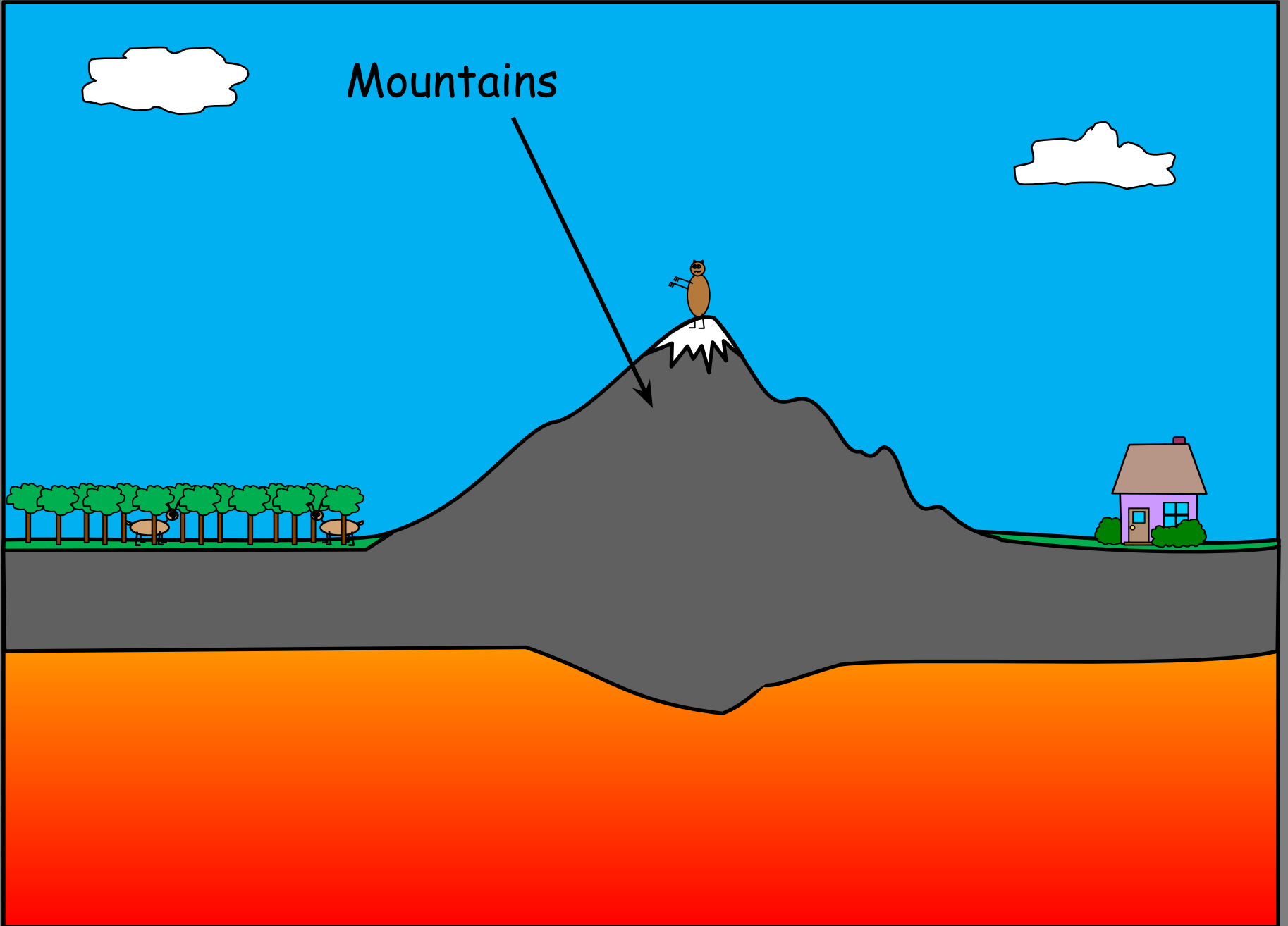






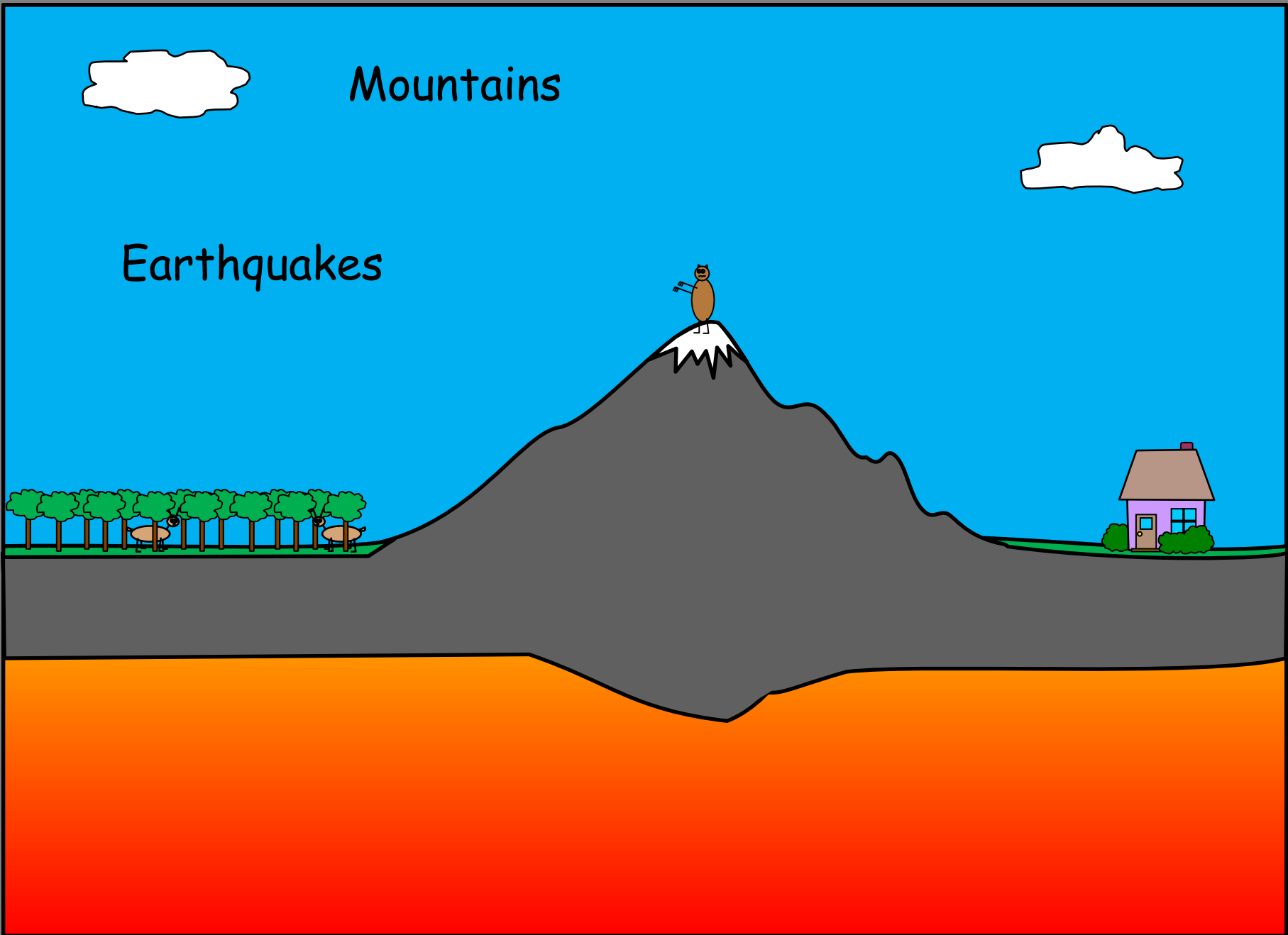


Mountains



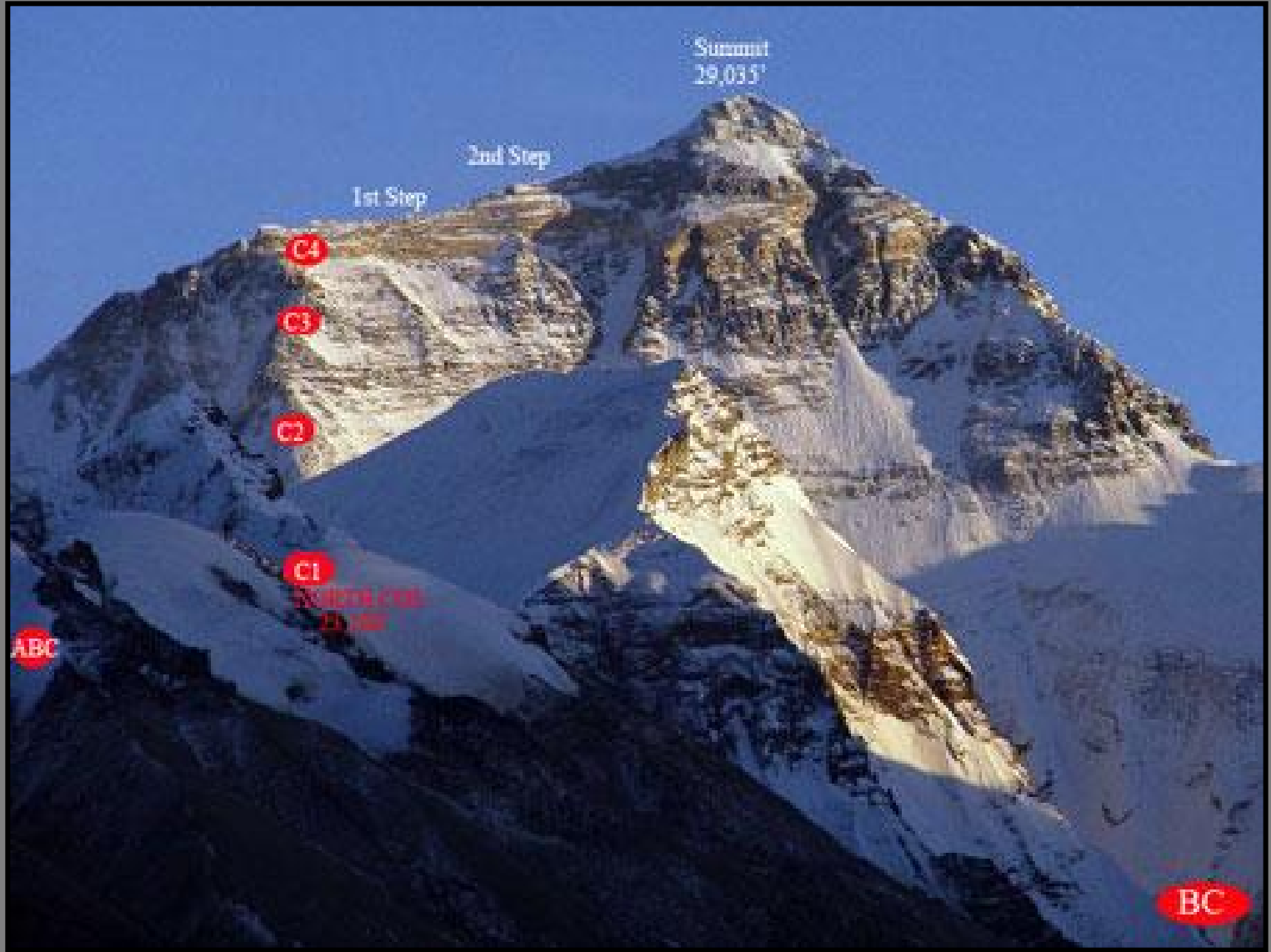
Mountains

Earthquakes









Summit  
29,035'

2nd Step

1st Step

C4


C3

C2

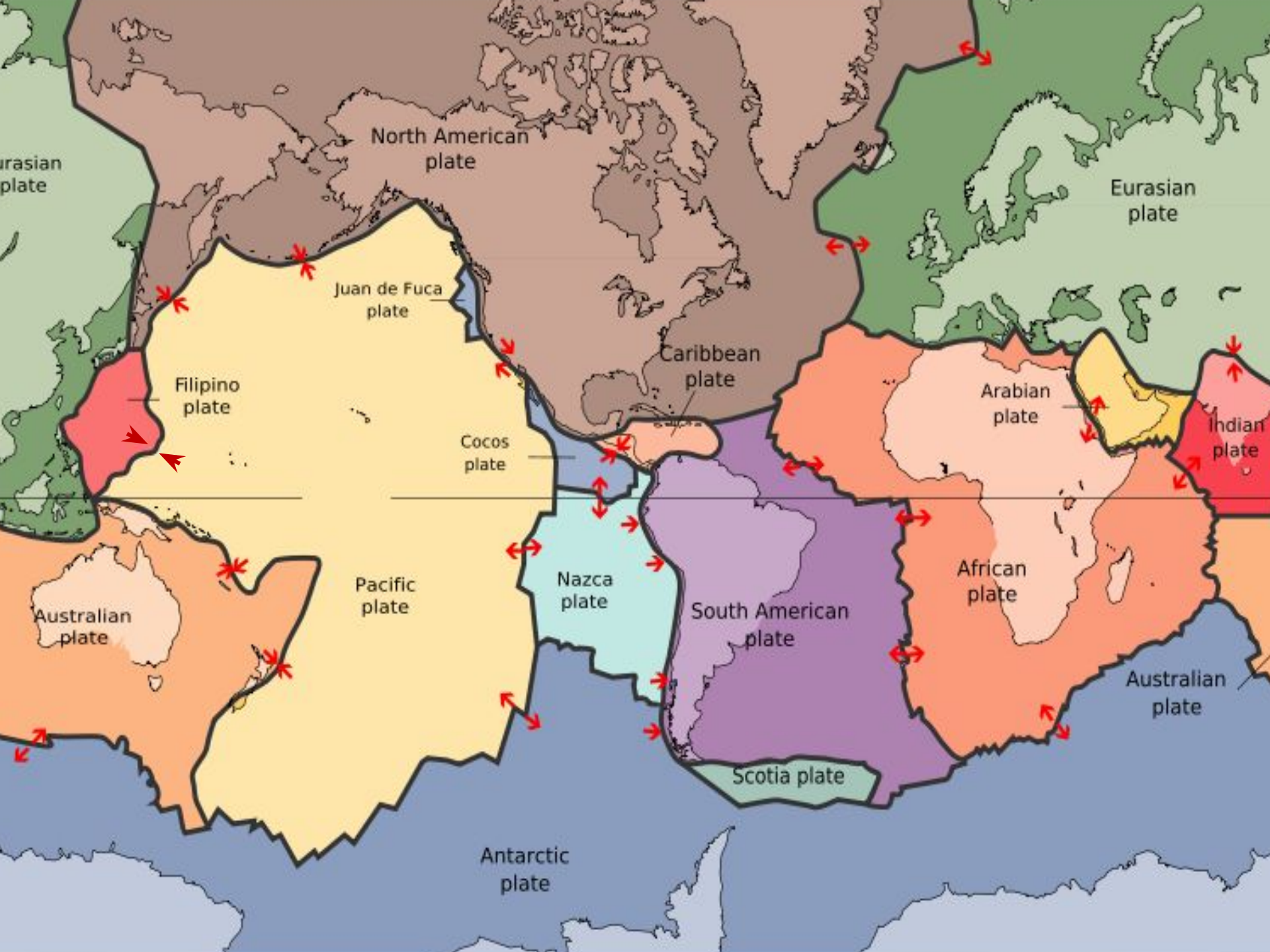
C1


ABC

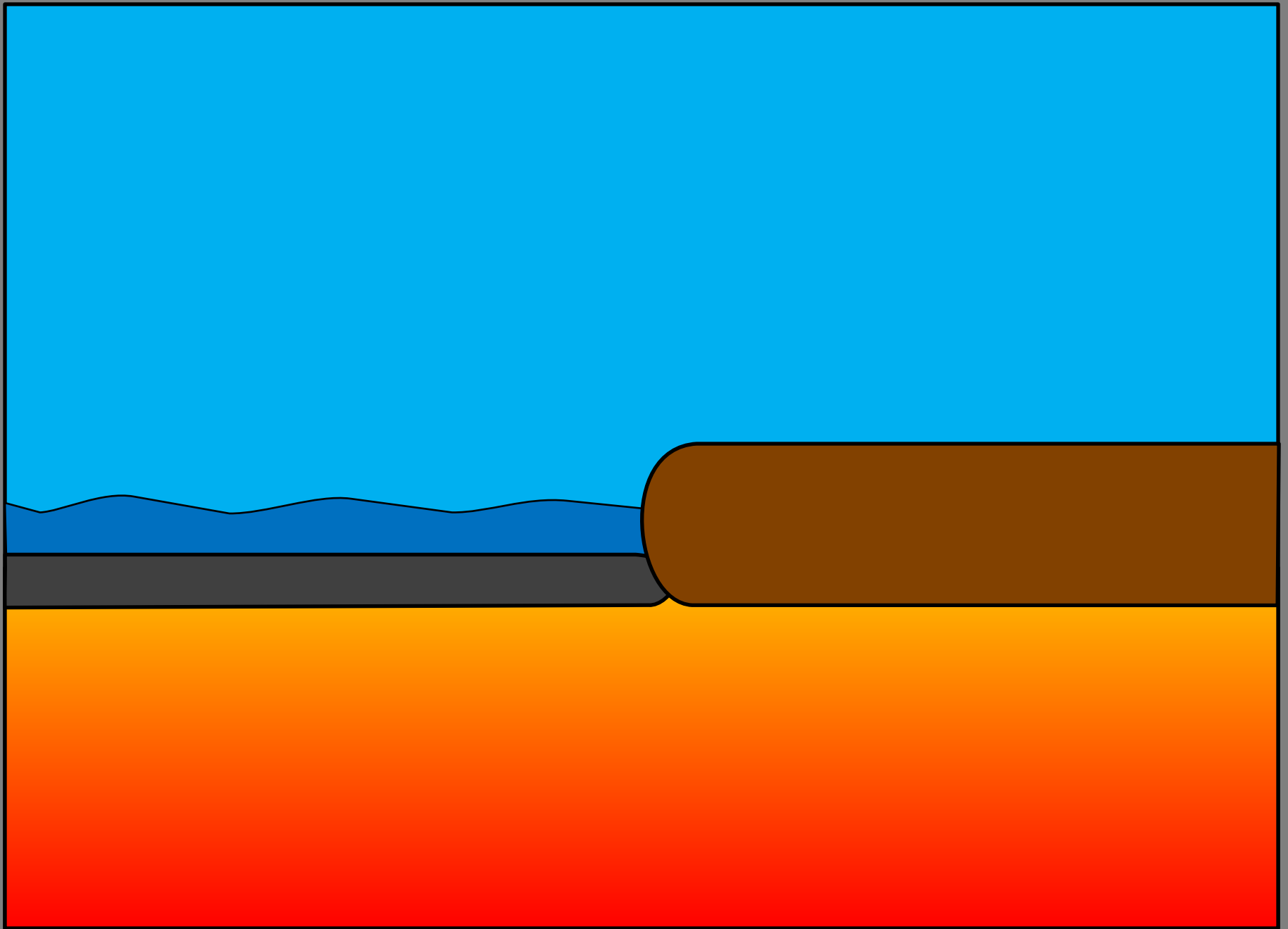
BC

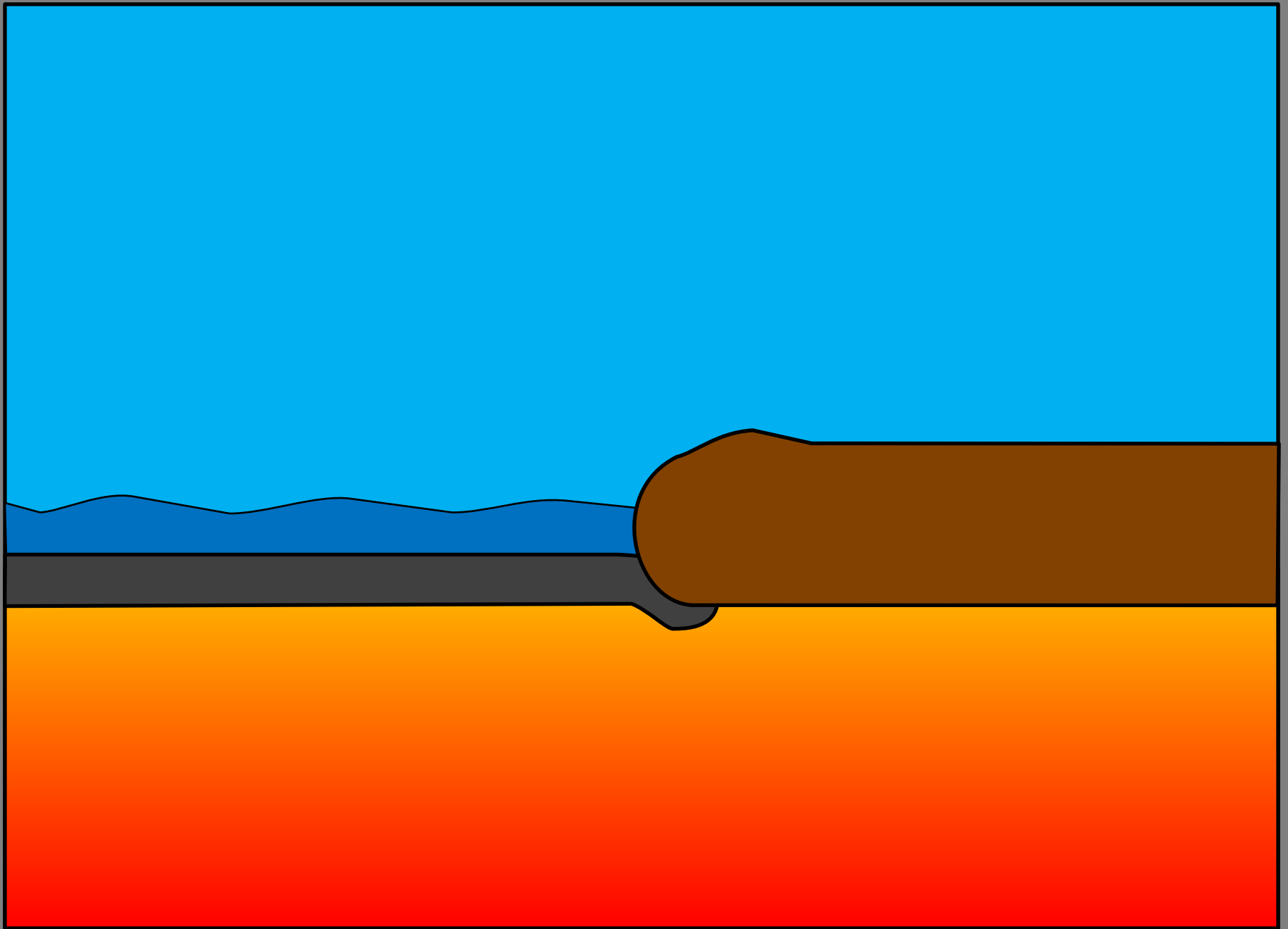
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Two plates with continental crust collide	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust		

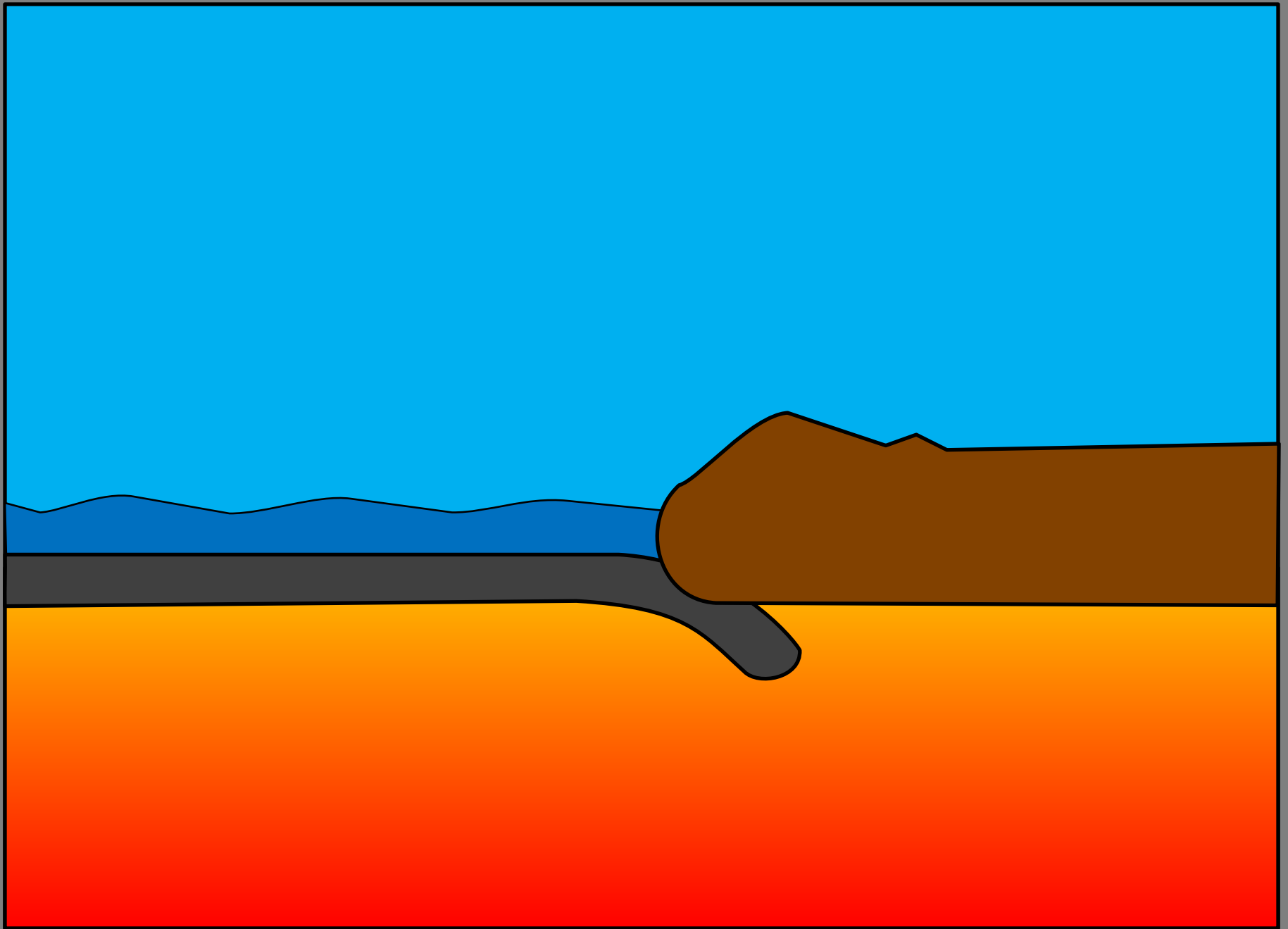
Continental crust collides with oceanic crust



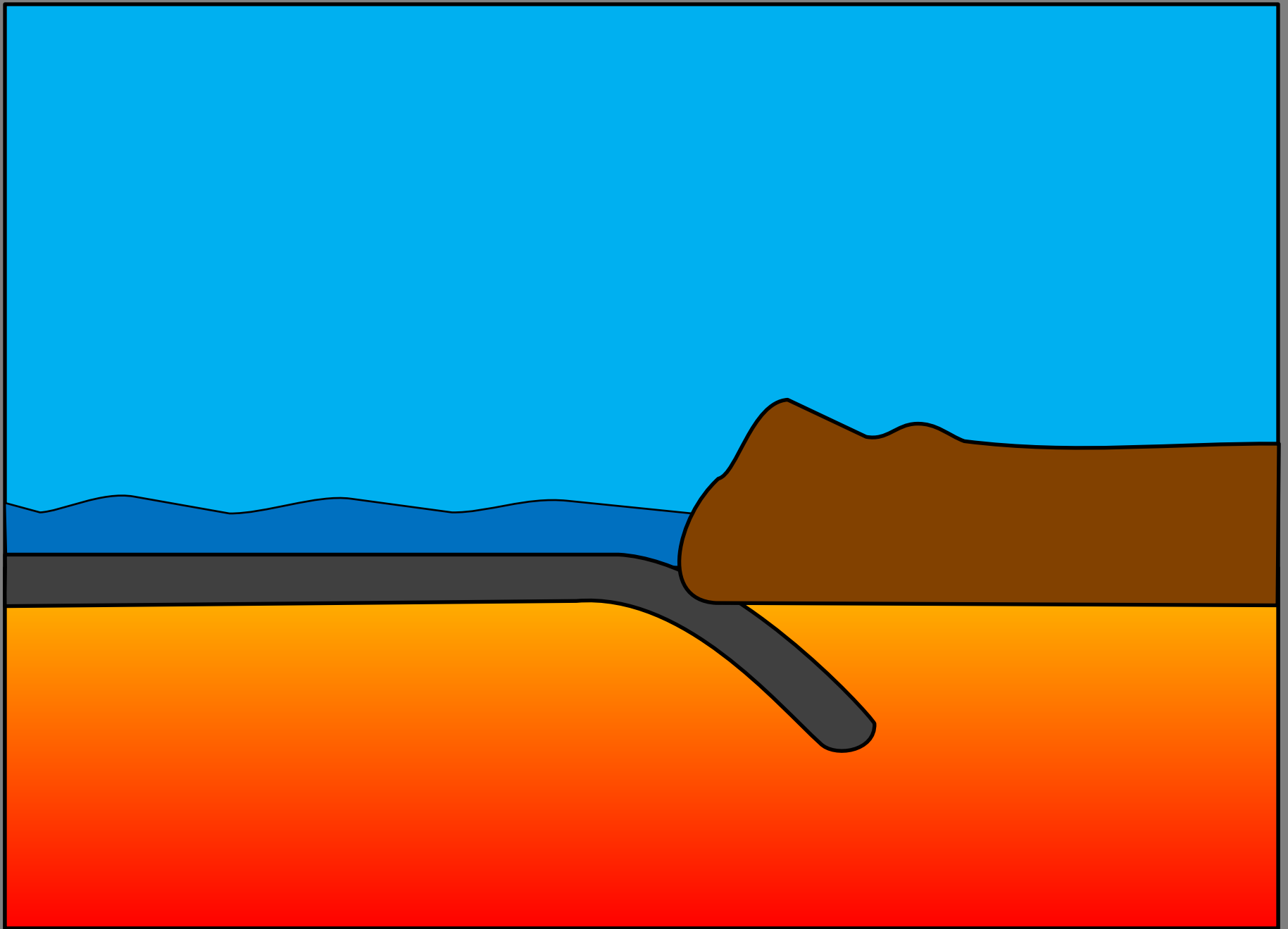
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust		



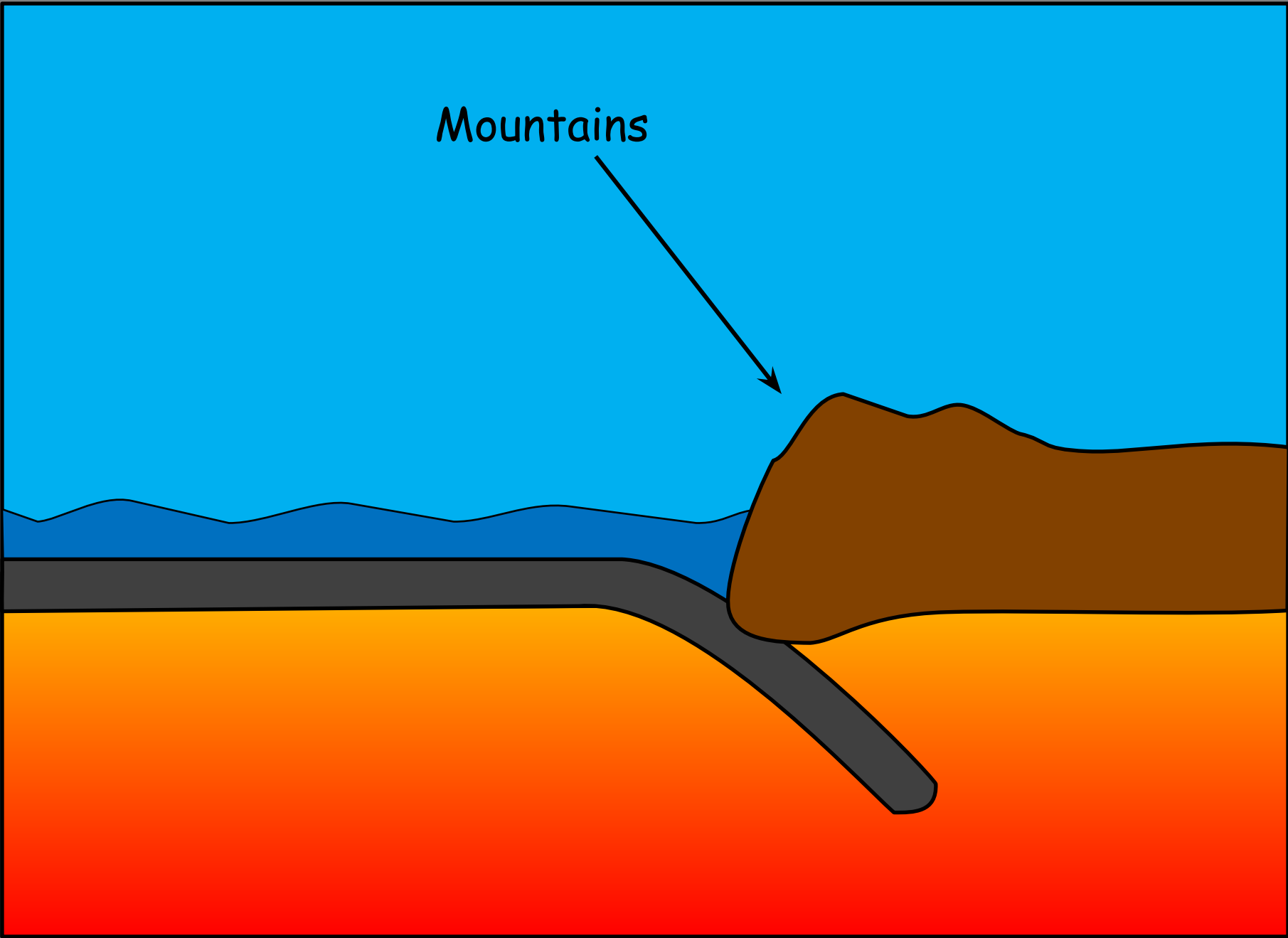
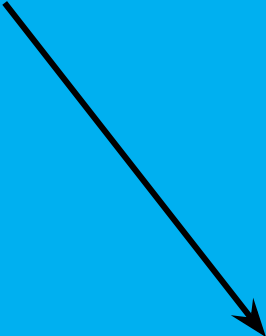




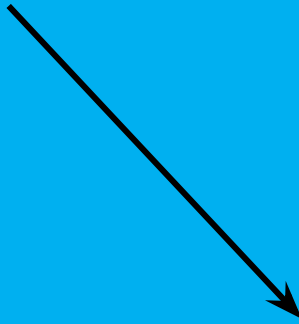




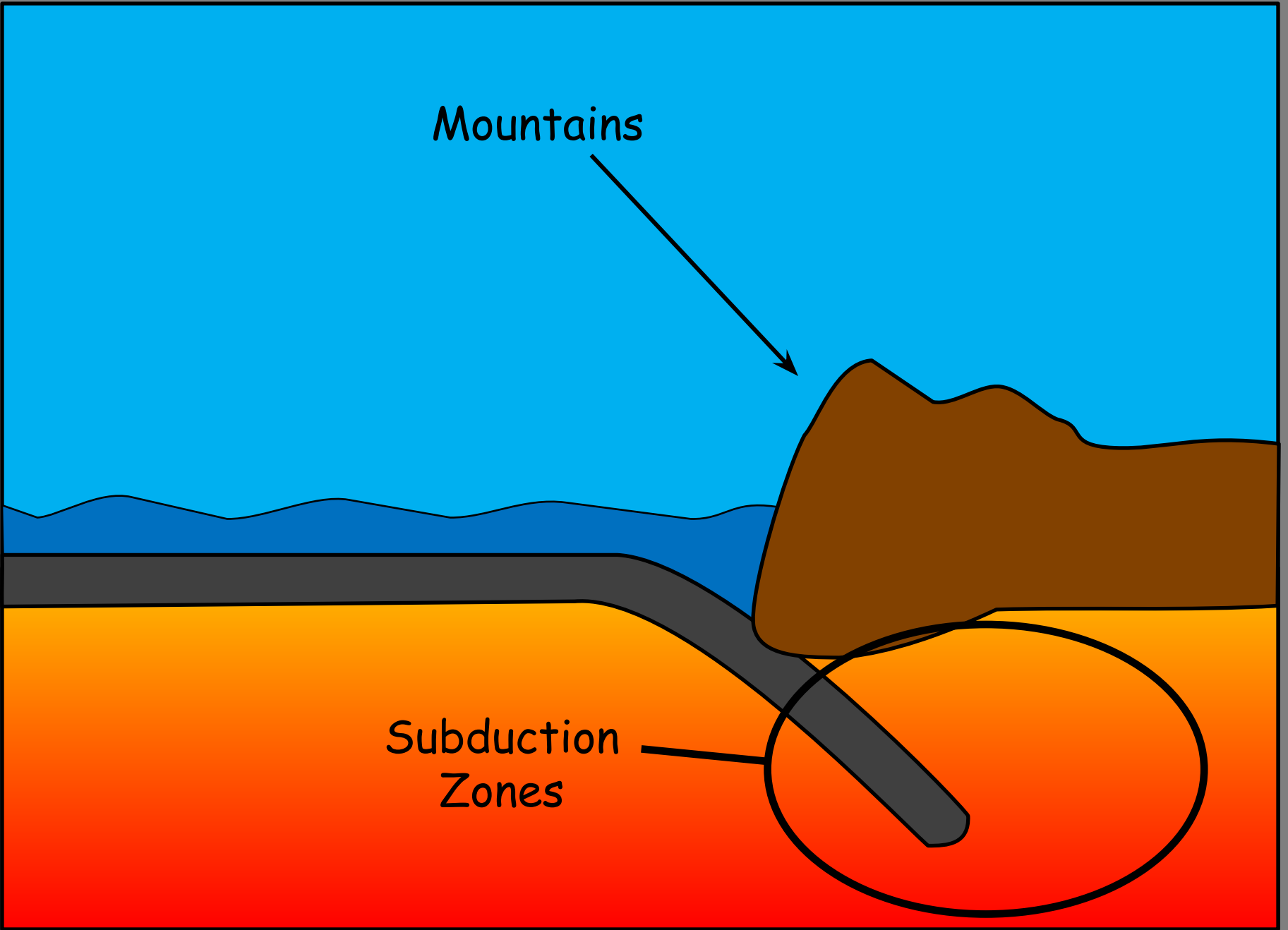
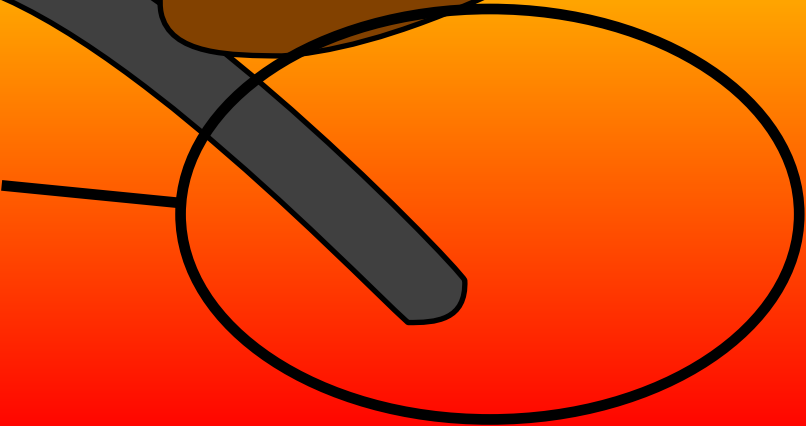
Mountains



