Geology

8.4.a. Compare and contrast the lithosphere and the asthenosphere. (DOK 1)

• Composition, density, and location of continental crust and oceanic crust

• Physical nature of the lithosphere (brittle and rigid) with the asthenosphere (plastic and flowing)

• How the lithosphere responds to tectonic forces (faulting and folding)

8.4.b. Describe the cause and effect relationship between the composition of and movement within the Earth's lithosphere. (DOK 1)

• Seismic wave velocities of earthquakes and volcanoes to lithospheric plate boundaries using seismic data

• Volcanoes formed at mid-ocean ridges, within intra-plate regions, at island arcs, and along some continental edges

• Modern distribution of continents to the movement of lithospheric plates since the formation of Pangaea

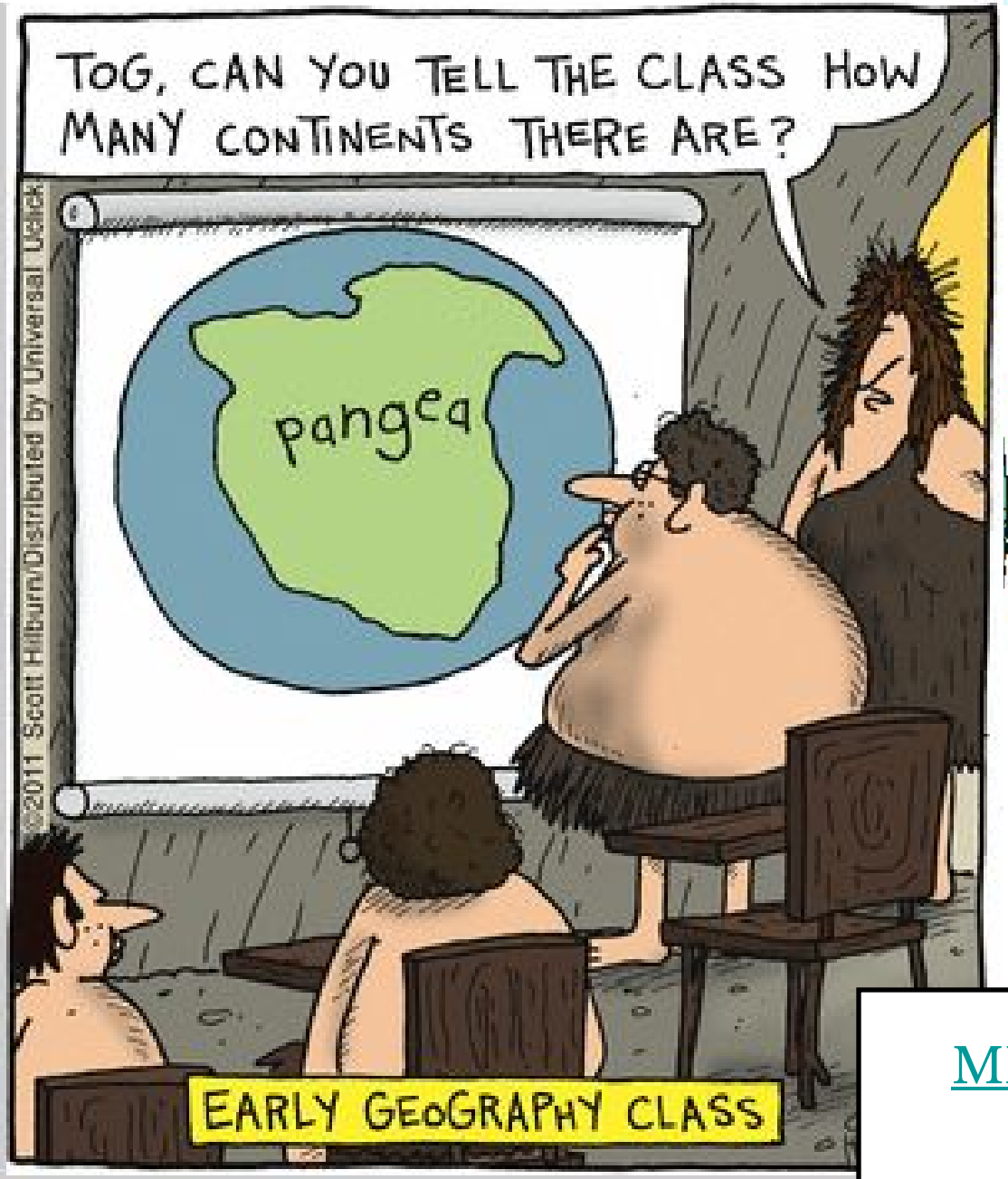
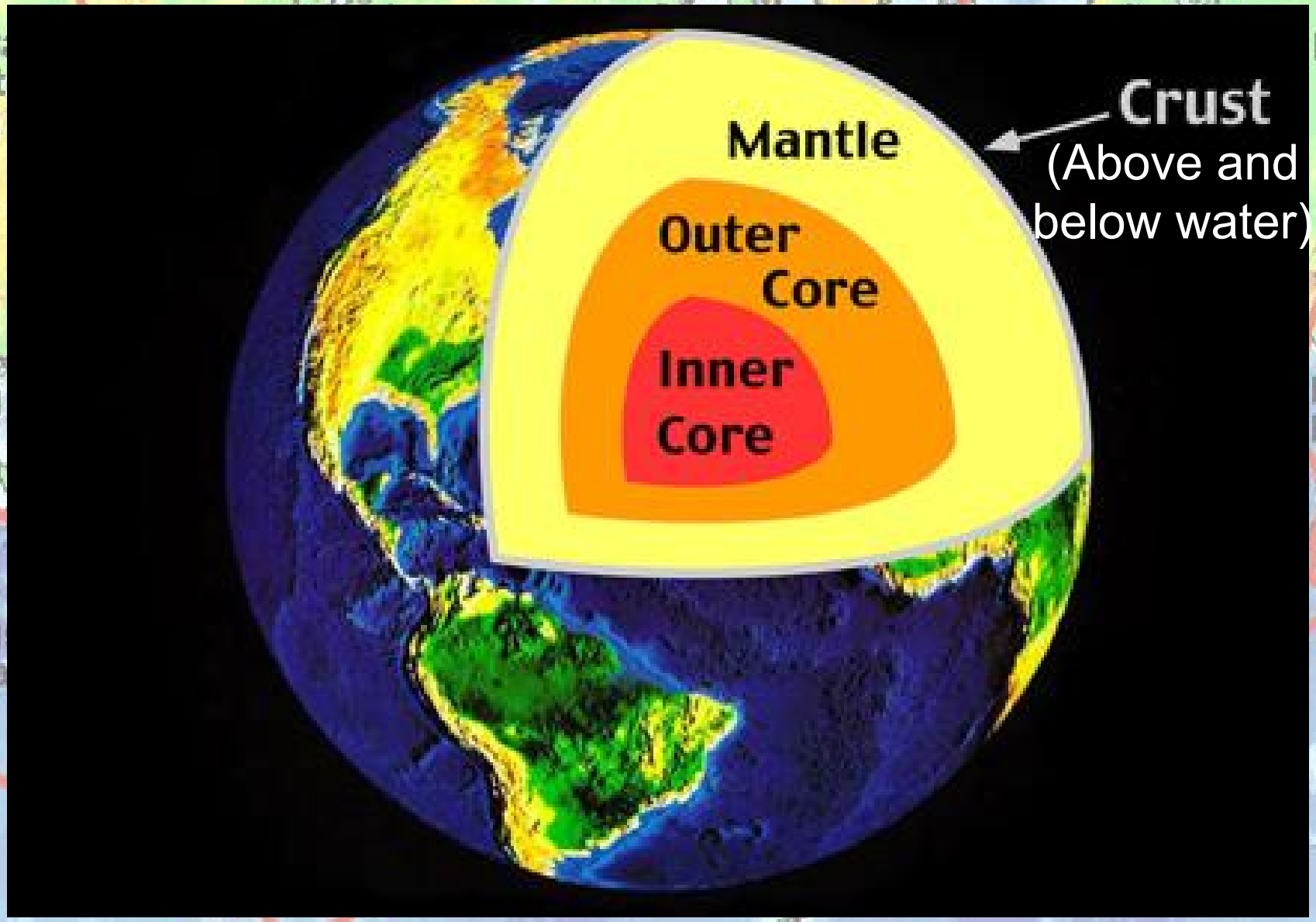


Plate Tectonics ("Continental Drift")

[MIT layers of the earth 6m]



Antarctic Plate

End of slide

Lithosphere:

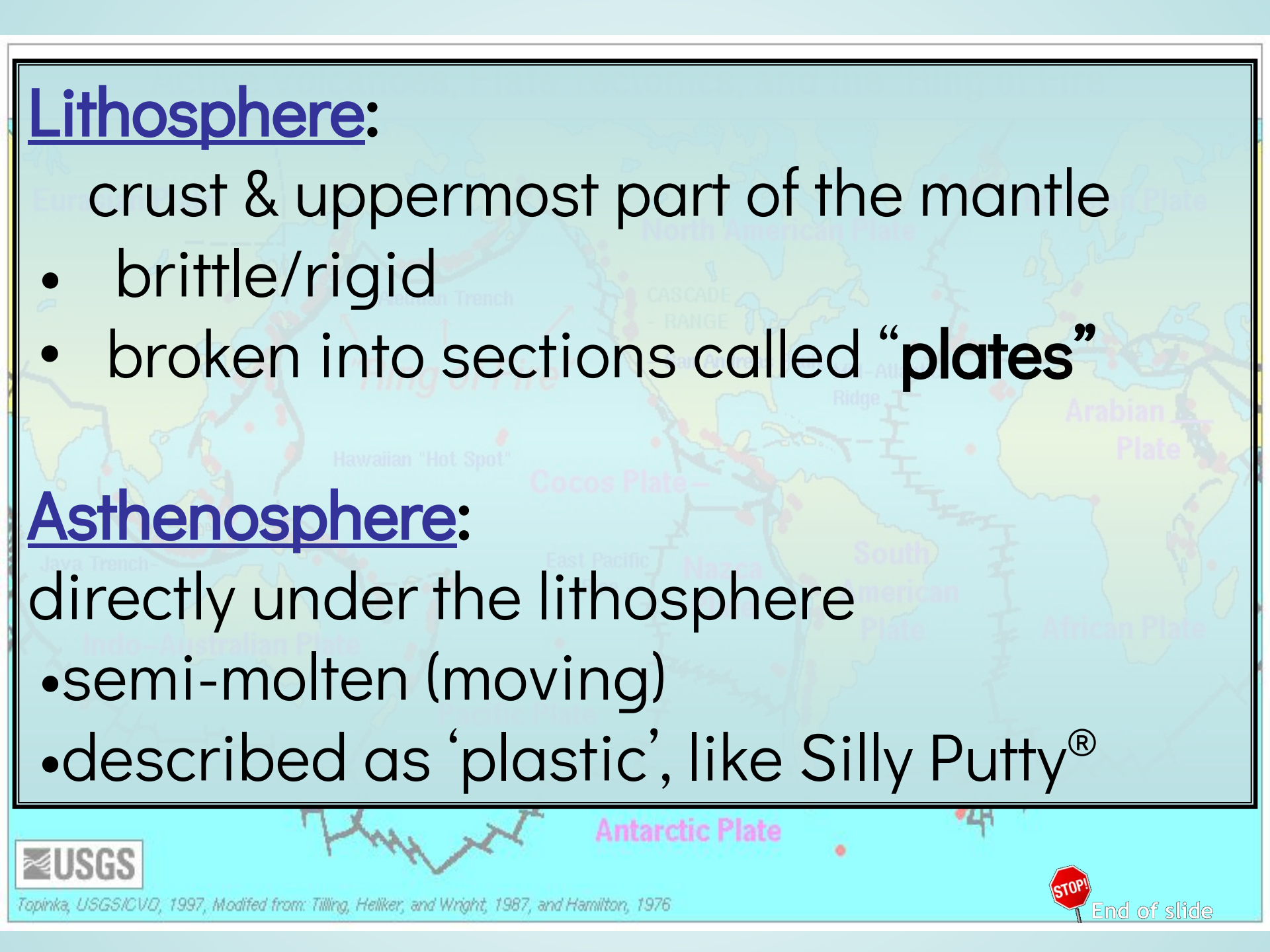
crust & uppermost part of the mantle

- brittle/rigid
- broken into sections called "**plates**"