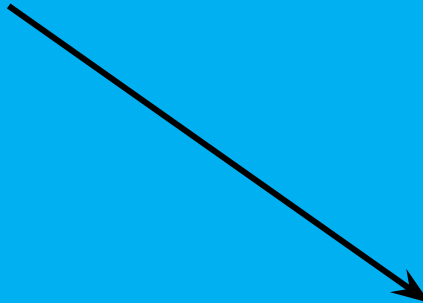
Mountains



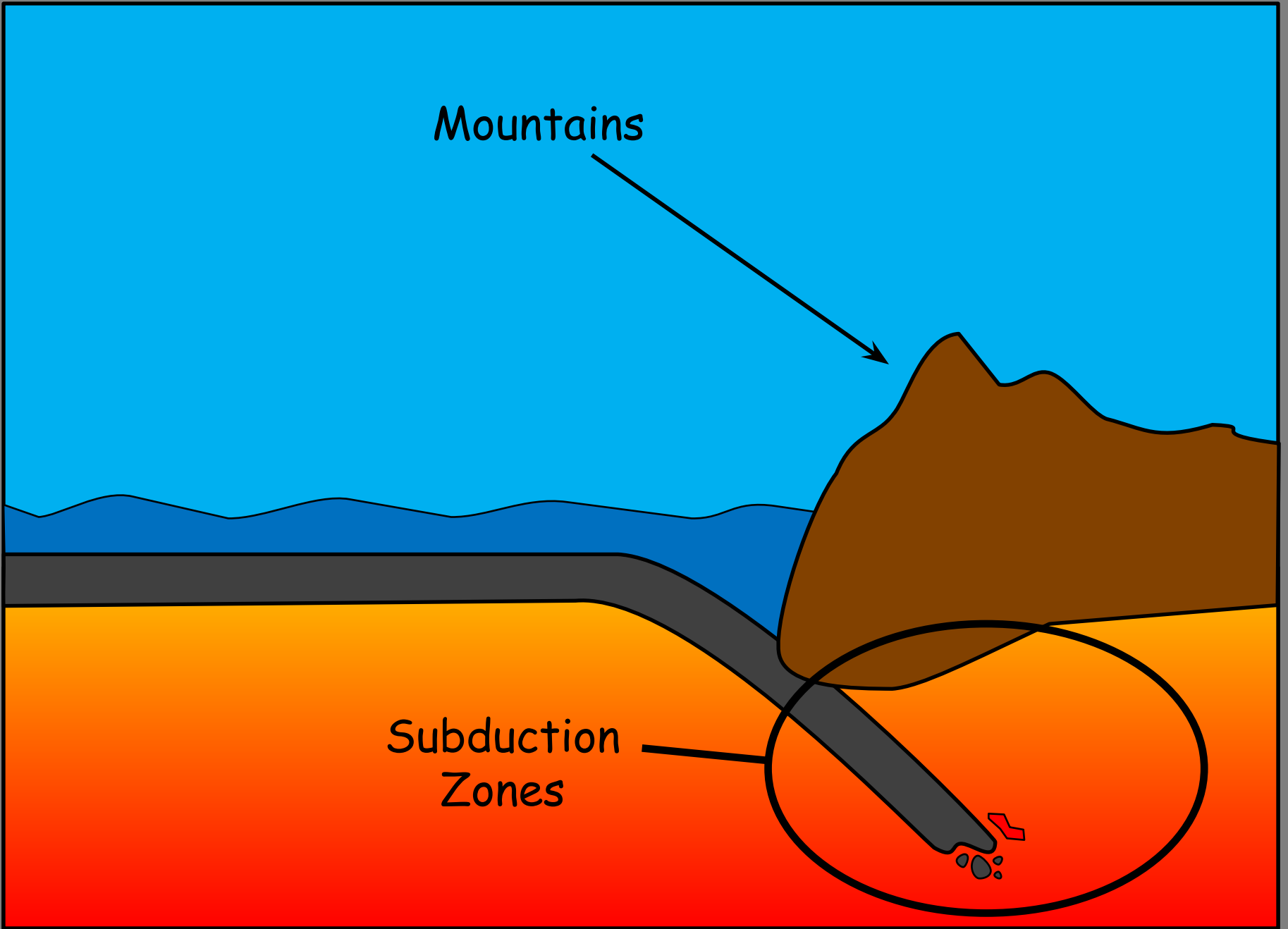
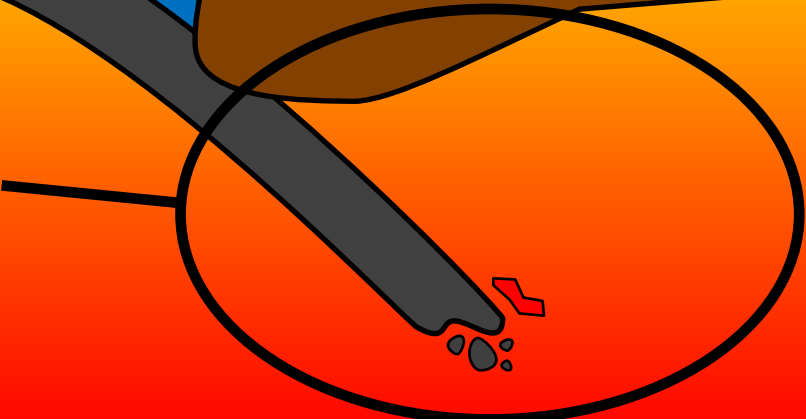
Subduction  
Zones



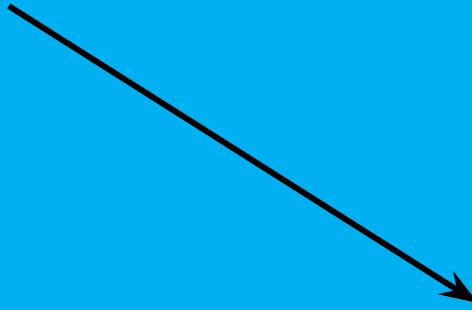
Mountains



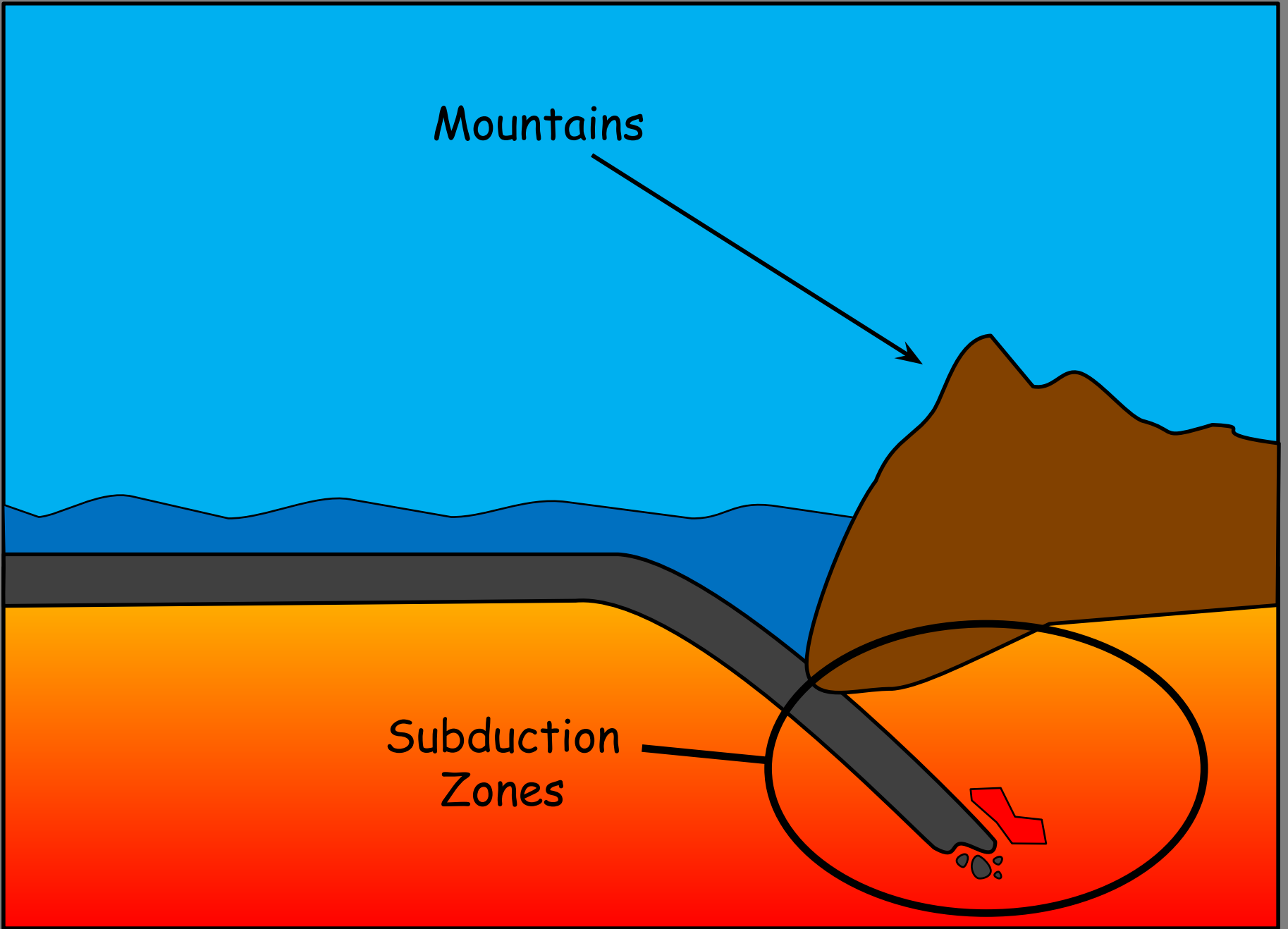
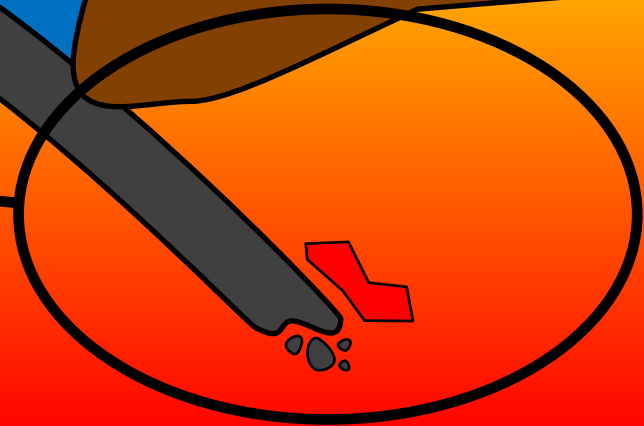
Subduction  
Zones



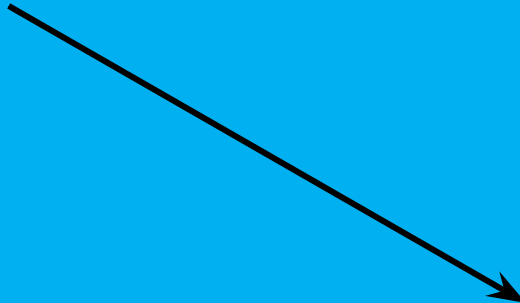
Mountains



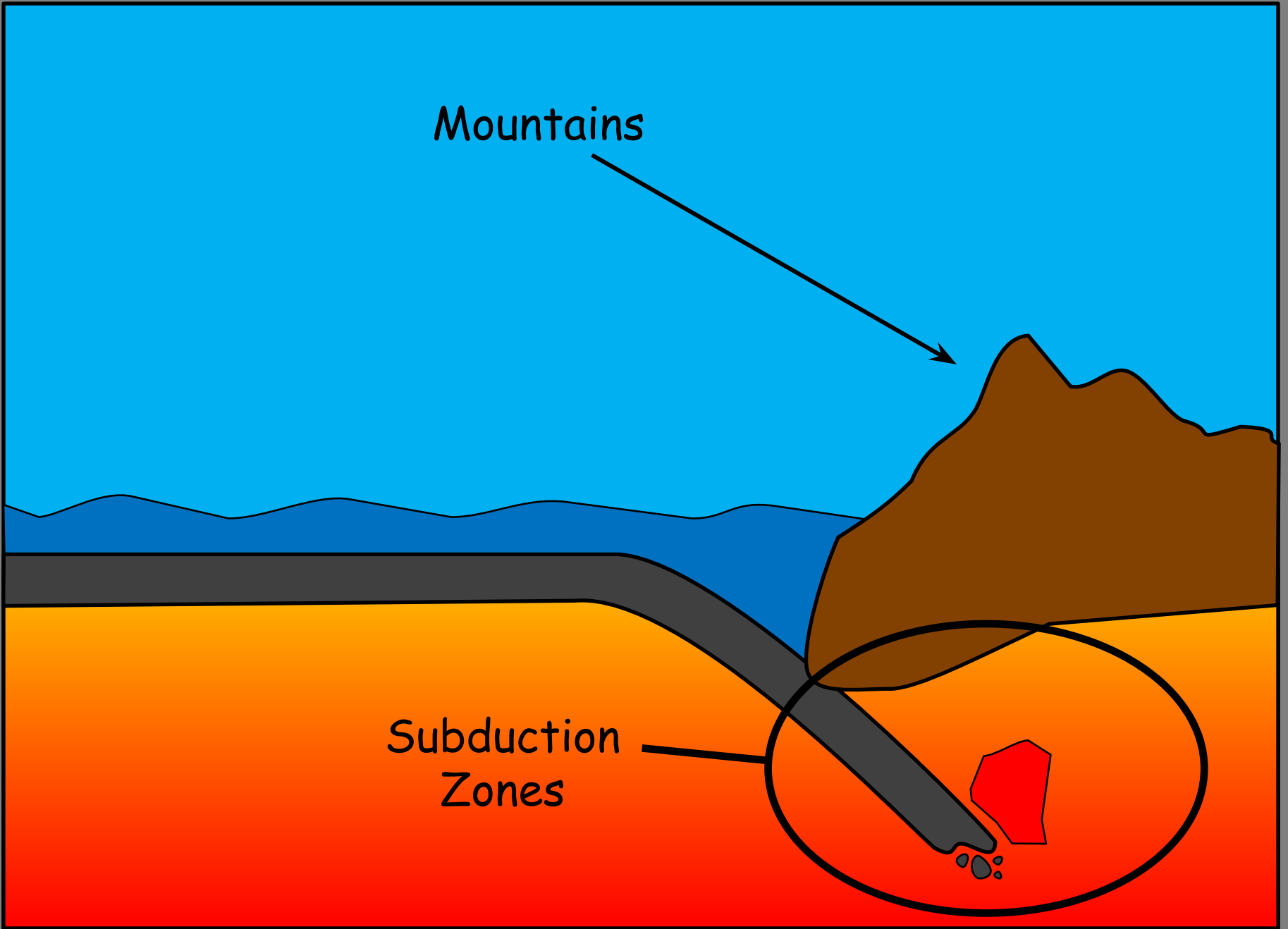
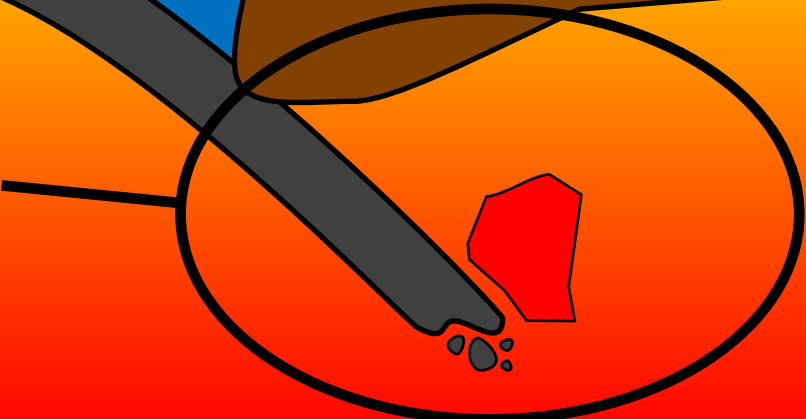
Subduction  
Zones



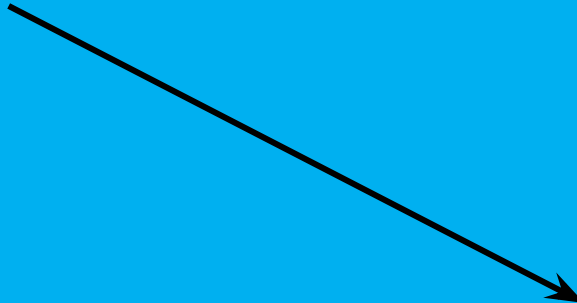
Mountains



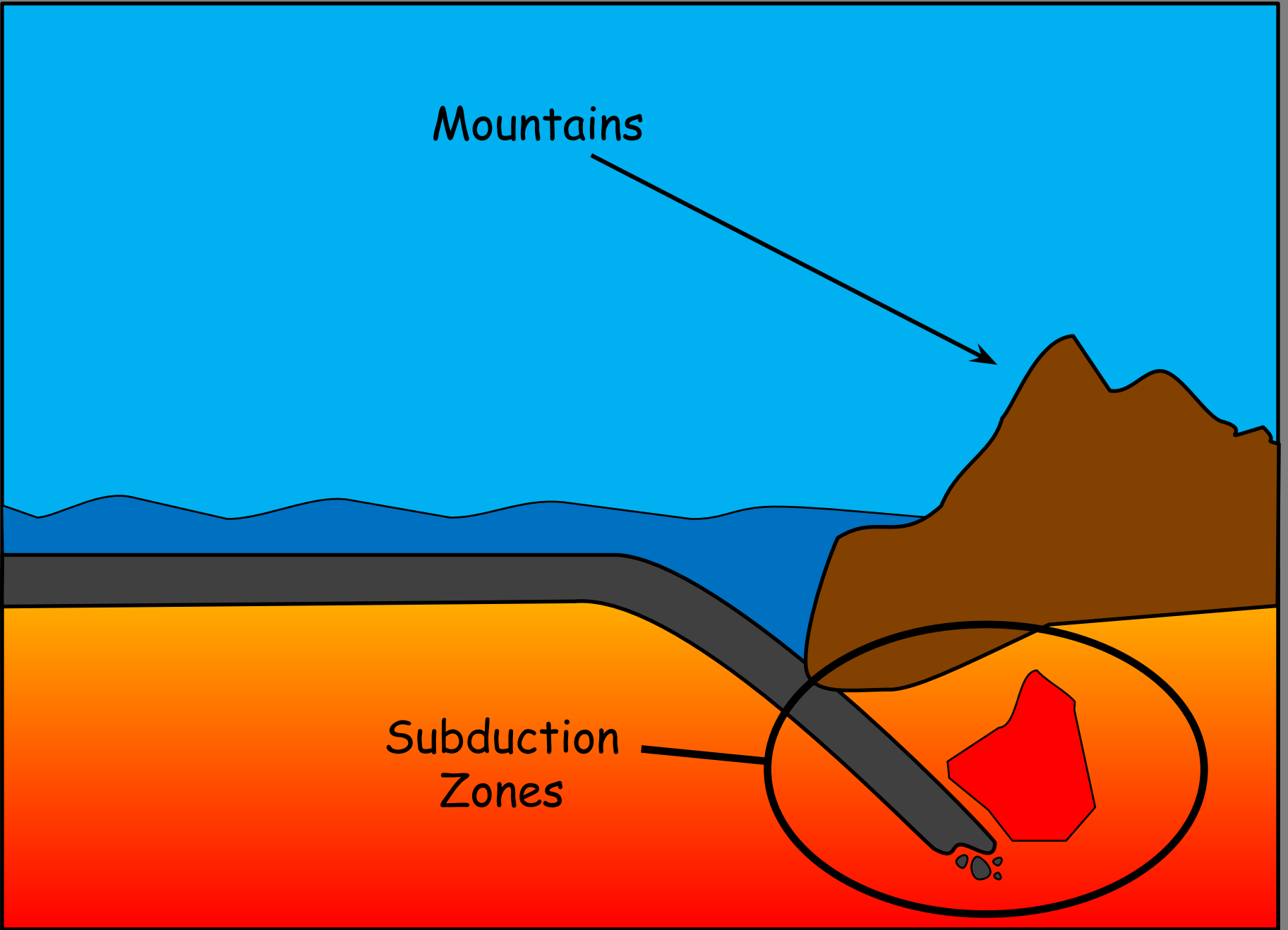
Subduction  
Zones



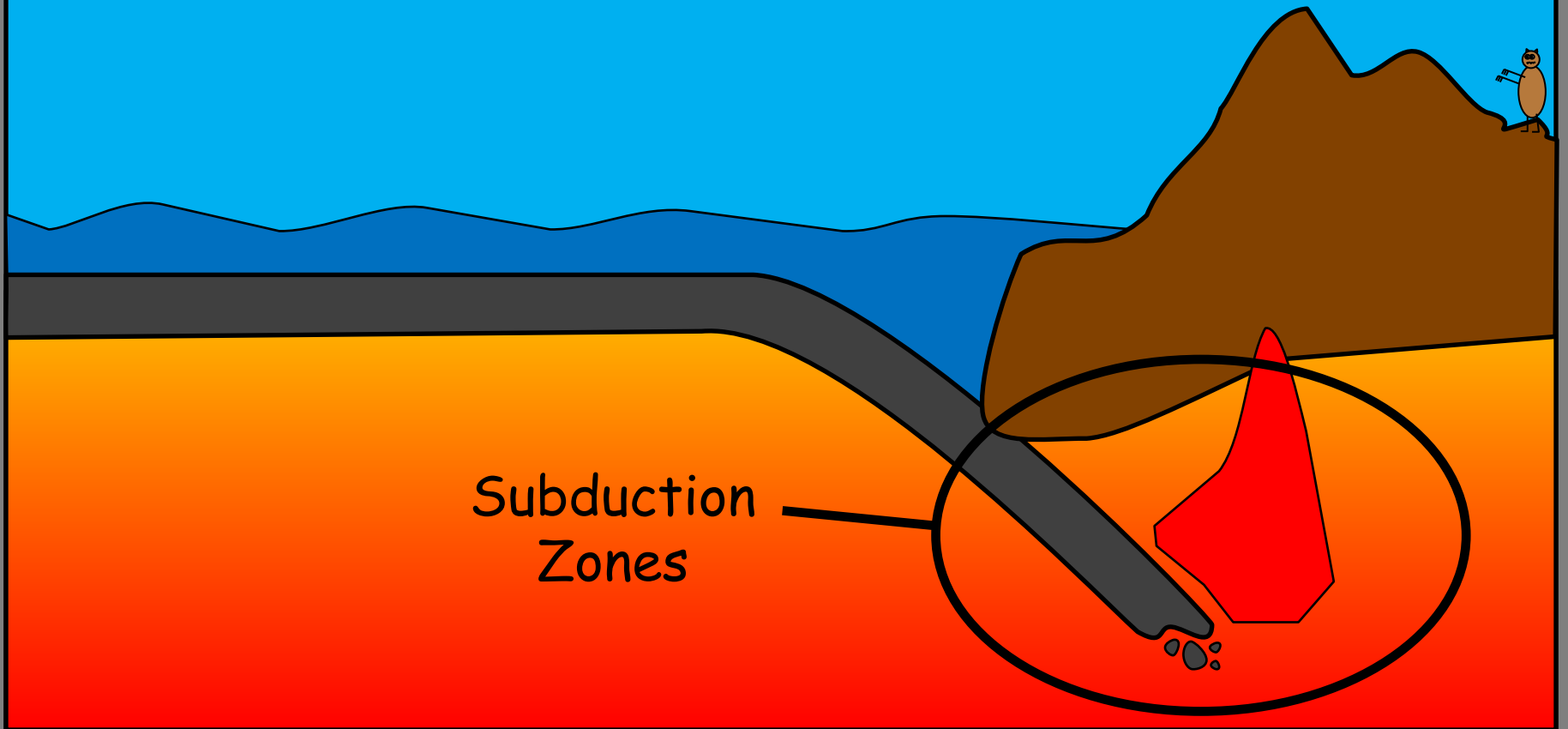
Mountains



Subduction  
Zones



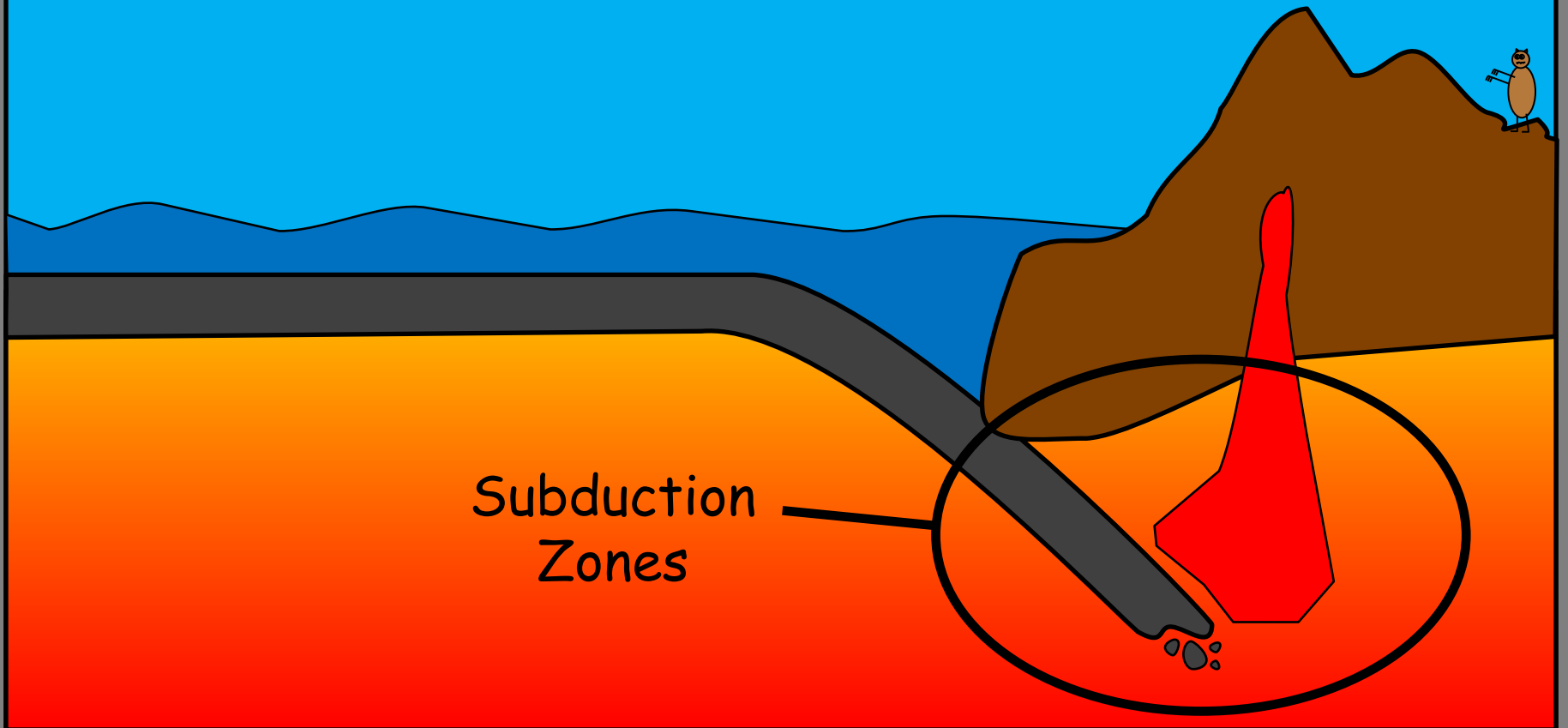
# Mountains



Subduction  
Zones

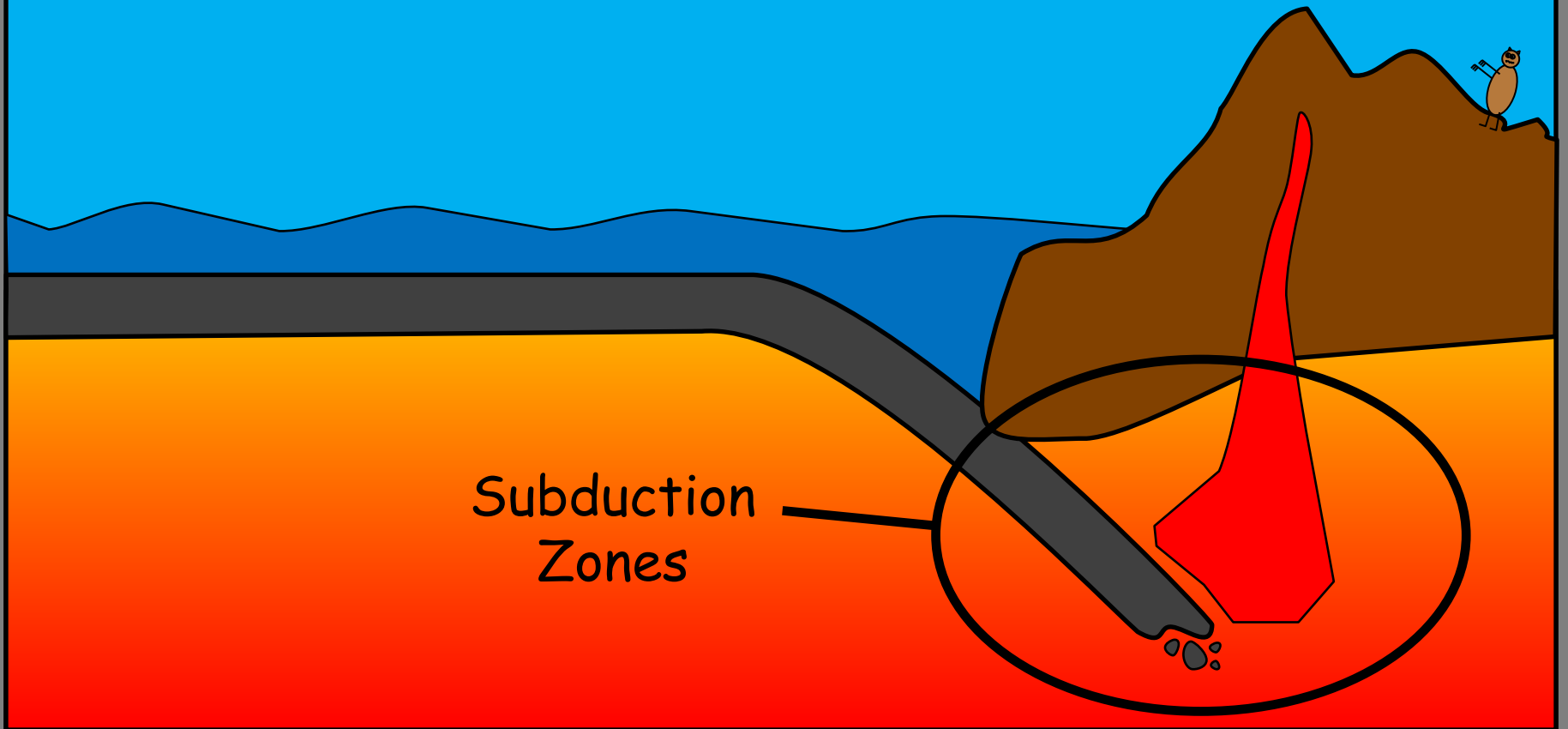


# Mountains



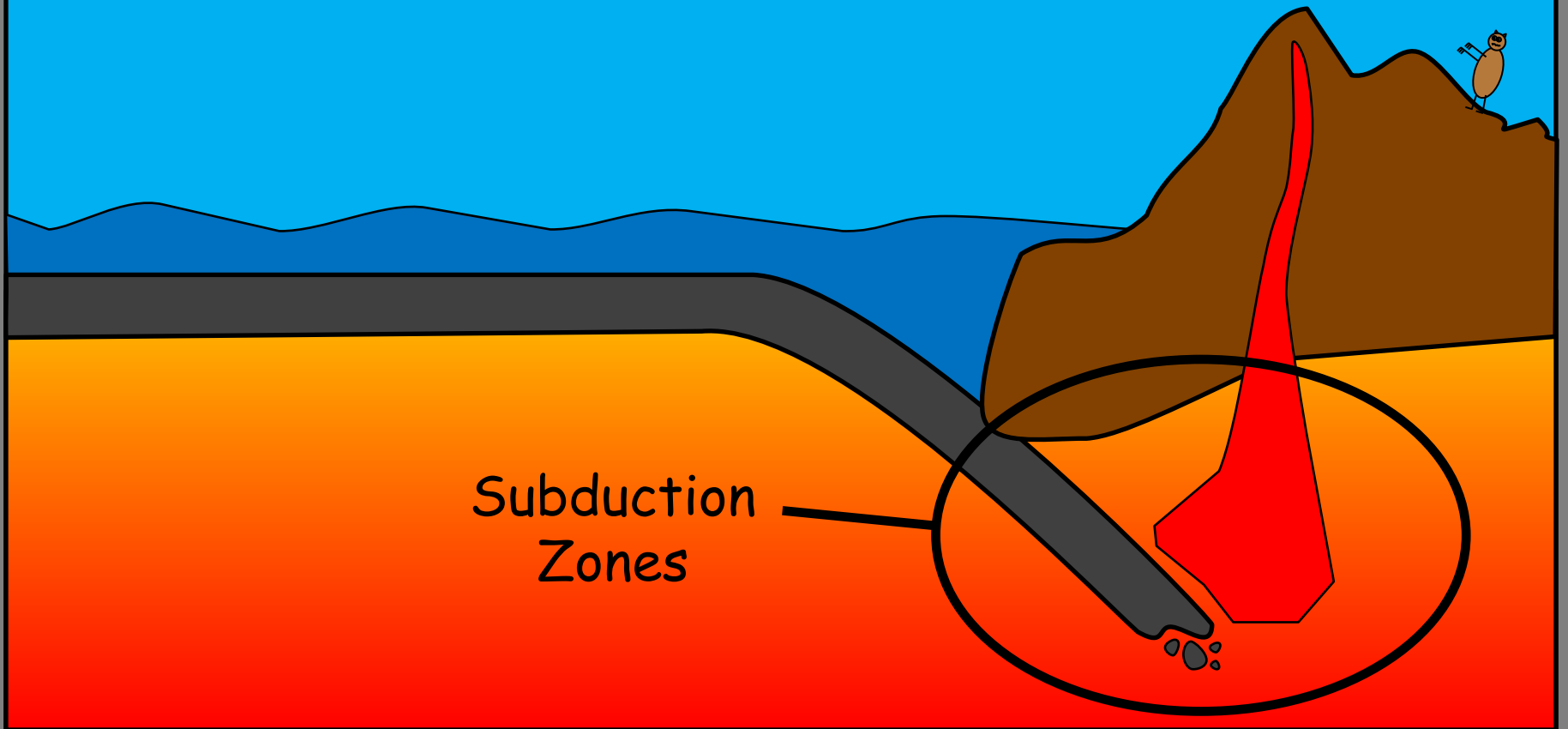
Subduction  
Zones

# Mountains



Subduction  
Zones

# Mountains

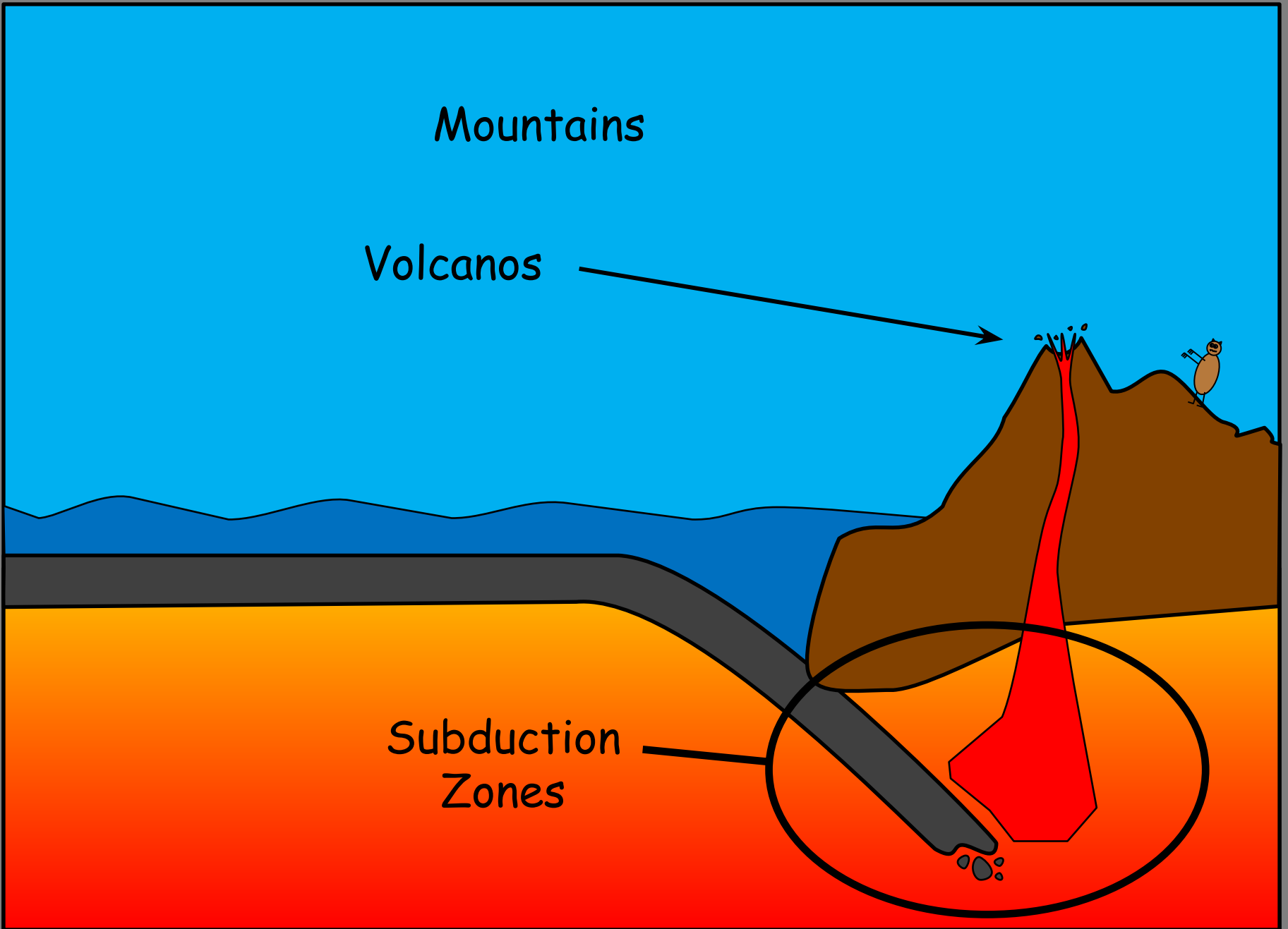


Subduction  
Zones

Mountains

Volcanos

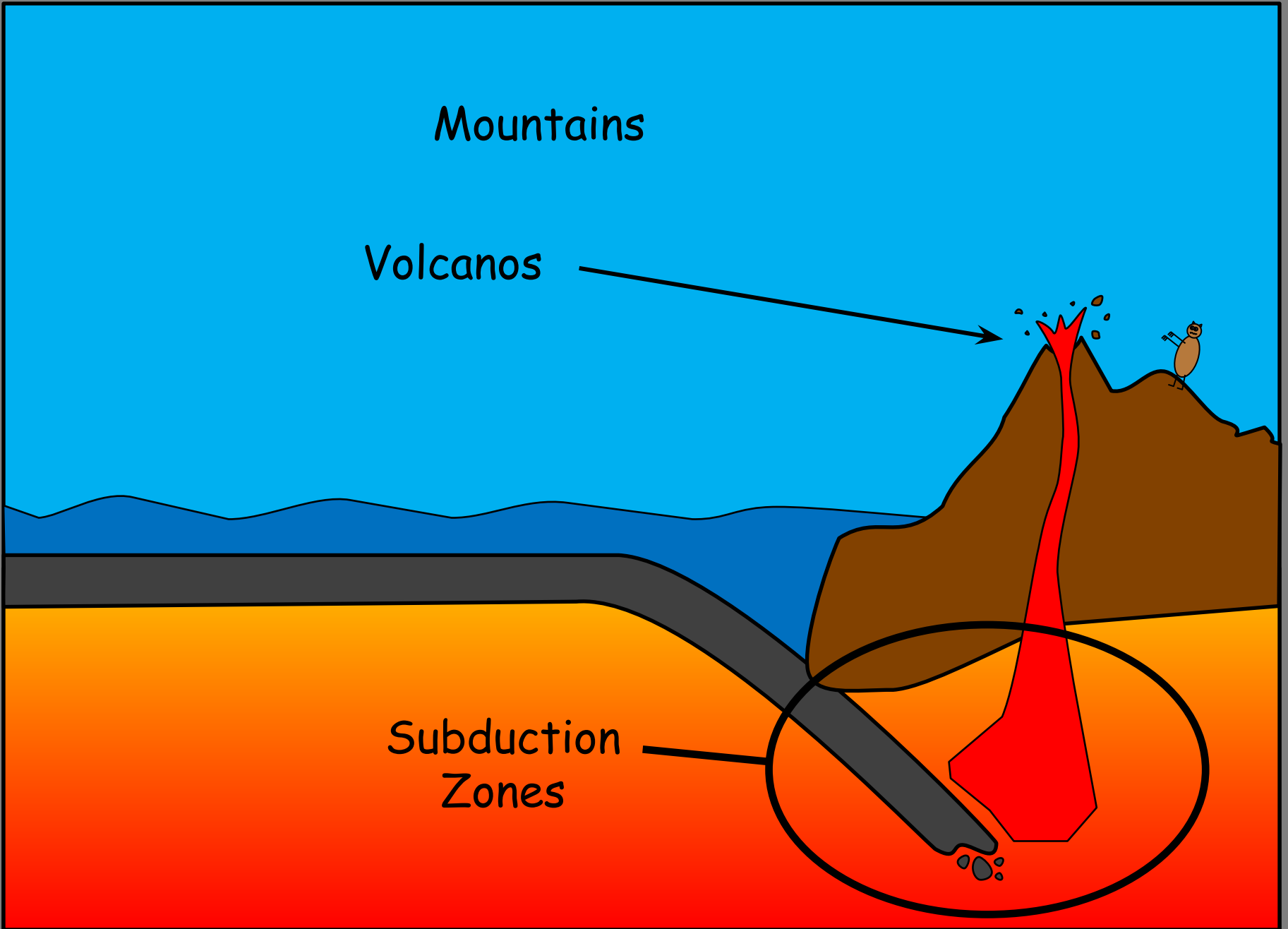
Subduction  
Zones



Mountains

Volcanos

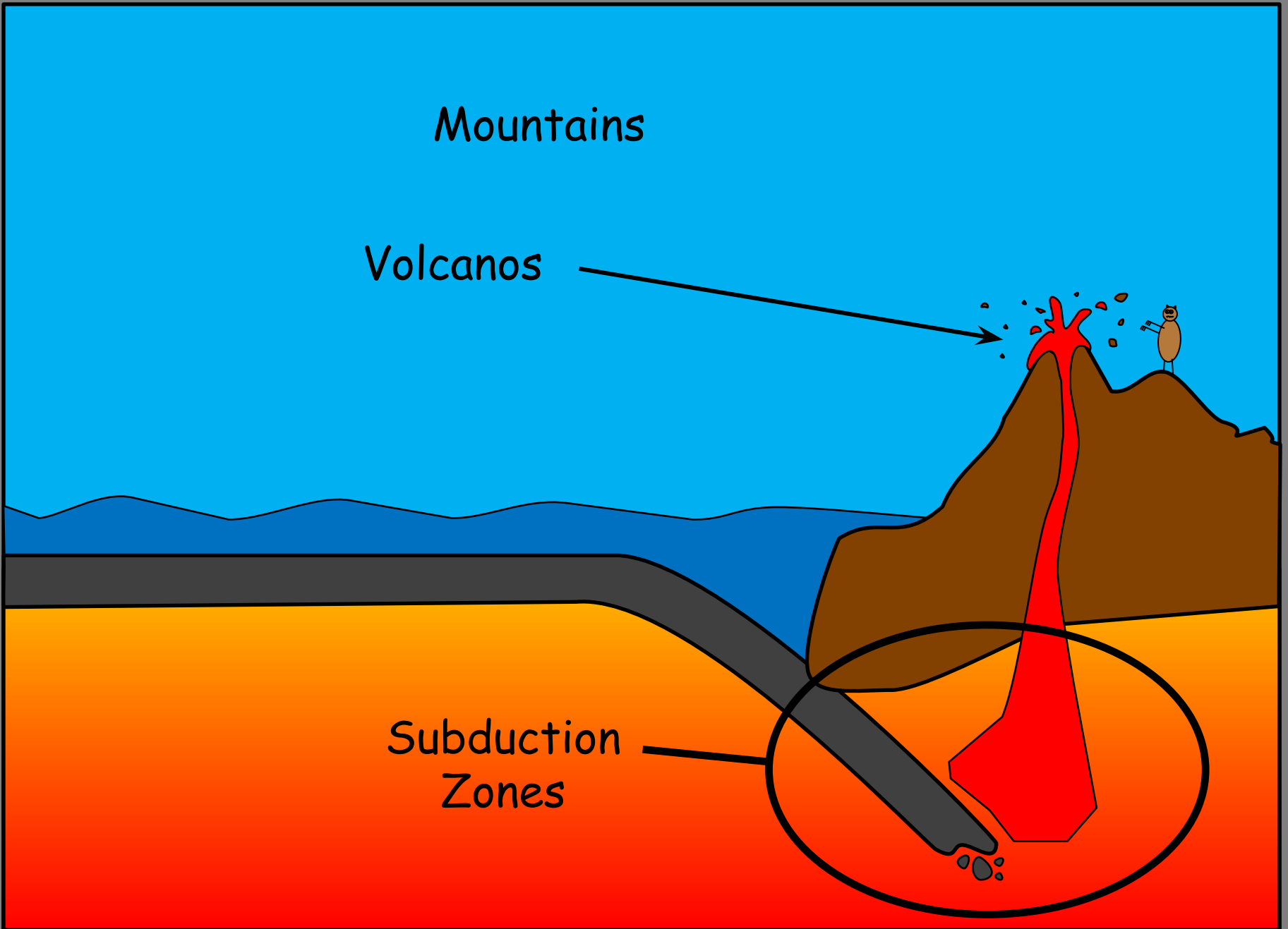
Subduction  
Zones



Mountains

Volcanos

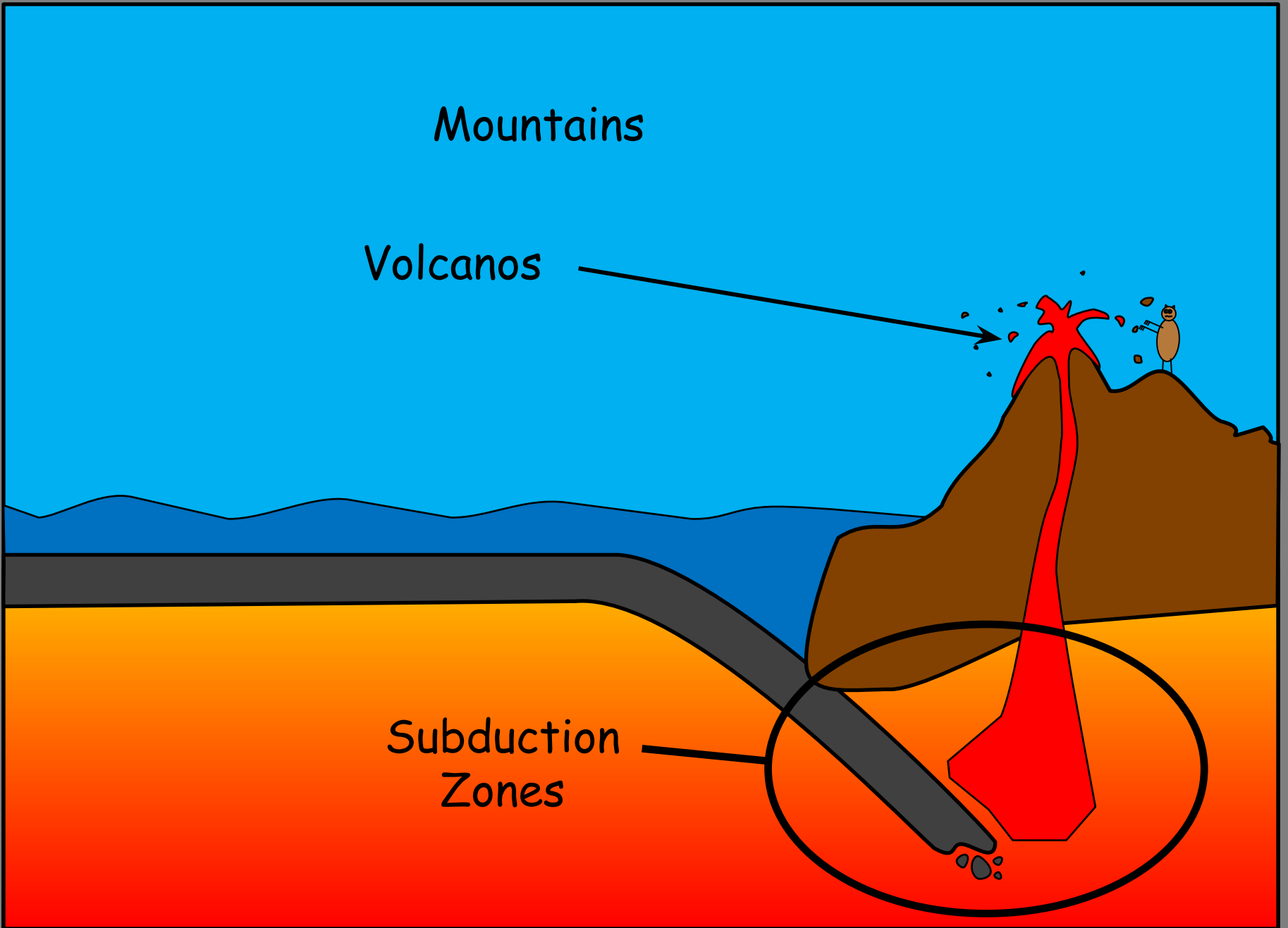
Subduction  
Zones



Mountains

Volcanos

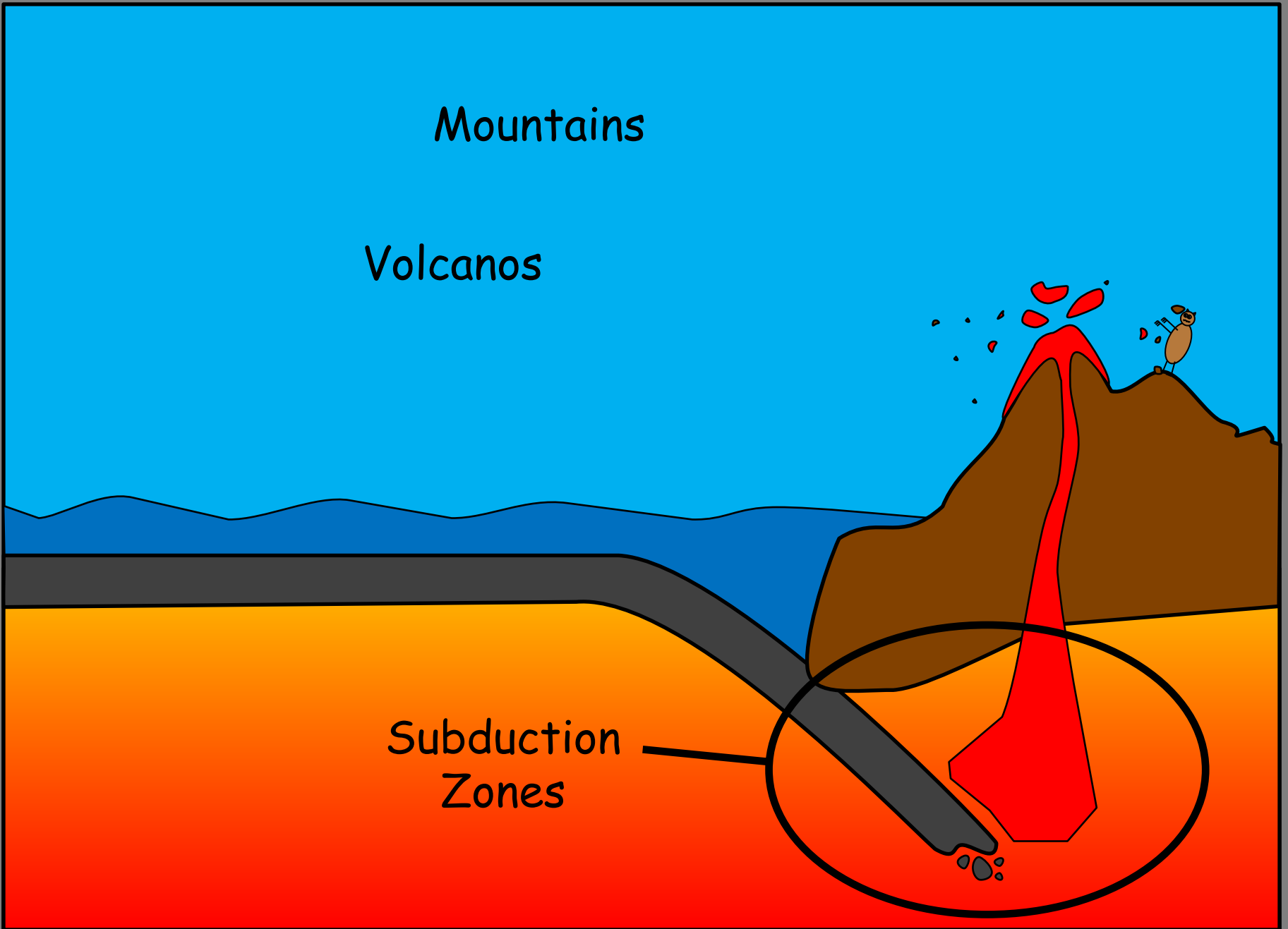
Subduction  
Zones



Mountains

Volcanos

Subduction  
Zones

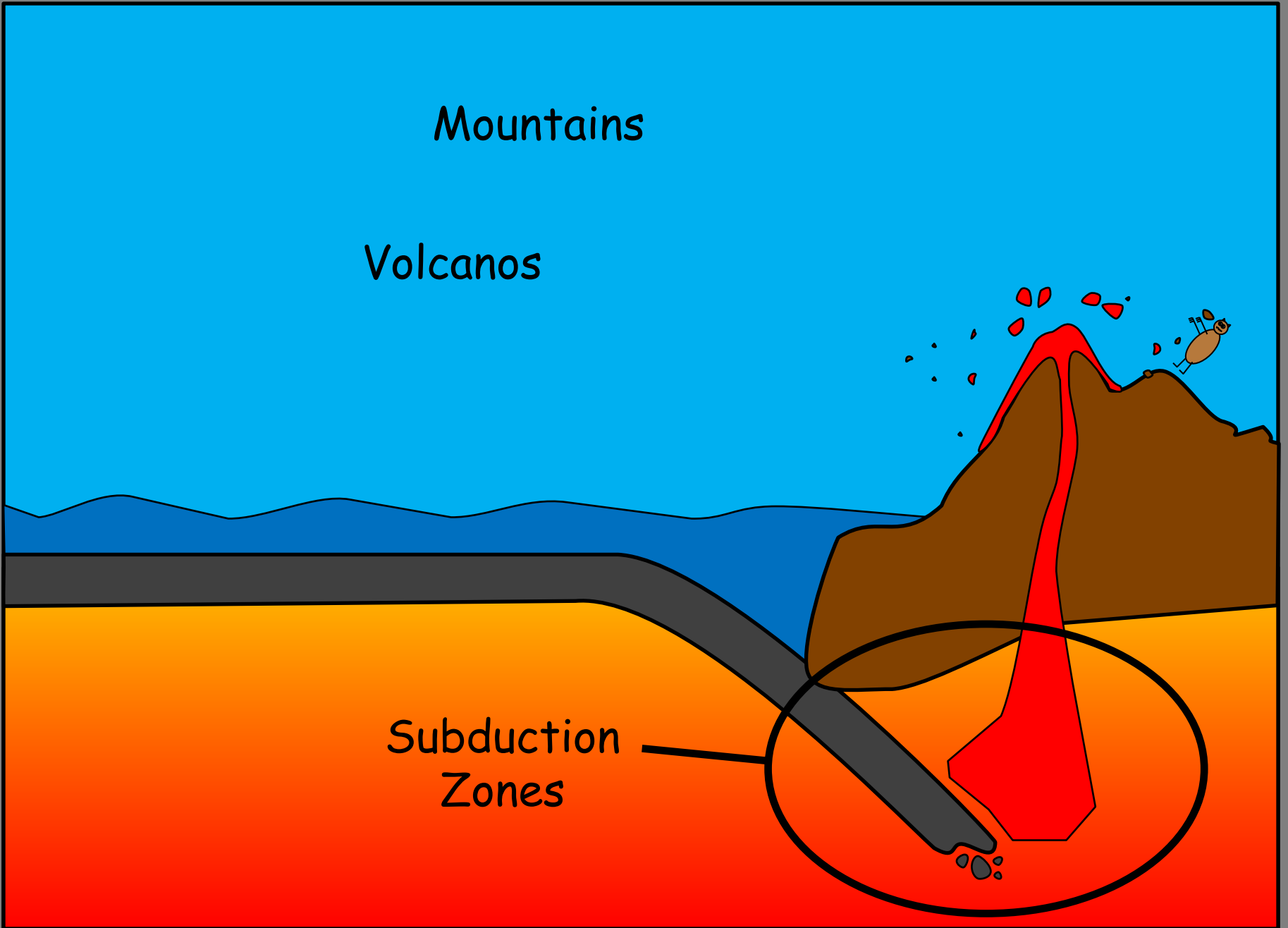




Mountains

Volcanos

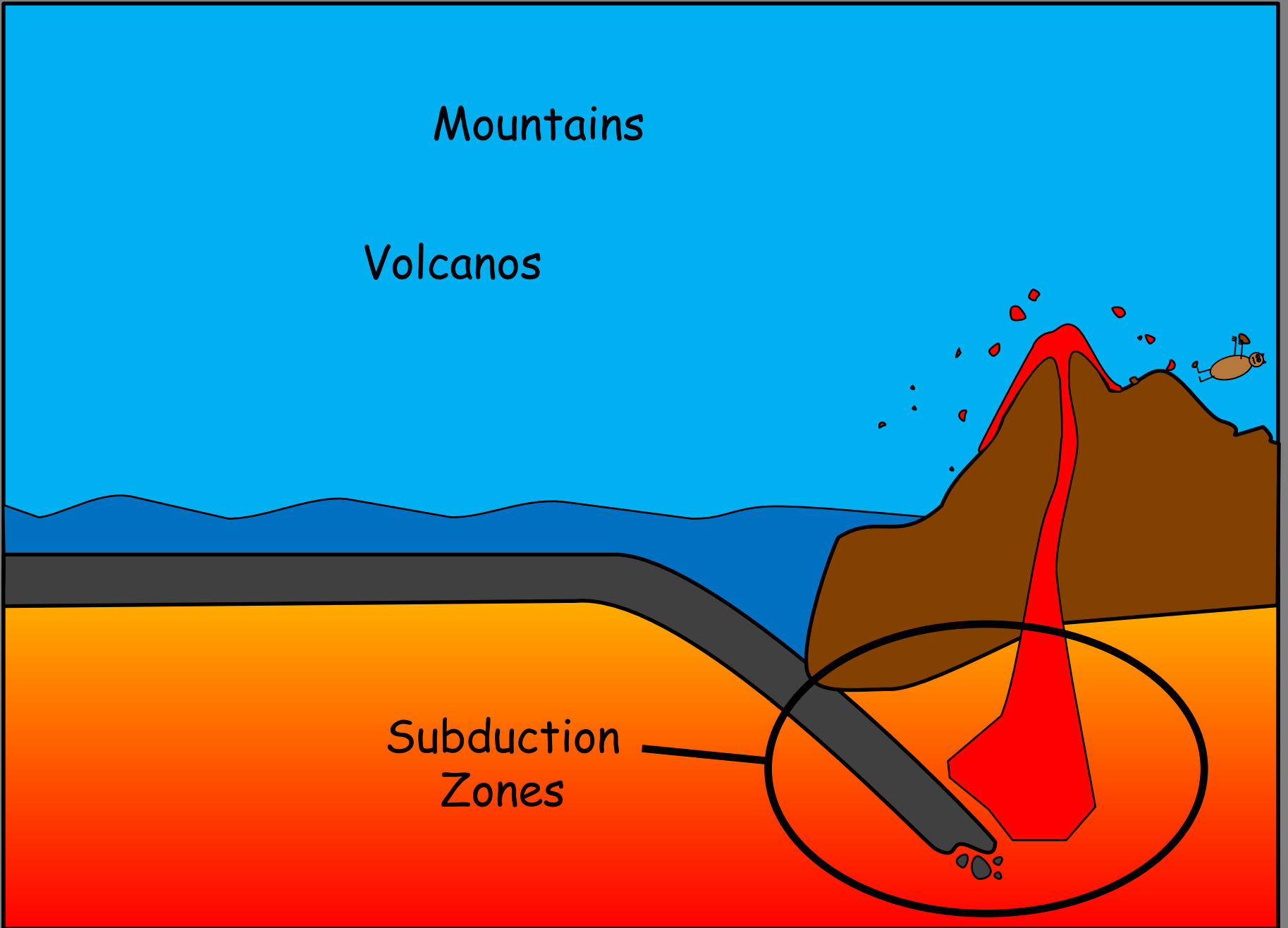
Subduction  
Zones



Mountains

Volcanos

Subduction  
Zones

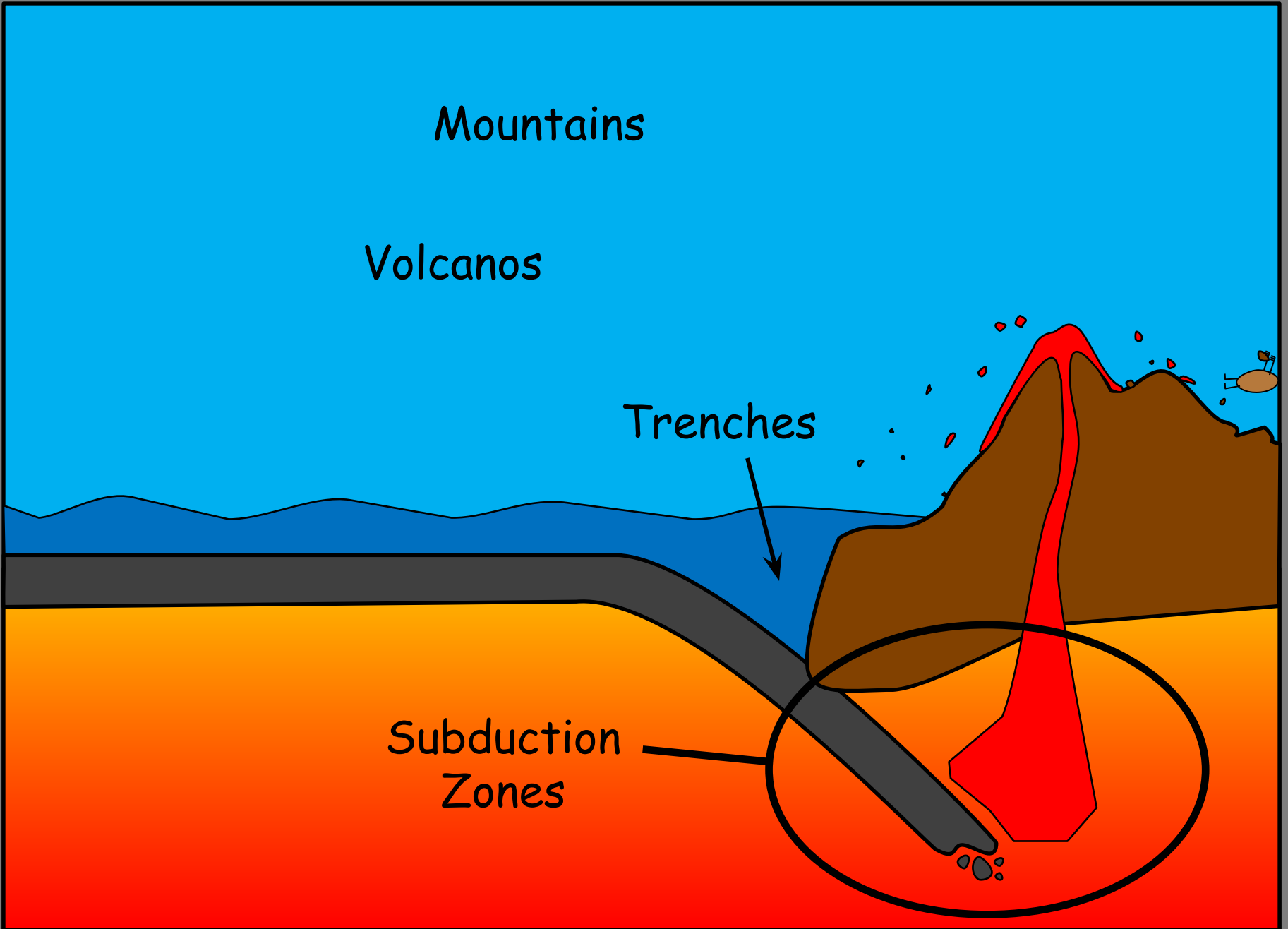


Mountains

Volcanos

Trenches

Subduction  
Zones

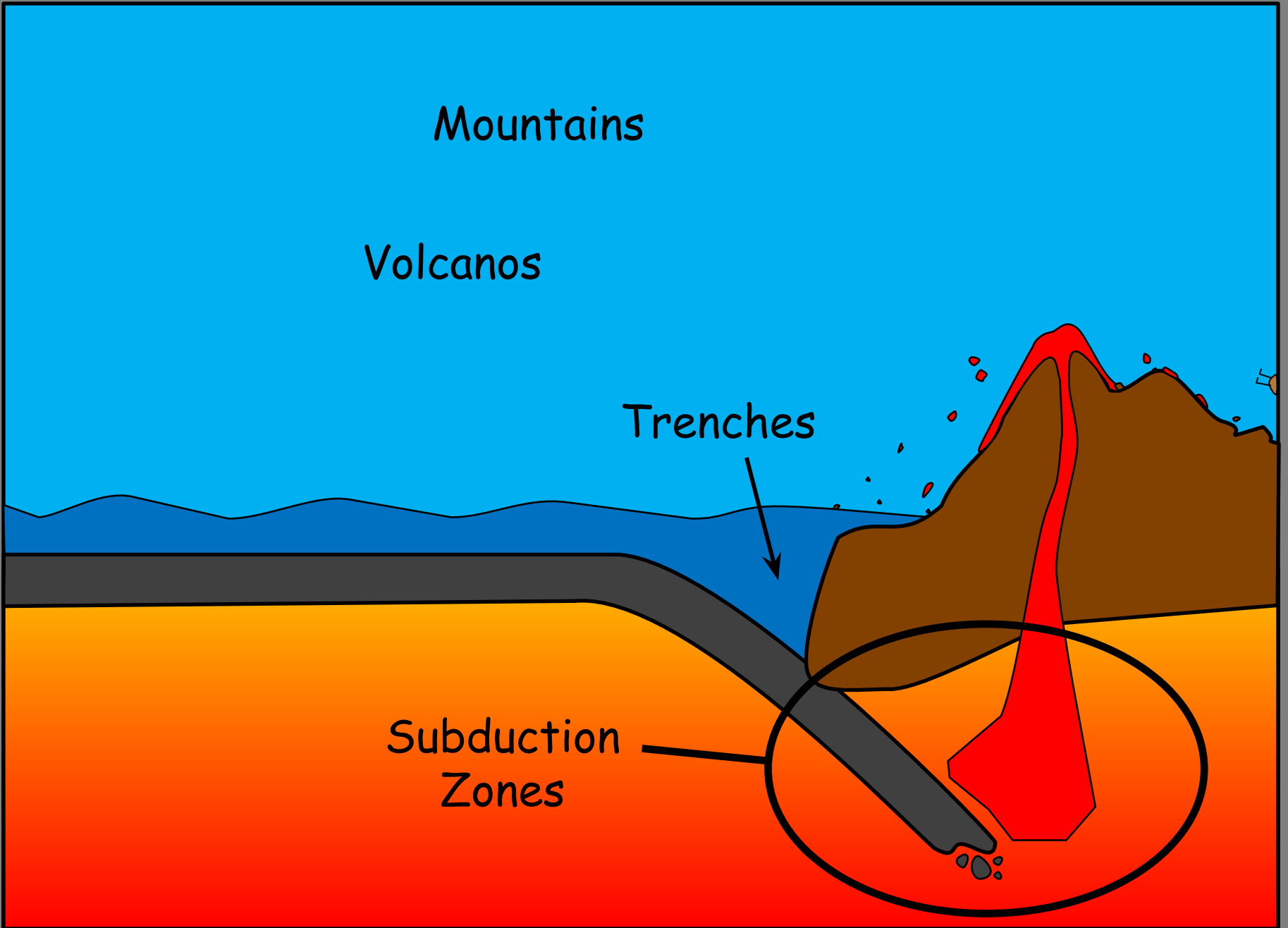


Mountains

Volcanos

Trenches

Subduction  
Zones

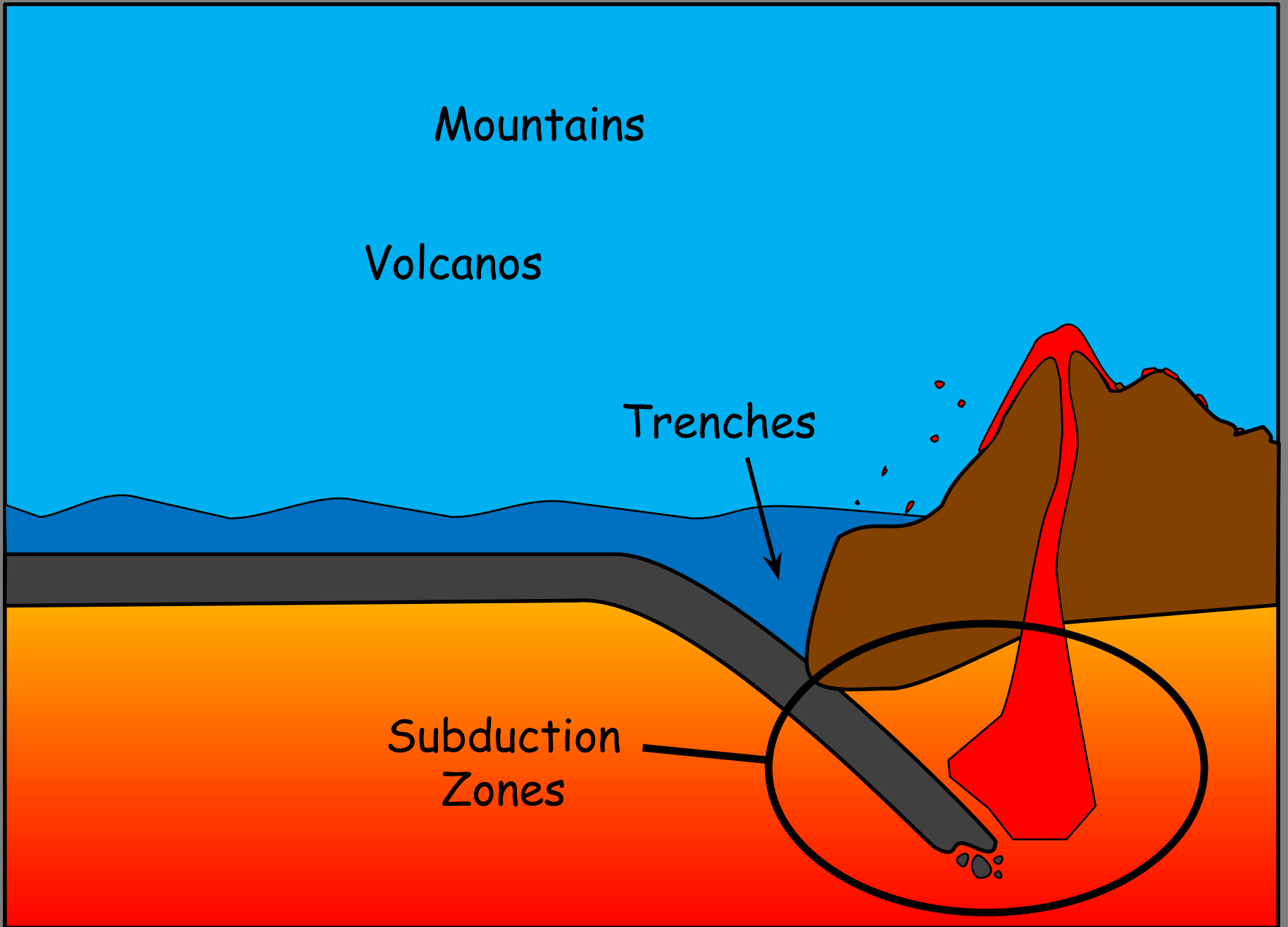