Asthenosphere:

directly under the lithosphere

- semi-molten (moving)
- described as 'plastic', like Silly Putty®

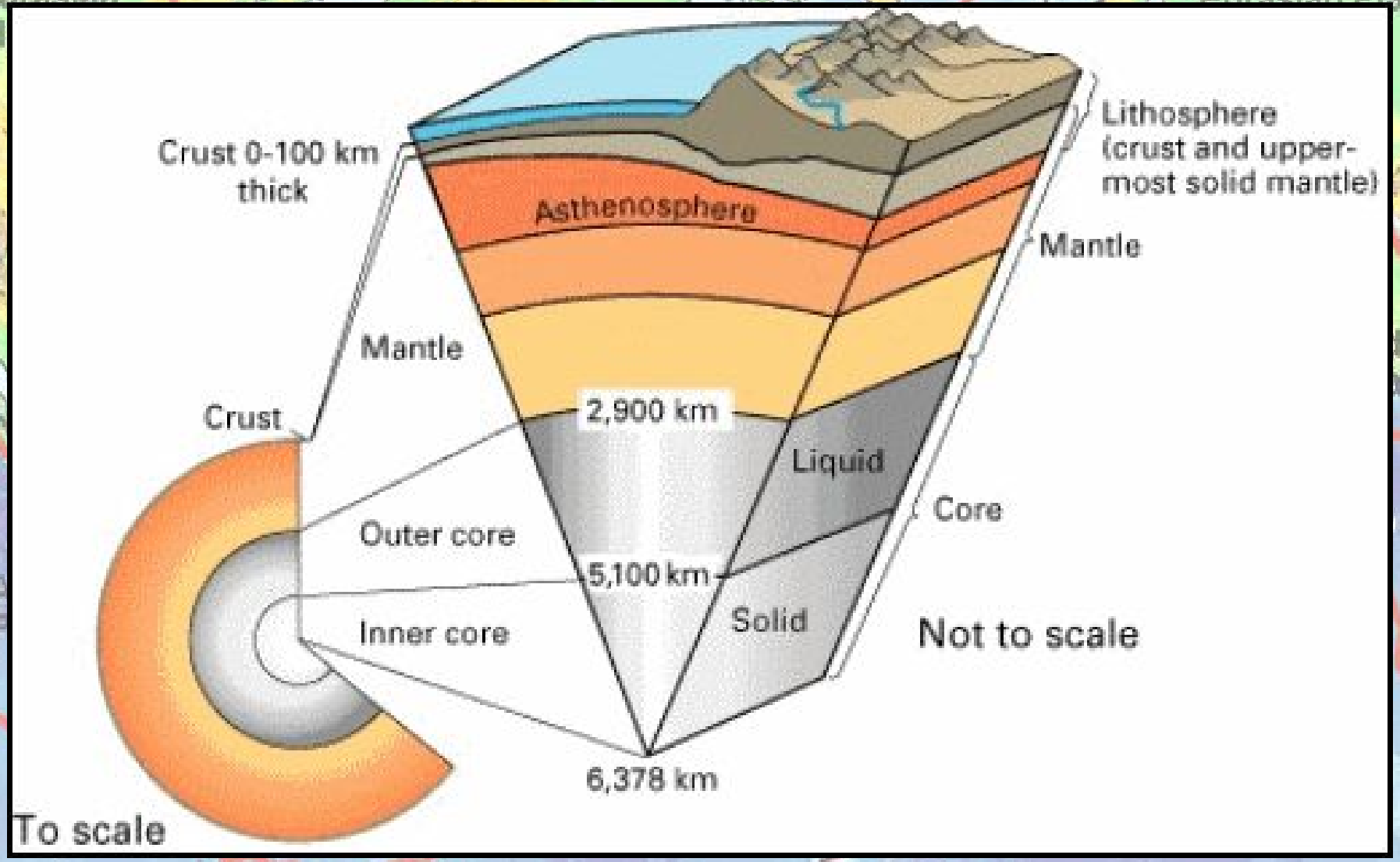


USGS

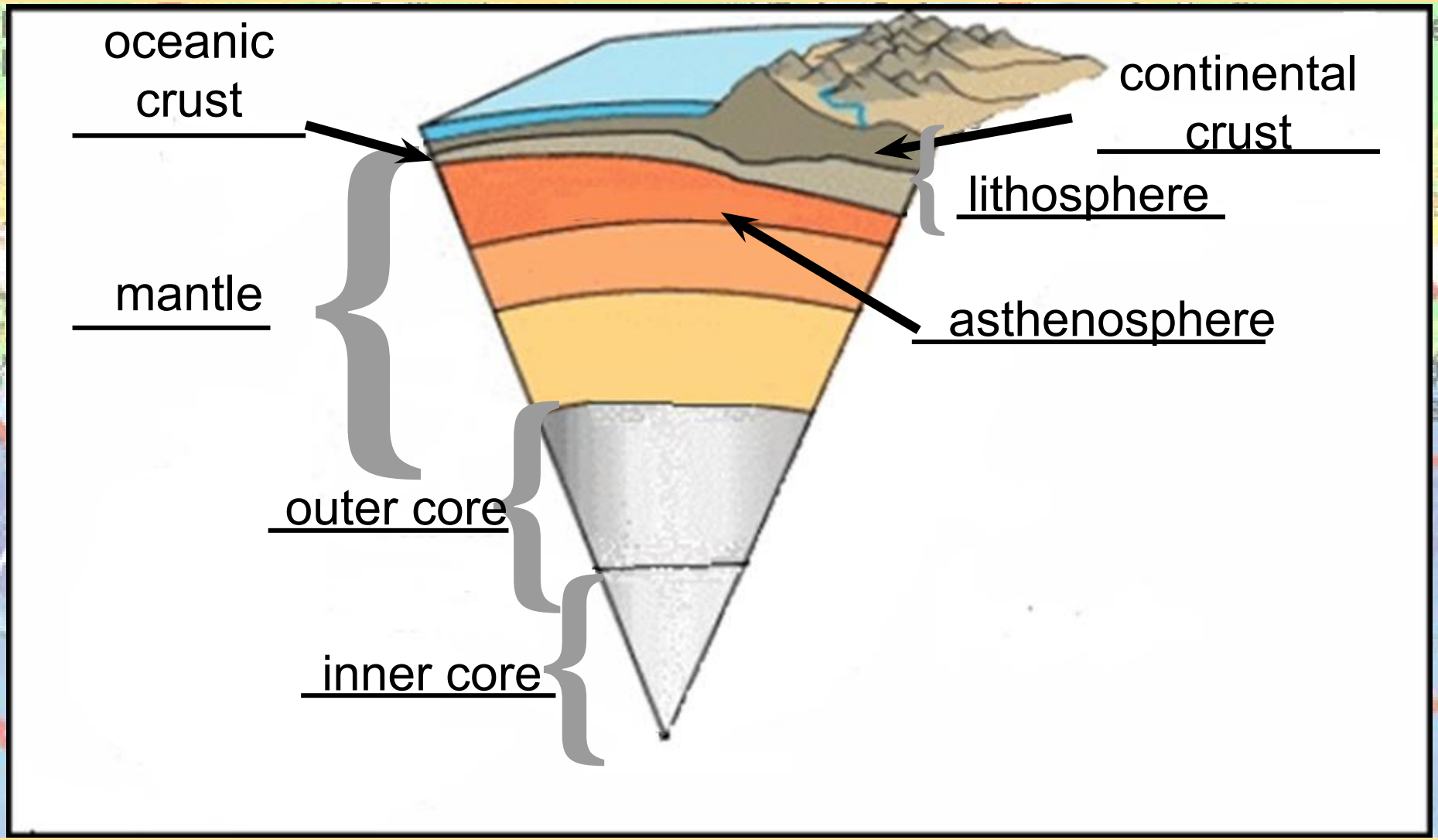
Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

STOP!

End of slide


Crust 0-100 km thick
Asthenosphere
Lithosphere (crust and upper-most solid mantle)
Mantle
Mantle
Crust
2,900 km
Liquid
Core
Outer core
5,100 km
Solid
Inner core
Not to scale
6,378 km
To scale

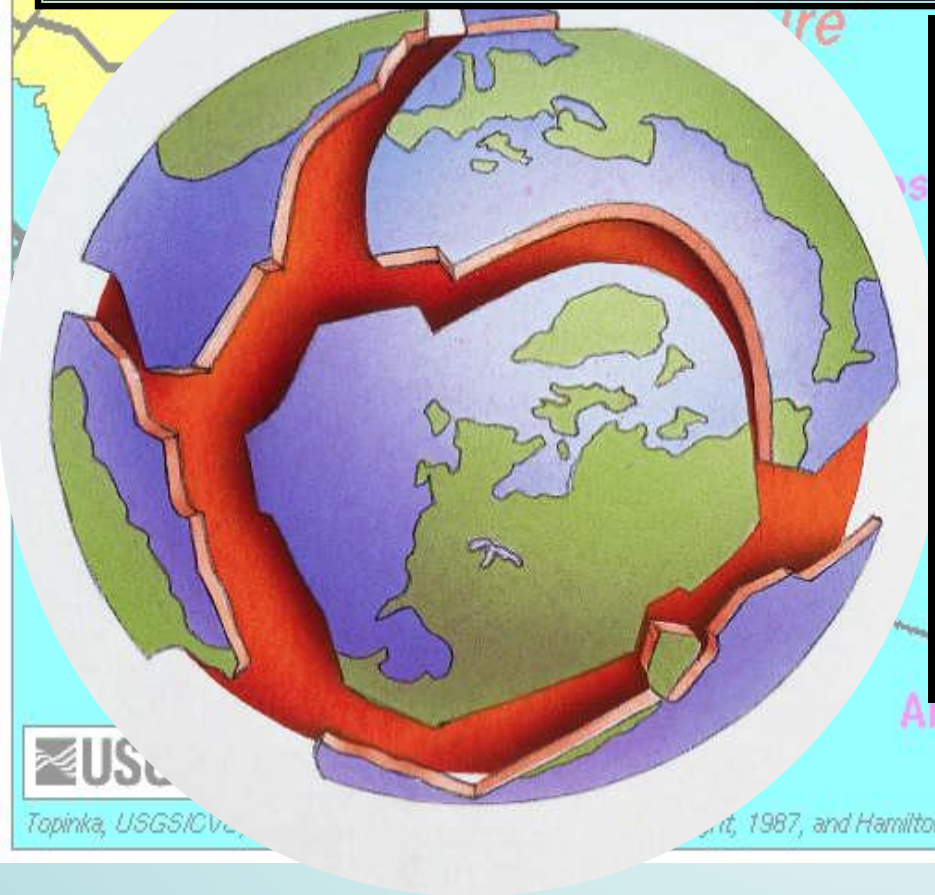
Layers of the Earth Worksheet

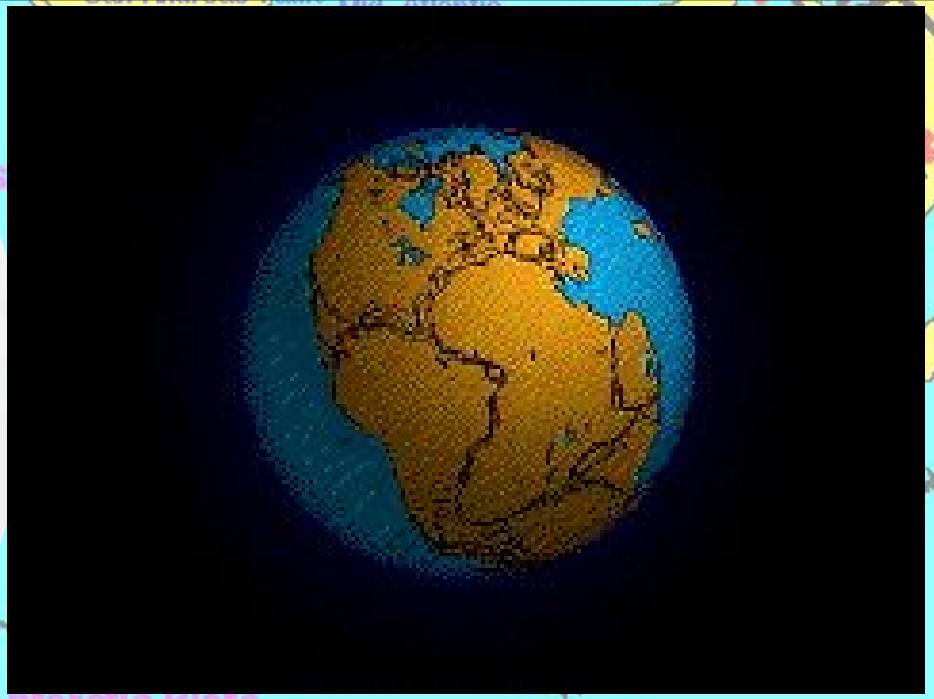


Correctly label your Layers of the Earth worksheet. You will have a quiz on this.

Plate tectonics:

theory that states that pieces of lithosphere are in constant, slow motion





Antarctic Plate

Topinka, USGS/CV… …nt, 1987, and Hamilton, 1976

STOP! End of slide

Plate movement causes changes:

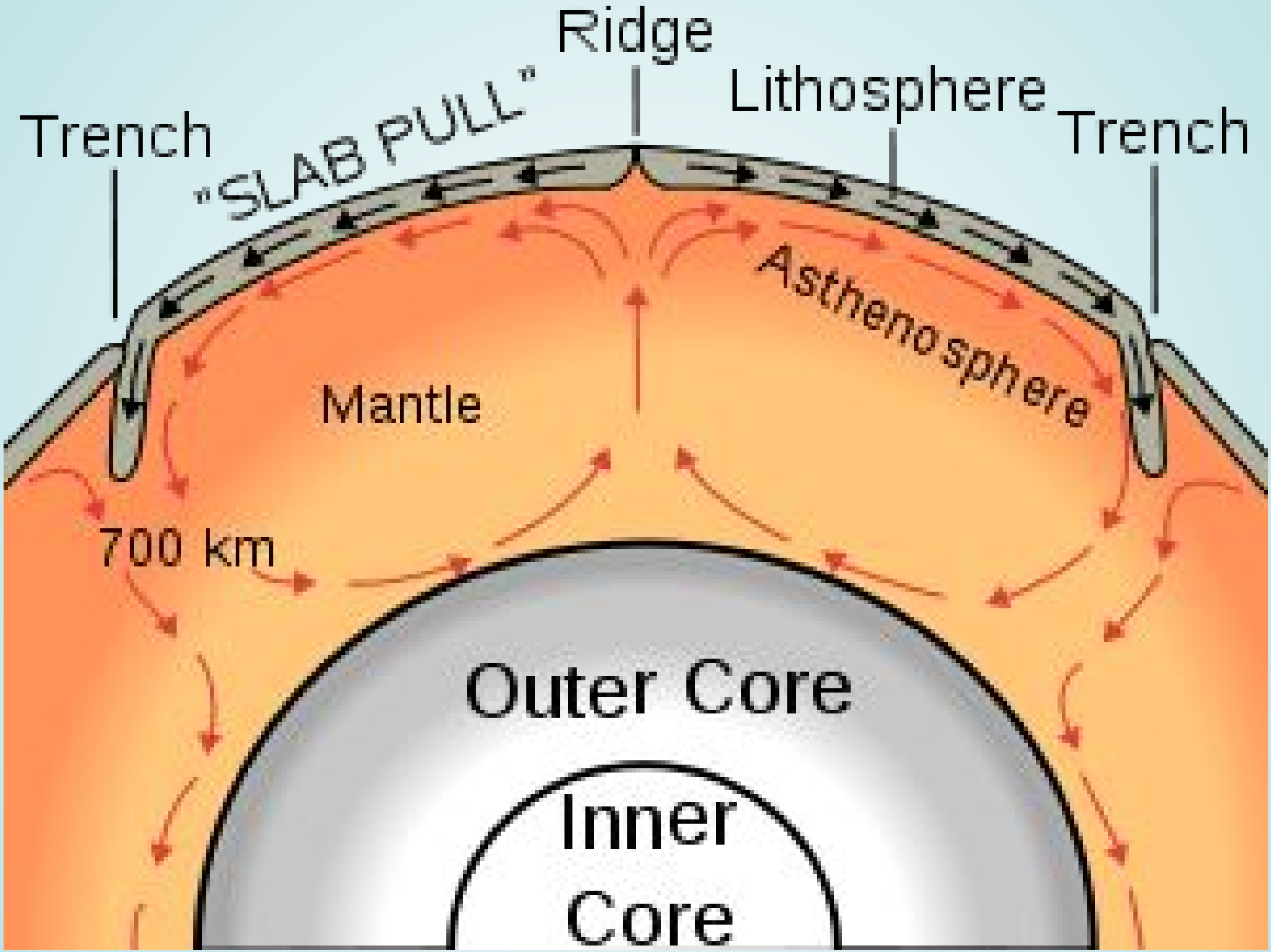
Slow changes:

- mountain chains
- trenches
- rift valleys

Fast changes:

- earthquakes
- tsunamis
- volcanoes

End of slide


Ridge
Lithosphere
Trench
"SLAB PULL"
Trench
Asthenosphere
Mantle
700 km
Outer Core
Inner
Core

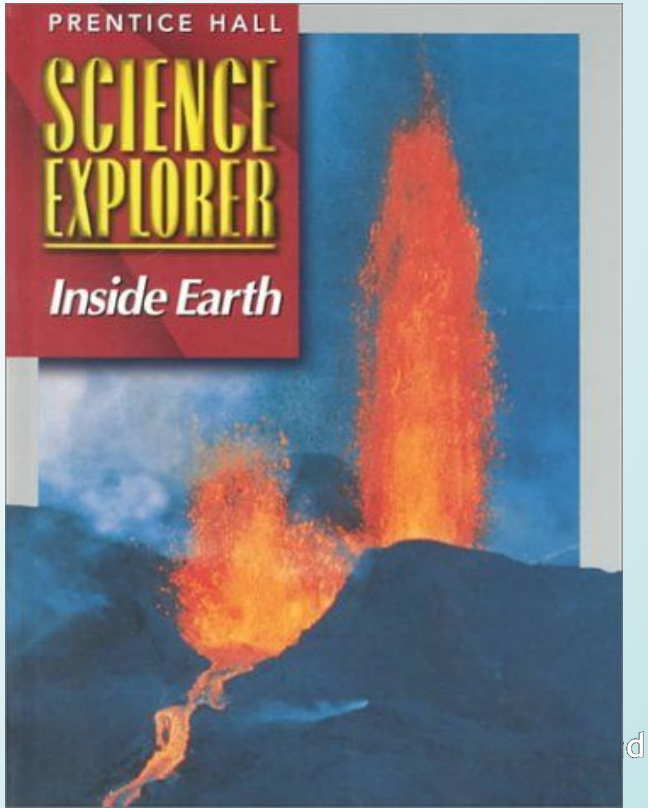
Science Explorer Textbook

Inside Earth

Convection Currents in the Mantle: pages 25-27

Use your textbook to define the following terms in your notes:

1. Radiation
2. Conduction
3. Convection
4. Density
5. Convection Current



d of slide

Plate boundaries:

area where plates meet

- resembles cracked shell of hard boiled egg

<u>3 types of plate boundaries</u>:

1. Divergent boundary
2. Convergent boundary
3. Transform boundary

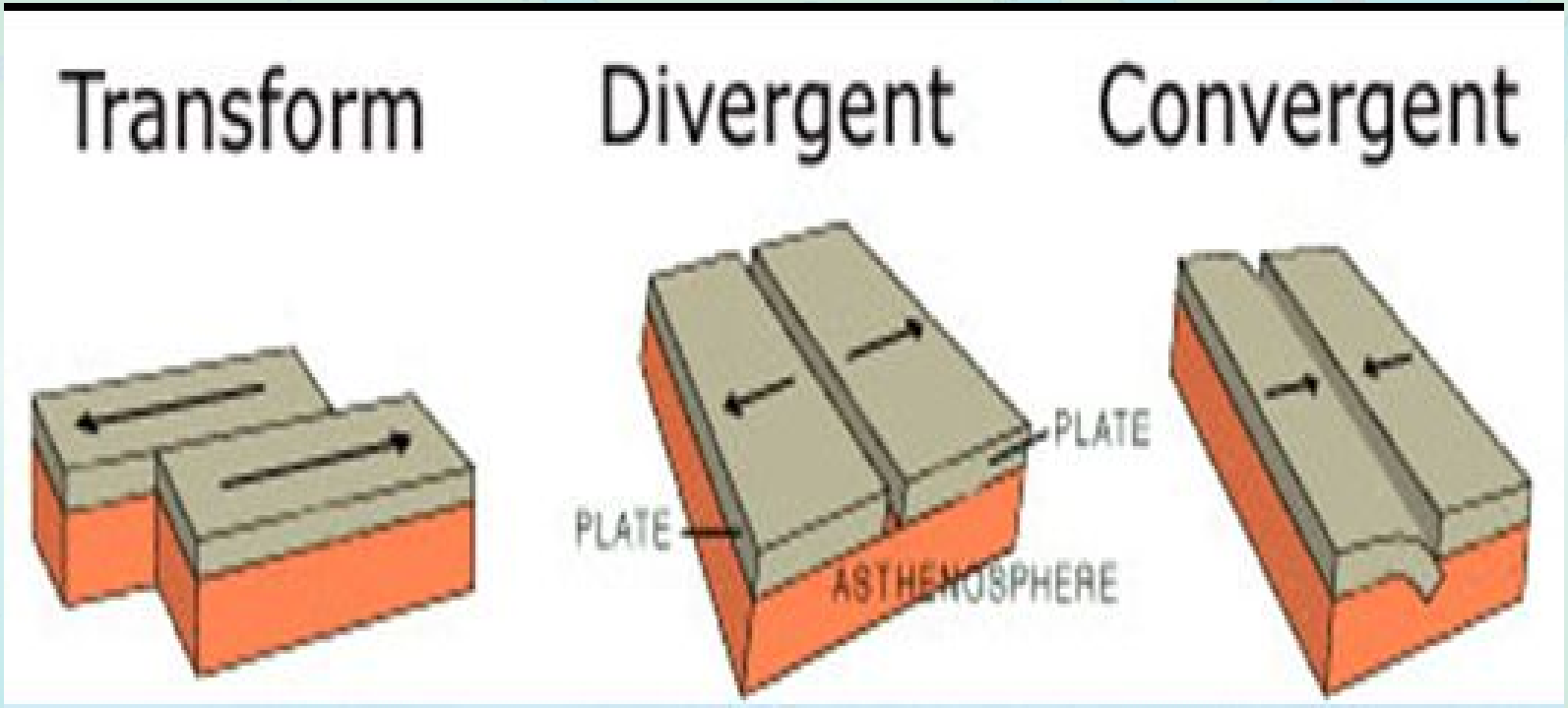
USGS

Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

STOP!

End of slide

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"



Pacific Plate

Antarctic Plate

USGS

Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

STOP!