Mountains

Volcanos

Trenches

Subduction  
Zones

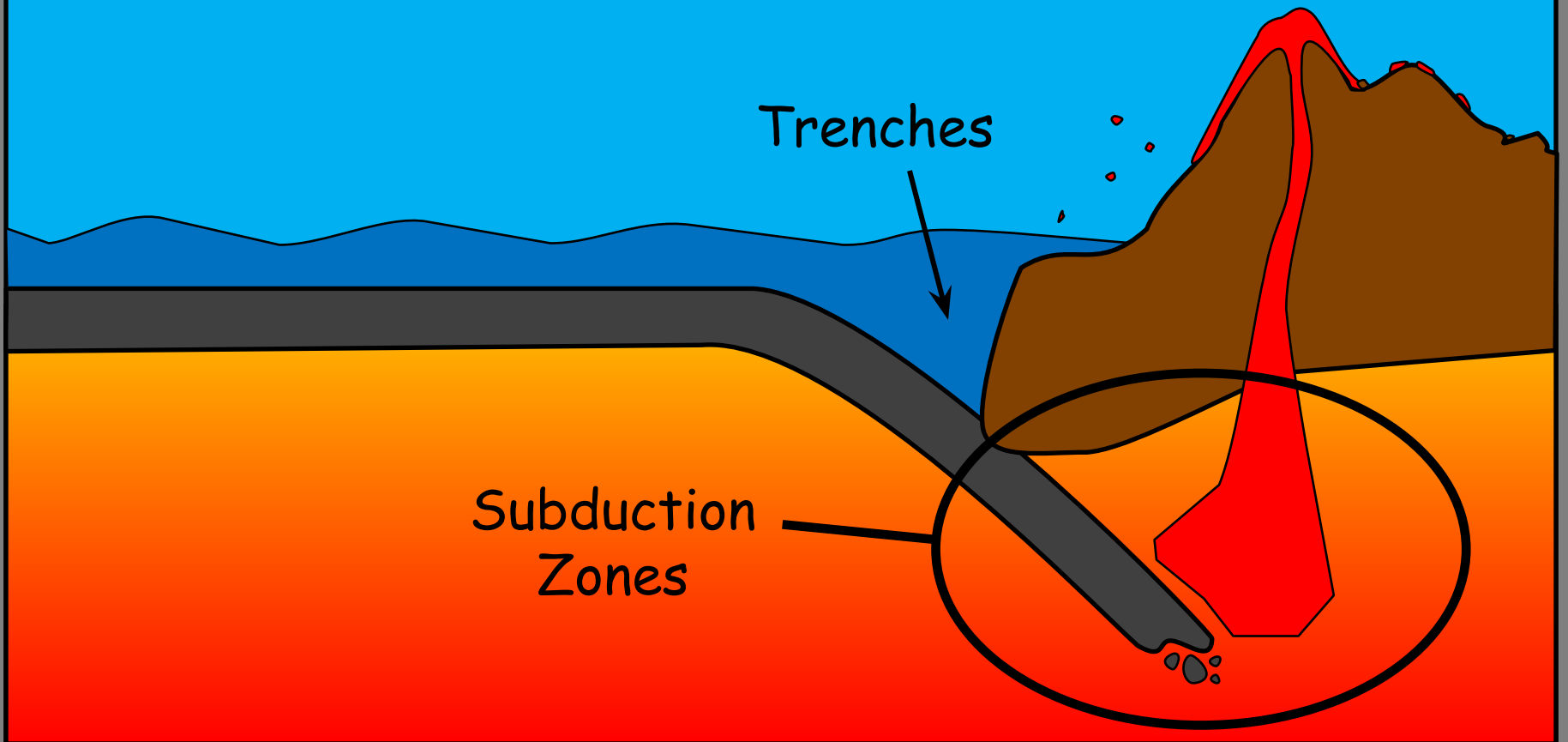


Mountains

Volcanos

Trenches

Subduction  
Zones

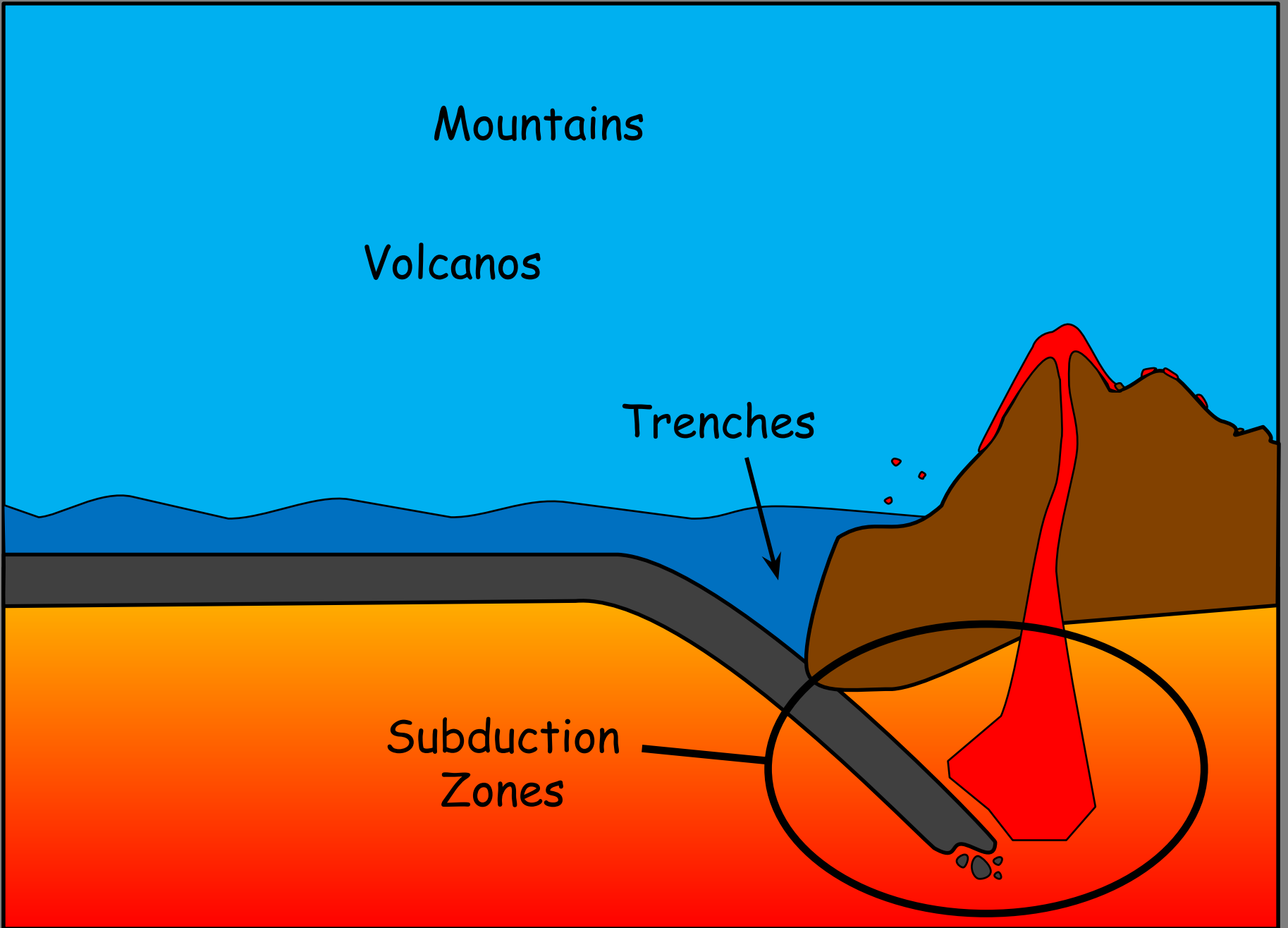


Mountains

Volcanos

Trenches

Subduction  
Zones

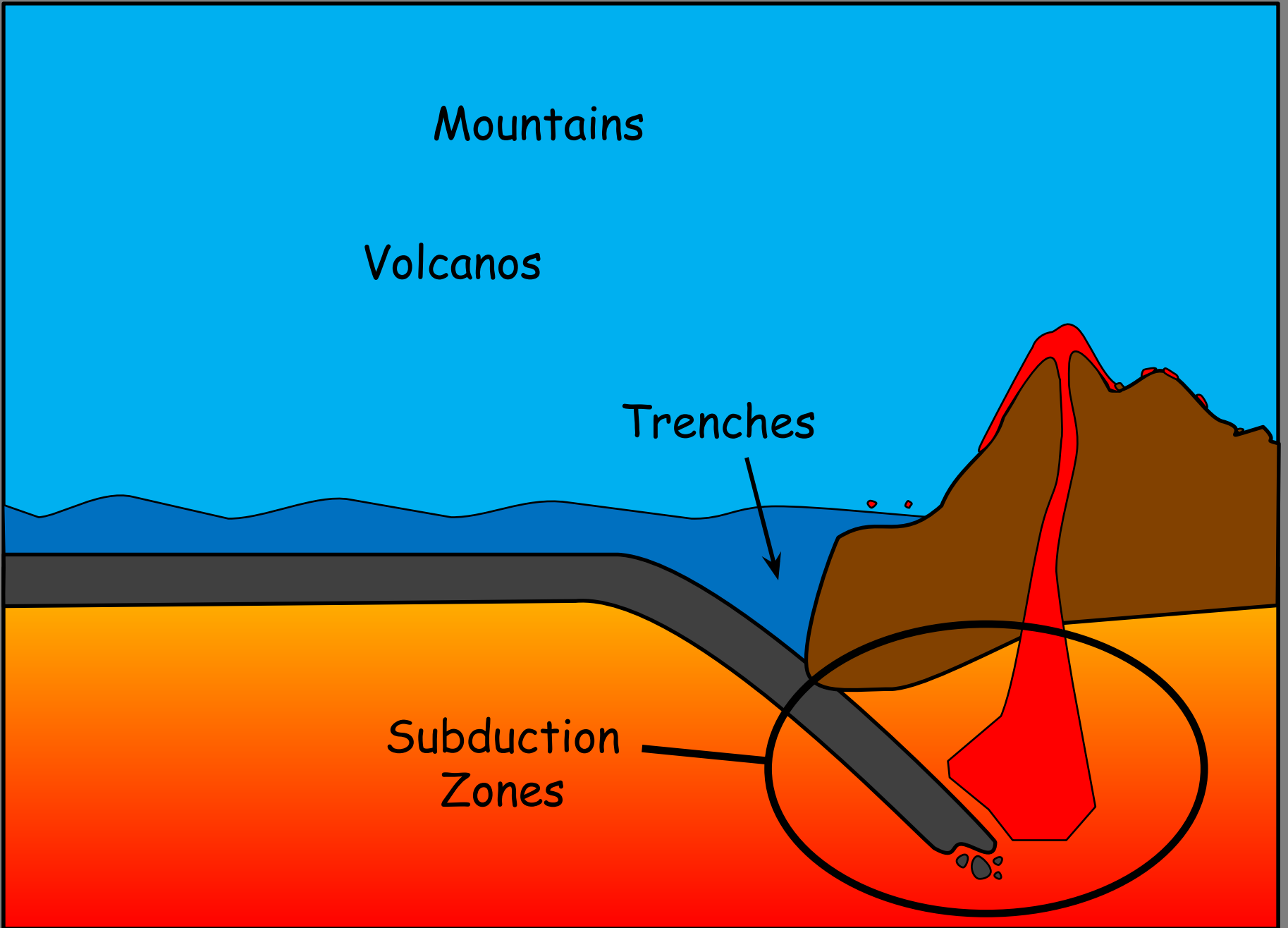


Mountains

Volcanos

Trenches

Subduction  
Zones



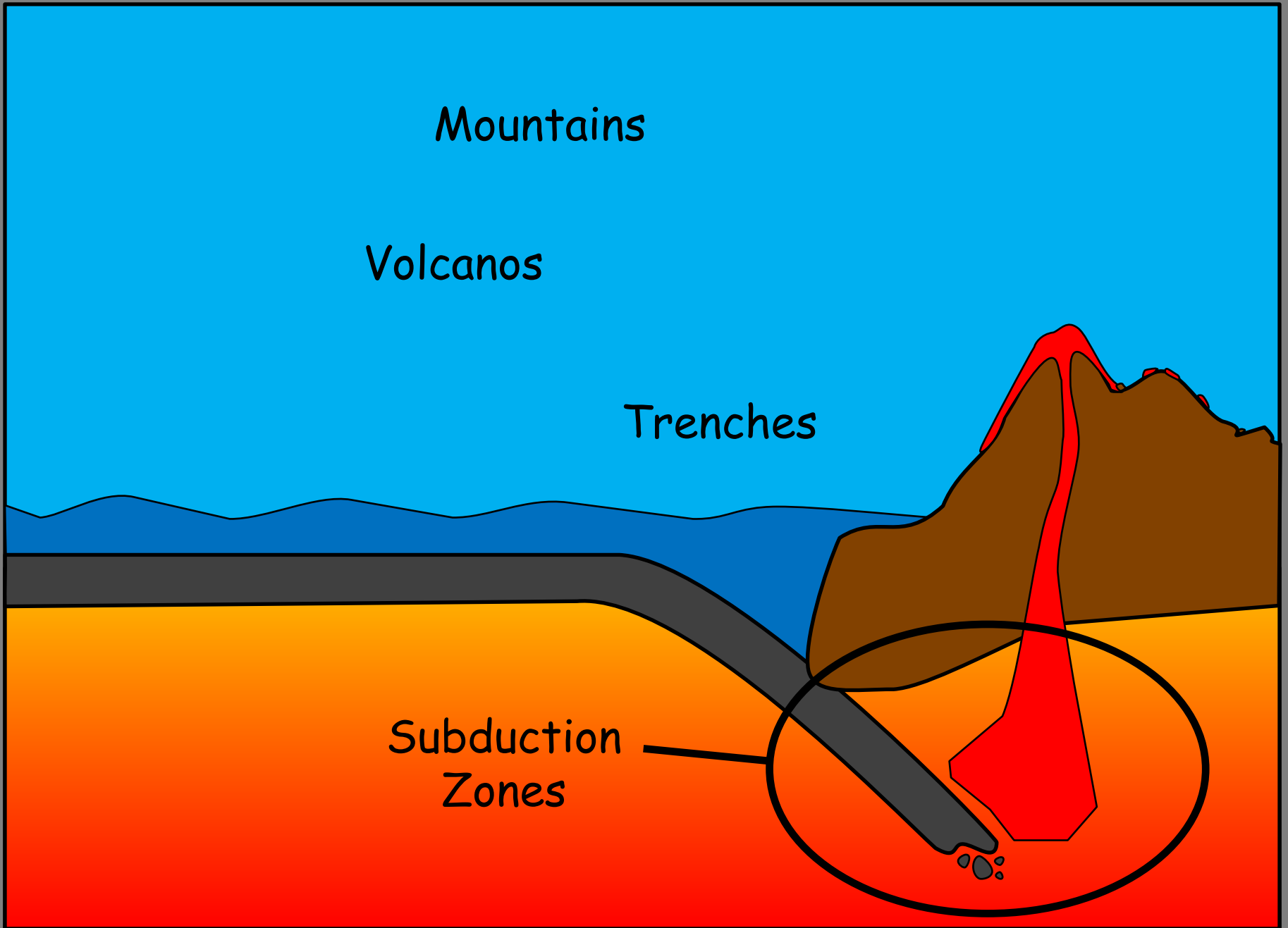


Mountains

Volcanos

Trenches

Subduction  
Zones



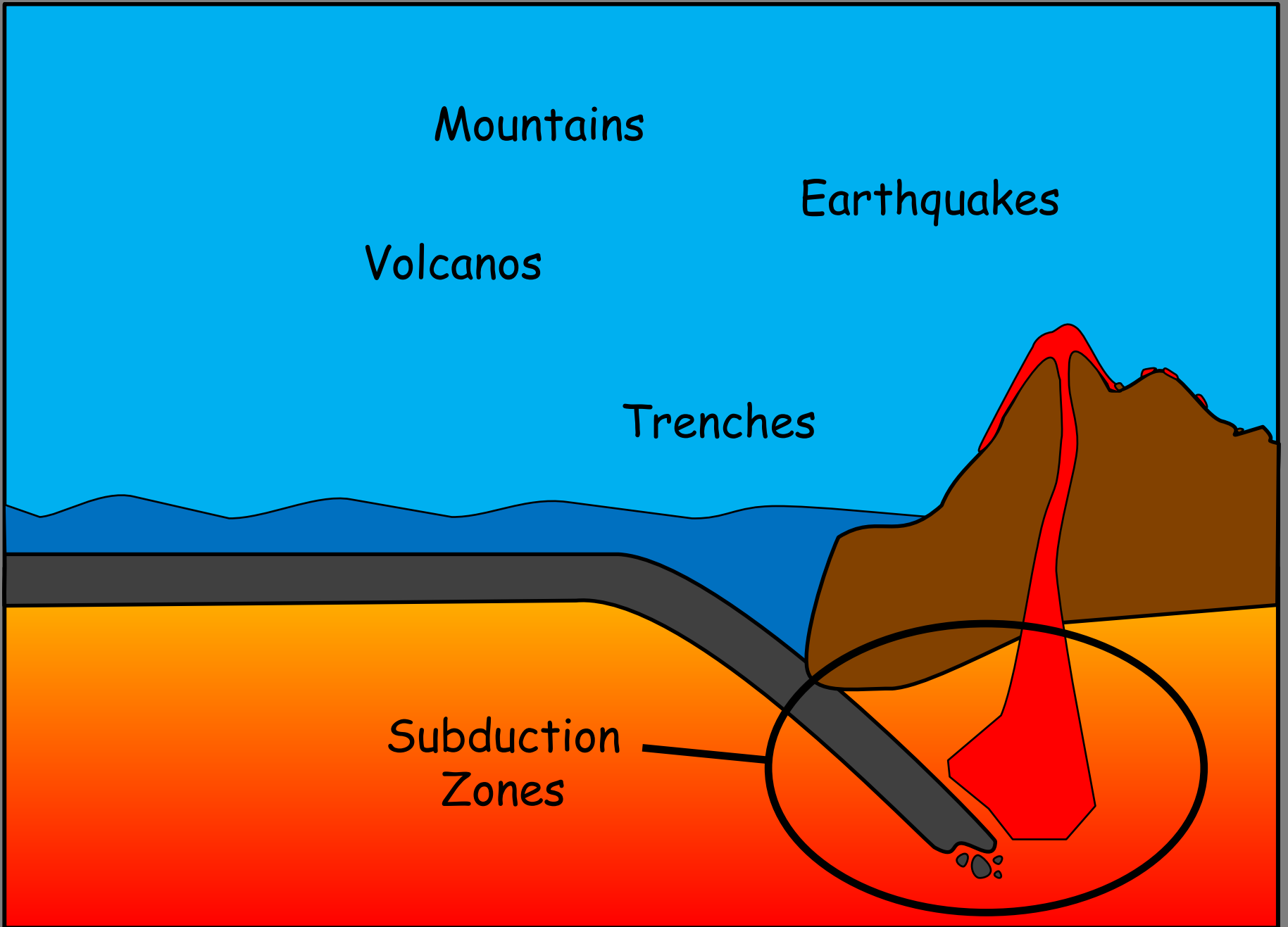
Mountains

Earthquakes

Volcanos

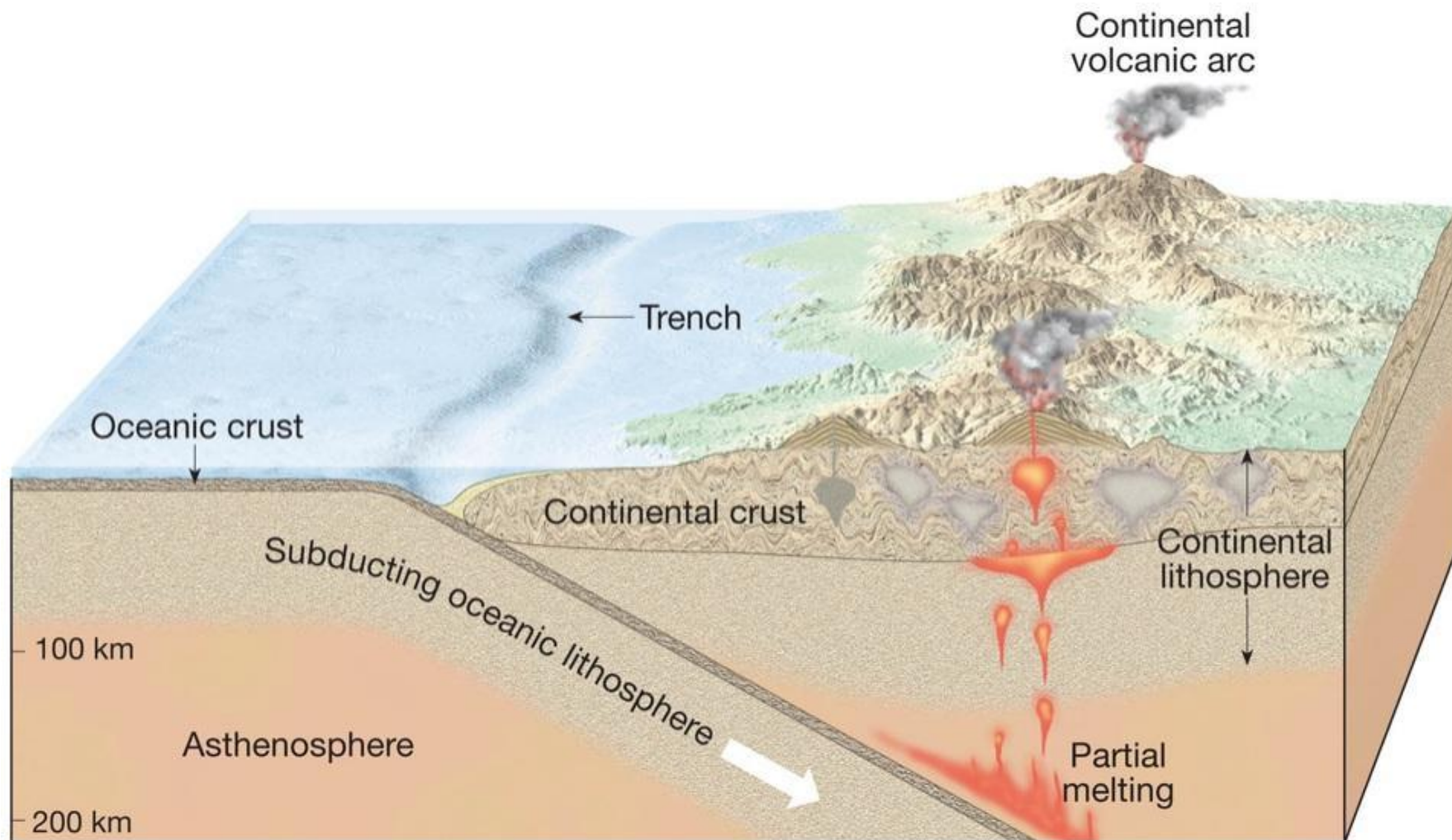
Trenches

Subduction  
Zones

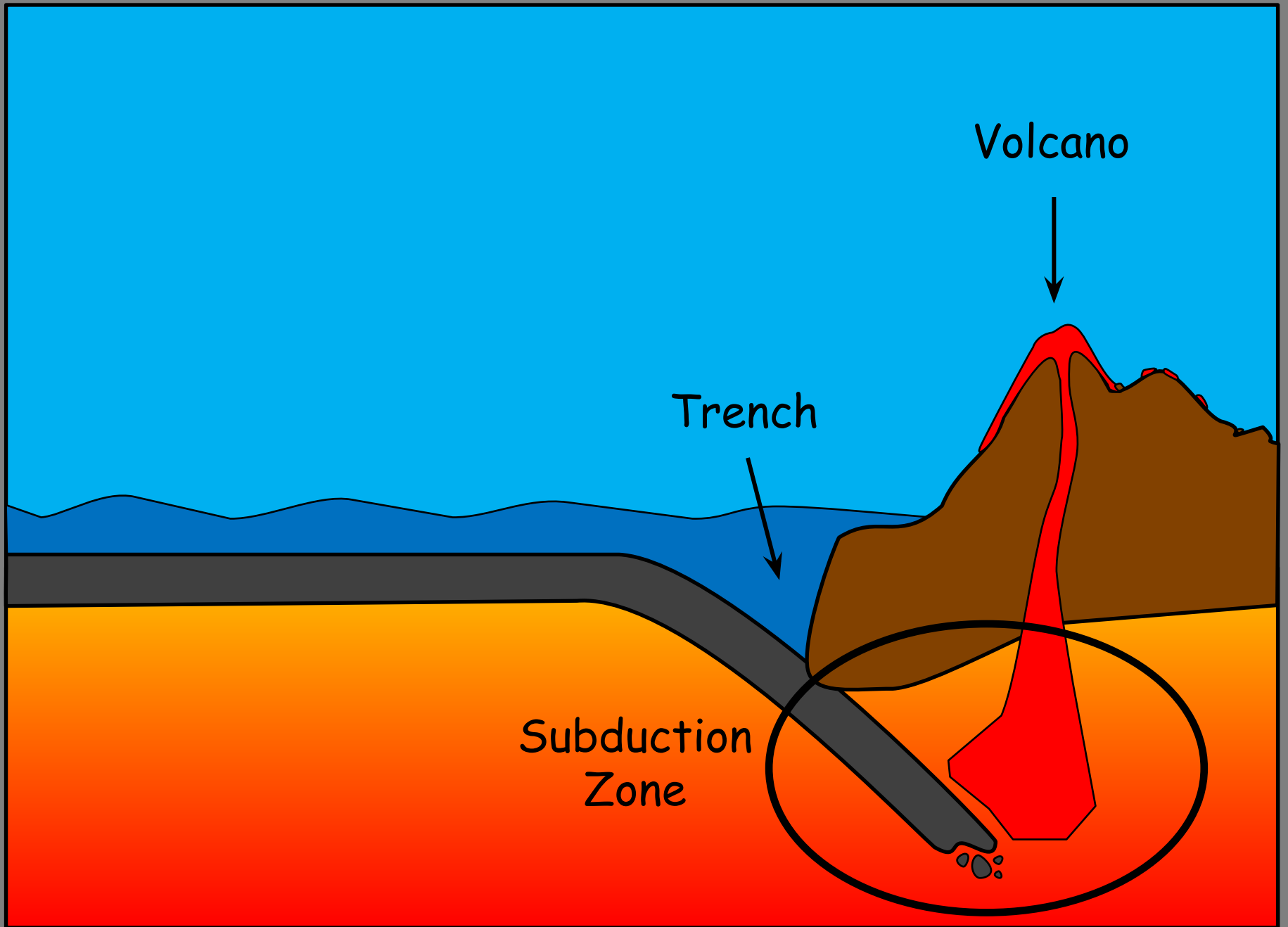










A. Oceanic-continental



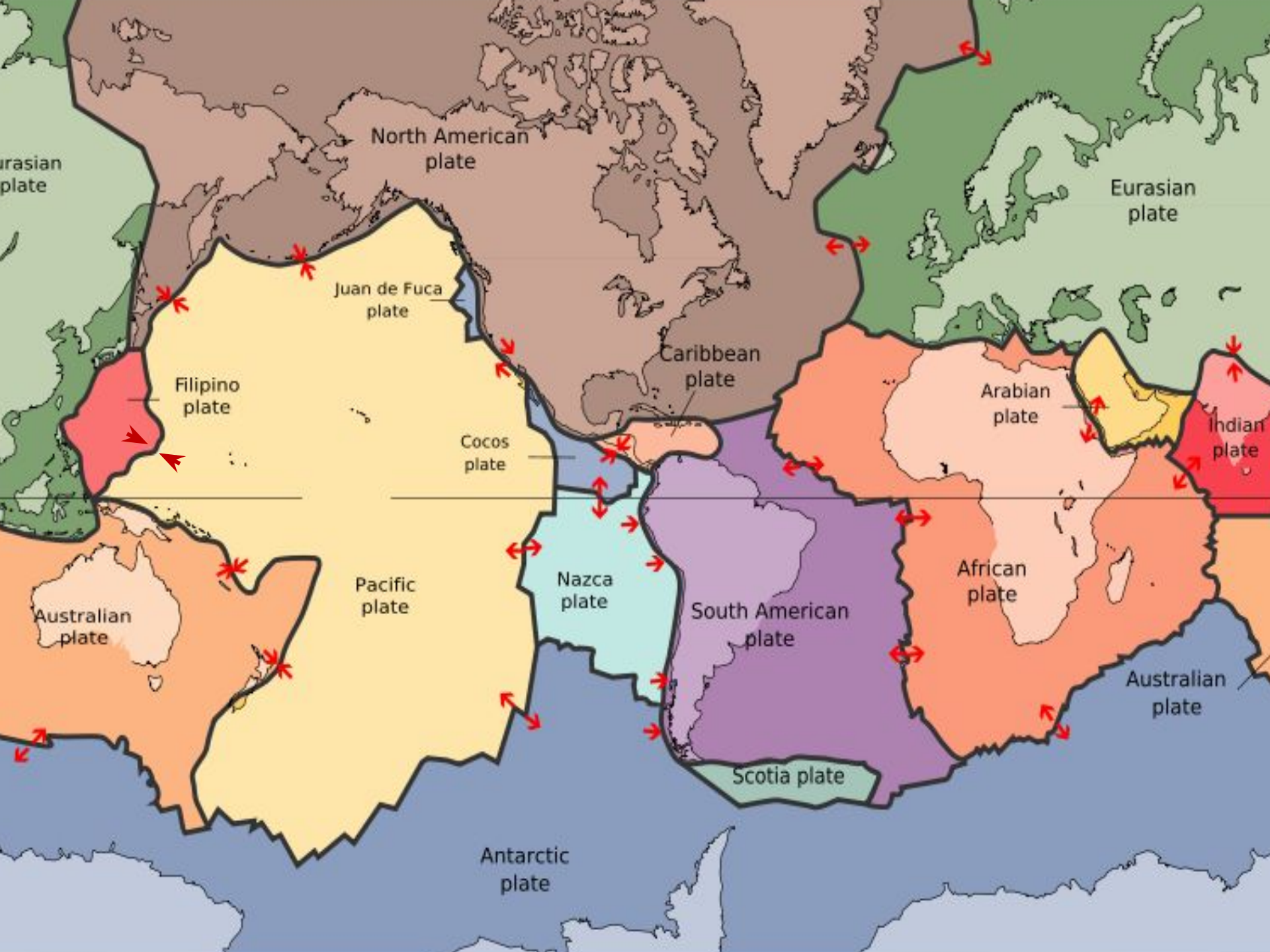
Volcano

Trench



Subduction  
Zone

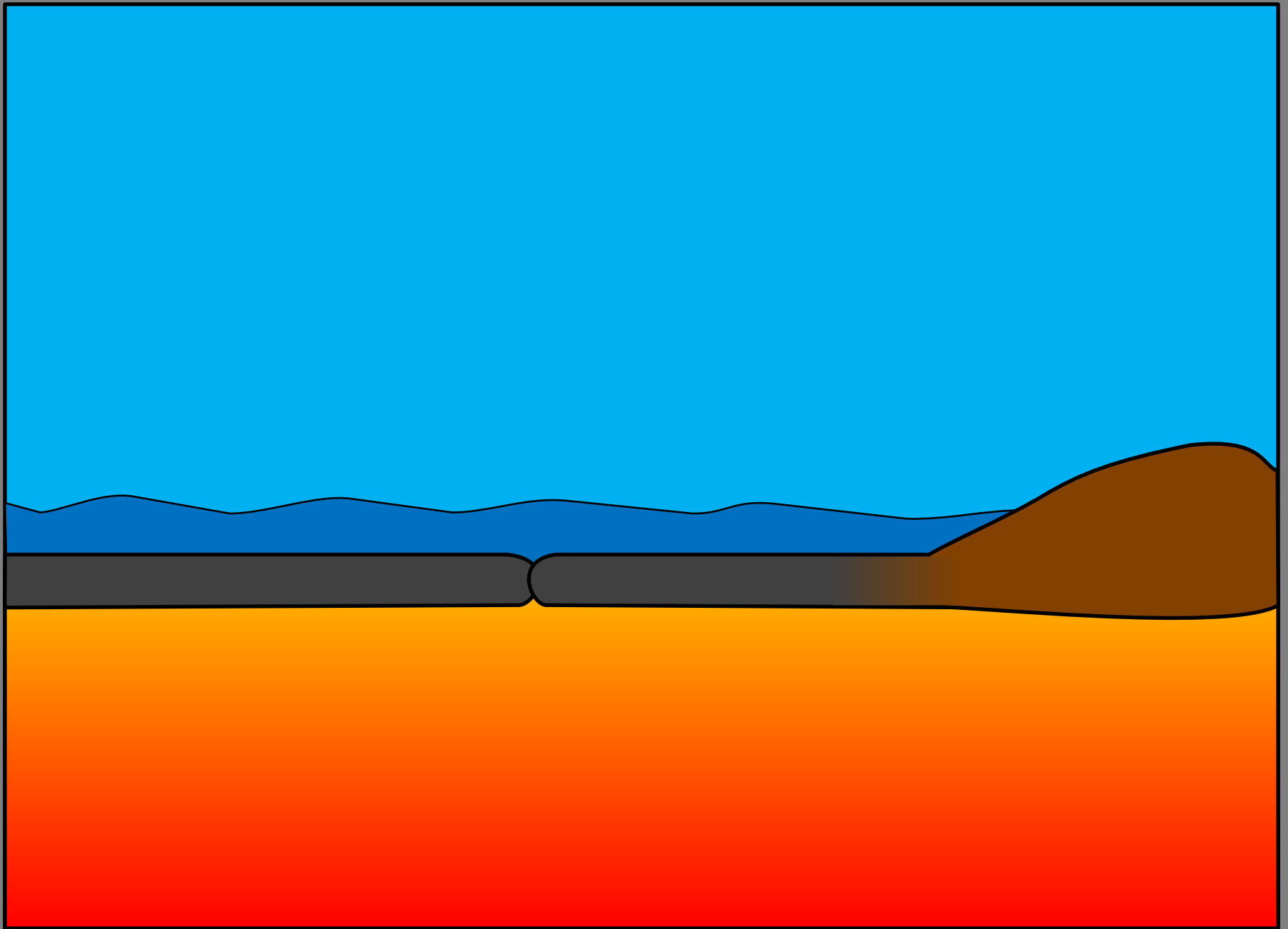
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
<b>Convergent</b> (Ocean vs. Ocean)	Oceanic crust collides with oceanic crust		

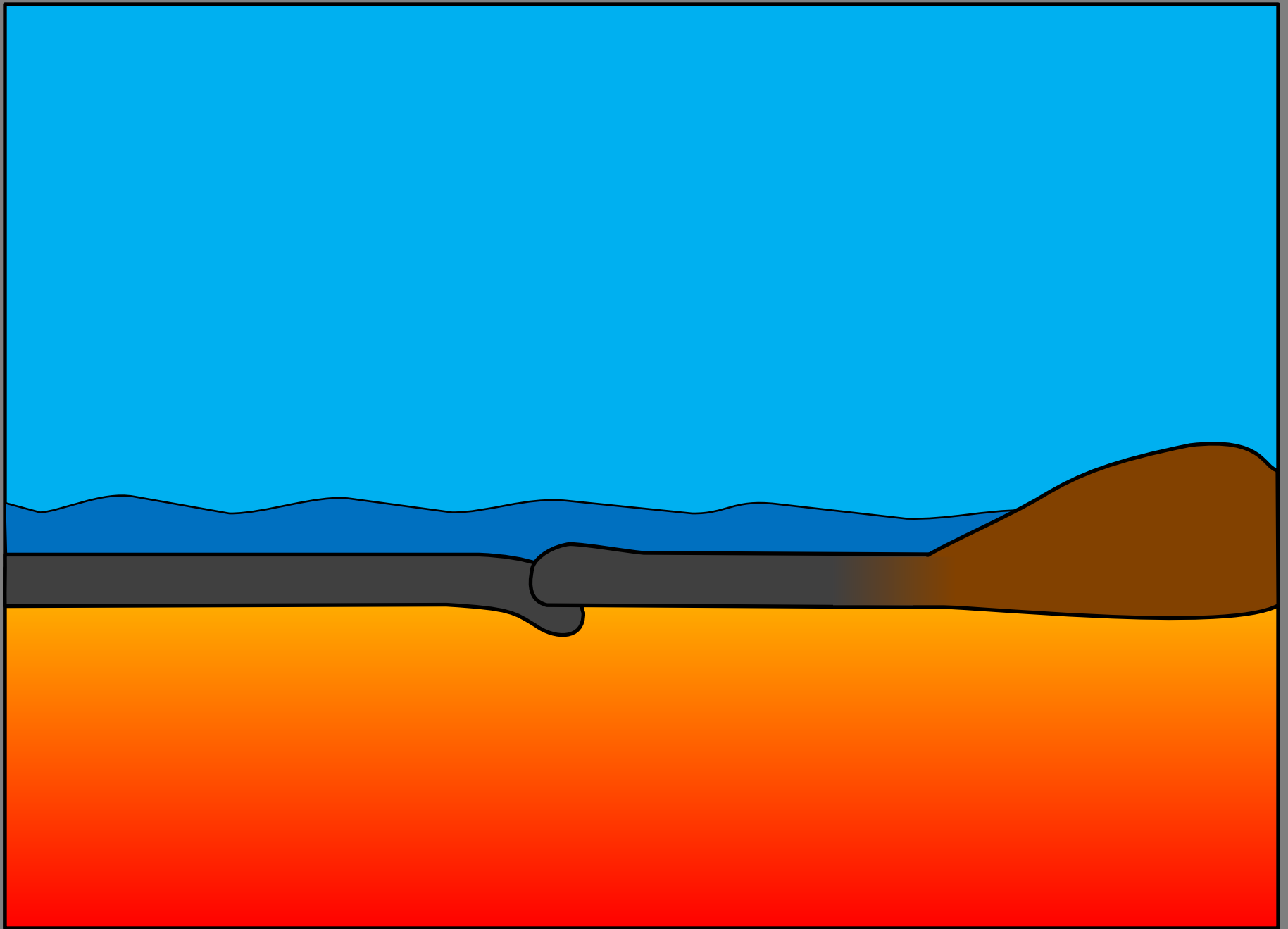
Oceanic crust collides with oceanic crust

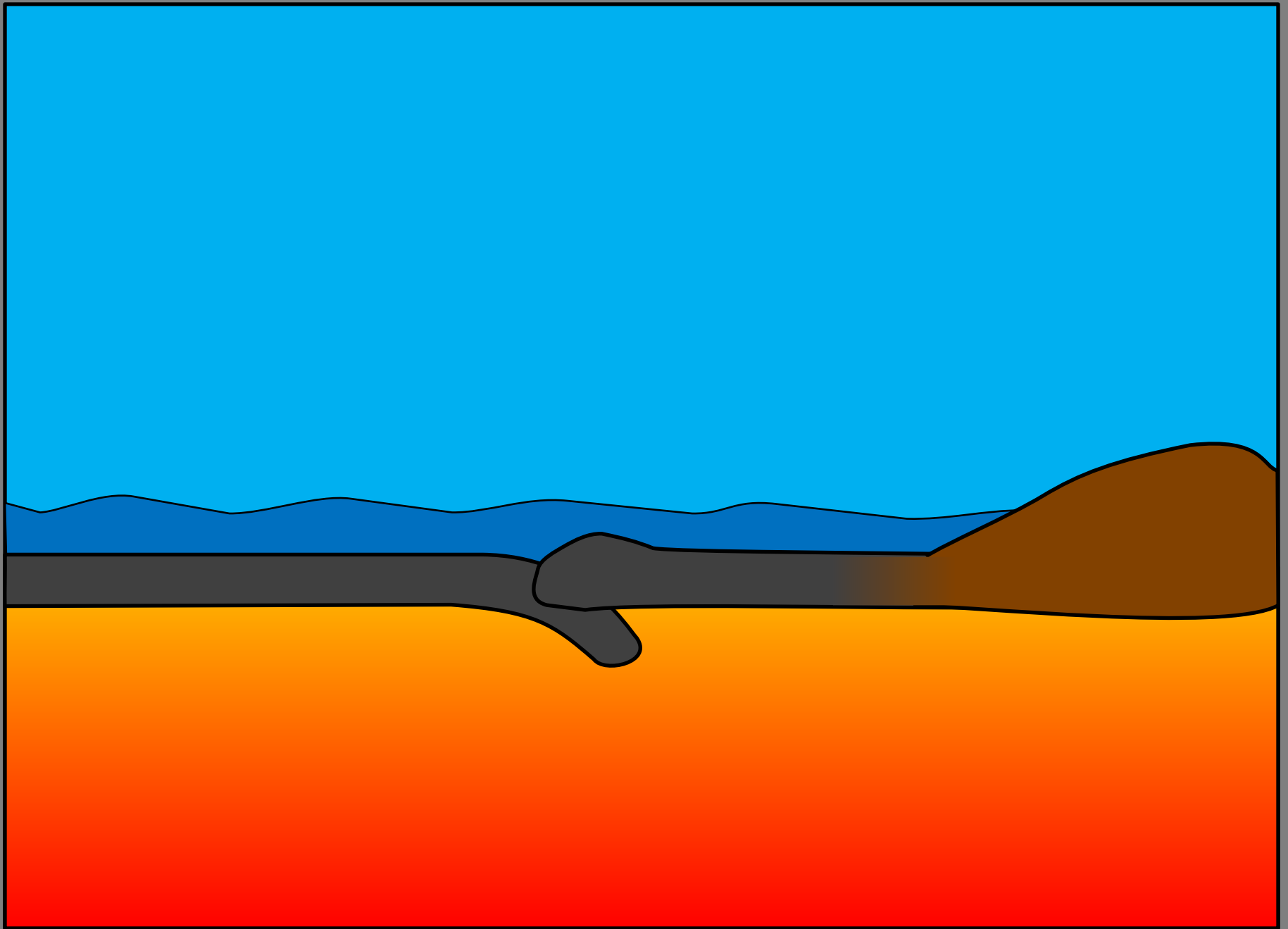


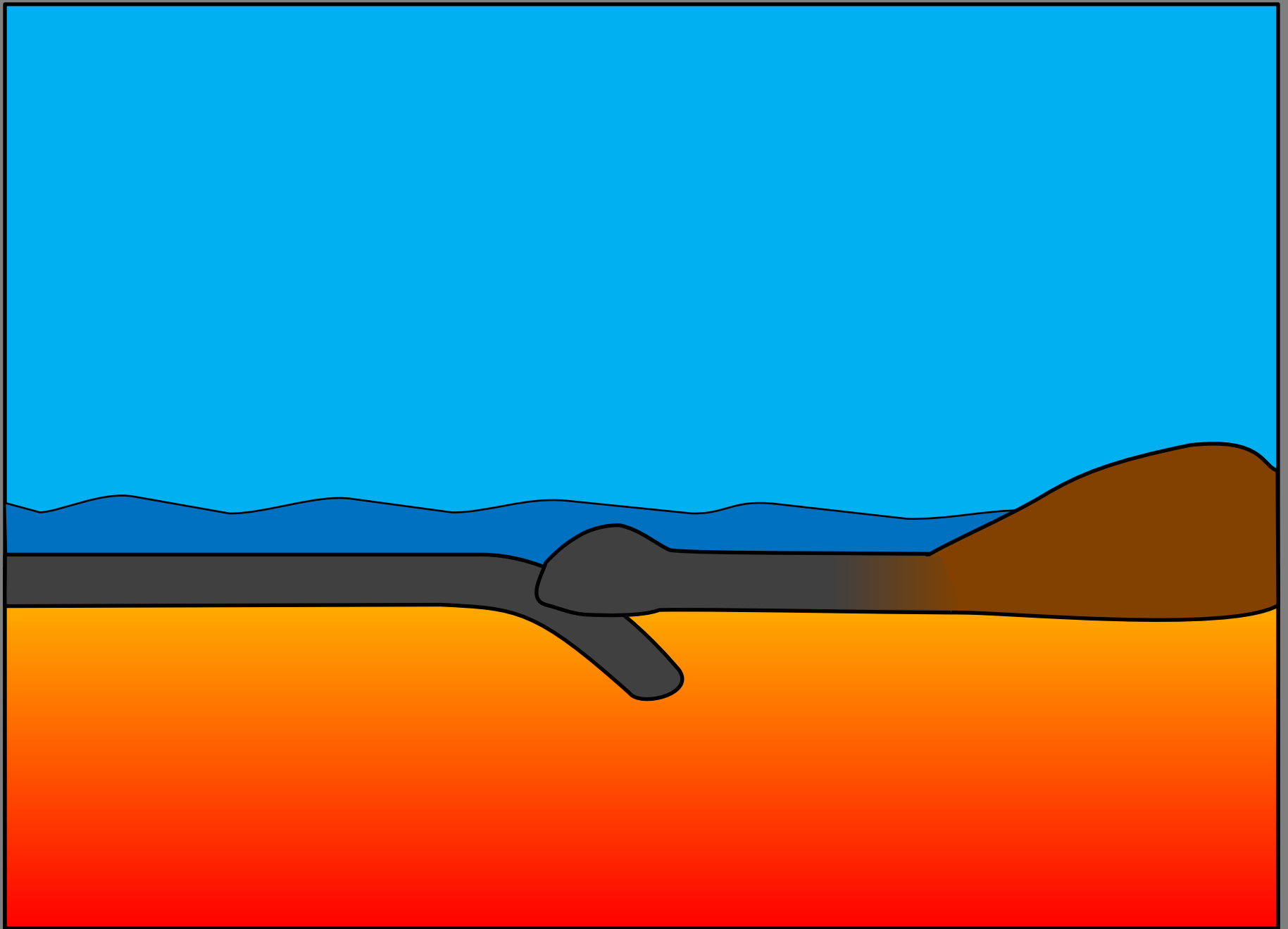


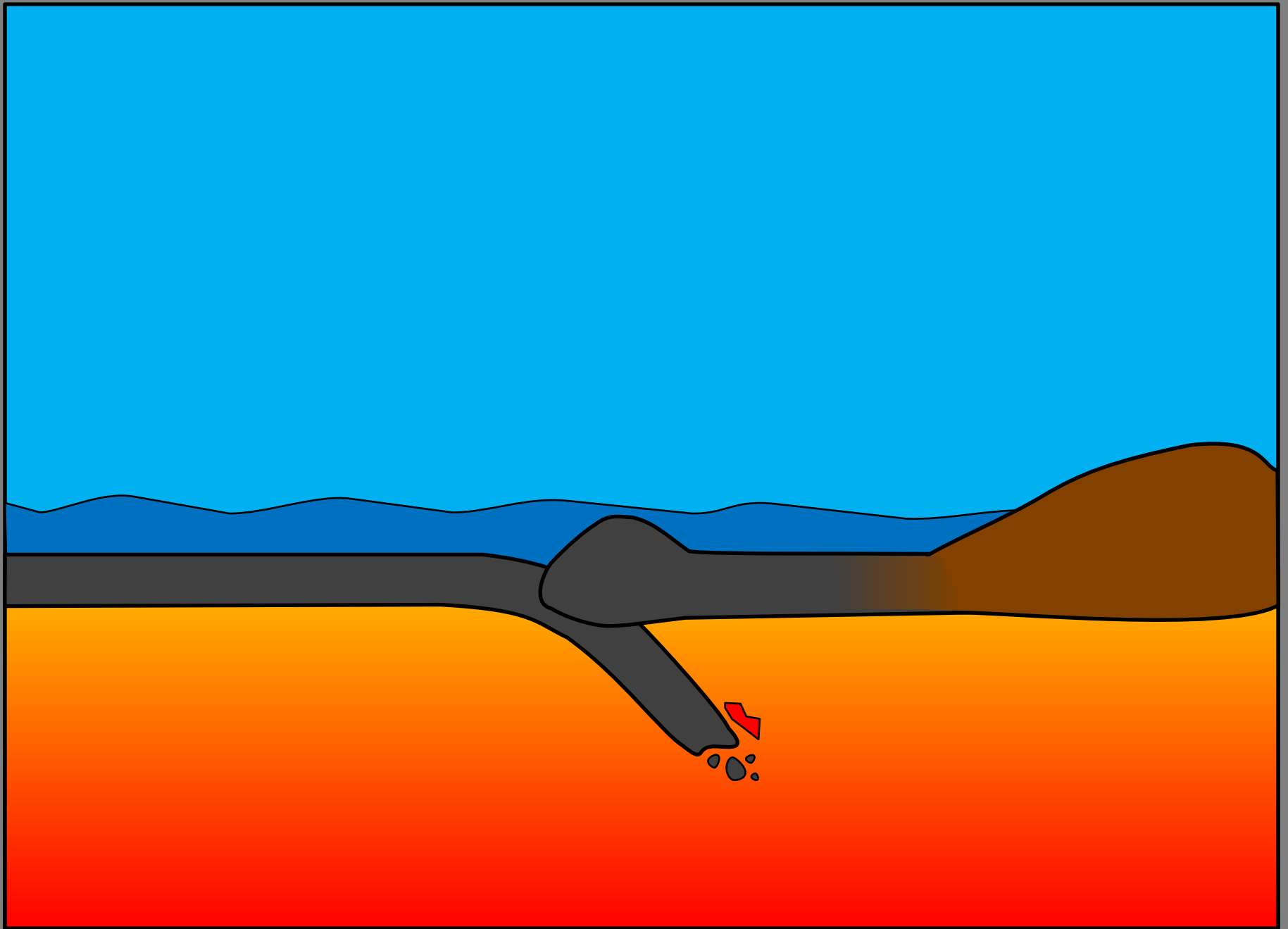
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
<b>Convergent</b> (Ocean vs. Ocean)	Oceanic crust collides with oceanic crust		