End of slide

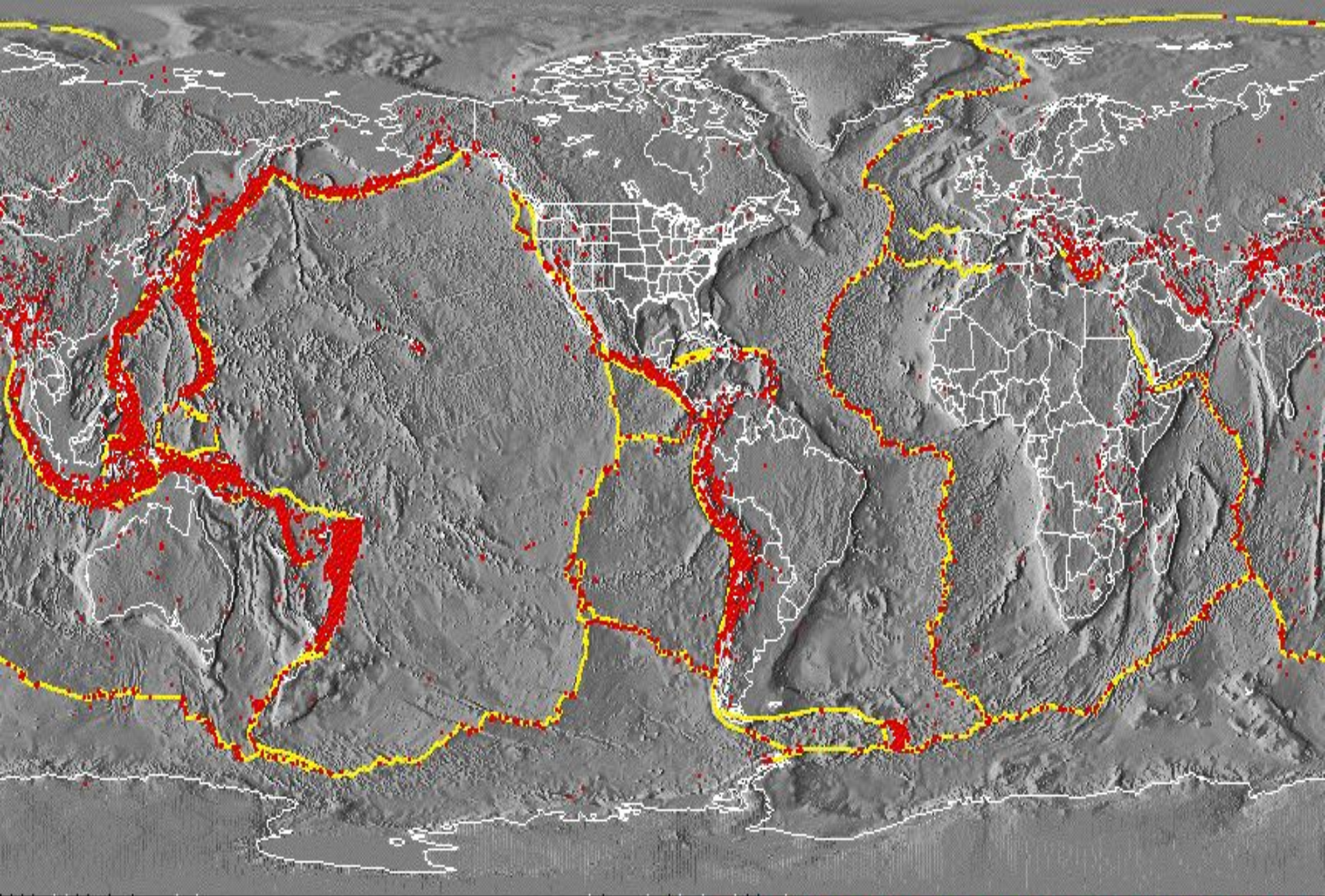
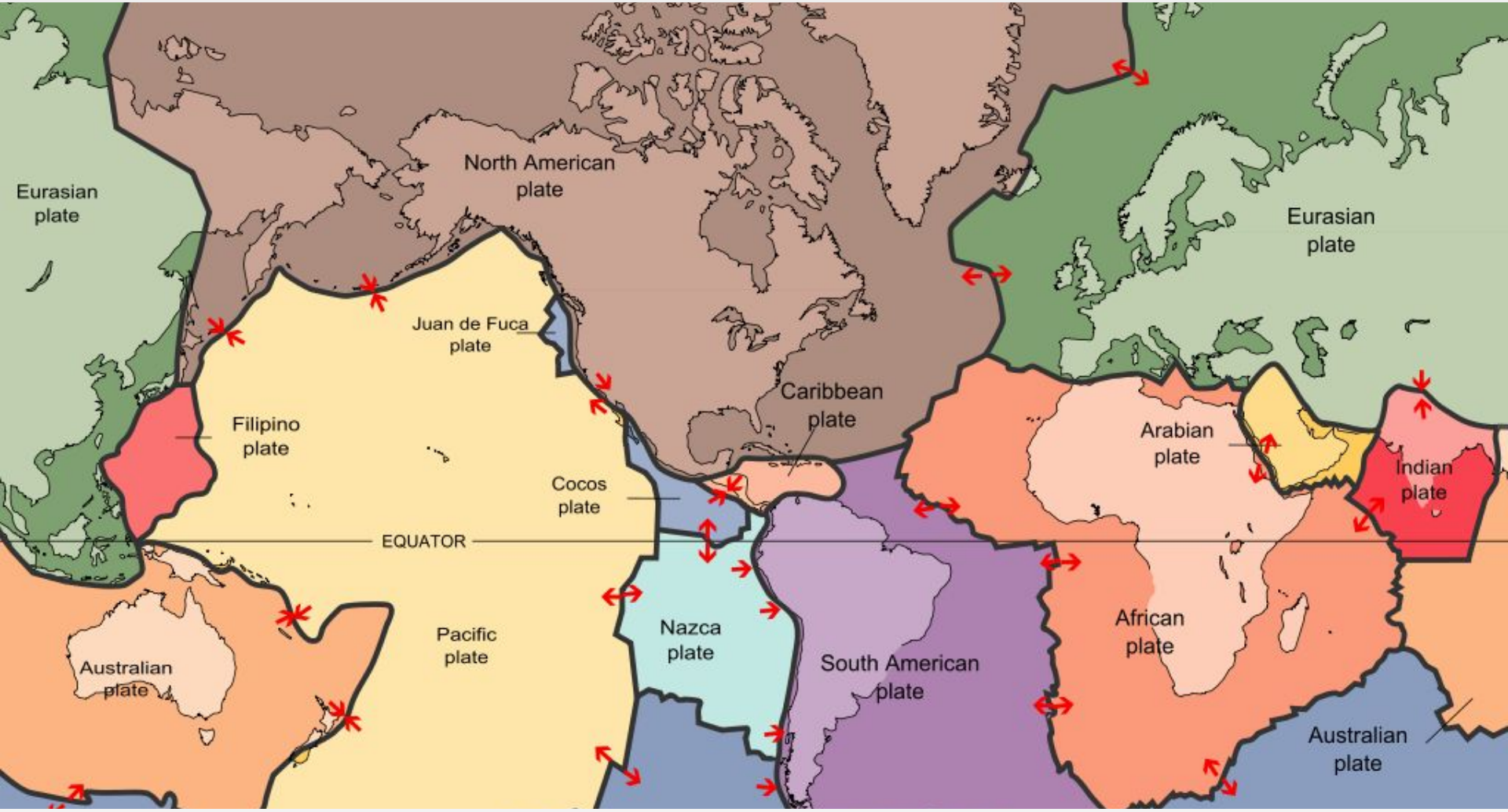

Crustal Plate Boundaries
Earthquake Epicenters, M 5, 1980-1990
Coastlines, Political Boundaries
STOP!
End of slide

Plate Boundaries Worksheet



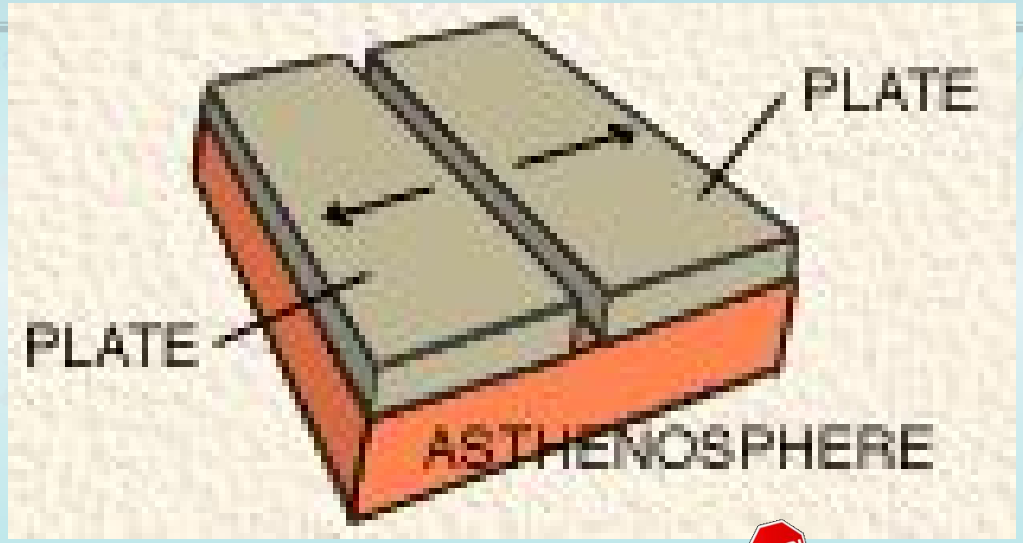
This is on the back of your Layers of the Earth worksheet. Find the various boundaries as we go through the notes.

Divergent boundary:

two plates move apart (diverge)

- can create a “rift valley”
- “new” land is exposed b/c it’s being pushed up by the force of the mantle.

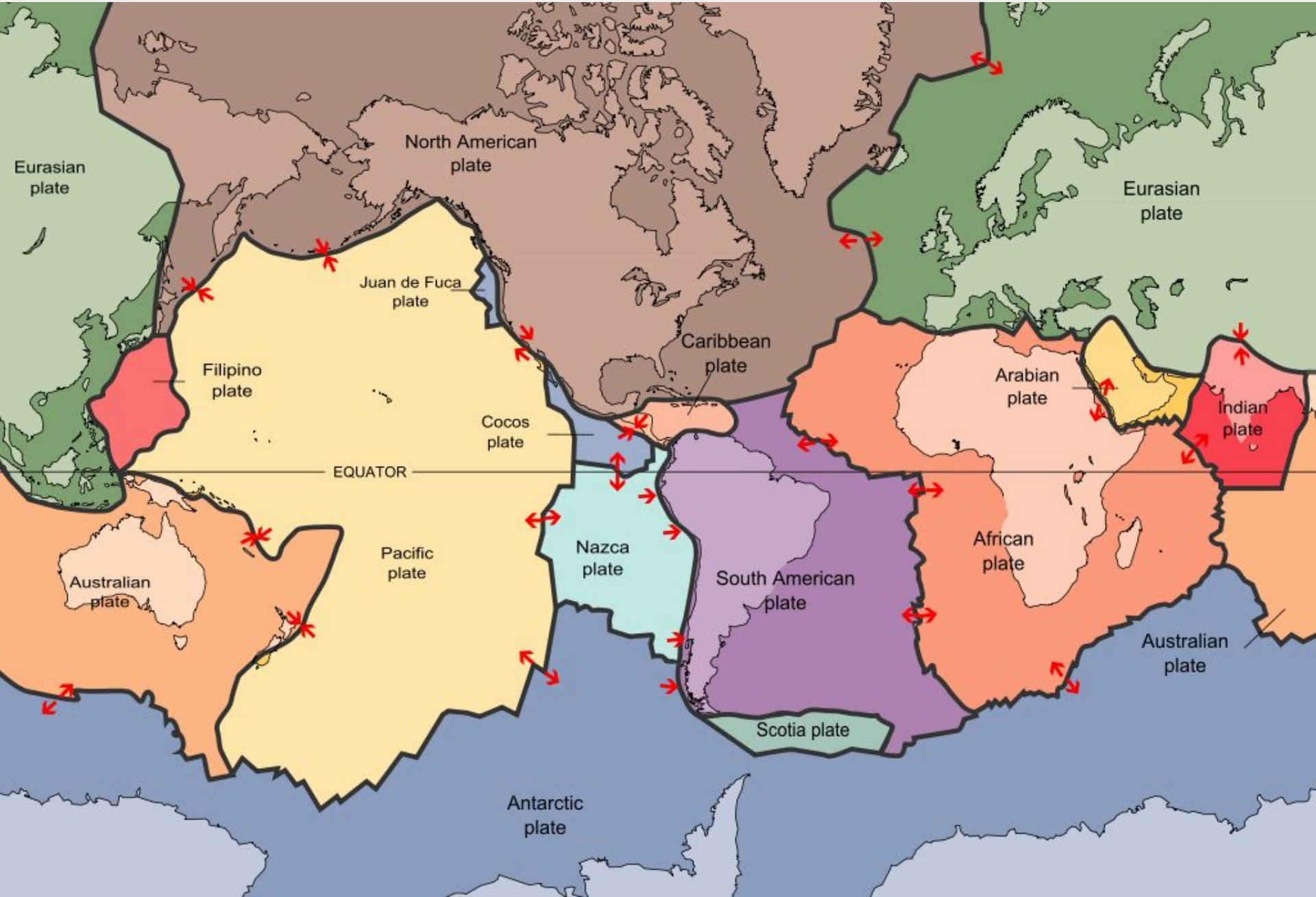
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.
- R. Frost



STOP!