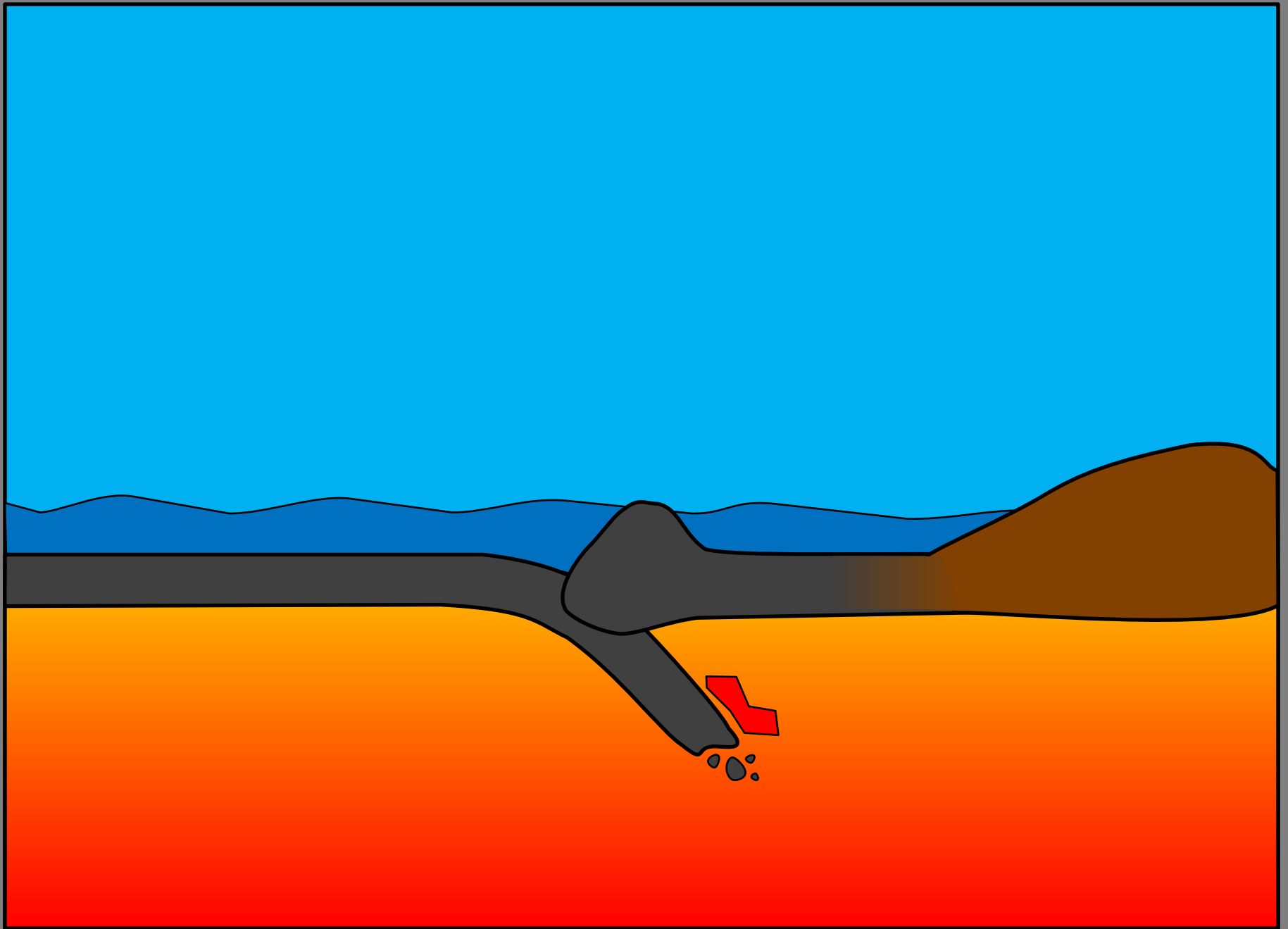




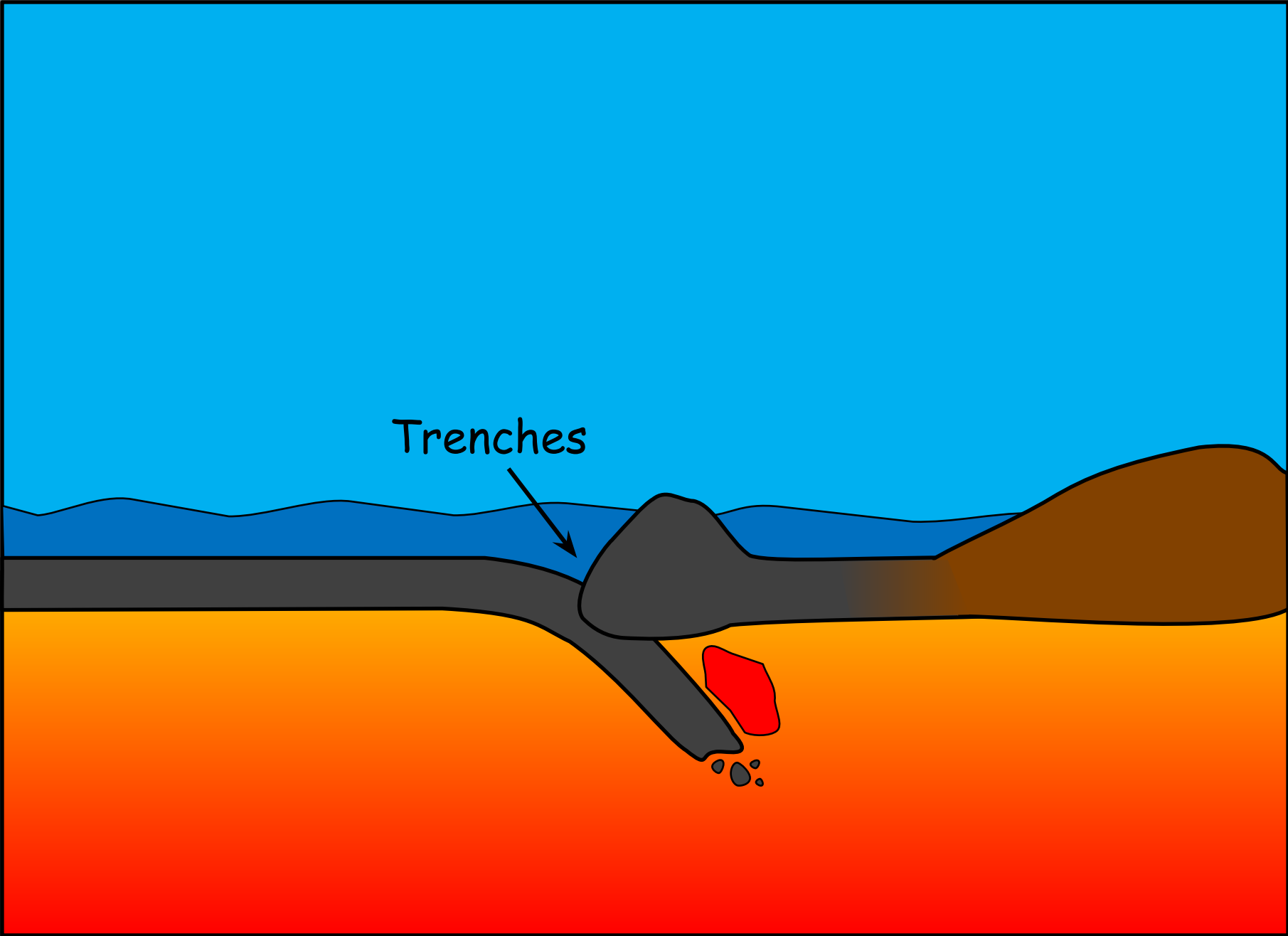






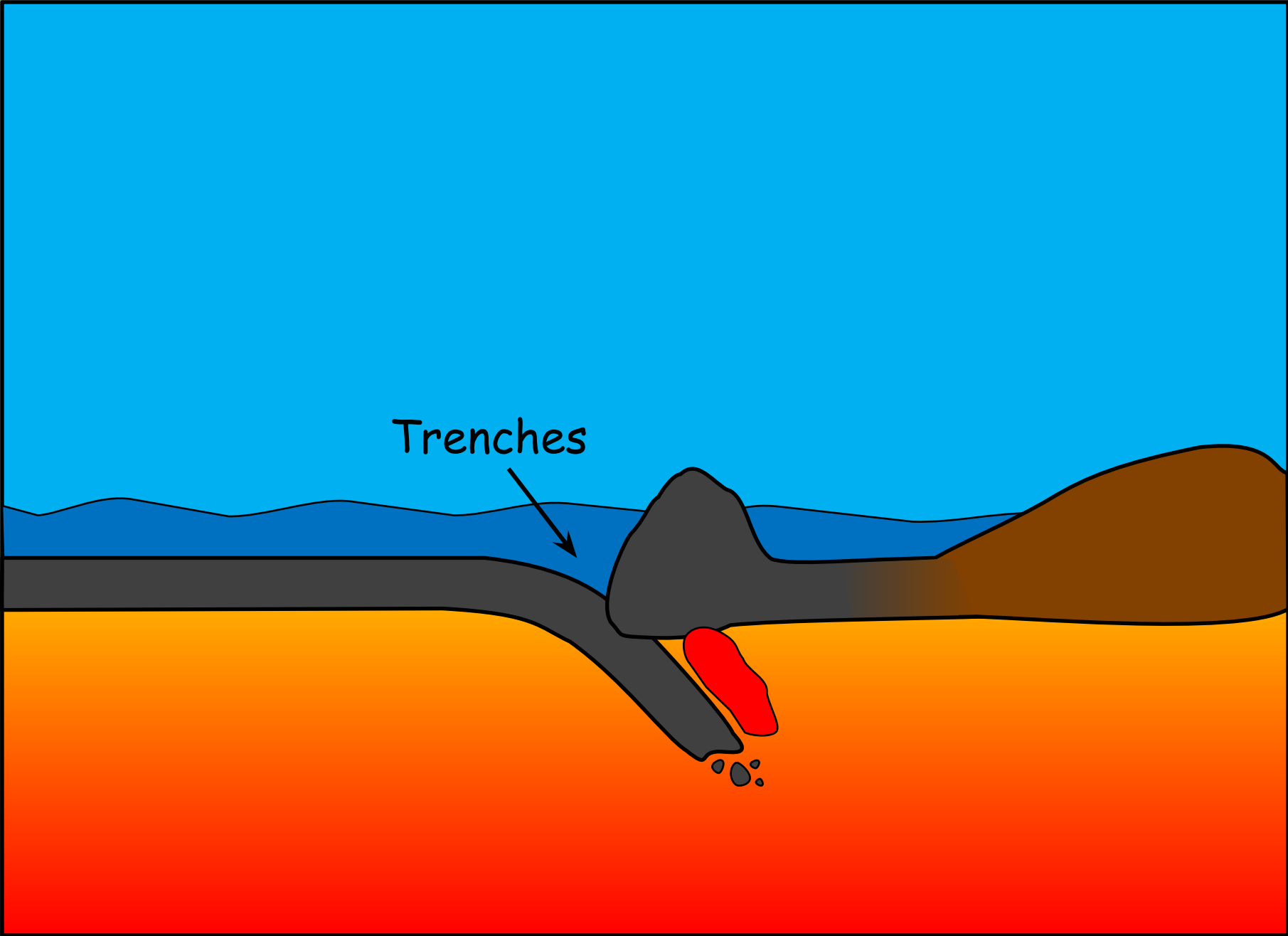


Trenches

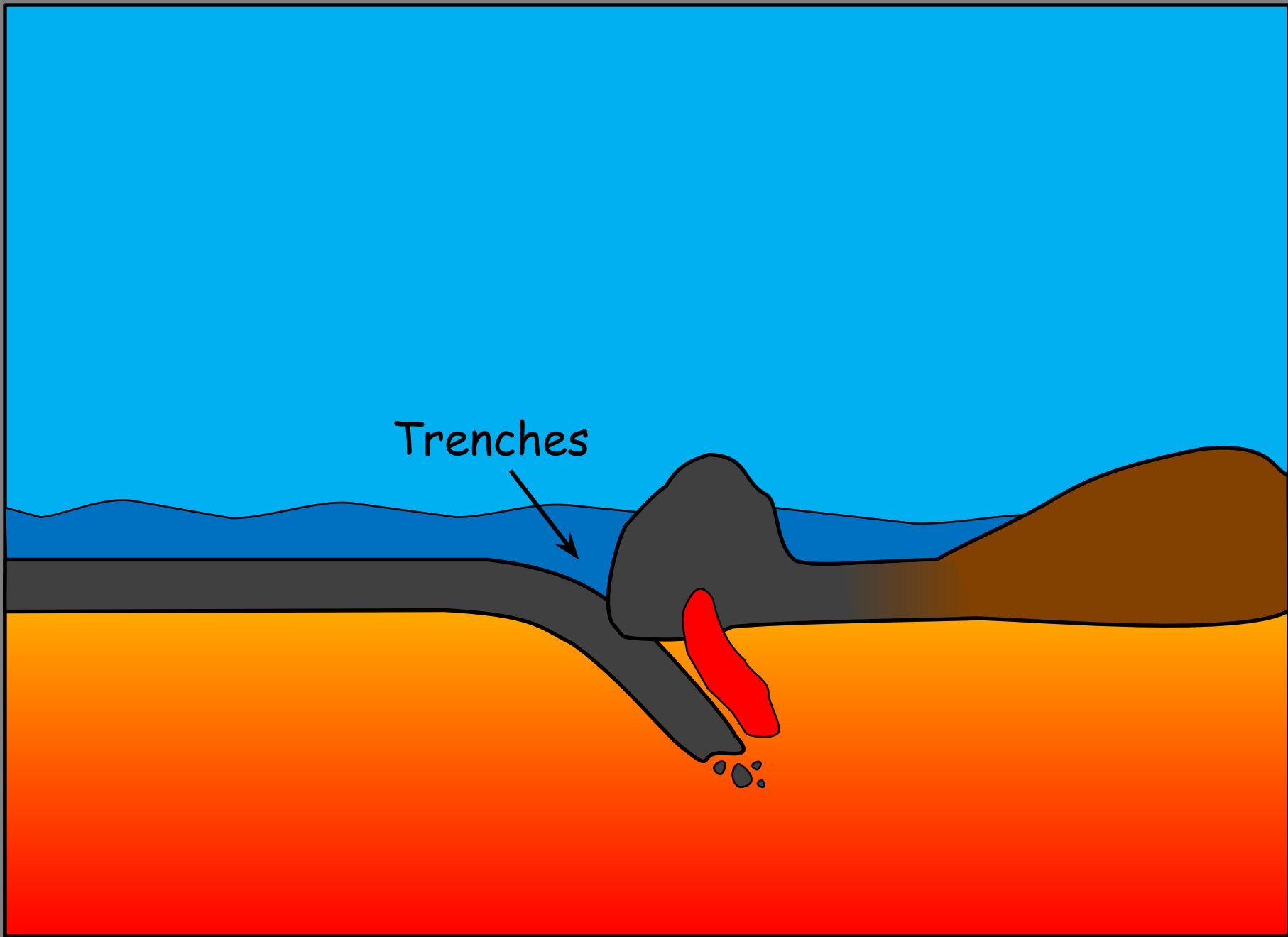




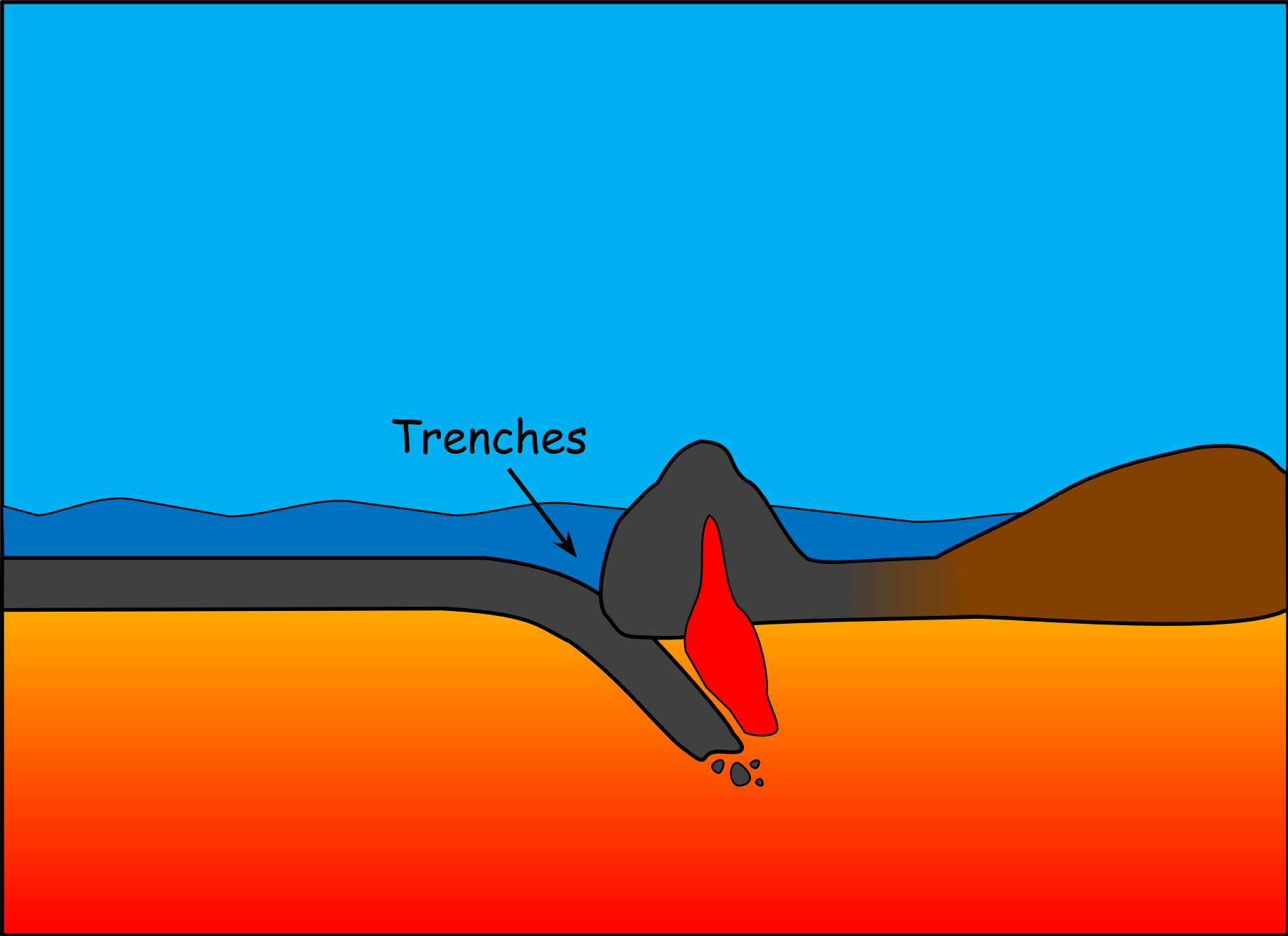
Trenches



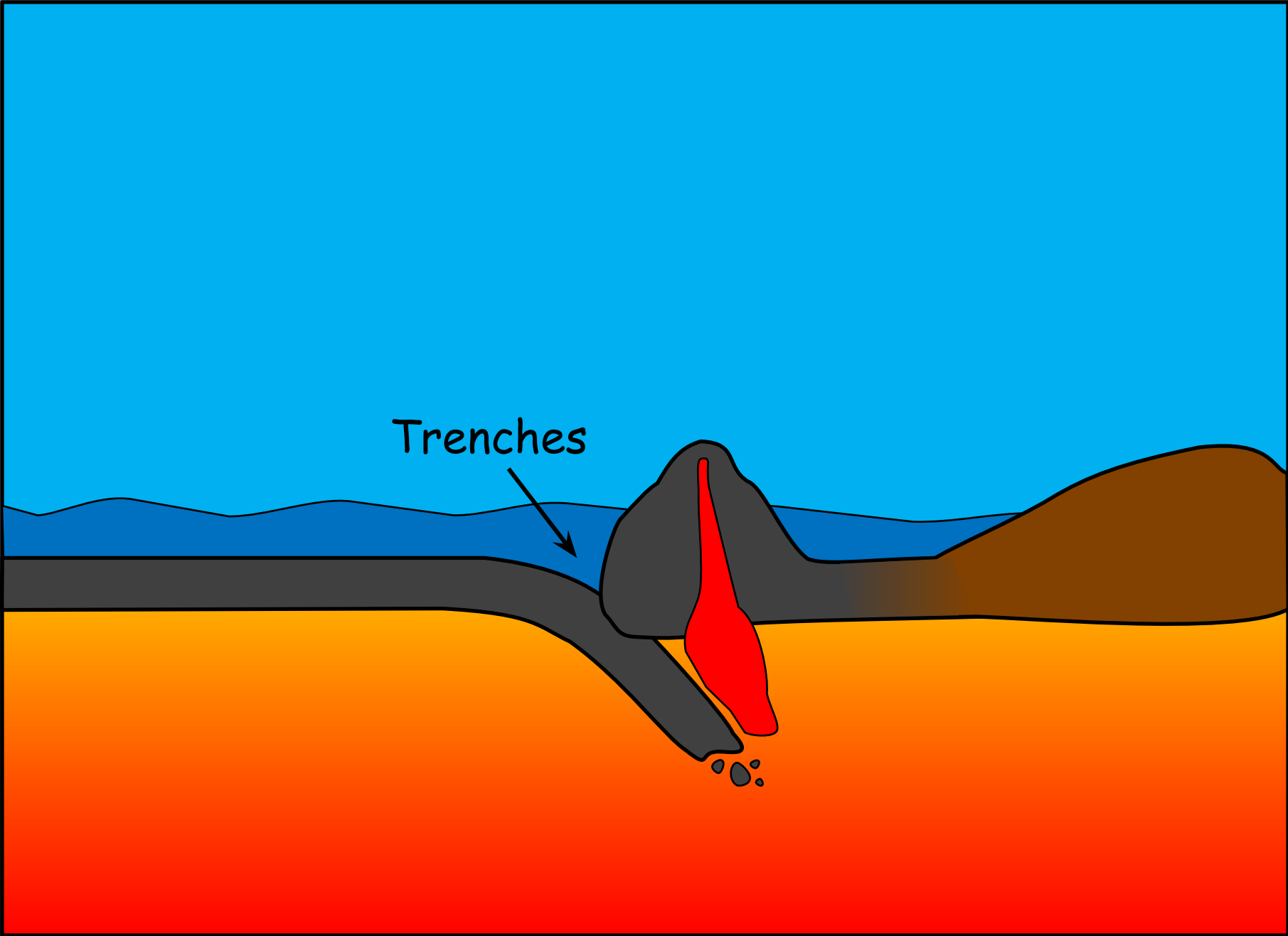
Trenches



Trenches



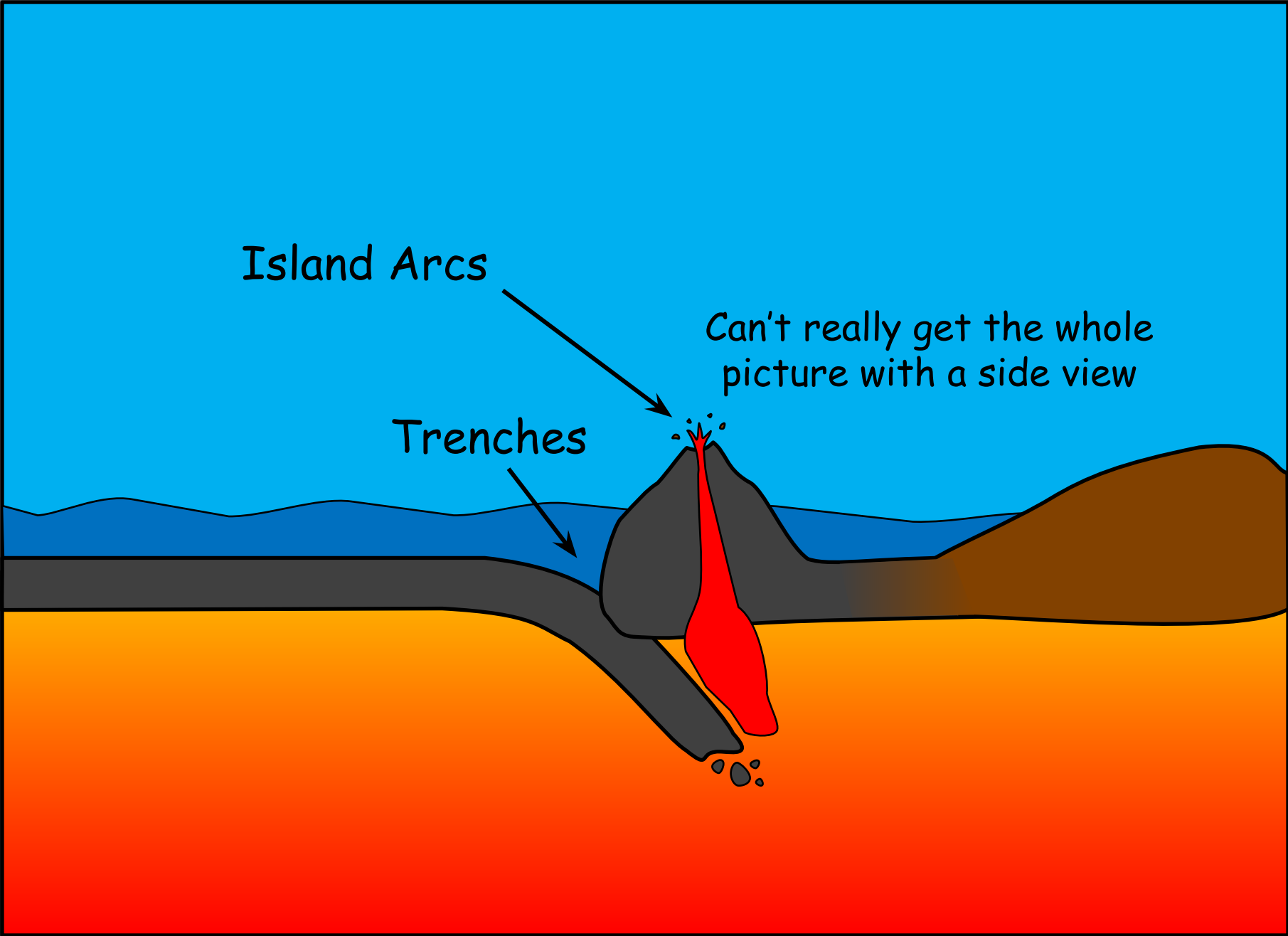
Trenches

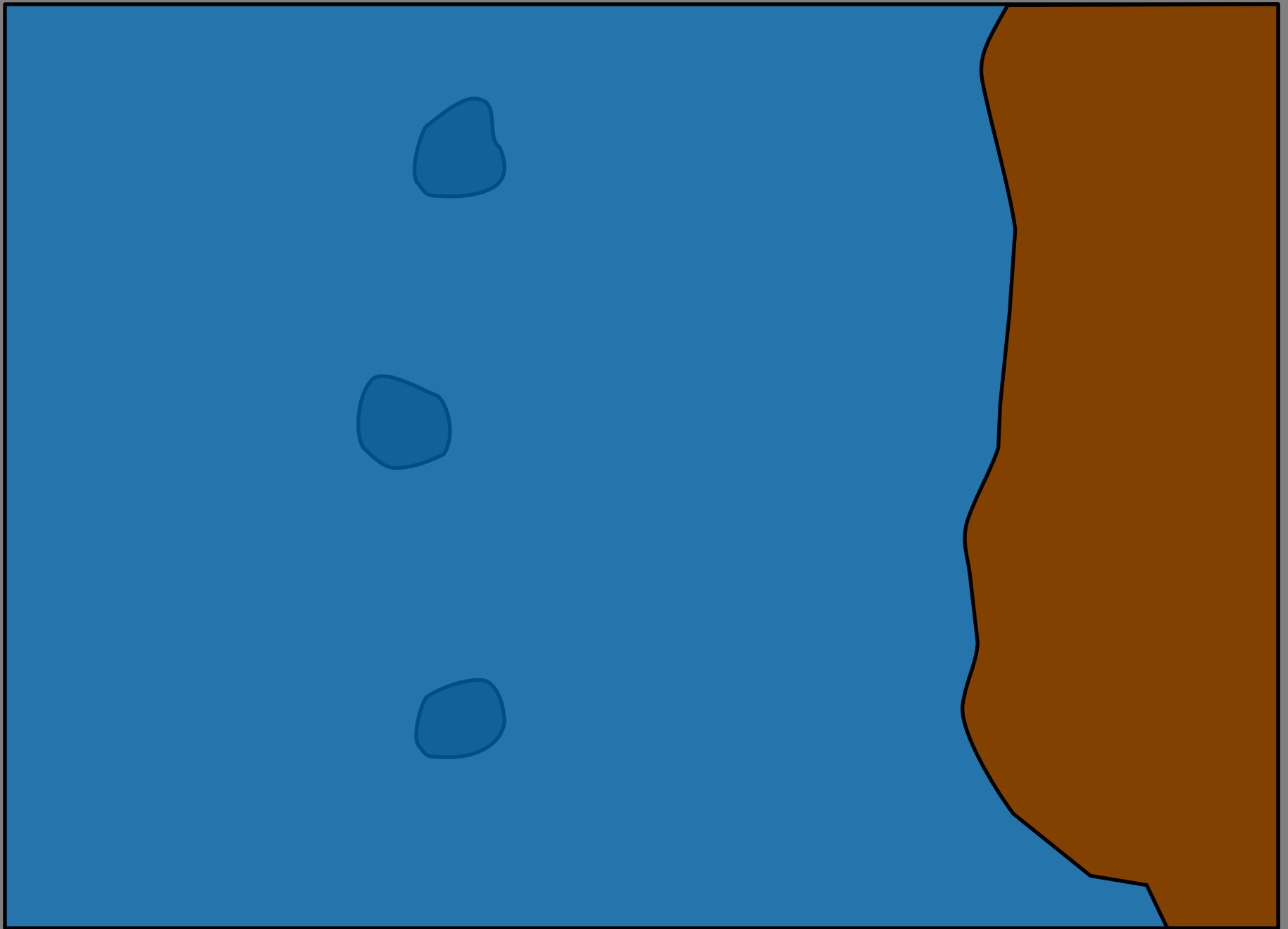


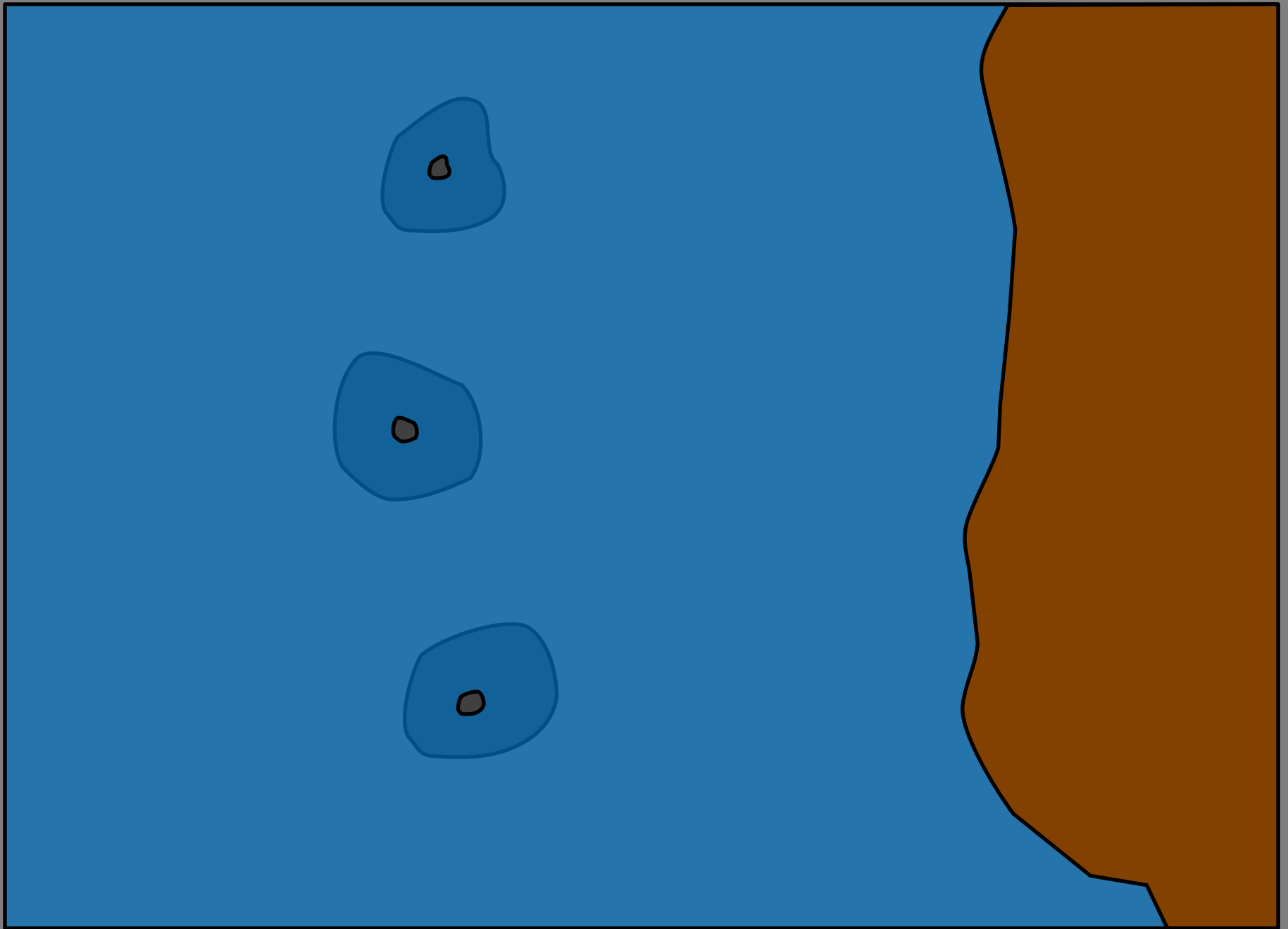
Island Arcs

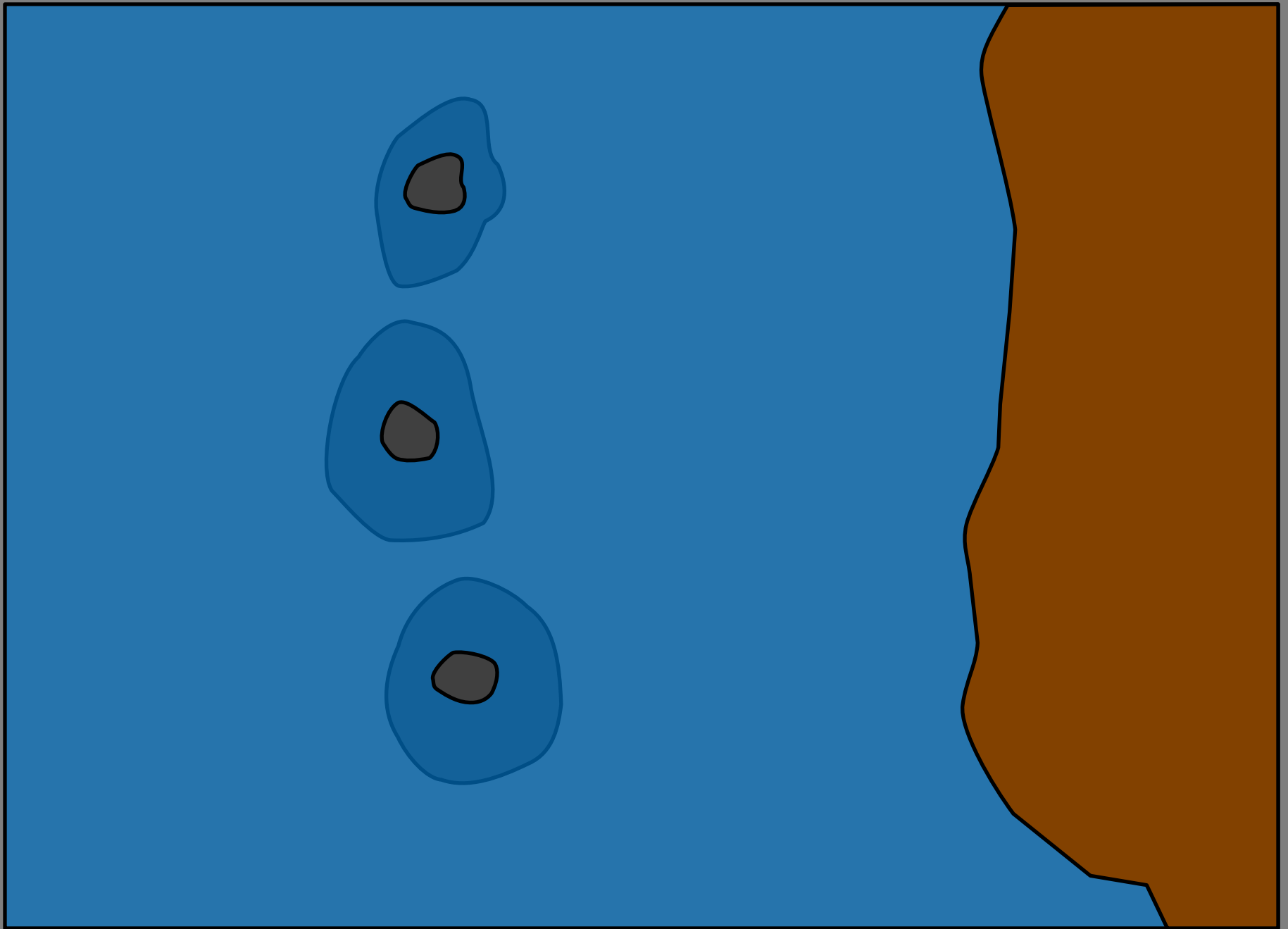
Can't really get the whole picture with a side view

Trenches

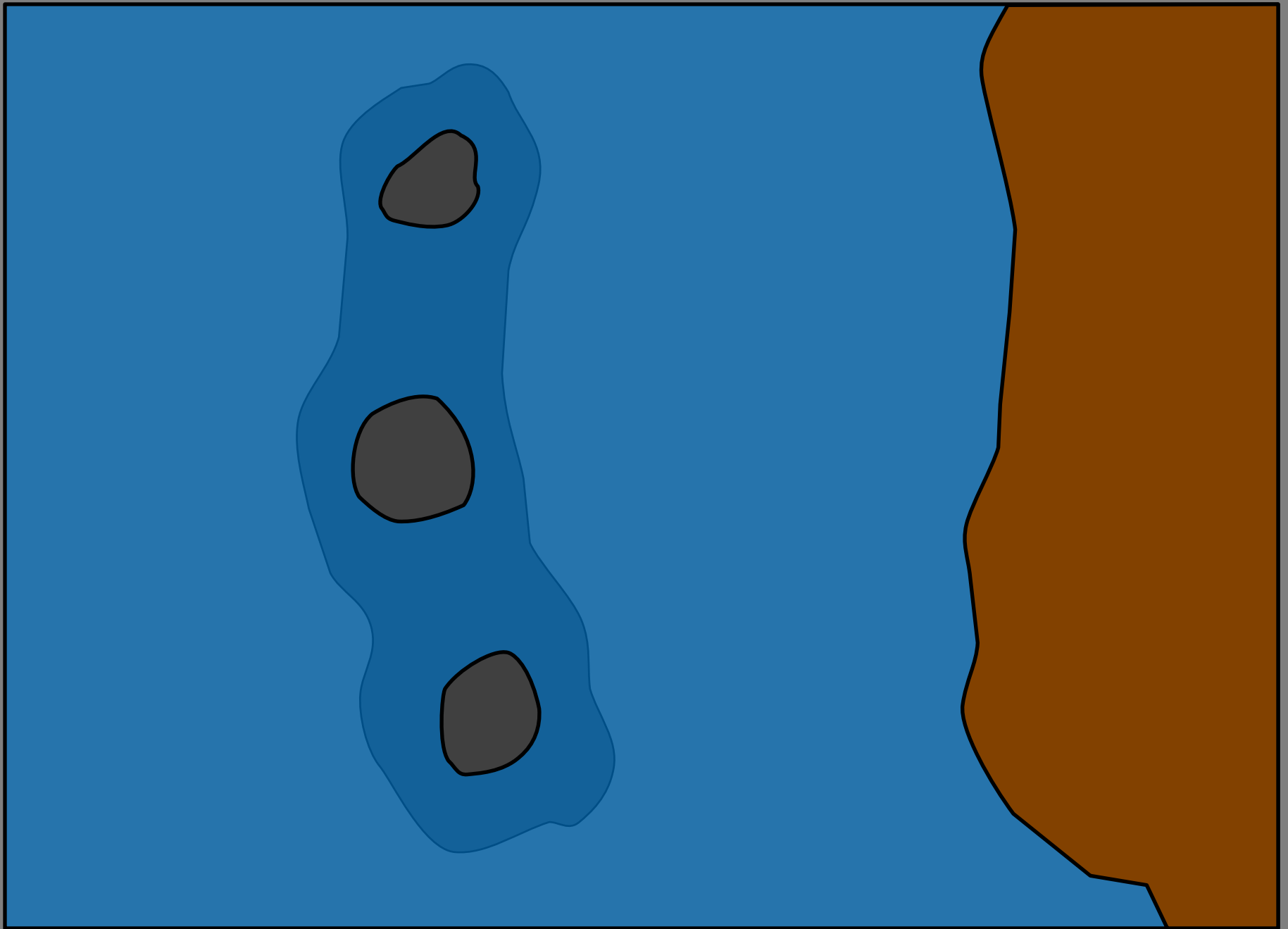


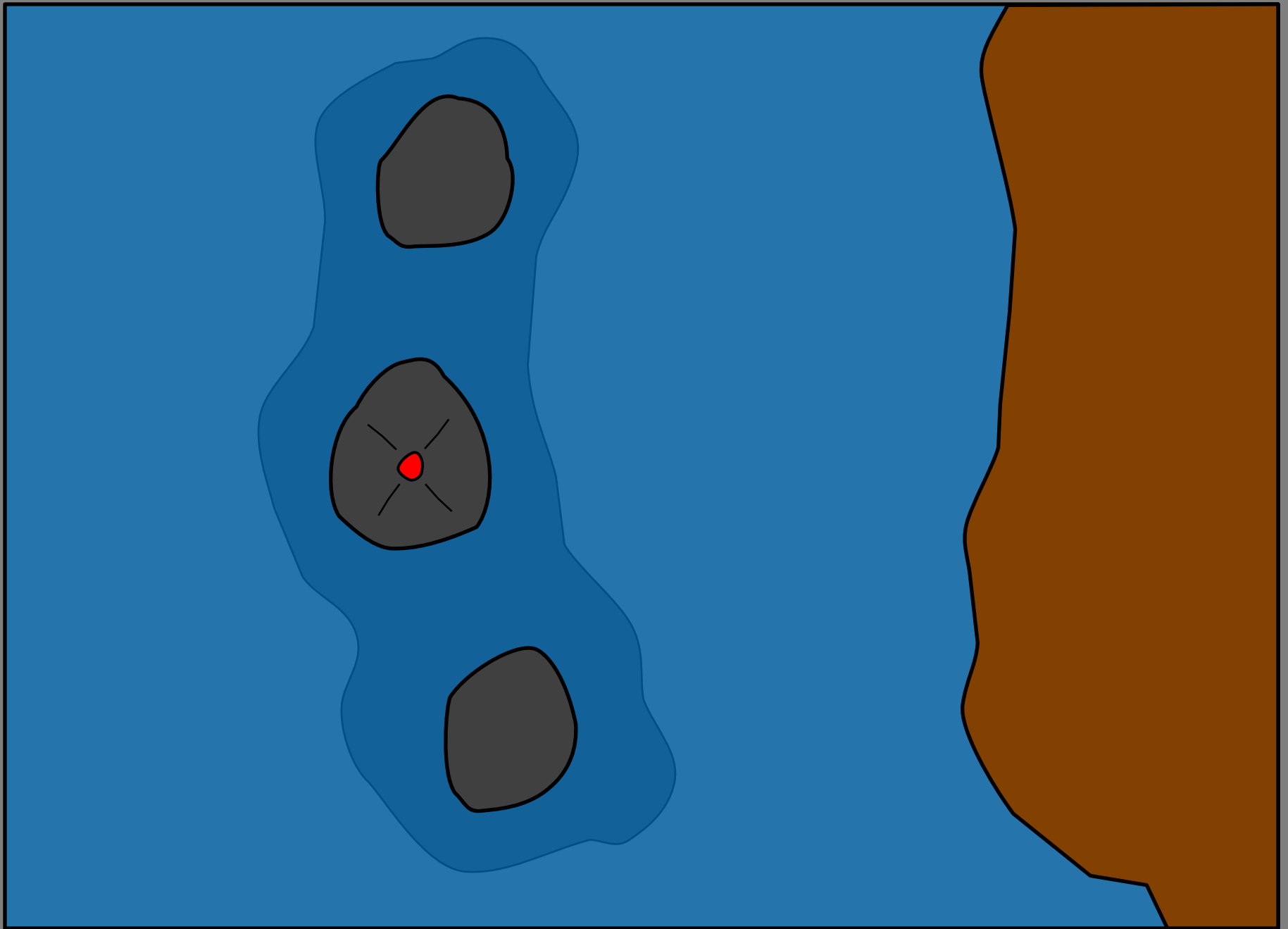


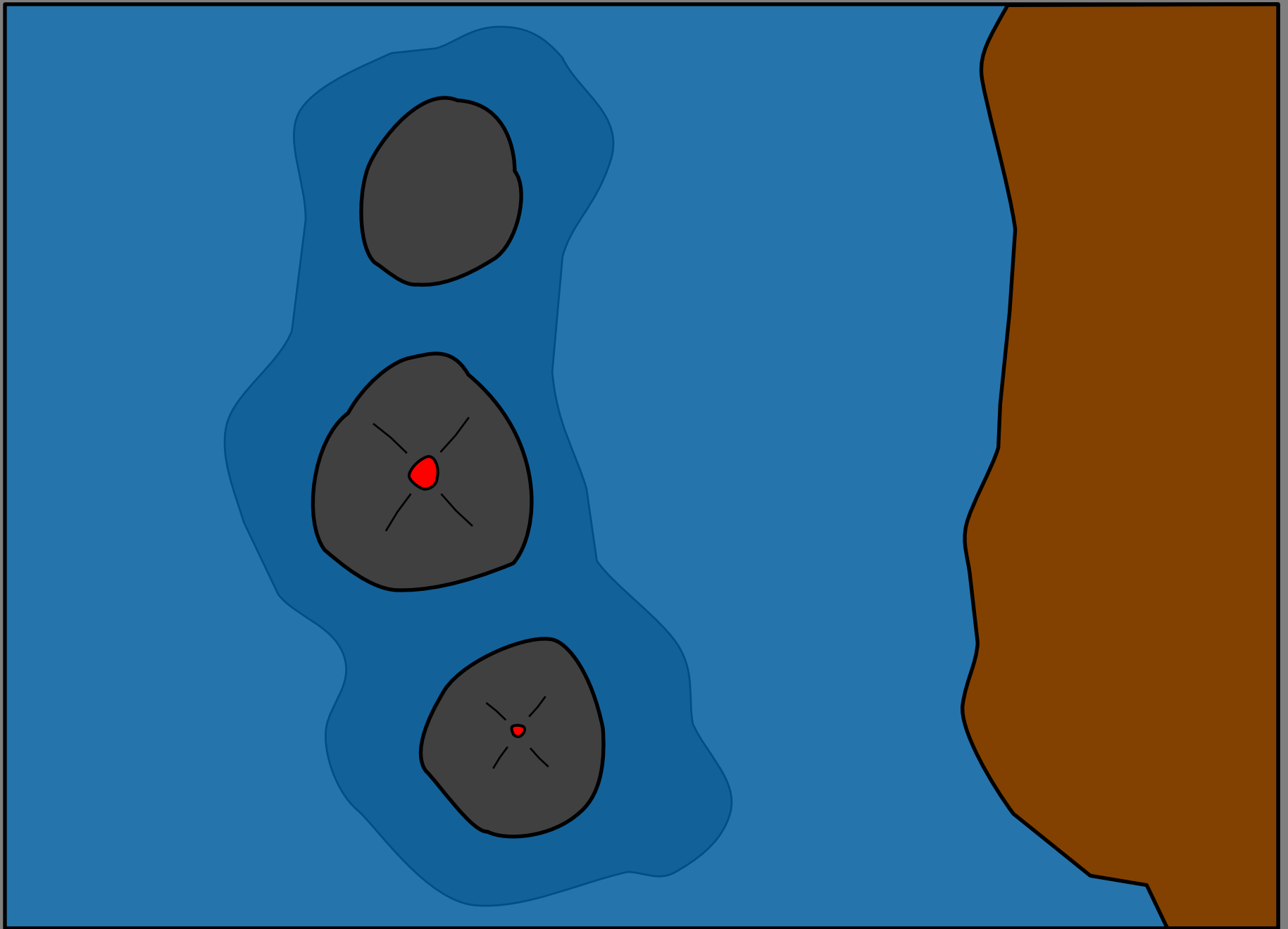


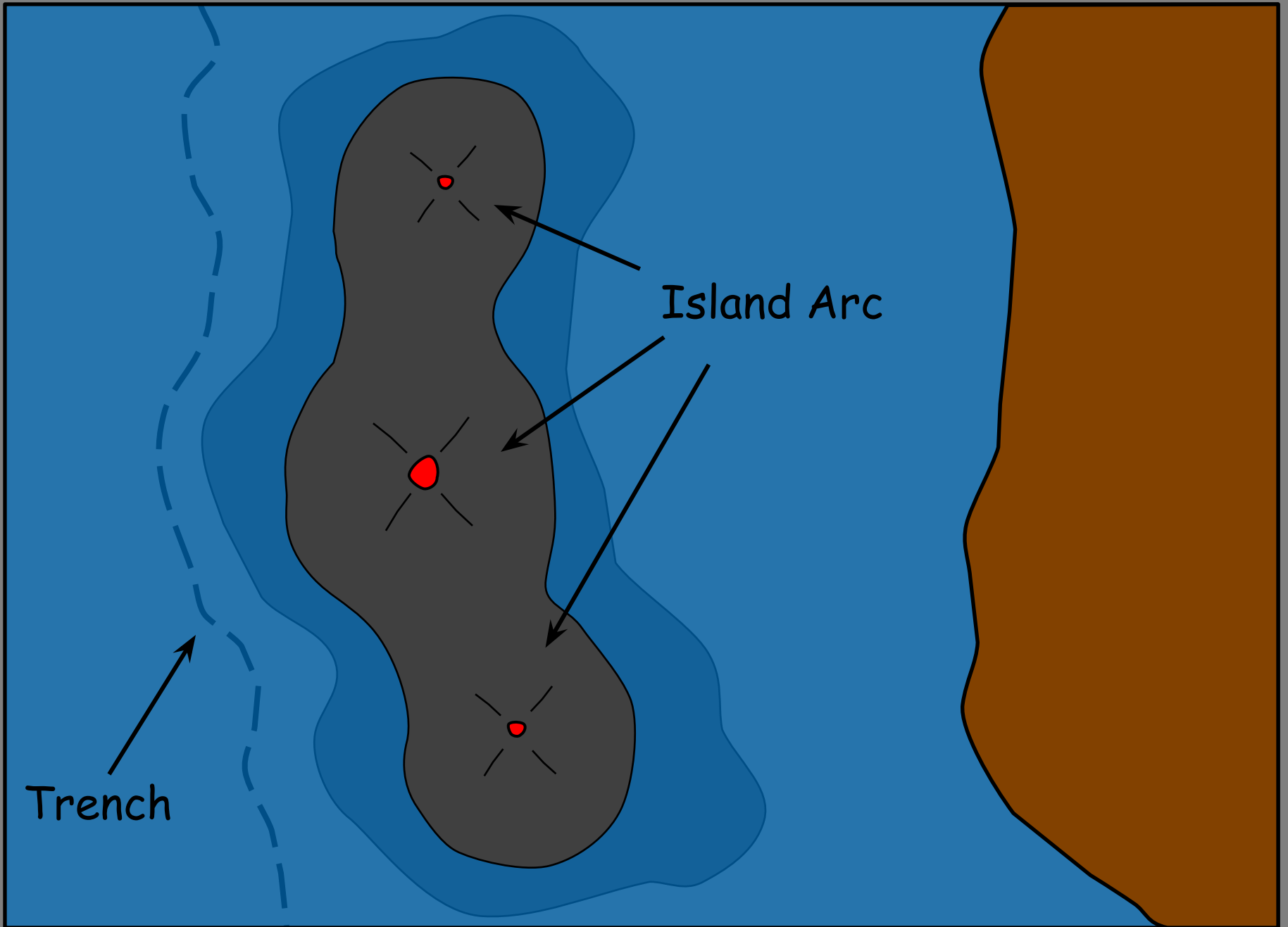






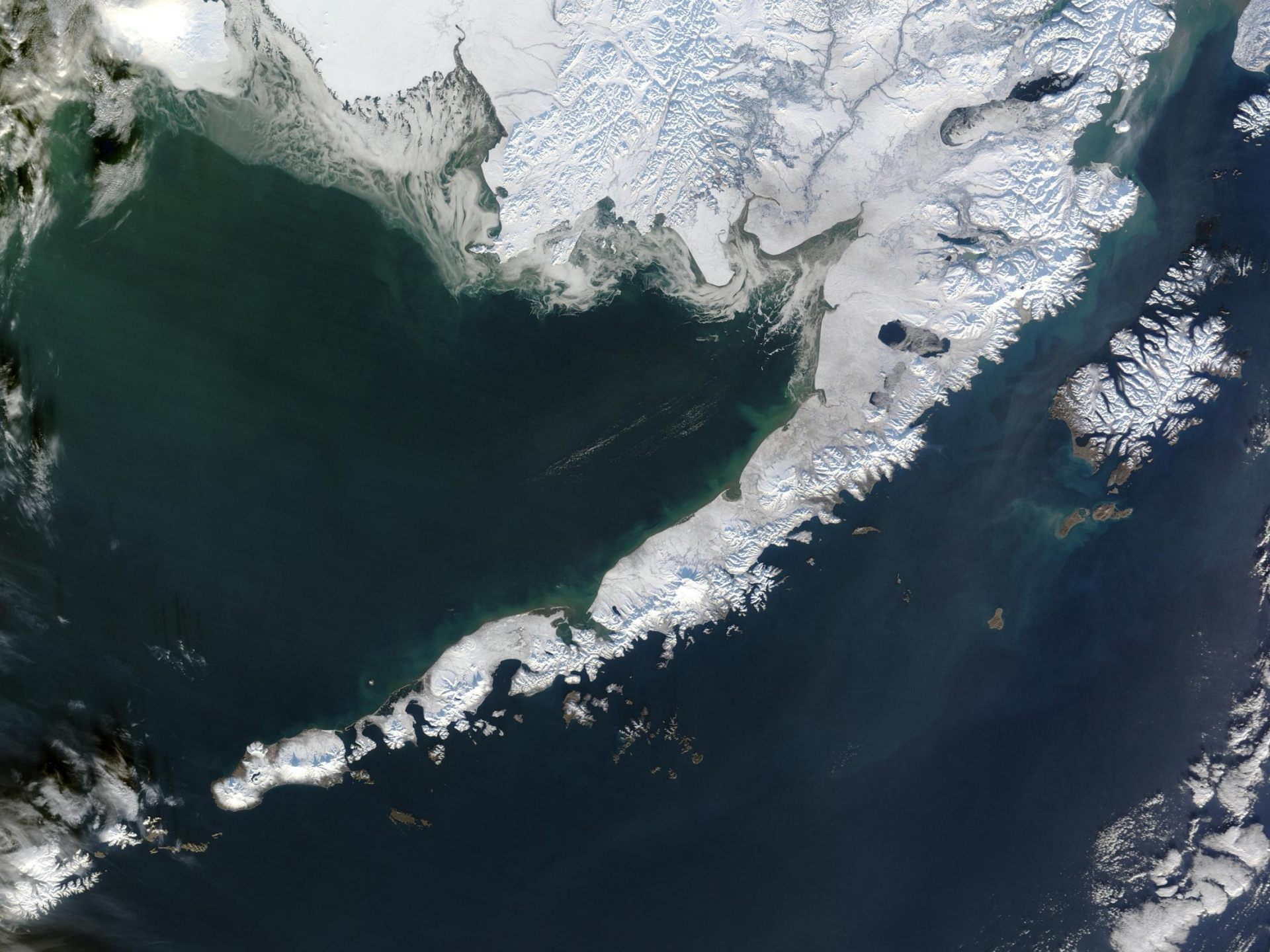






Trench

Island Arc





*Siberia*

*Alaska*

*Bering Sea*

*Komandorski Islands*

*Attu*

*Kiska*

*Dutch Harbor  
Unalaska*

*Pacific Ocean*

**Orientation Map**  
**Aleutian Islands**

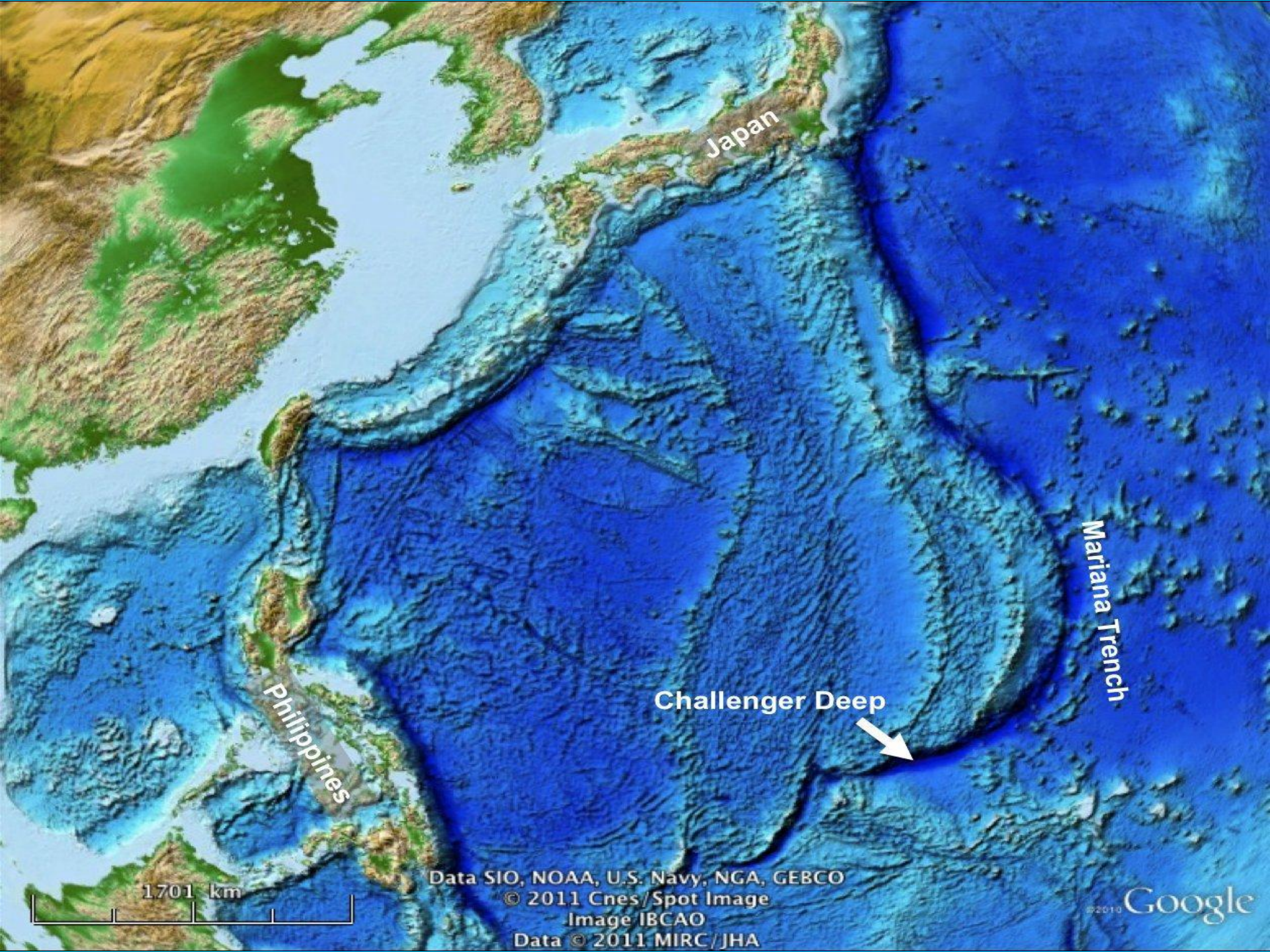
Copyright © 2006 Destroyer History Foundation

300 nm









Japan

Philippines

Challenger Deep

Mariana Trench

1701 km

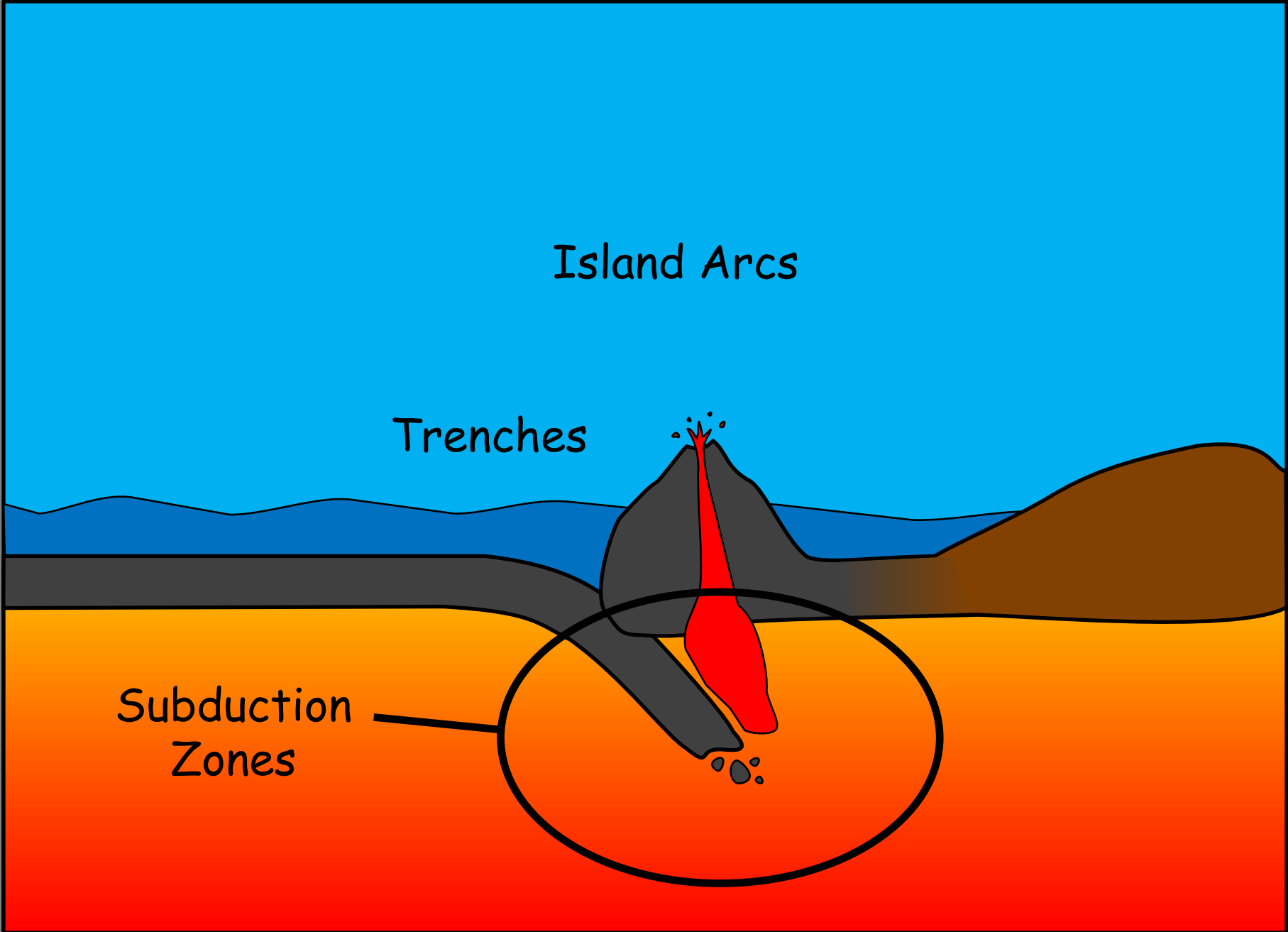
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
© 2011 Cnes/Spot Image  
Image IBCAO  
Data © 2011 MIRC/JHA

©2010 Google

Island Arcs

Trenches

Subduction  
Zones

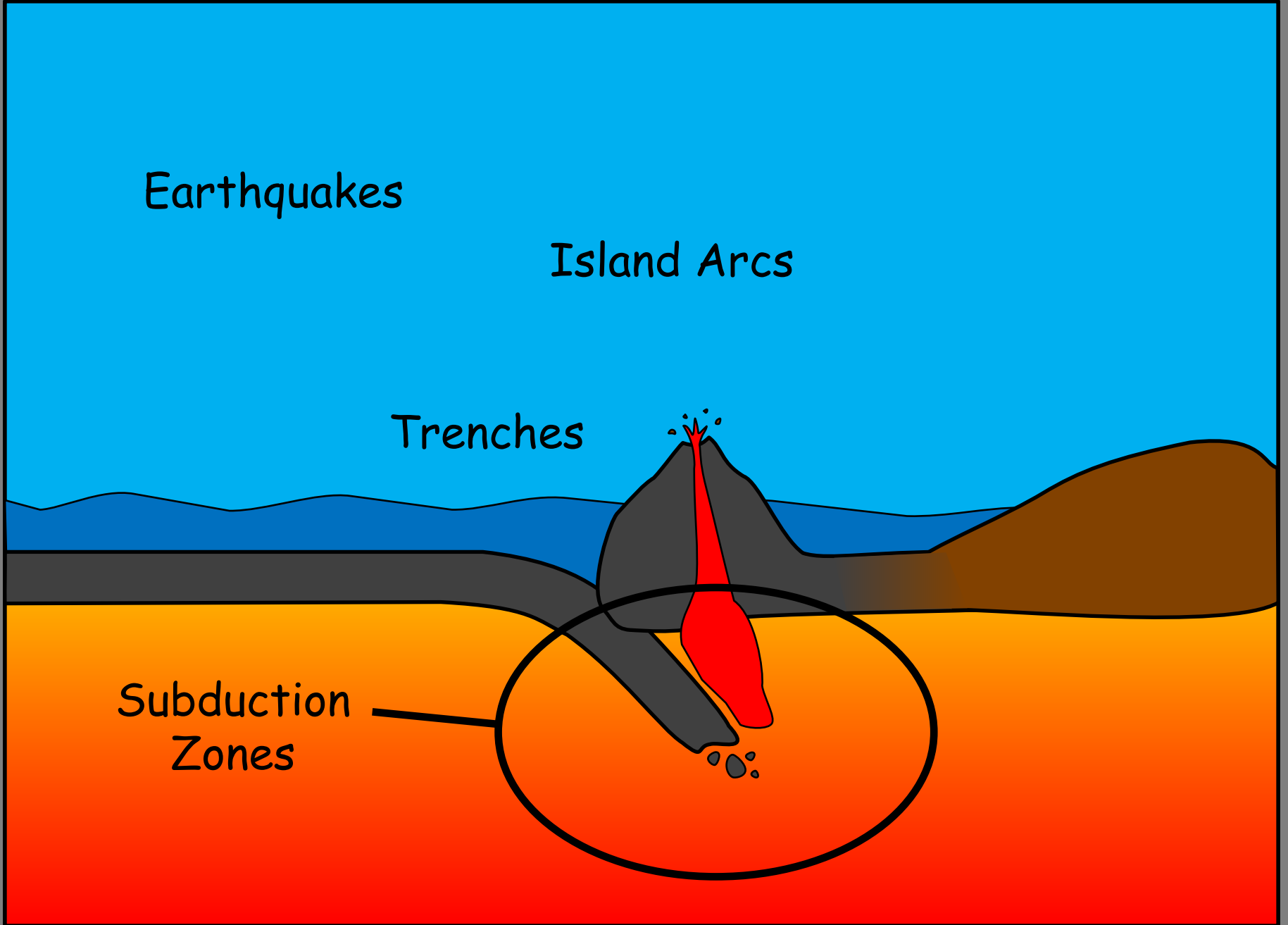




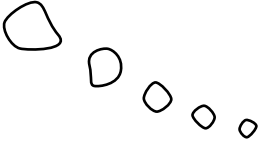
Earthquakes

Island Arcs

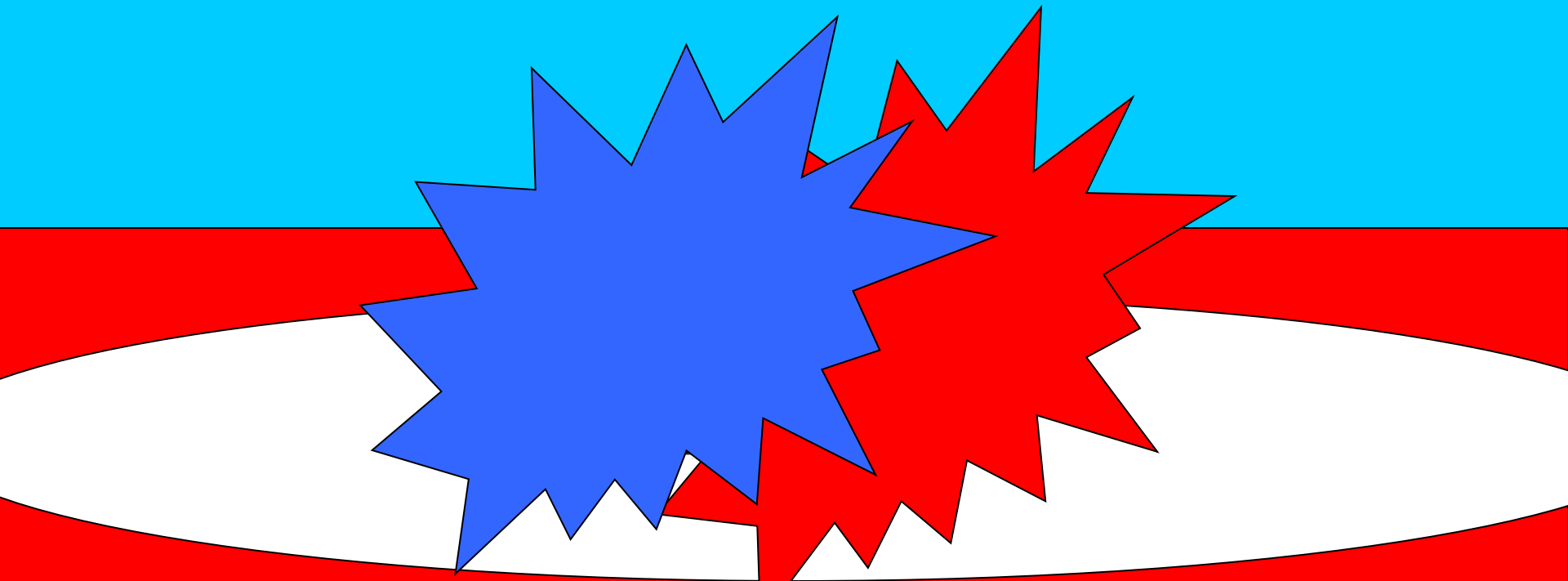
Trenches

Subduction  
Zones



Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
<b>Convergent</b> (Ocean vs. Ocean)	Oceanic crust collides with oceanic crust	Island Arcs Trenches Earthquakes Subduction Zones	
<b>Divergent</b>			

# *Divergent Boundary*



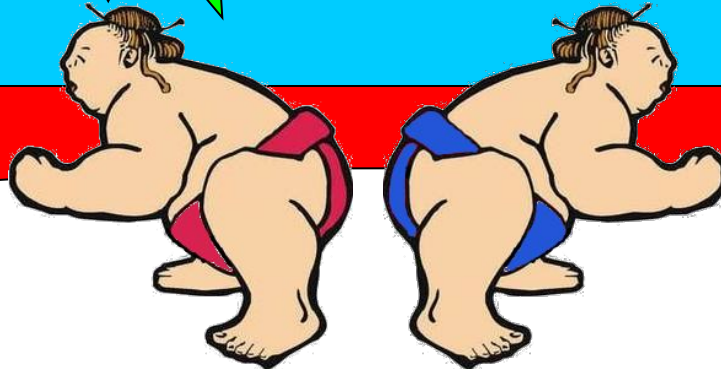
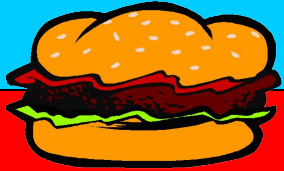
# "D" stands for <sup>Divergent</sup> Boundary

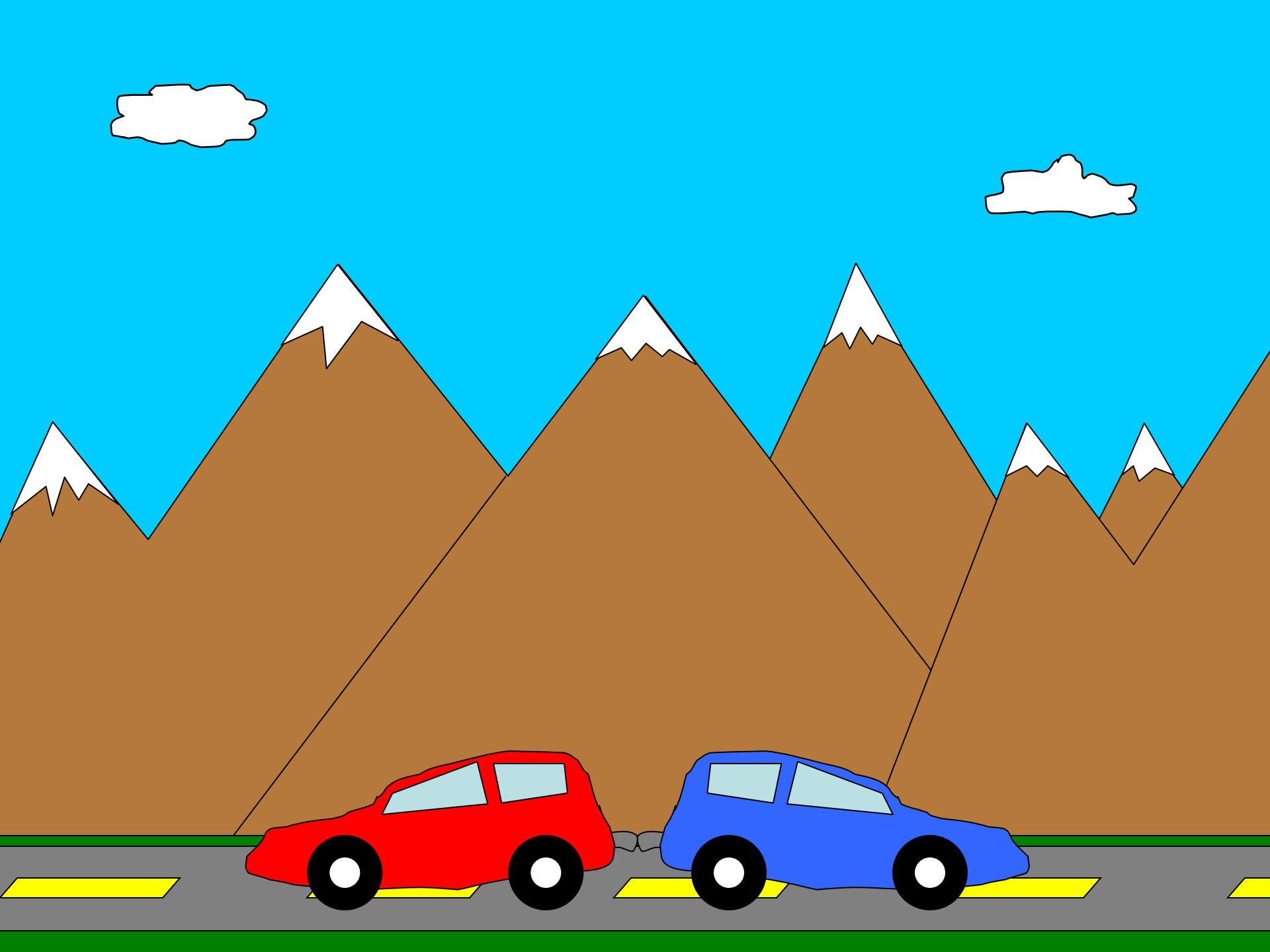
Divide



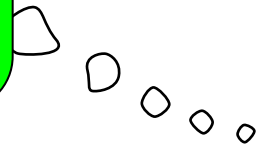
Dash Away

Distance

Donuts

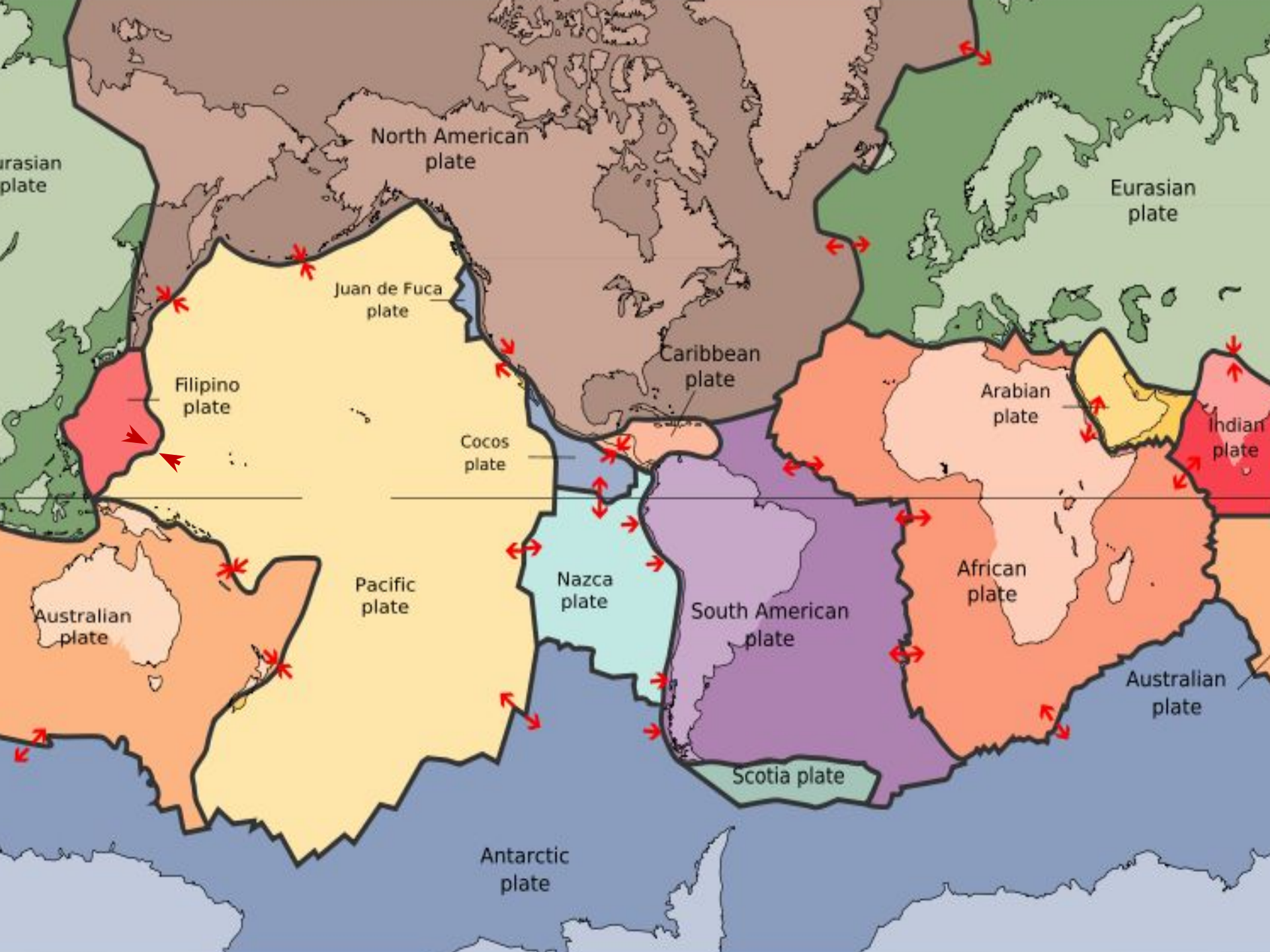




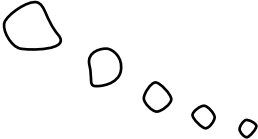


Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust	Volcanoes Trenches	
<b>Convergent</b> (Ocean vs. Ocean)			
<b>Divergent</b>	Two plates move away from each other - usually ocean crust		