End of slide

Find a Divergent Boundary

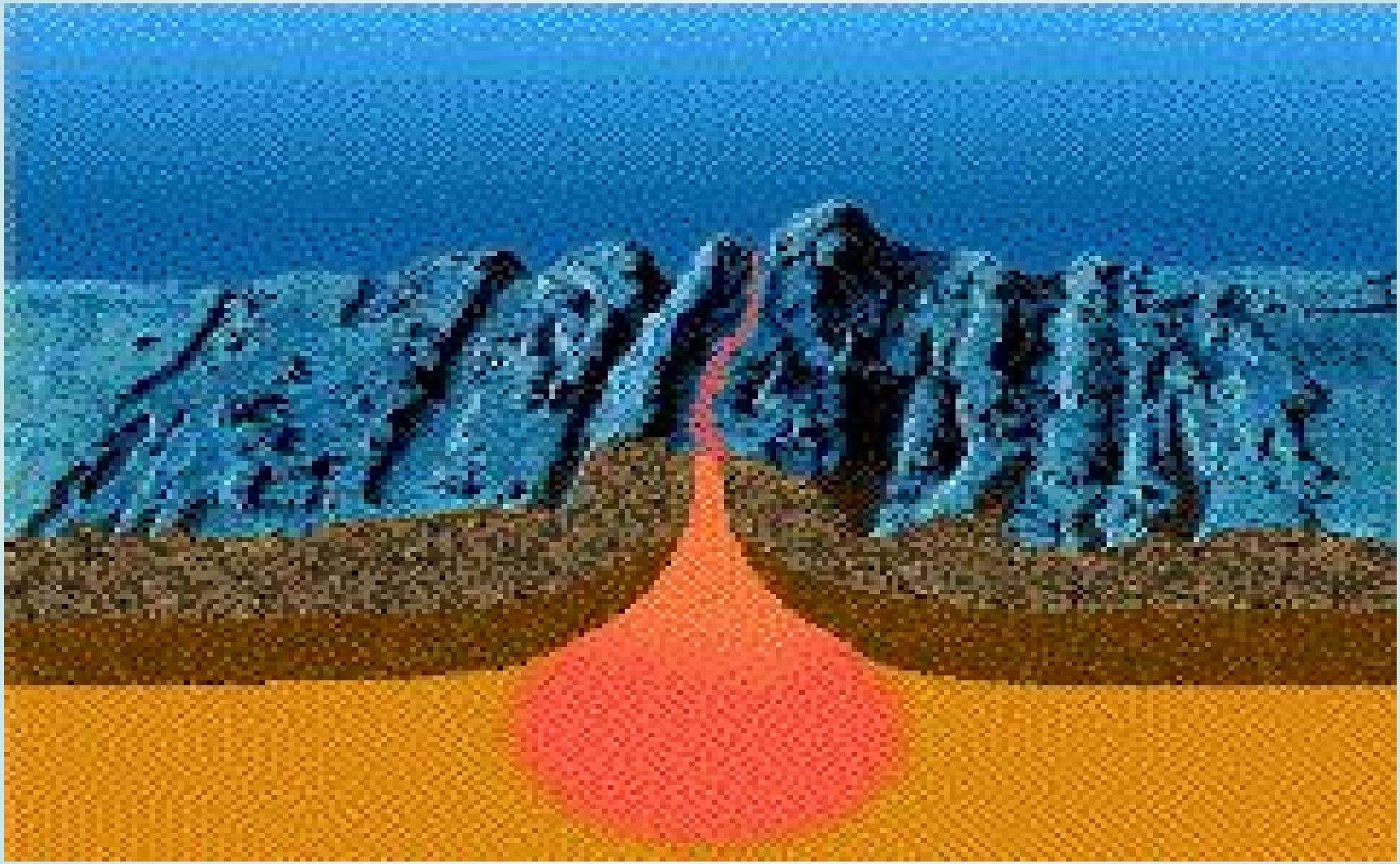


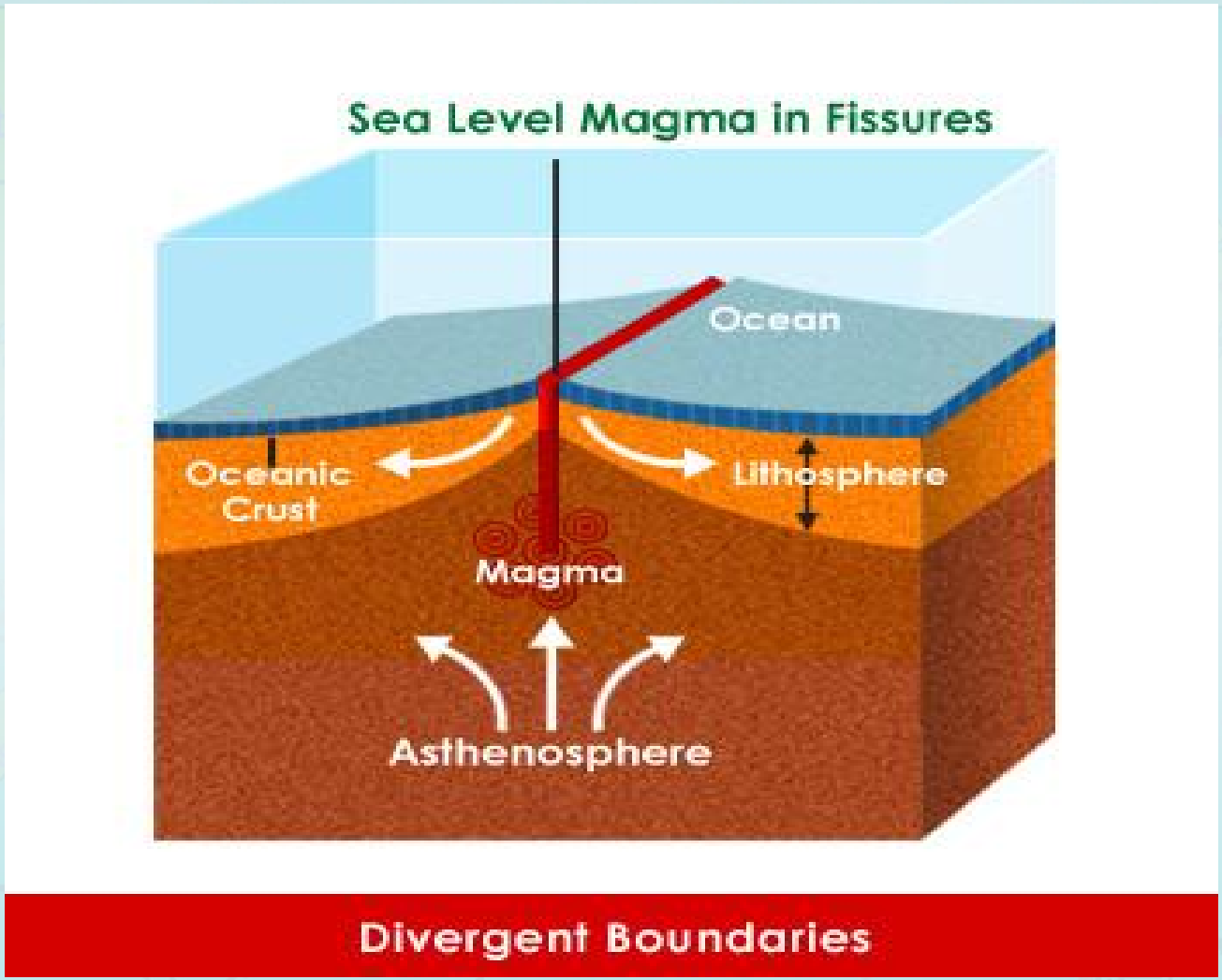
End of slide

Sea-floor spreading:

as molten material rises thru the cracks in the ocean floor, ridges (mountains) are formed.

- caused by underwater volcanoes
- occurs at DIVERGENT boundaries





Bill Nye Mid Atlantic Ridge

Seafloor Spreading Instructions

Materials Needed:

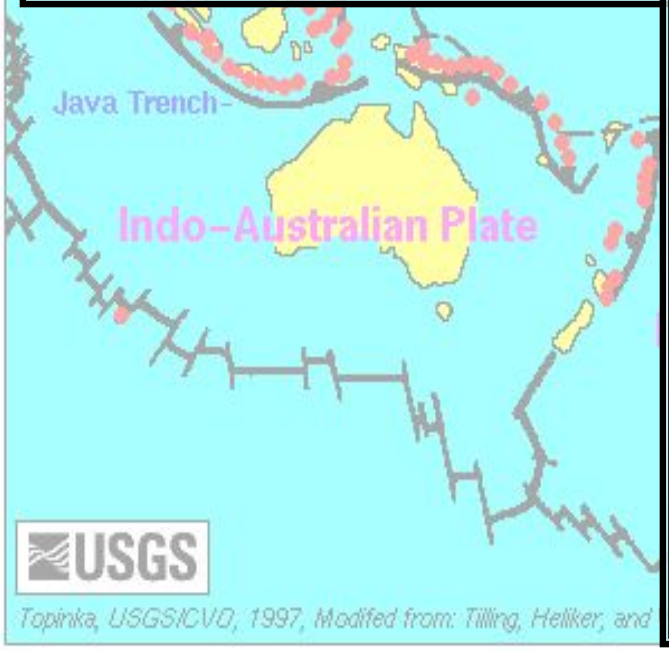
- Africa/South America sheet,
- colored pencils or markers,
- Partner and 2 desks

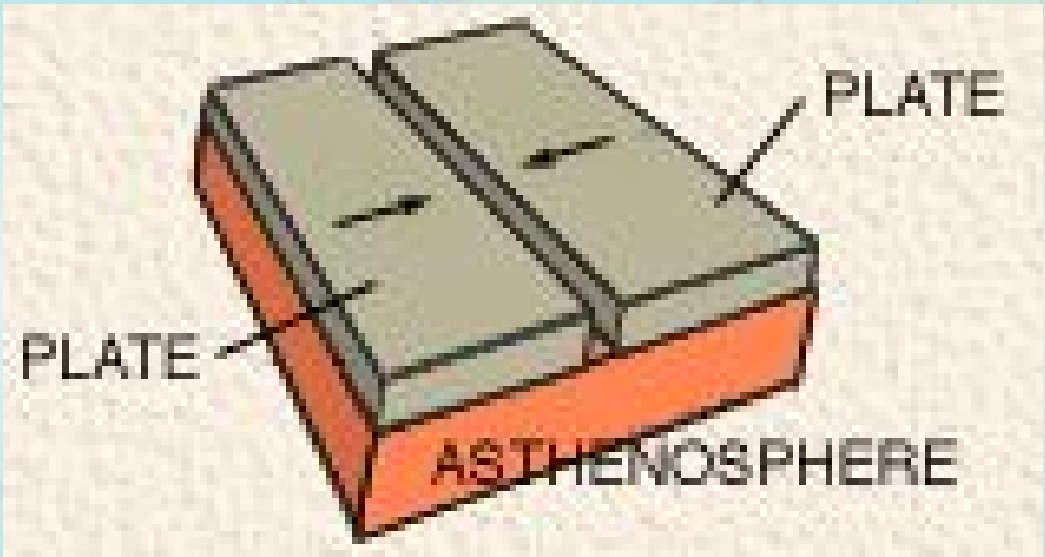
1. Push your desk against your partners.
2. Cut along the dotted line on the sheet you have been given.
3. Turn Africa and South America so that they face one another. Stick this sheets halfway down between the two desks that are facing one another. Push the desks together tightly. Fold down the pages so that Africa and South America are close to one another (like Pangaea).
4. Use a red colored pencil to draw a line down the middle of the desk. Pull the papers out a little. This will show a red line on the African paper and and South American paper.
5. Choose a different color. Repeat step 4 until you run out of paper.

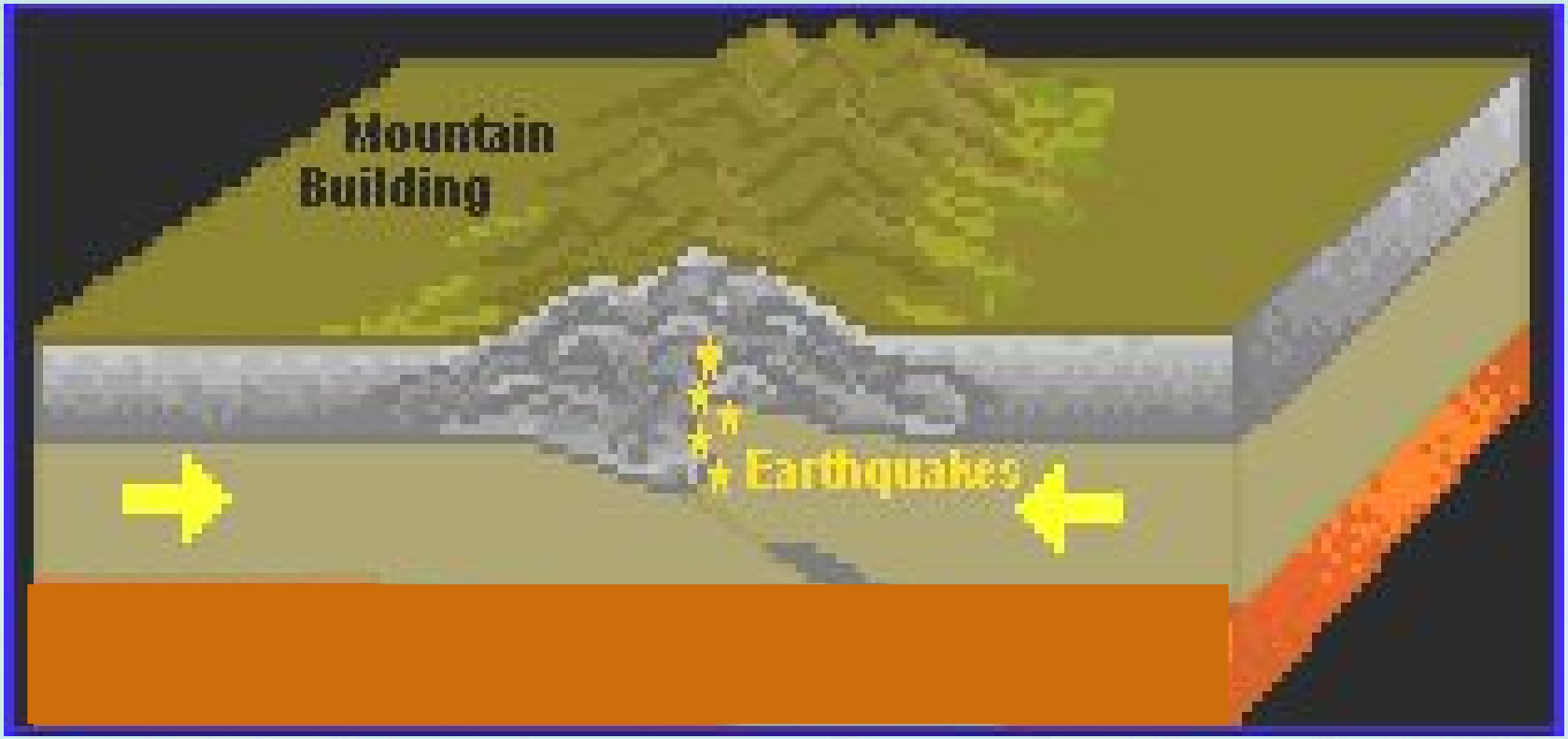
Convergent boundary:

2 plates come together (converge/collide)

- creates **mountains** or **trenches**
- can force magma to surface



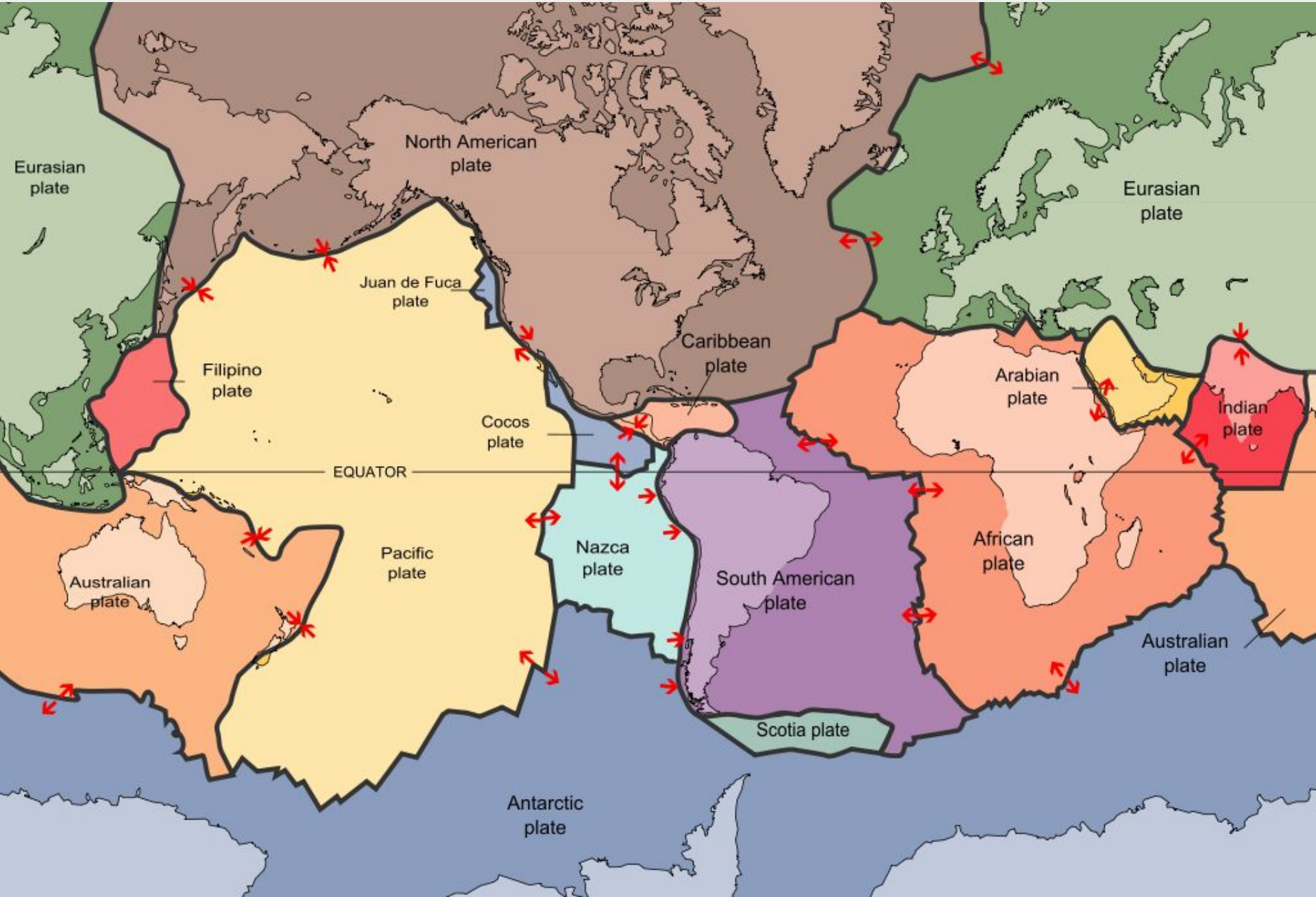




USGS

Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

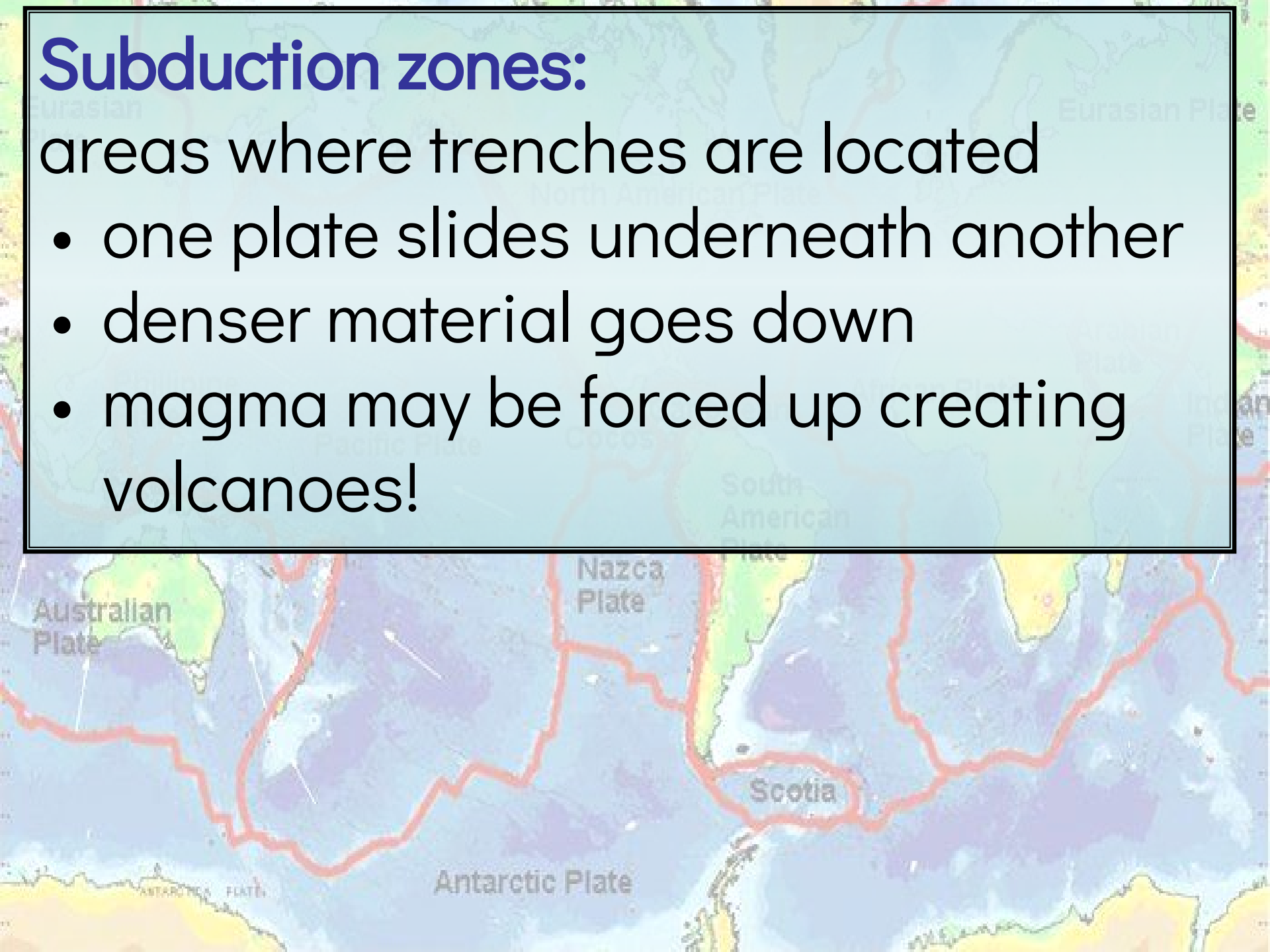
Find a convergent boundary



Subduction zones:

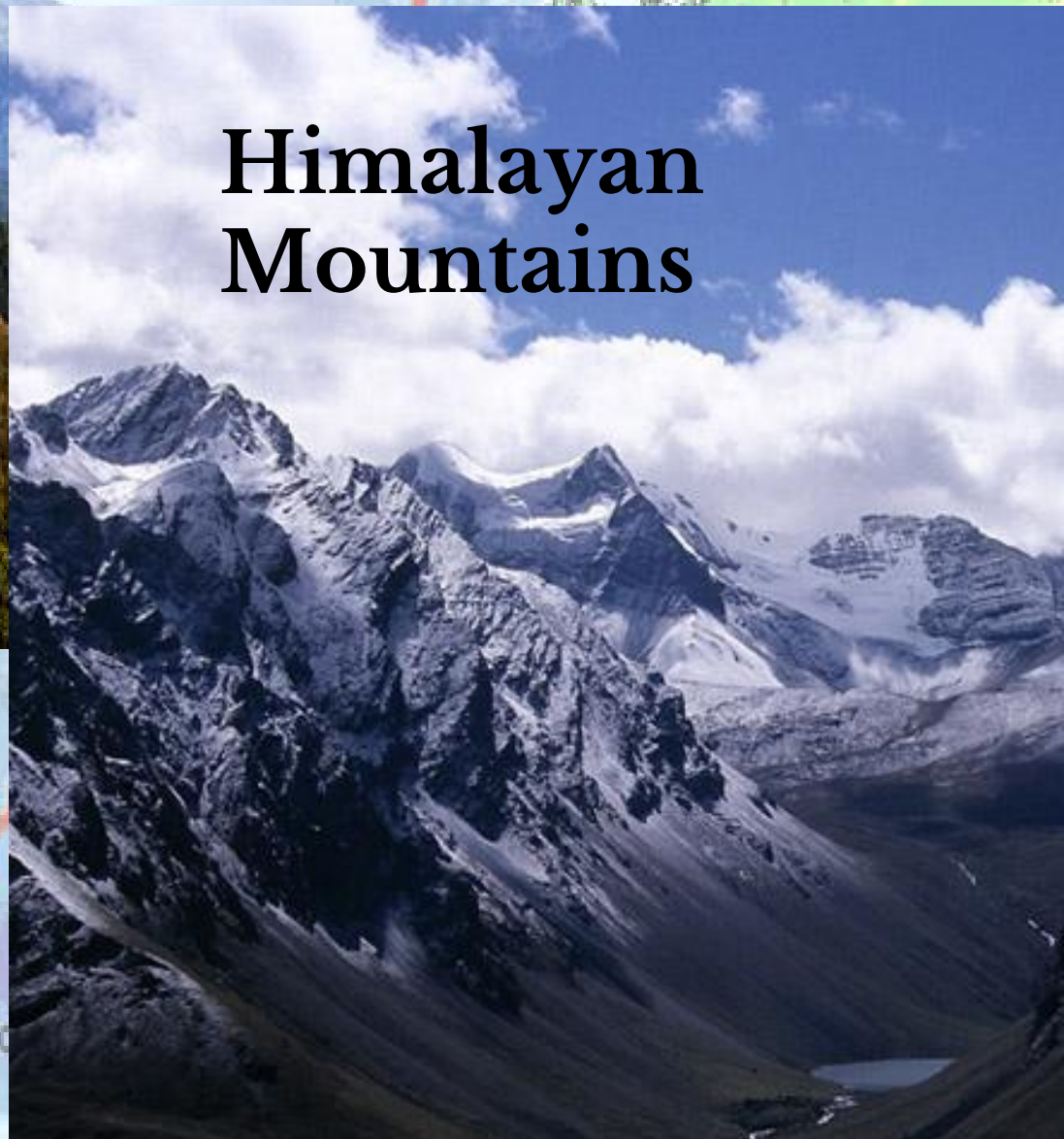
areas where trenches are located

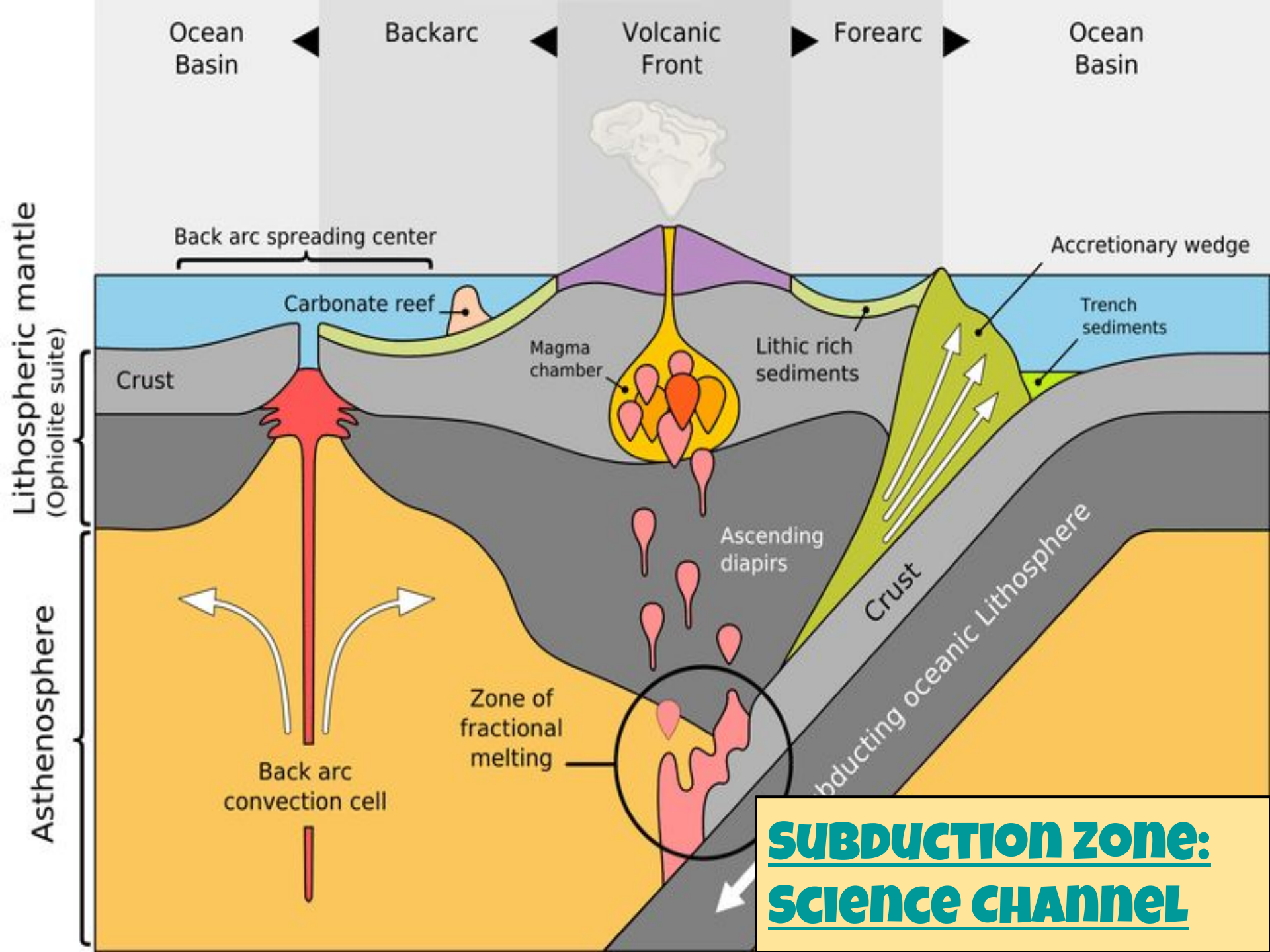
- one plate slides underneath another
- denser material goes down
- magma may be forced up creating volcanoes!



Smoky Mountains

Himalayan Mountains

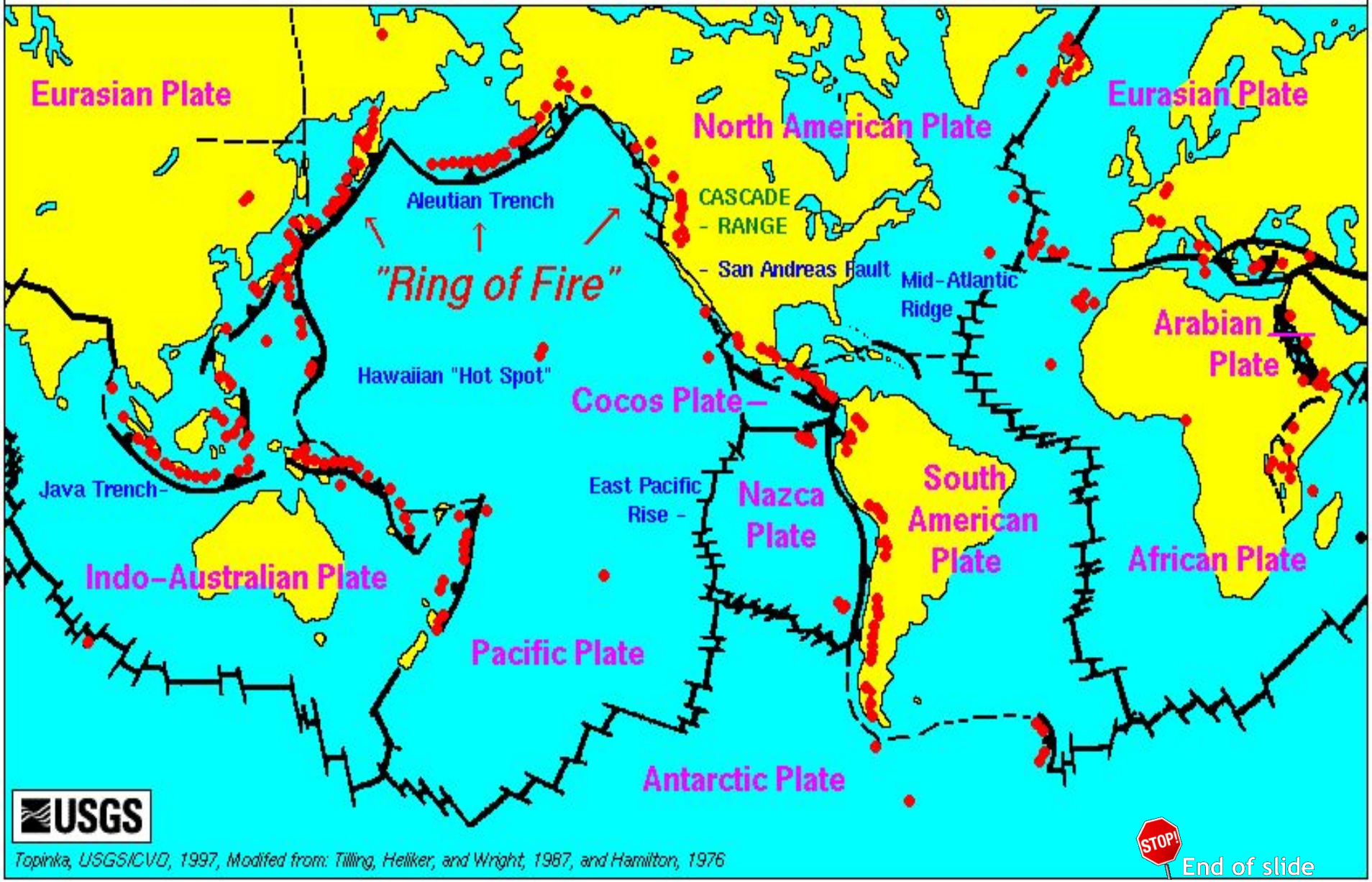



Ocean Basin
Backarc
Volcanic Front
Forearc
Ocean Basin
Back arc spreading center
Accretionary wedge
Carbonate reef
Trench sediments
Magma chamber
Lithic rich sediments
Crust
Lithospheric mantle
(Ophiolite suite)
Ascending diapirs
Crust
Asthenosphere
Zone of fractional melting
Back arc convection cell
bducting oceanic Lithosphere
SUBDUCTION ZONE: SCIENCE CHANNEL

Trenches:
where crust bends (sinks) into the earth

Deep ocean trenches:
where oceanic crust bends (sinks) into the earth

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"

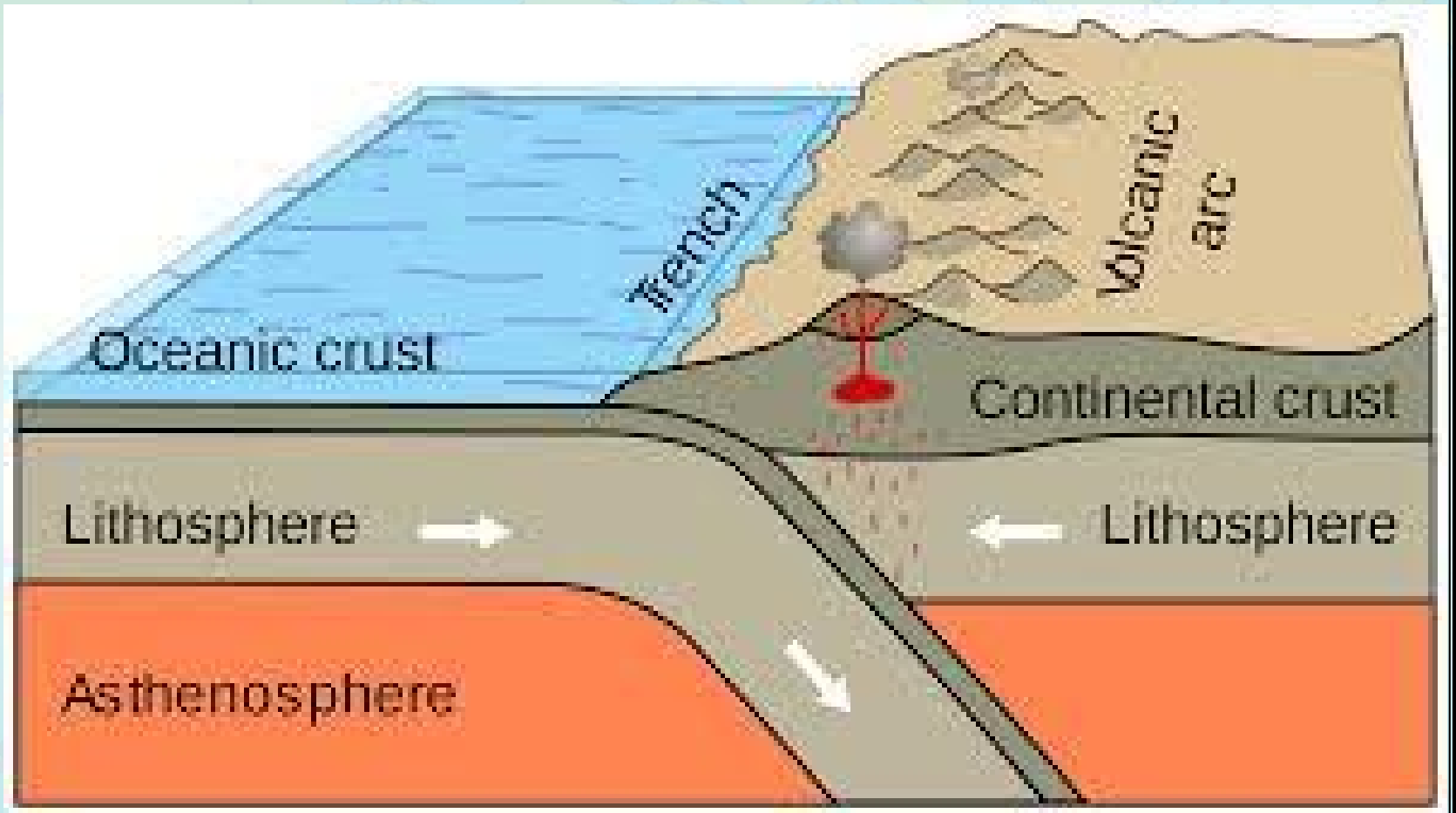


Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

STOP!