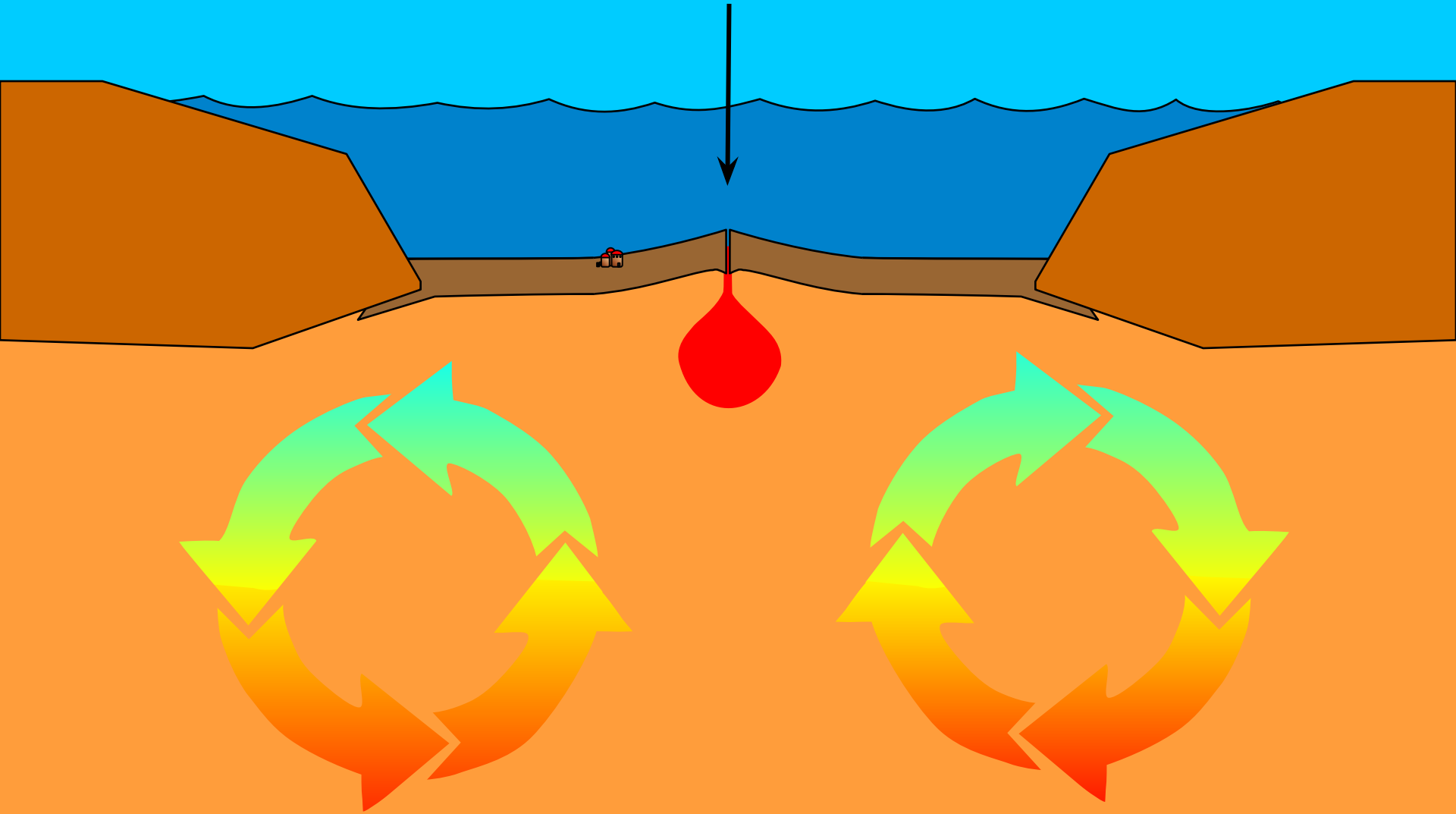
Two plates move away from each other (usually ocean crust)

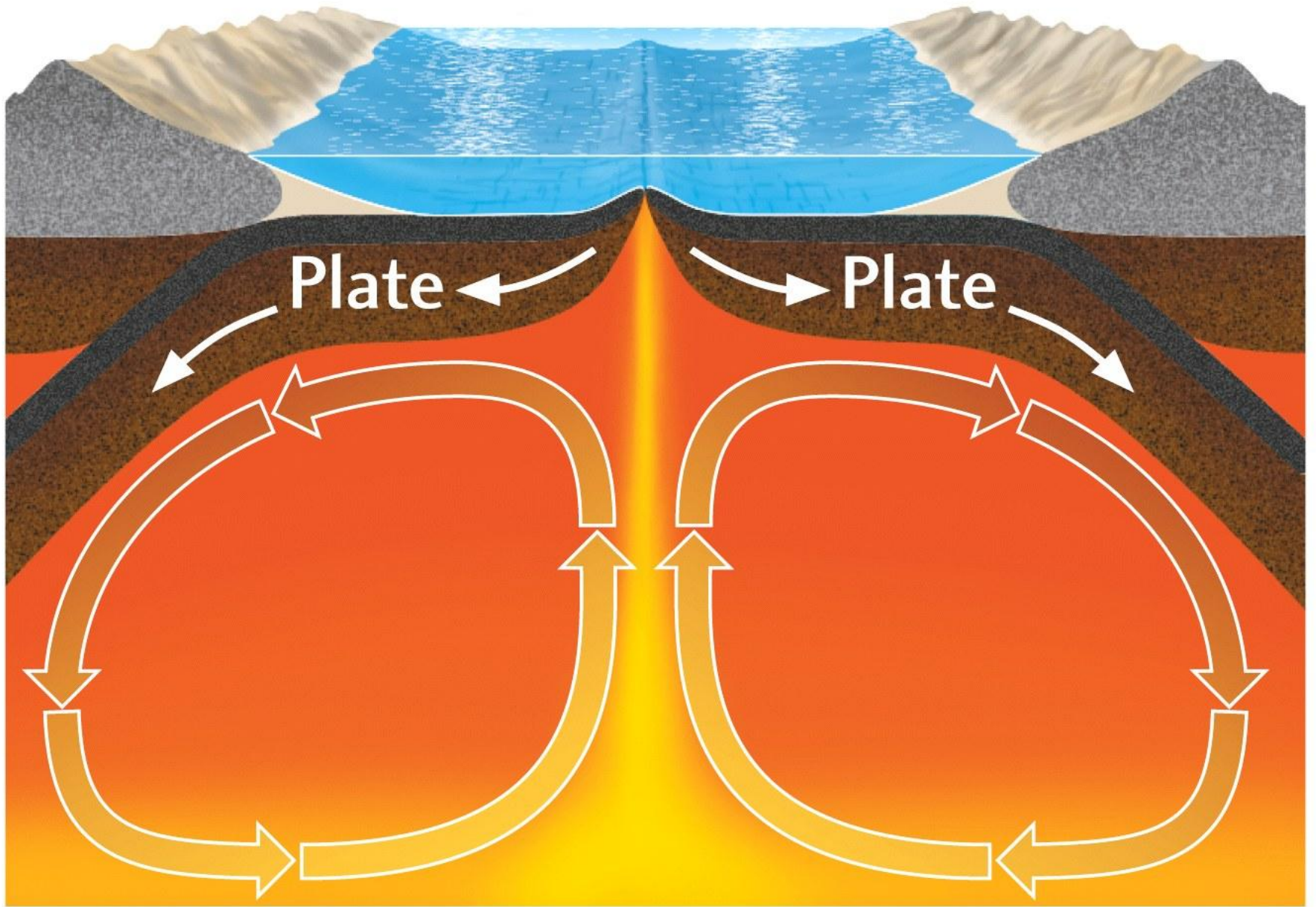




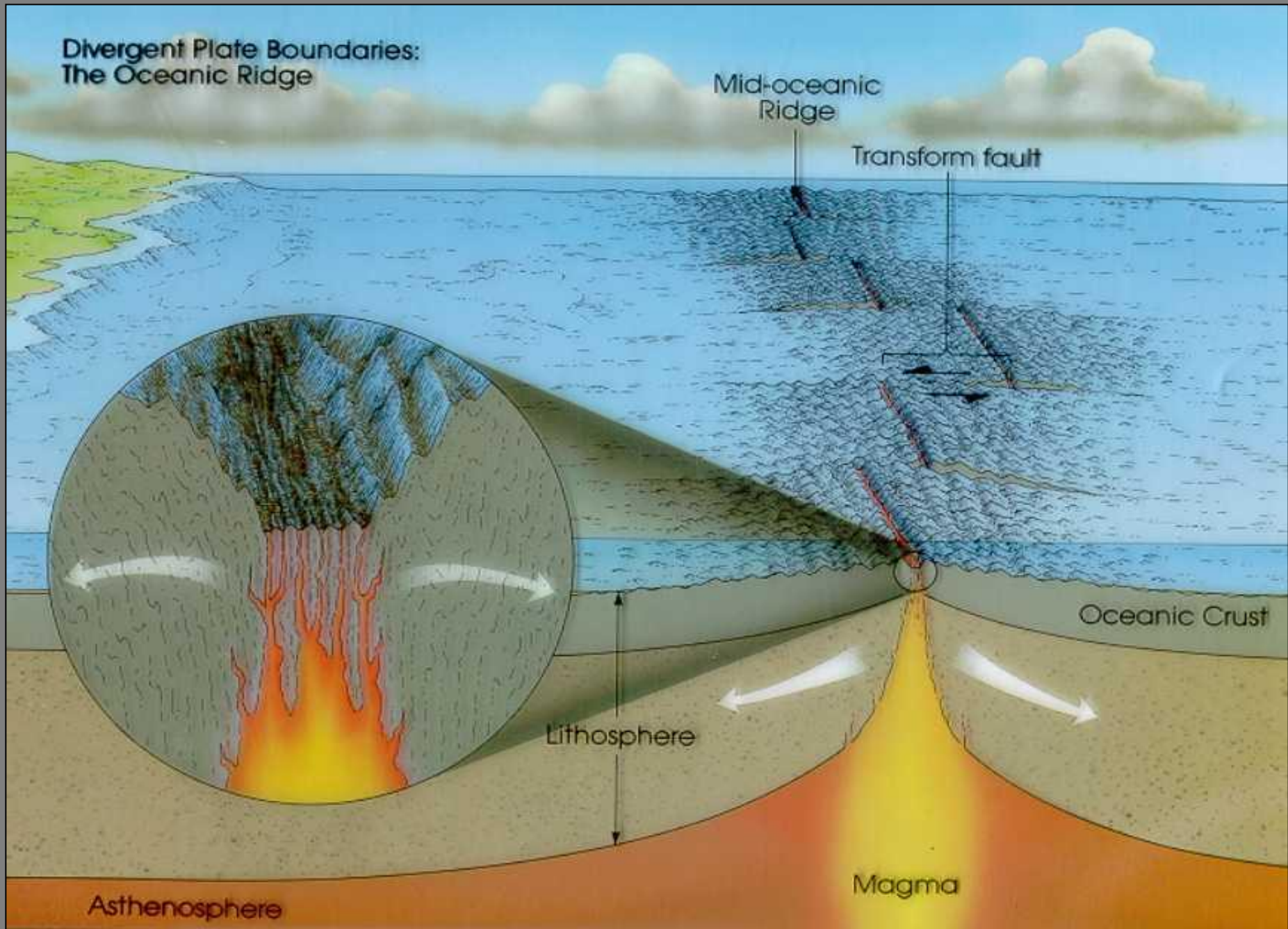
Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
<b>Convergent</b> (Ocean vs. Ocean)	Two oceanic crusts colliding	Island Arcs Trenches Earthquakes Subduction Zones	
<b>Divergent</b>	Two plates move away from each other - usually ocean crust		

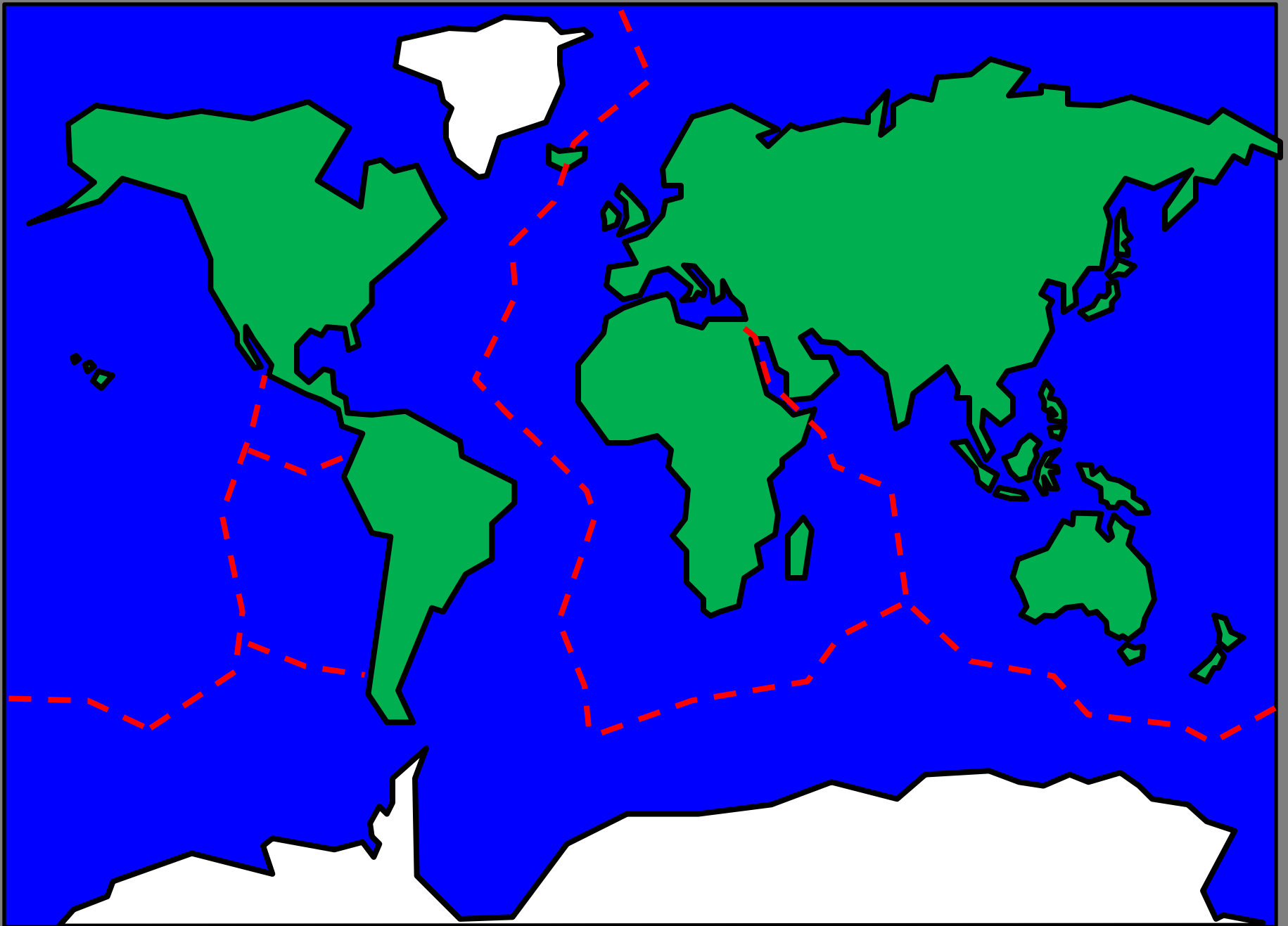
Divergent Boundary





# Divergent Plate Boundaries: The Oceanic Ridge







[www.arcticsharks.com](http://www.arcticsharks.com)



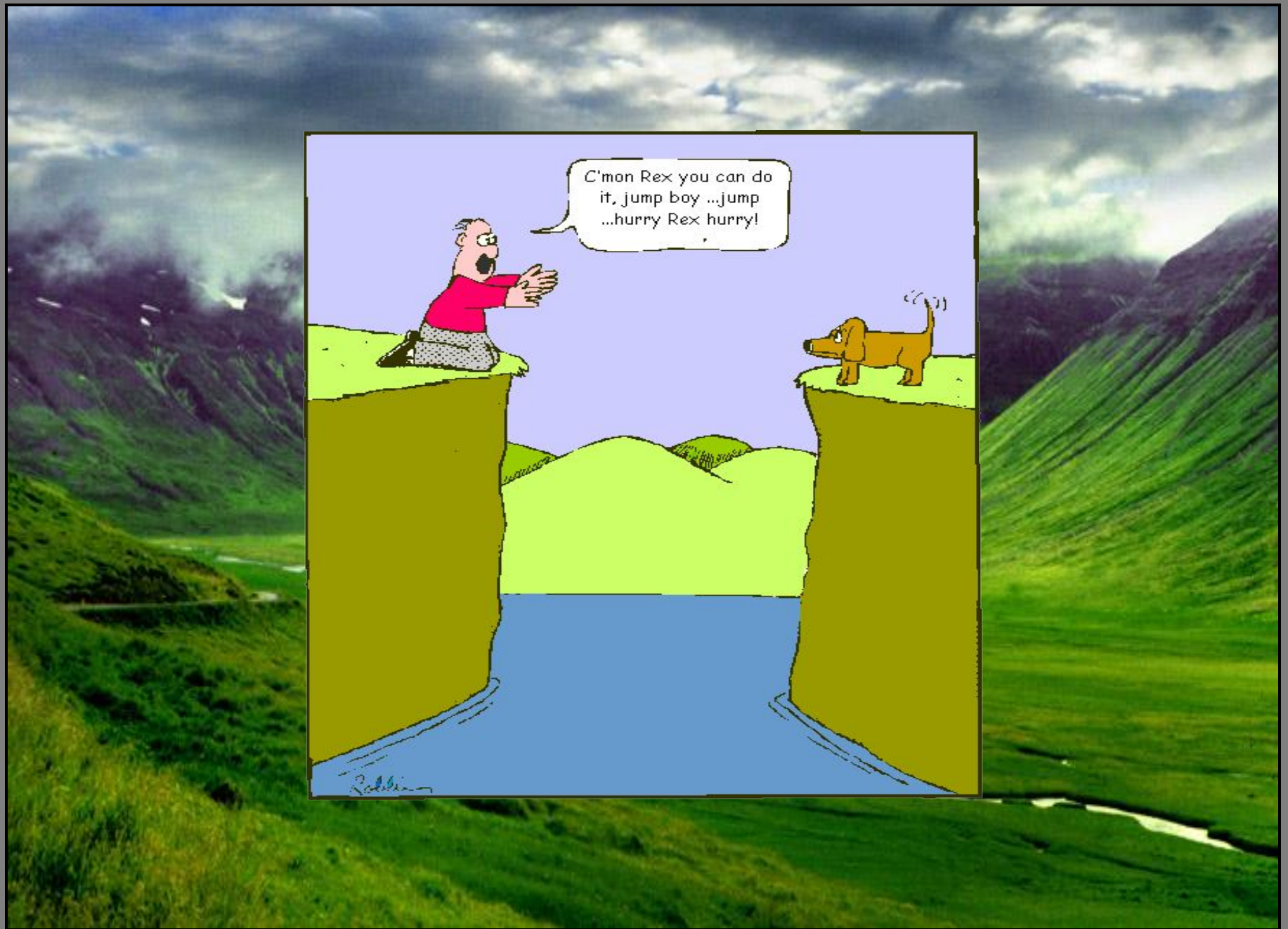


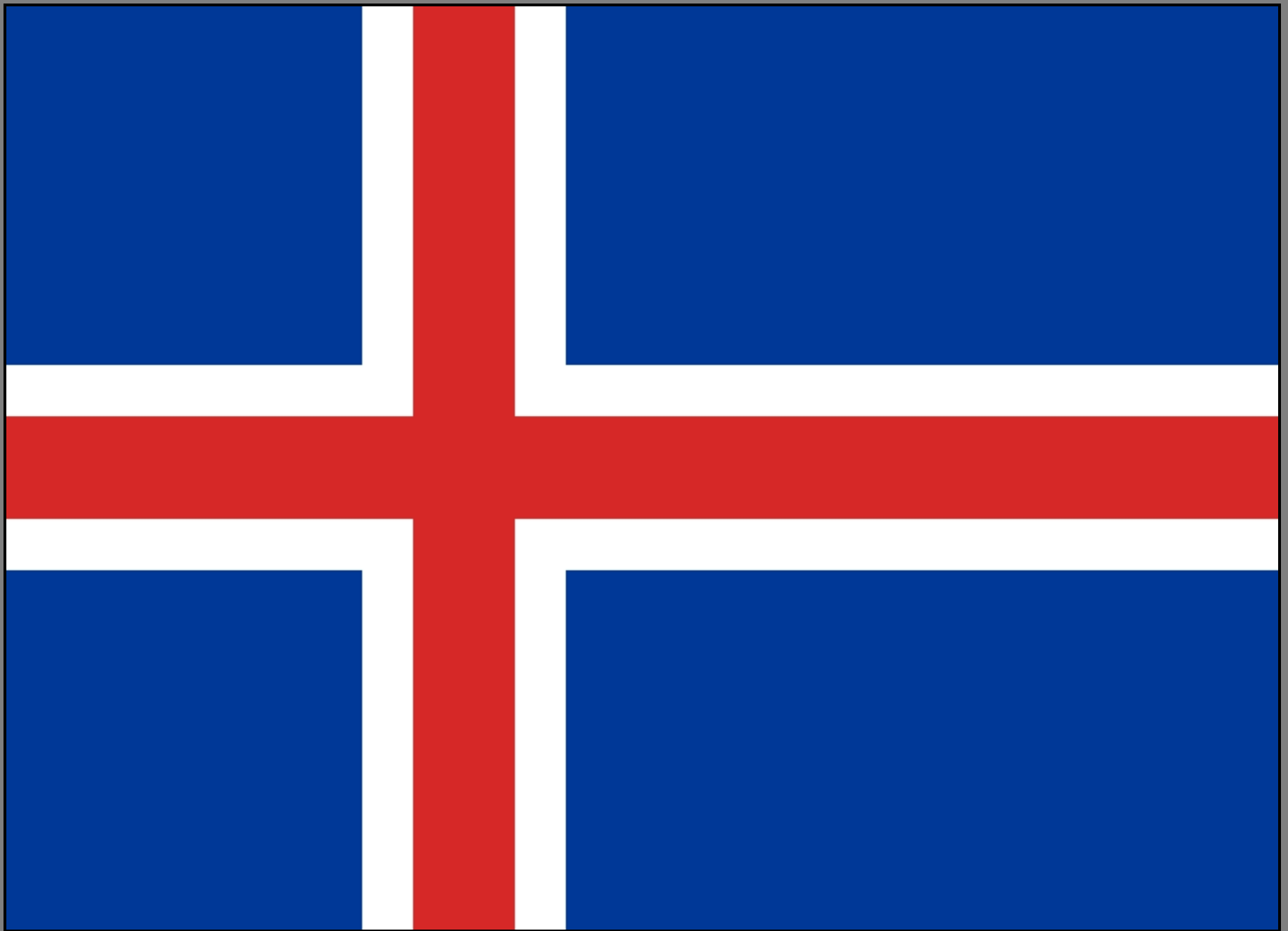




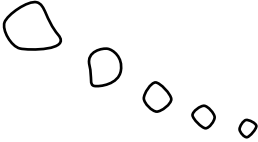
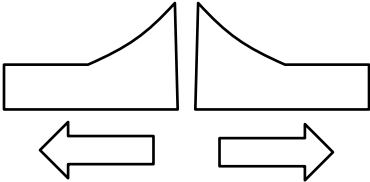






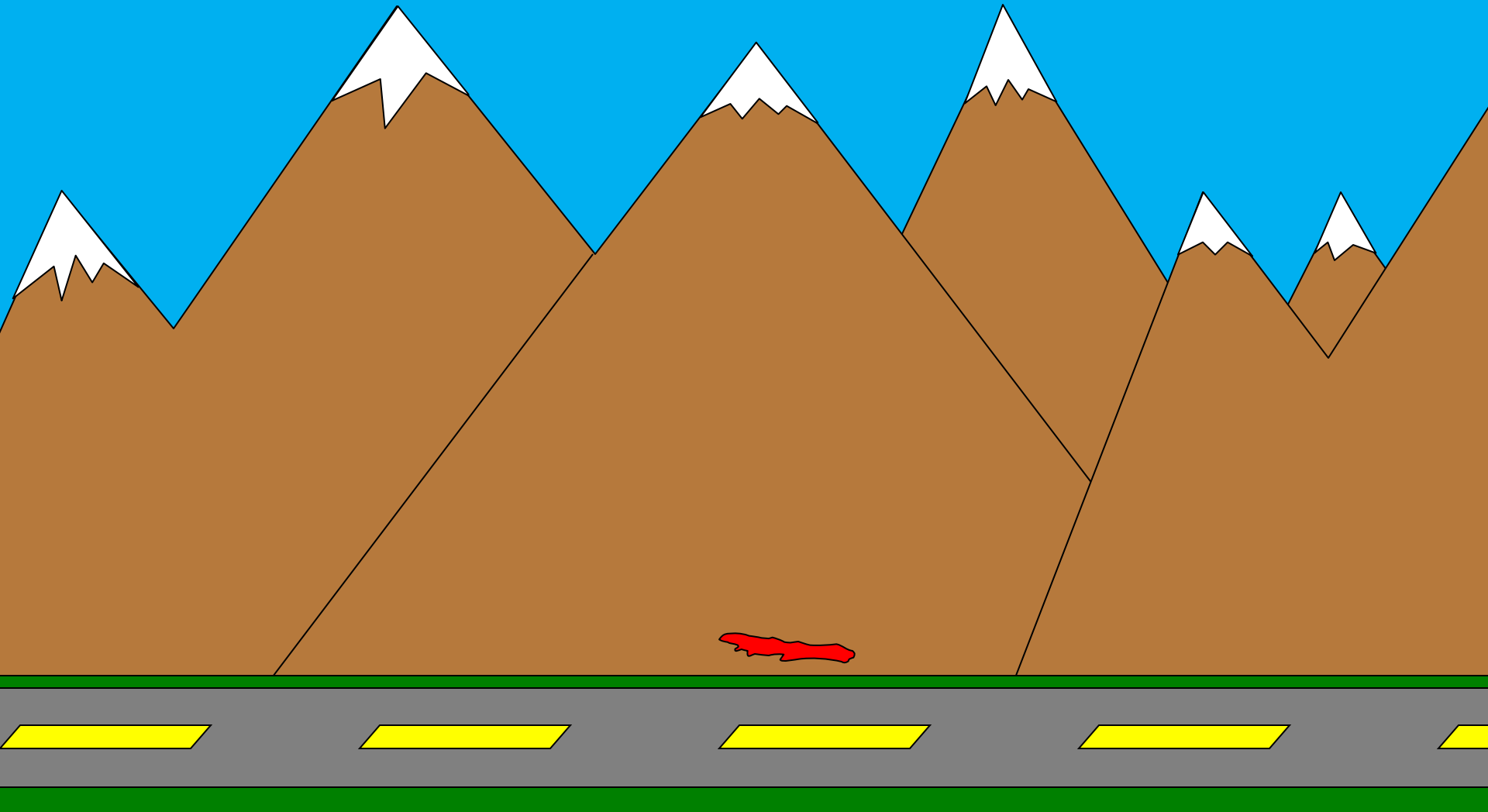




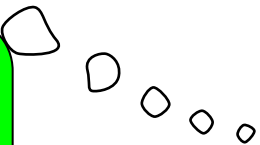
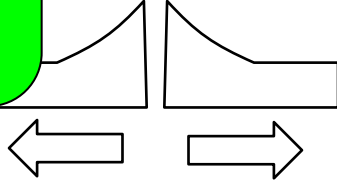


Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
<b>Convergent</b> (Ocean vs. Ocean)	Two oceanic crusts colliding	Island Arcs Trenches Earthquakes Subduction Zones	
<b>Divergent</b>	Two plates move away from each other - usually ocean crust	Mid-Ocean Ridges Seafloor Spreading Earthquakes	
<b>Transform</b>			

# Transform Boundary

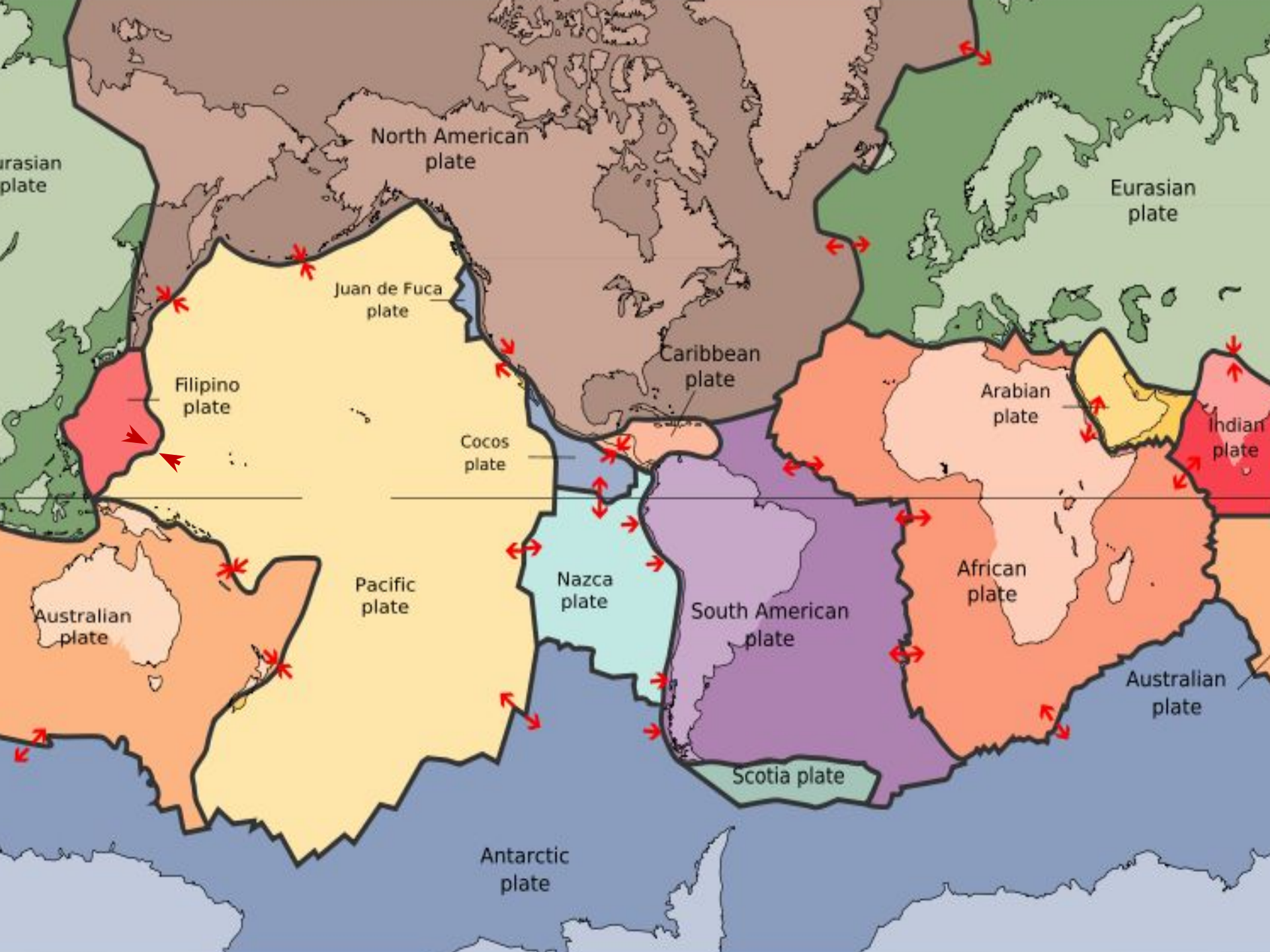
“T” CONTINENTAL PLATE PLATE PLATE PLATE PLATE

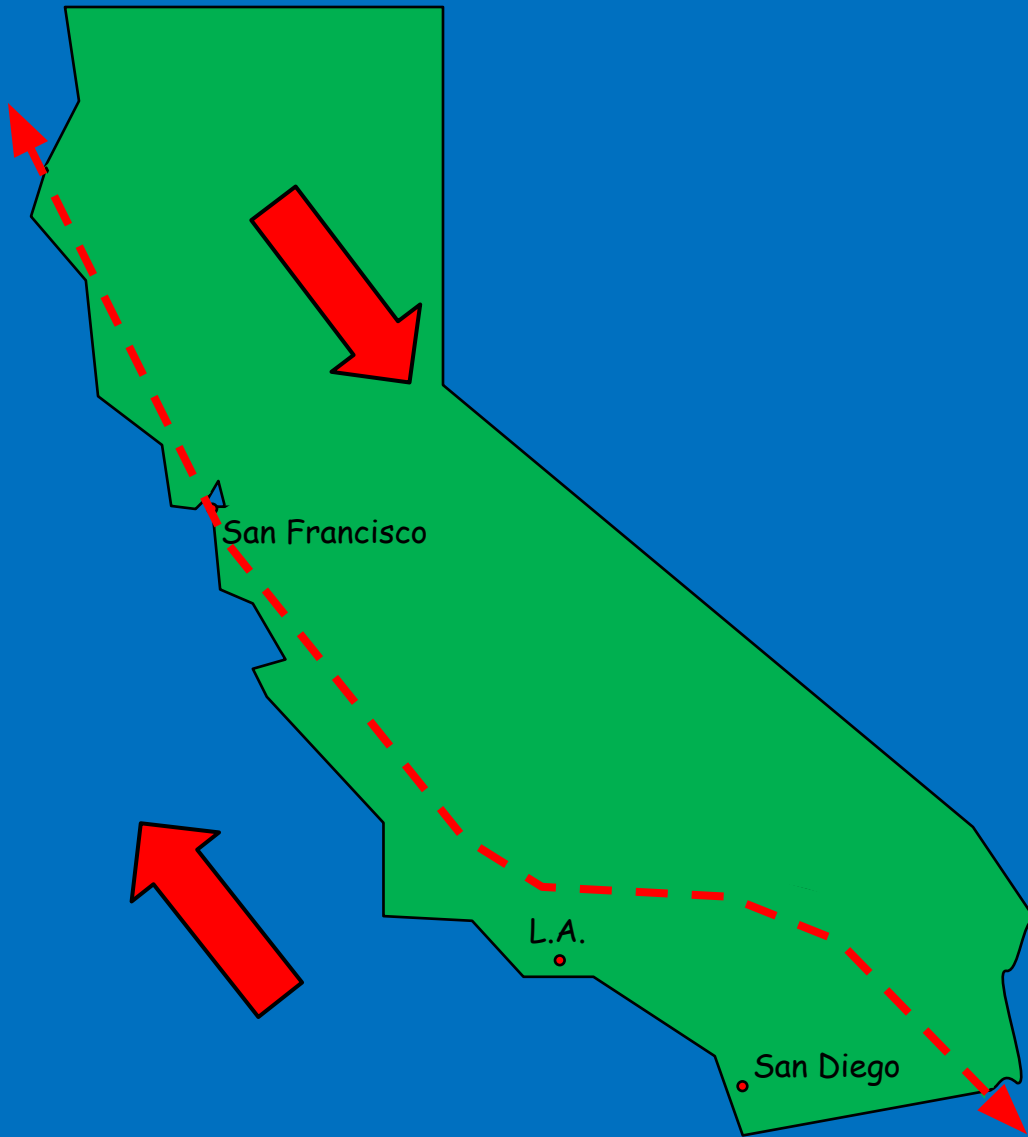


Type of Boundary	Definition	What it creates	Picture
<b>Convergent</b> (Land vs. Land)	Continental crust collides with continental crust	Mountains Earthquakes	
<b>Convergent</b> (Land vs. Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
<b>Convergent</b> (Ocean vs. Ocean)		Island Arcs	
<b>Divergent</b>			
<b>Transform</b>	Two plates scraping past each other		

Two plates scraping past each other





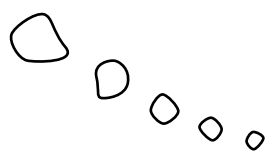
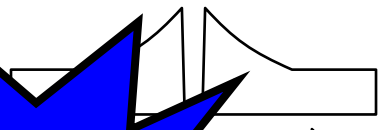
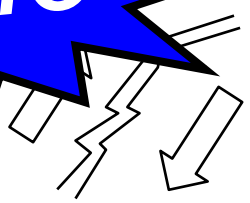




# San Andreas Fault





Type of Boundary	Definition	What it creates	Picture
Convergent (Land vs Land)	Continental crust collides with continental crust	Mountains Earthquakes	
Convergent (Land vs Ocean)	Continental crust collides with oceanic crust	Volcanoes Trenches Earthquakes Subduction Zones	
Convergent (Ocean vs. Ocean)	Two oceanic crusts colliding	Island Arcs Trenches Earthquakes Subduction Zones	
Divergent	Oceanic plates moving apart	Ocean Ridges Floor Spreading Earthquakes	
Transform	Oceanic plates scraping past each other	Earthquakes	

**That**

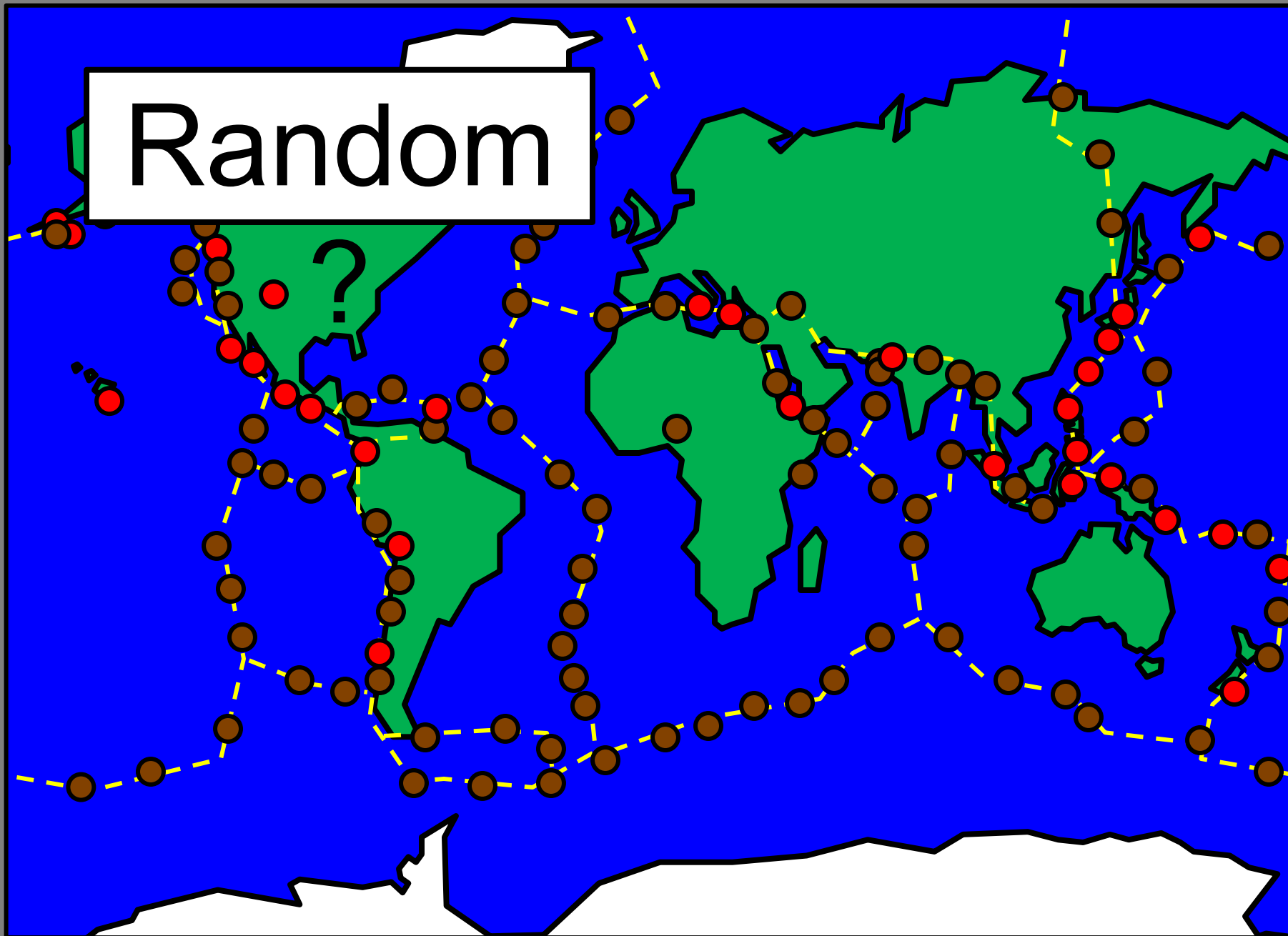
**is**

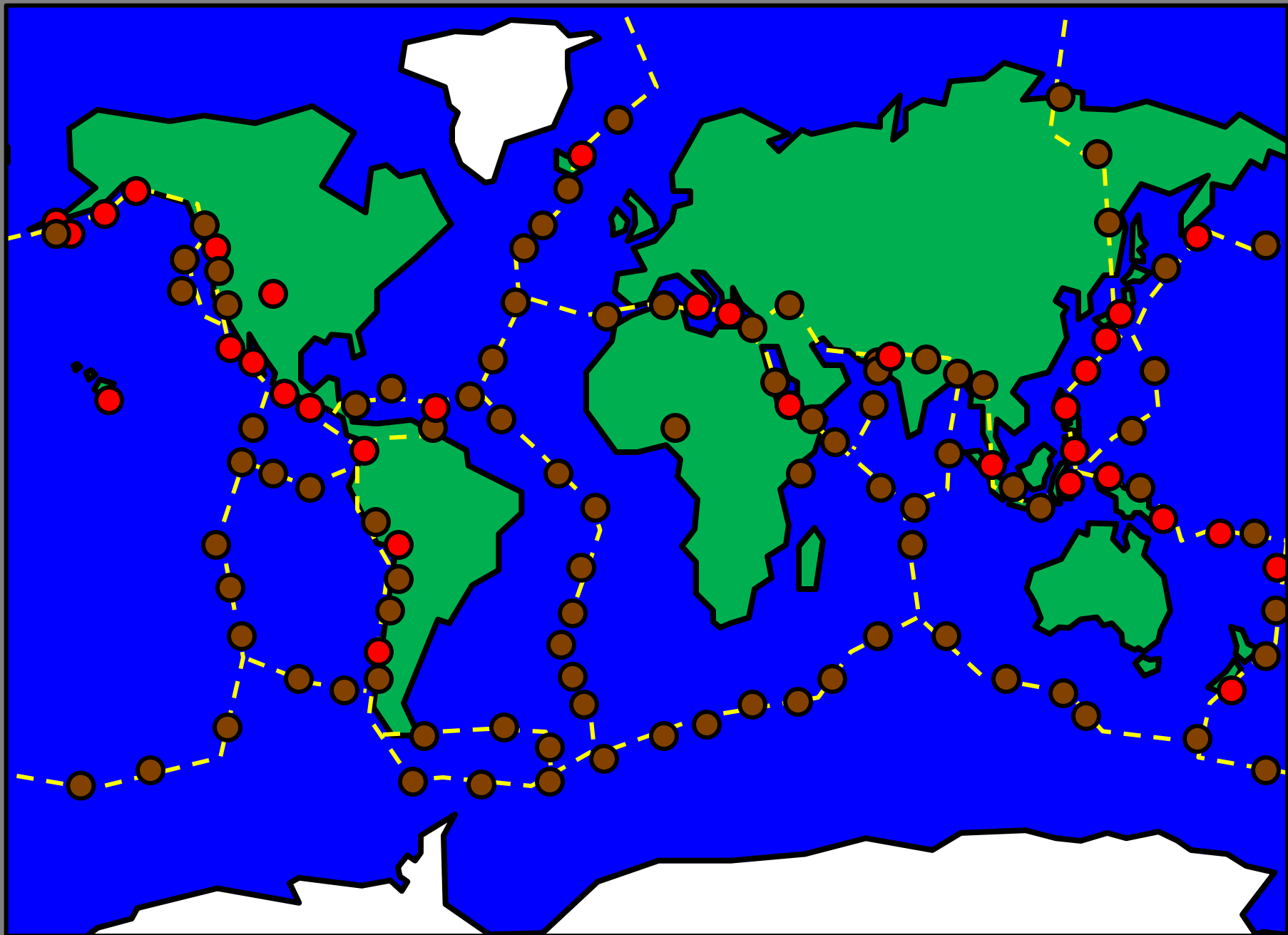
**a**

**beautiful**

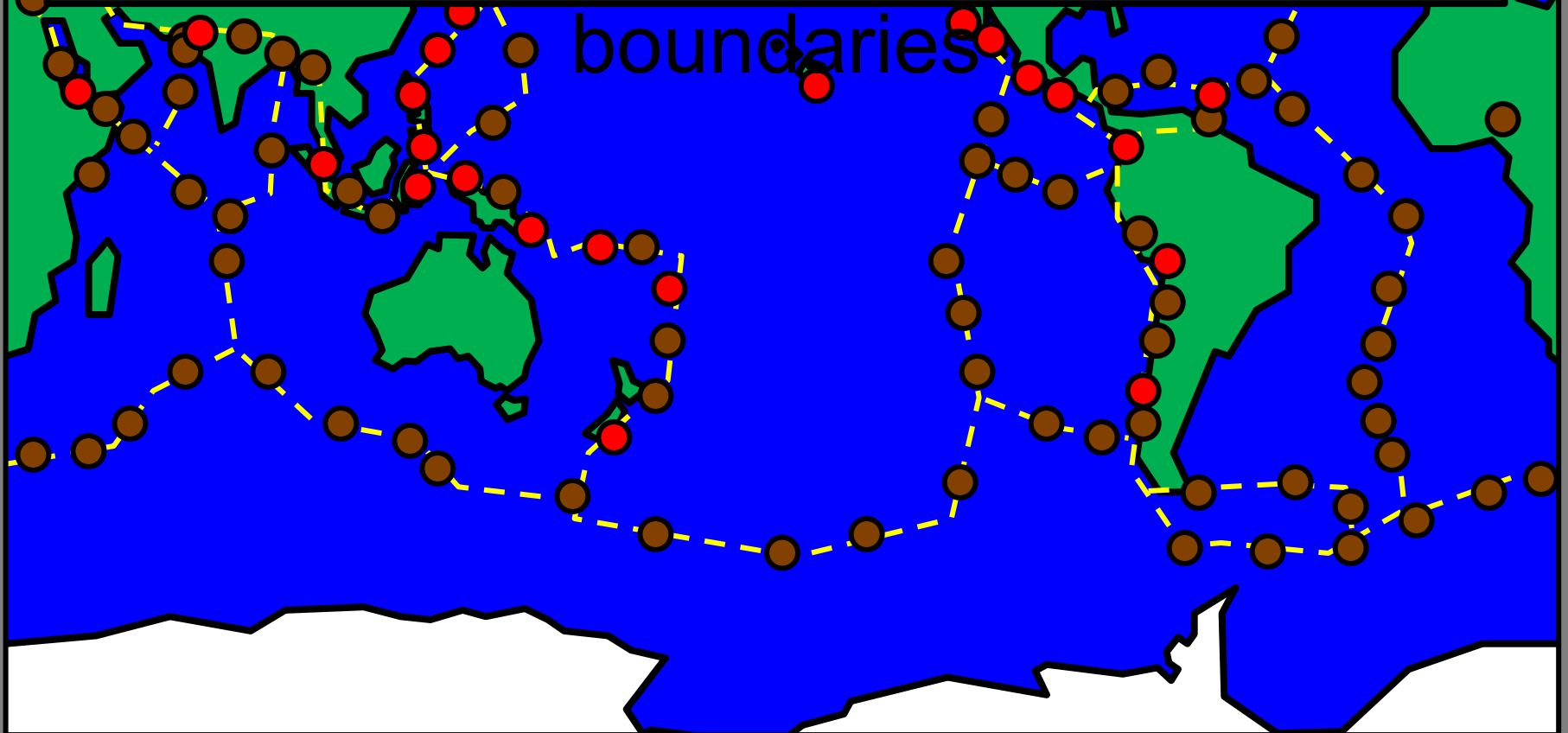
**Table**

Random

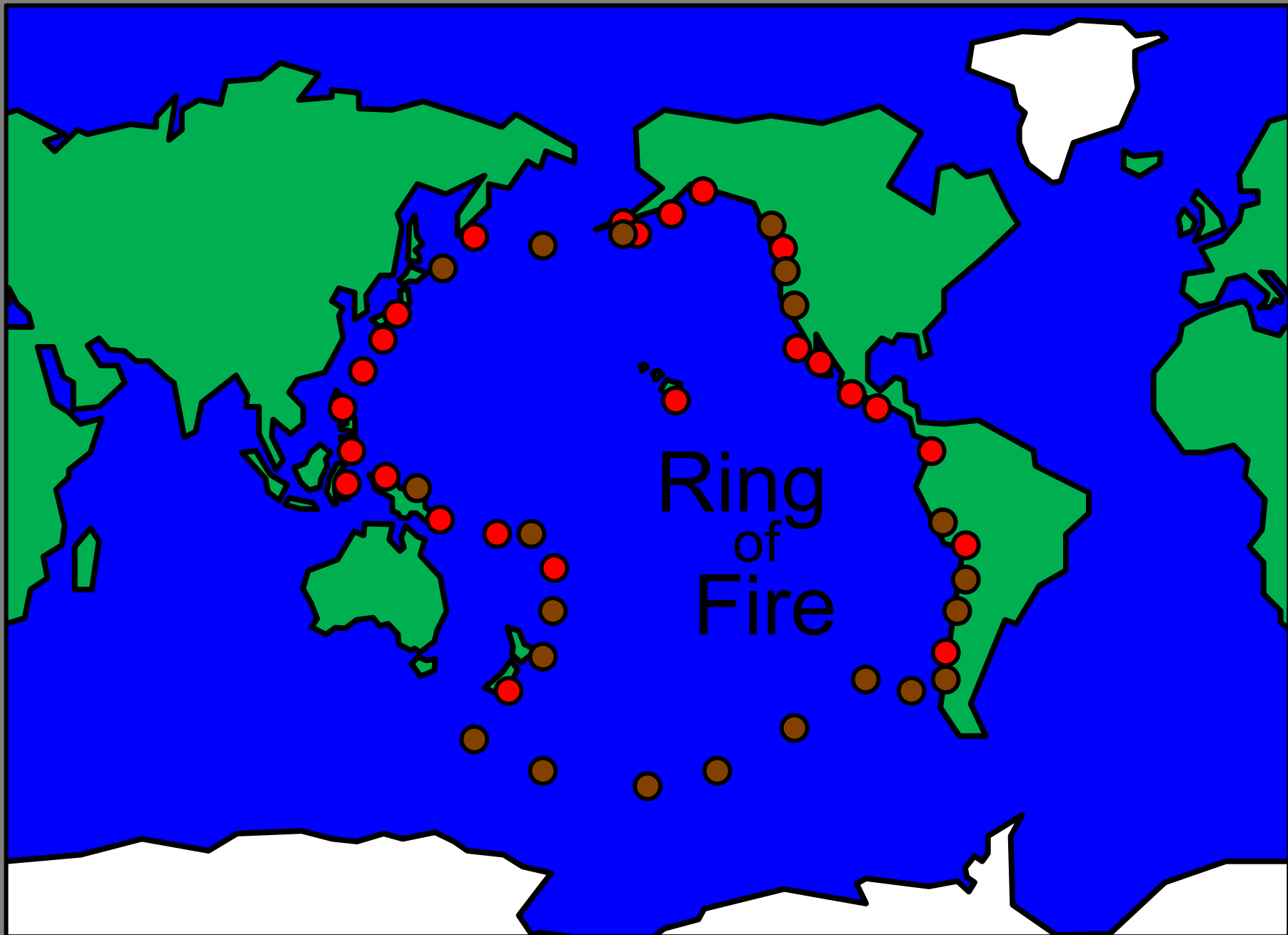


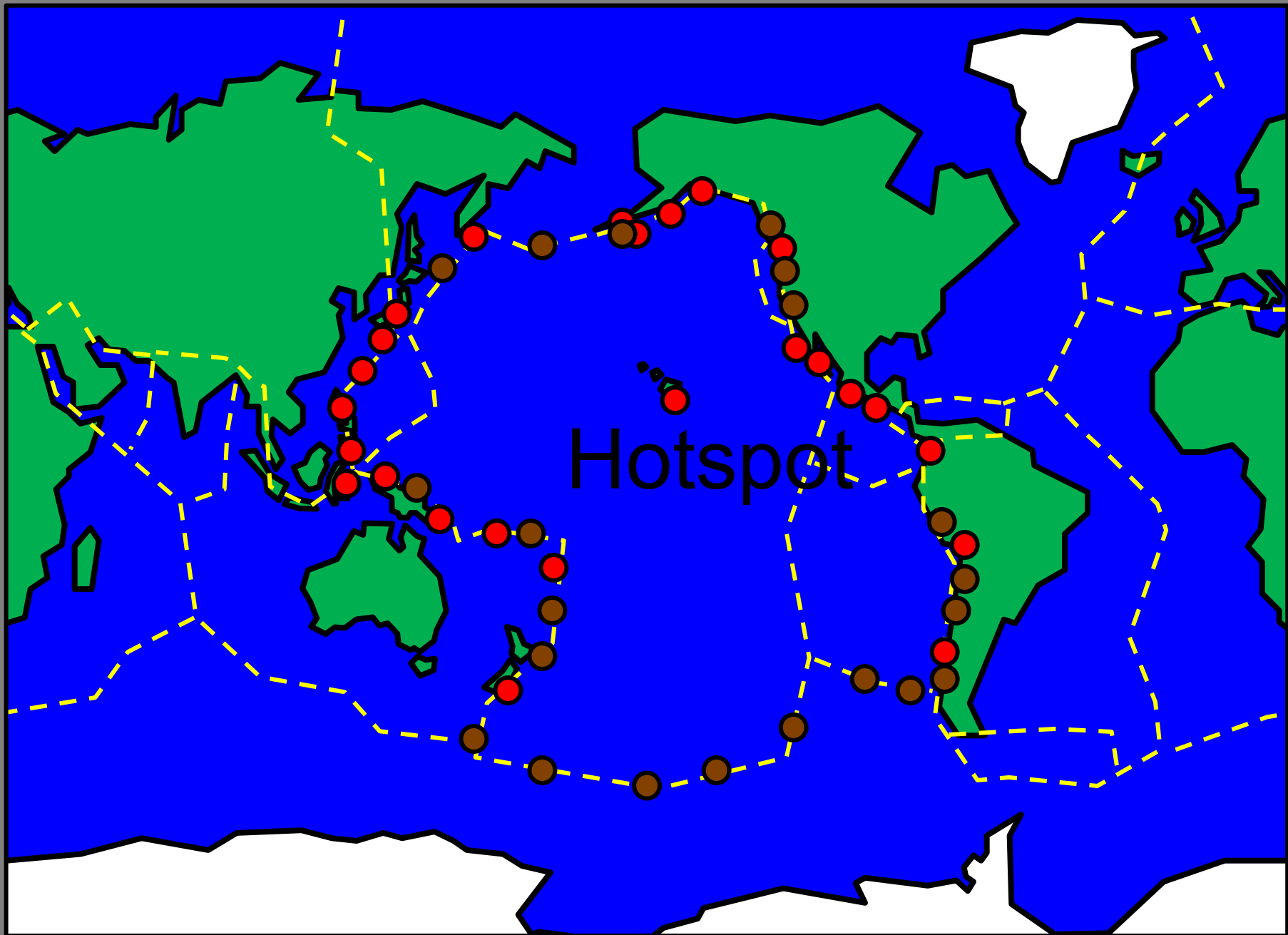


Most of the world's volcanoes and earthquakes happen at plate boundaries, especially convergent



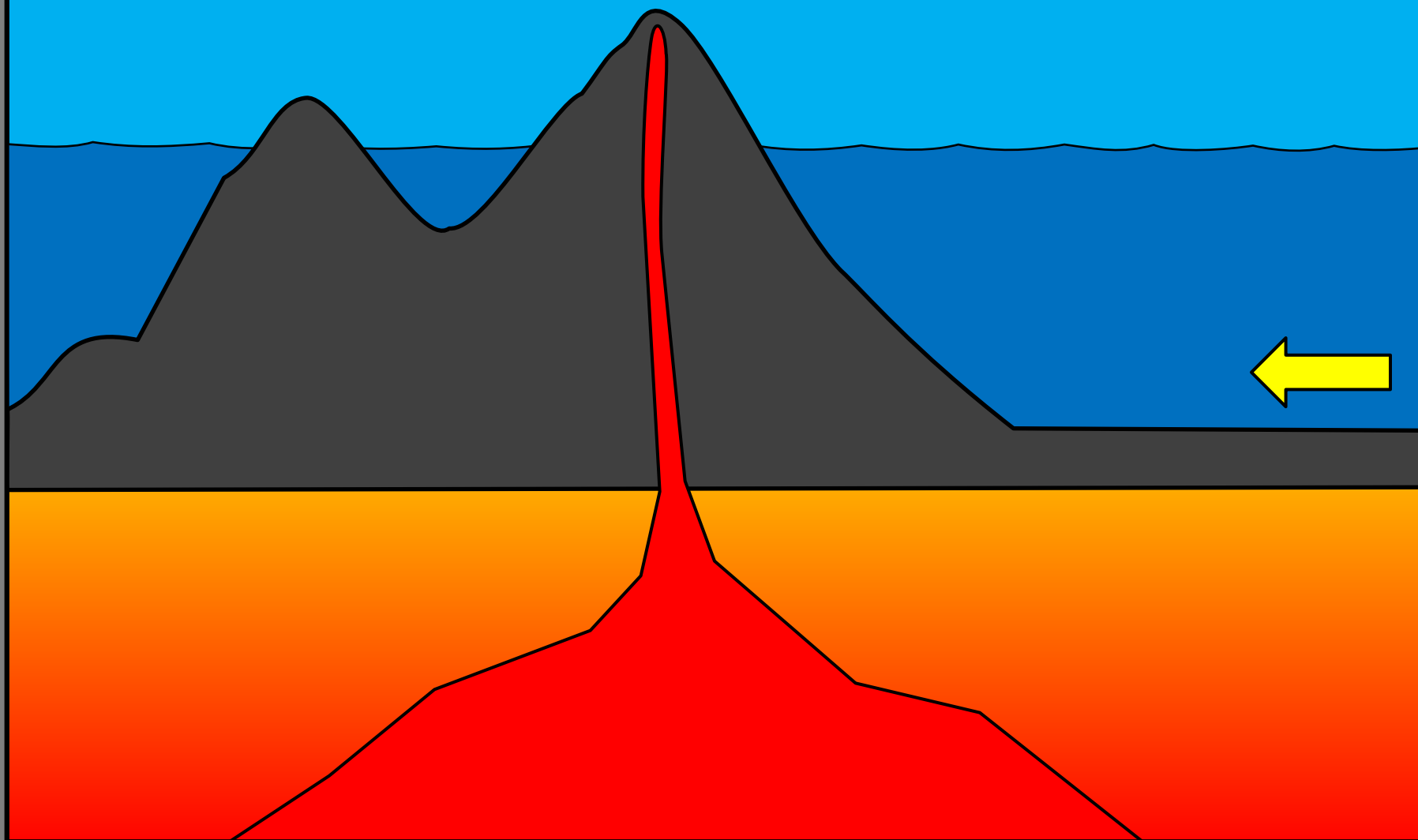




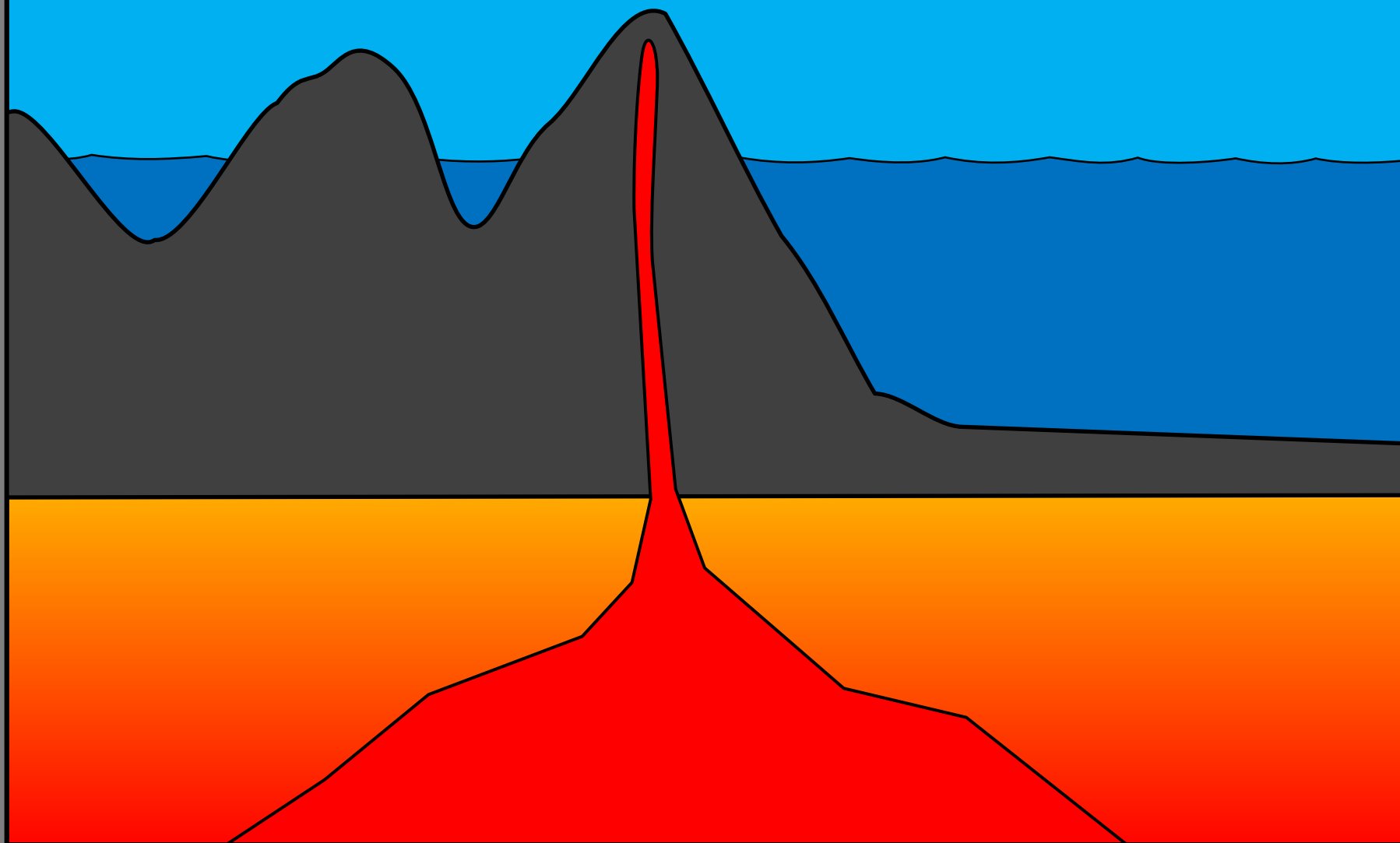


Hotspot

# Hotspot

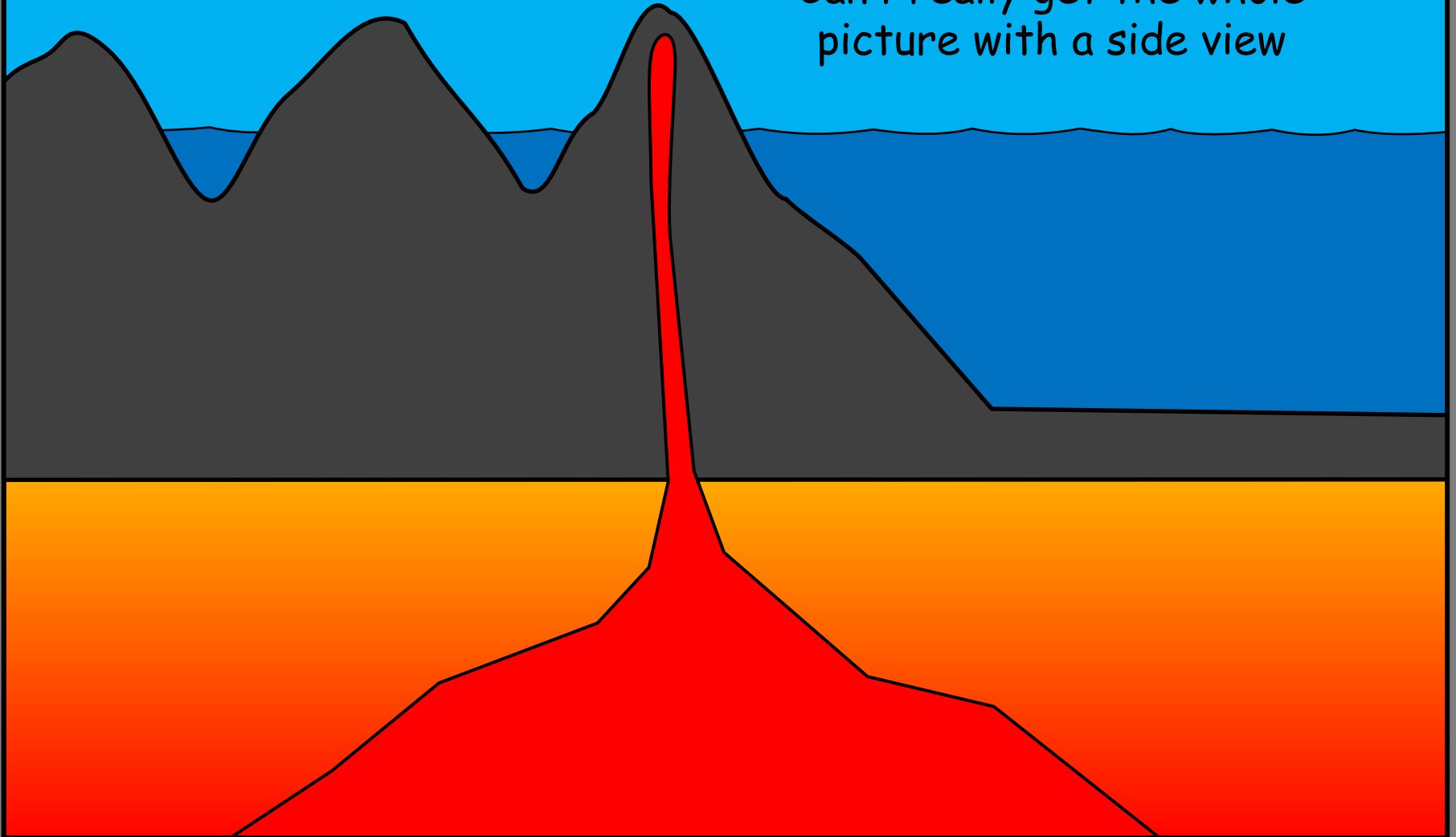


# Hotspot

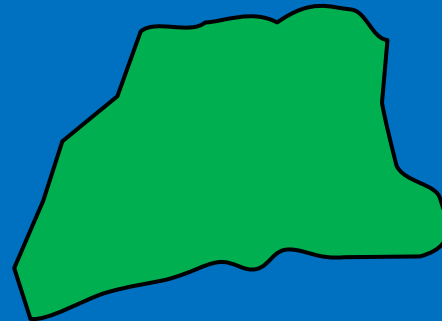


# Hotspot

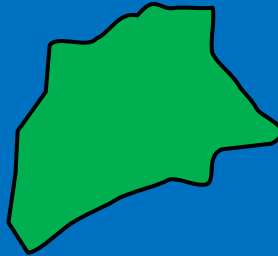
Can't really get the whole picture with a side view



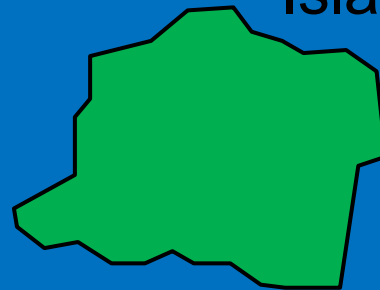
Island #1



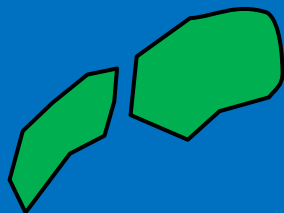
Island #1



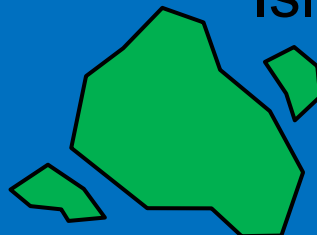
Island #2



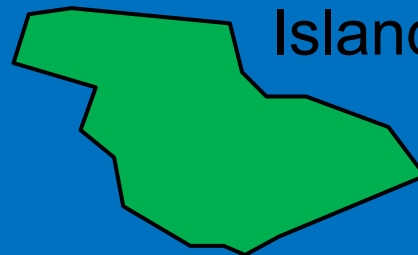
Island #1



Island #2

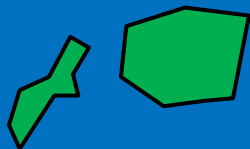


Island #3





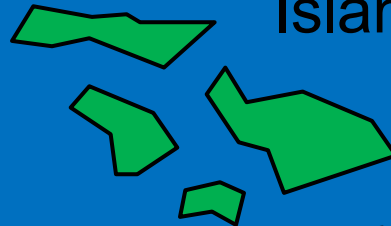
Island #1



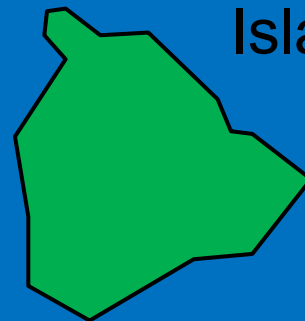
Island #2



Island #3



Island #4



# Hotspot



A location that is volcanically active even though it is not located near a plate boundary

# Quiz Time

What are the three driving forces of plate movement?

# Quiz Time

How does convection  
move the plates?

# Quiz Time

How does gravity  
move the plates?

# Quiz Time

How does pressure  
move the plates?

# Quiz Time

What is the lithosphere?

# Quiz Time

What is the asthenosphere?



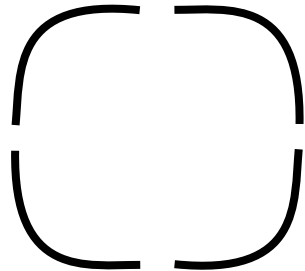
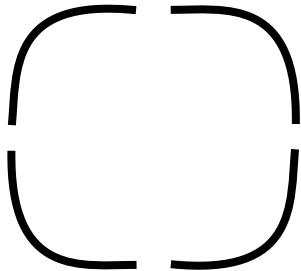
# Quiz Time

Which type of crust is younger, thinner, and more dense?

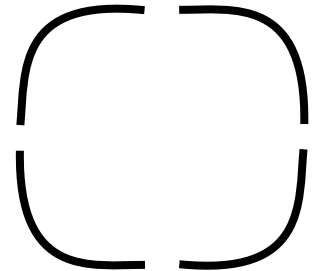
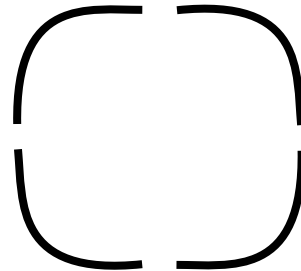
Oceanic or continental

# Quiz Time

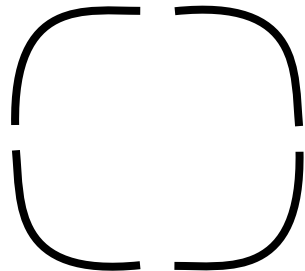
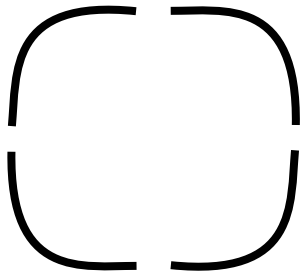
a.



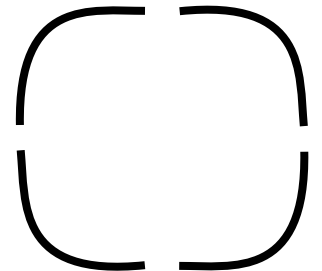
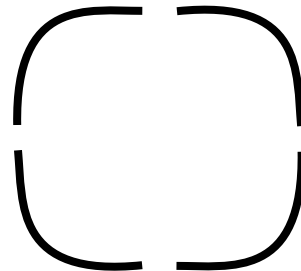
c.



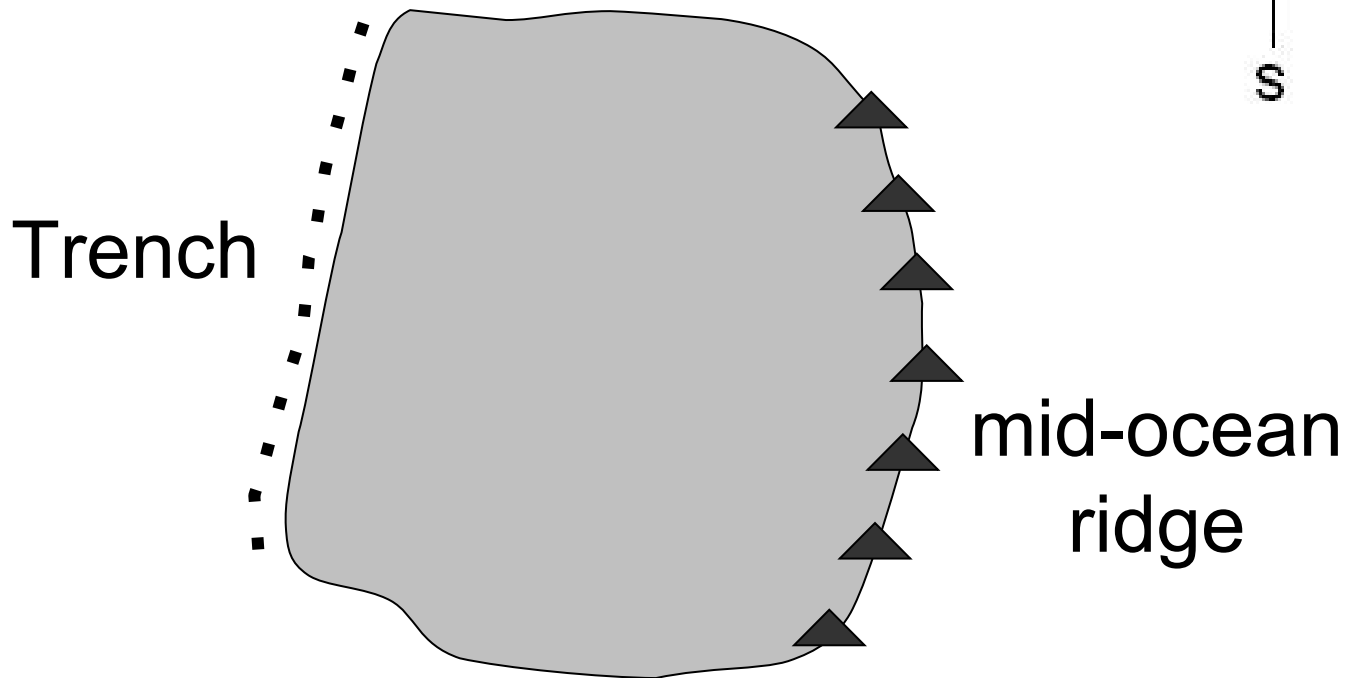
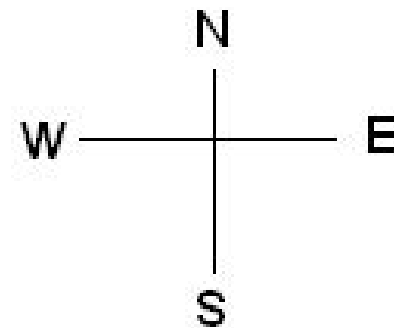
b.

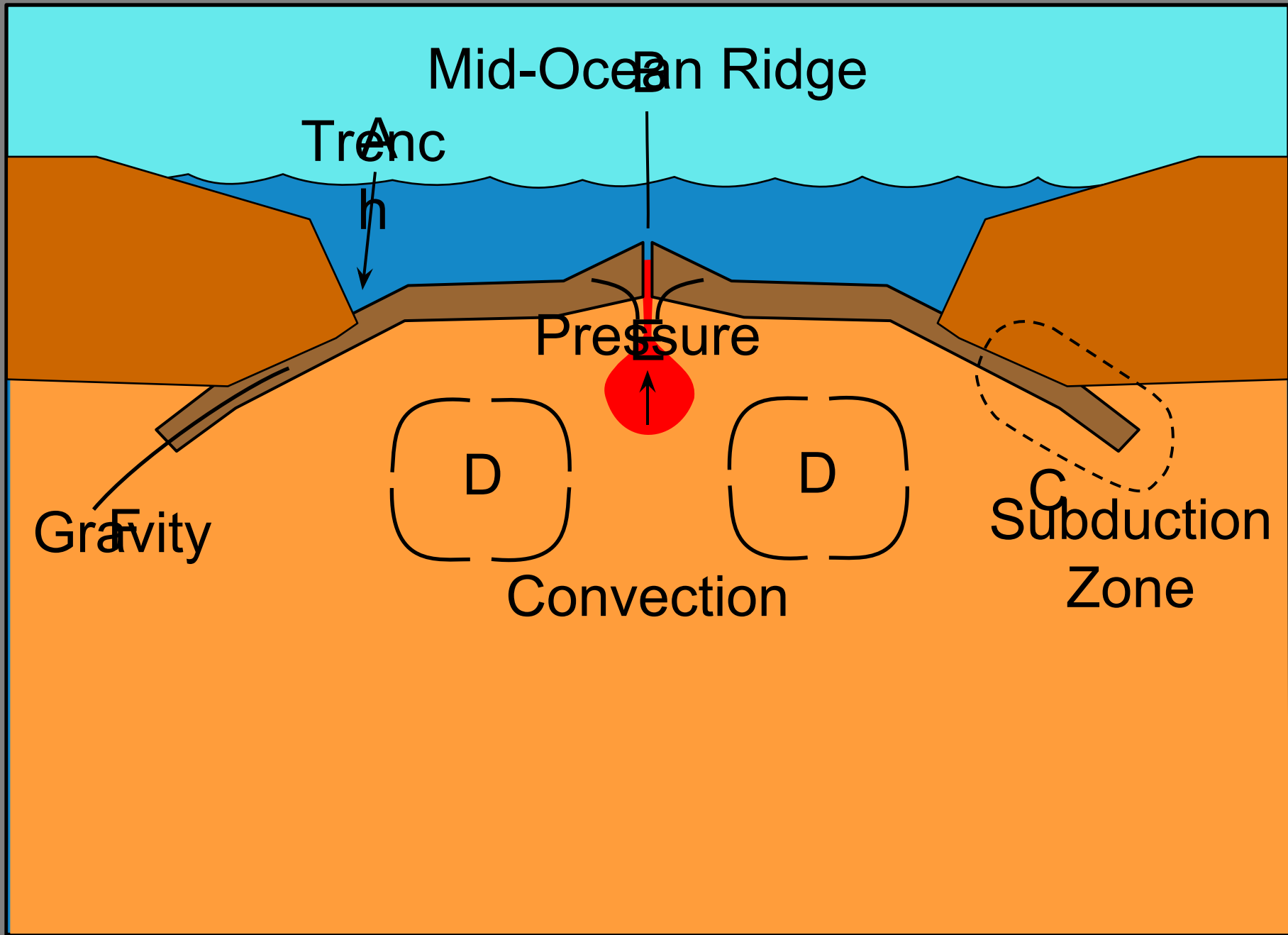


d.



# Quiz Time





# Quiz Time

Where do most of the world's earthquakes and volcanoes occur?

# Quiz Time

What do you call a place that is volcanically active even though it is not located near a plate boundary?

A cartoon illustration on a bright blue background. On the left, a grey tombstone with a black outline and a rounded top sits on a white ground line. The tombstone is inscribed with the name 'Alfred Wegener' and 'R.I.P.' below it. A white speech bubble with a black outline originates from the top of the tombstone and points towards the center of the frame. Inside the speech bubble, the words 'THE END!' are written in a bold, black, sans-serif font.

*THE END!*

Alfred  
Wegener  
r  
R.I.P.