End of slide

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"

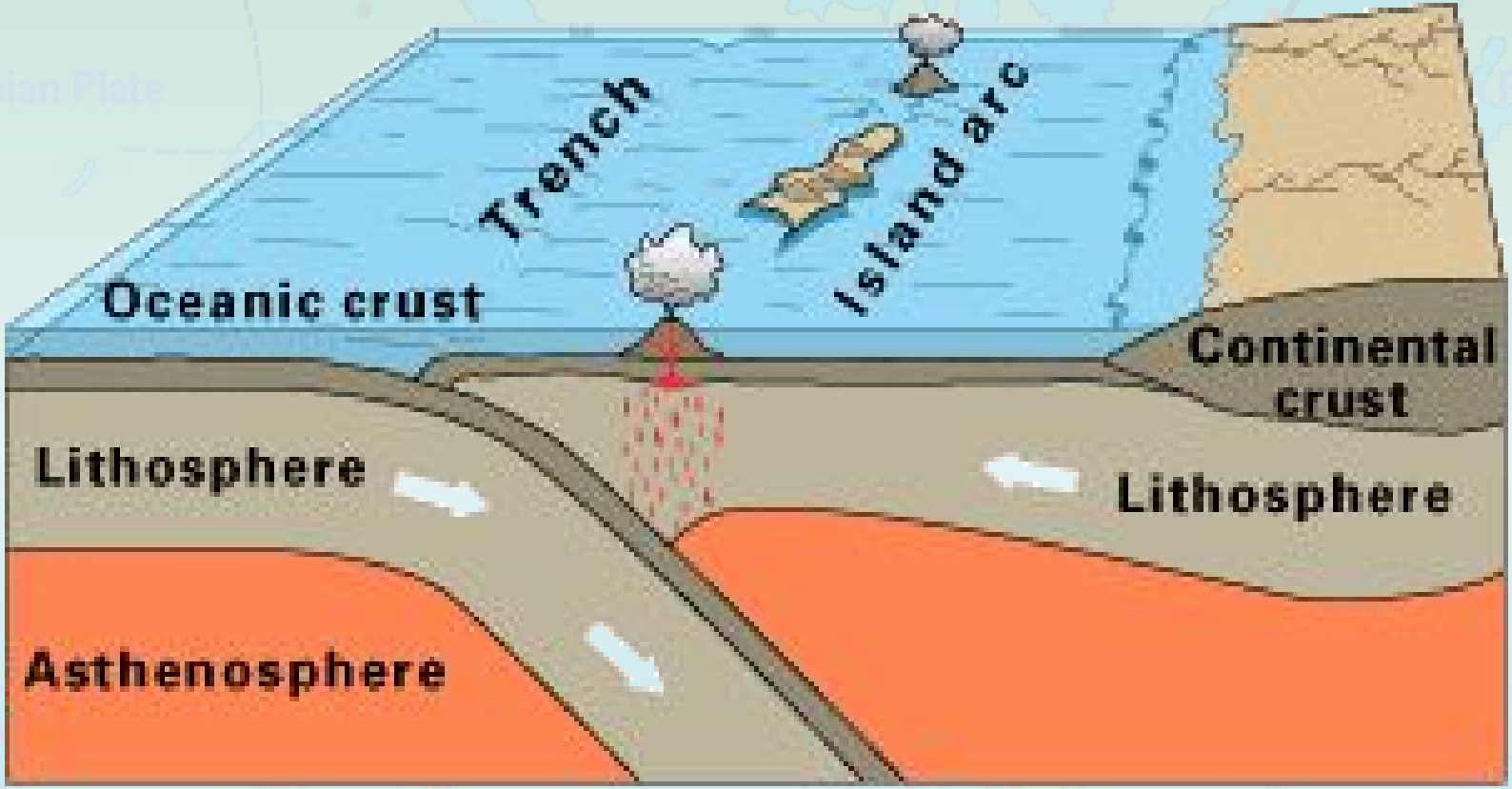


USGS

Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

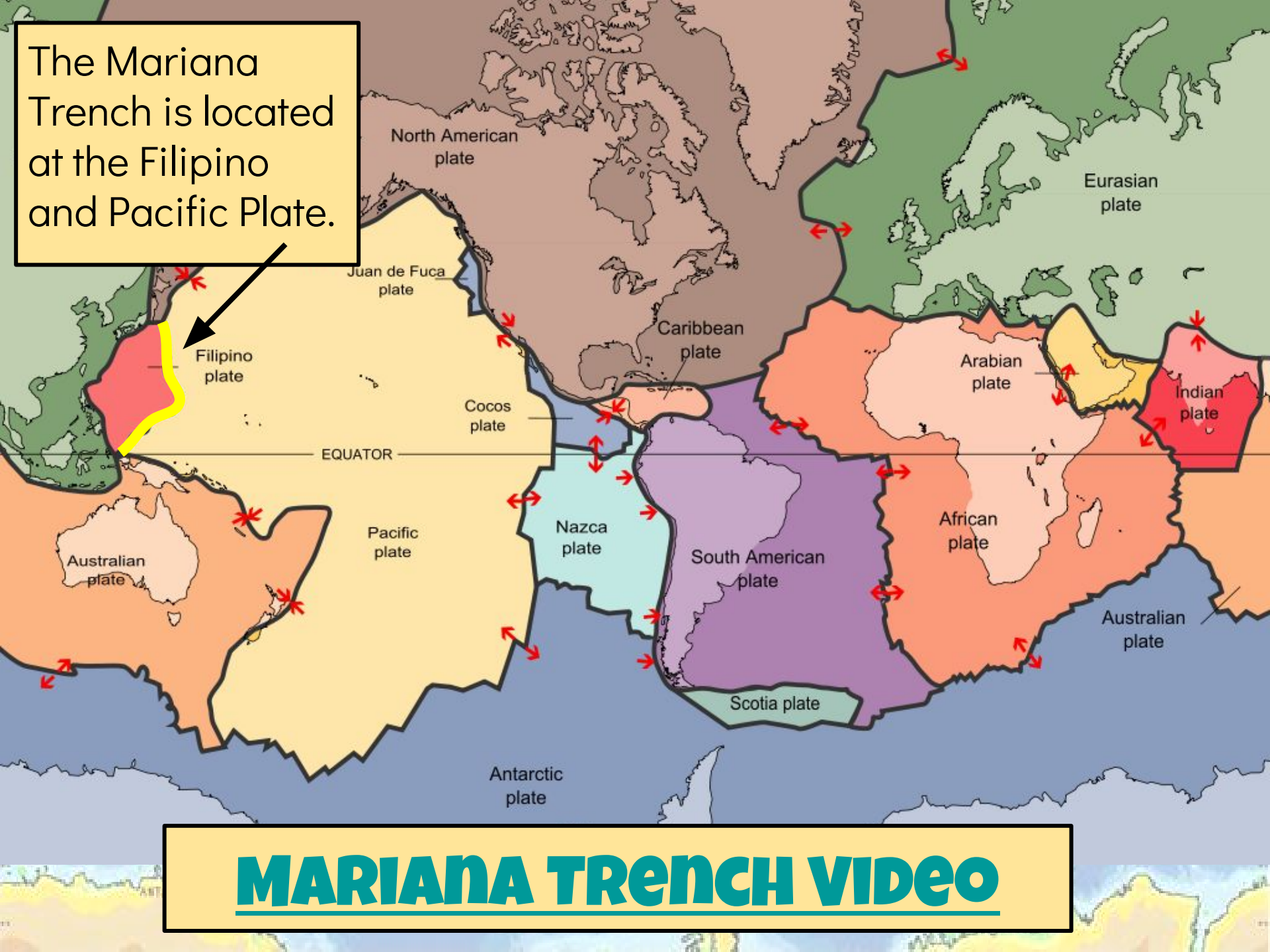
STOP!

End of slide



Oceanic-oceanic convergence

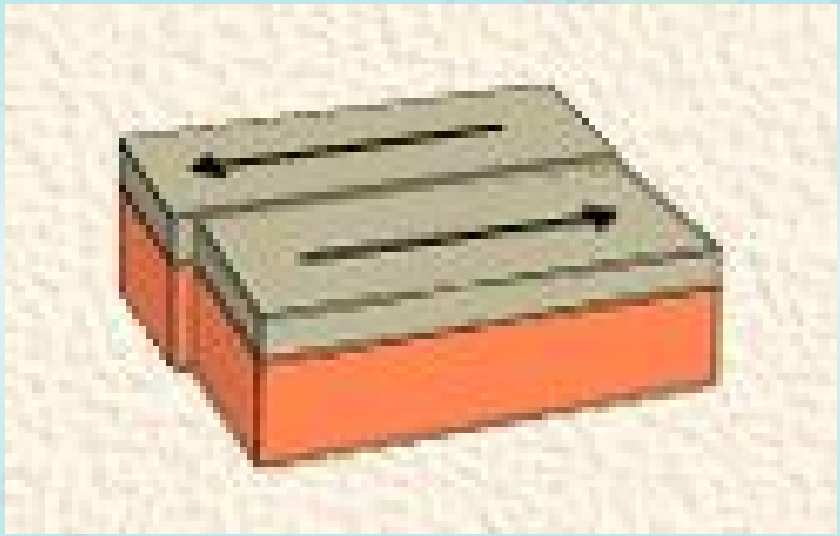
Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976


The Mariana Trench is located at the Filipino and Pacific Plate.
North American plate
Eurasian plate
Juan de Fuca plate
Caribbean plate
Filipino plate
Arabian plate
Indian plate
Cocos plate
EQUATOR
Pacific plate
Nazca plate
South American plate
African plate
Australian plate
Australian plate
Scotia plate
Antarctic plate
MARIANA TRENCH VIDEO

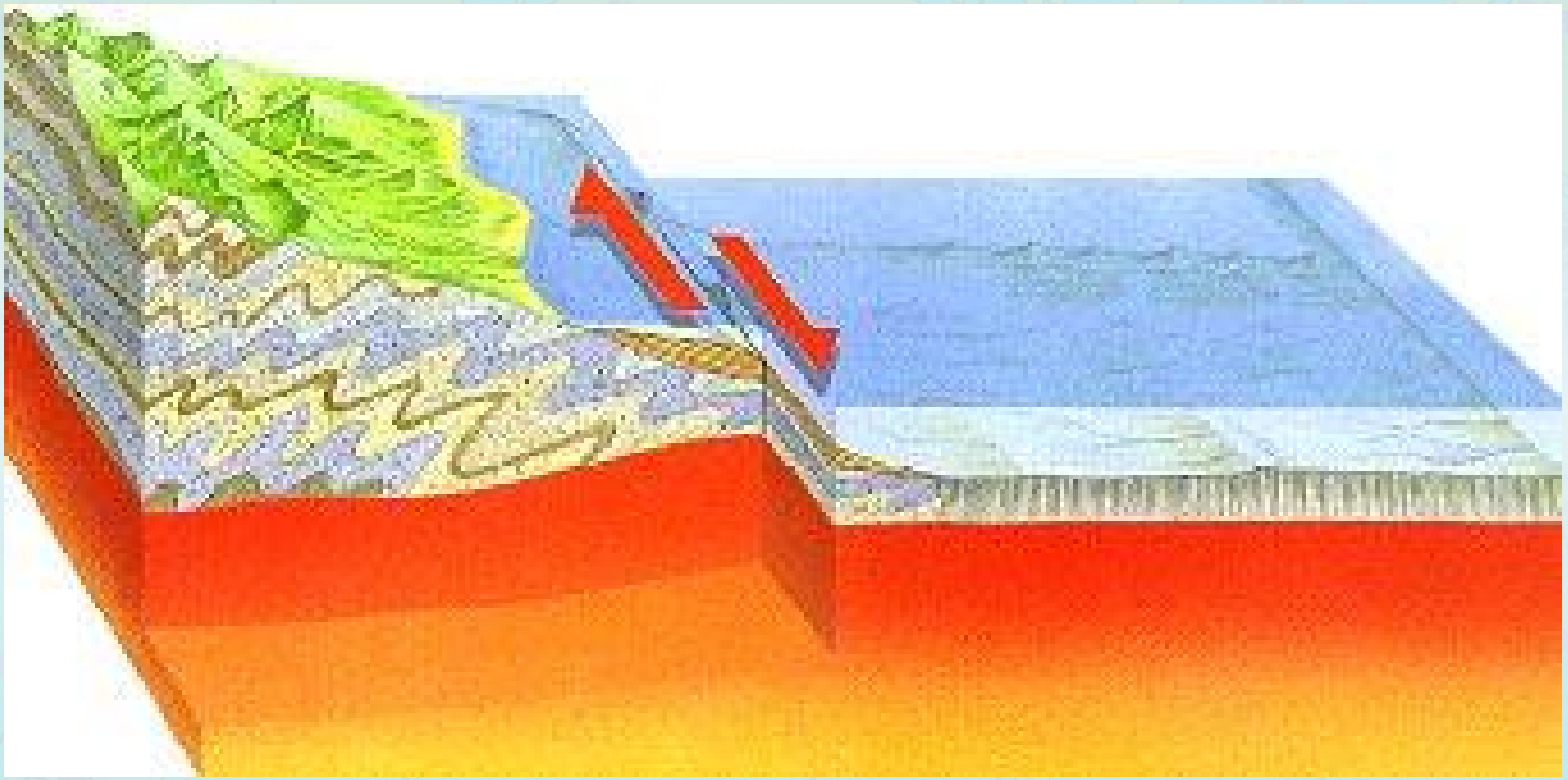
3. Transform boundary:

2 plates slip past each other in opposite directions

- causes earthquakes



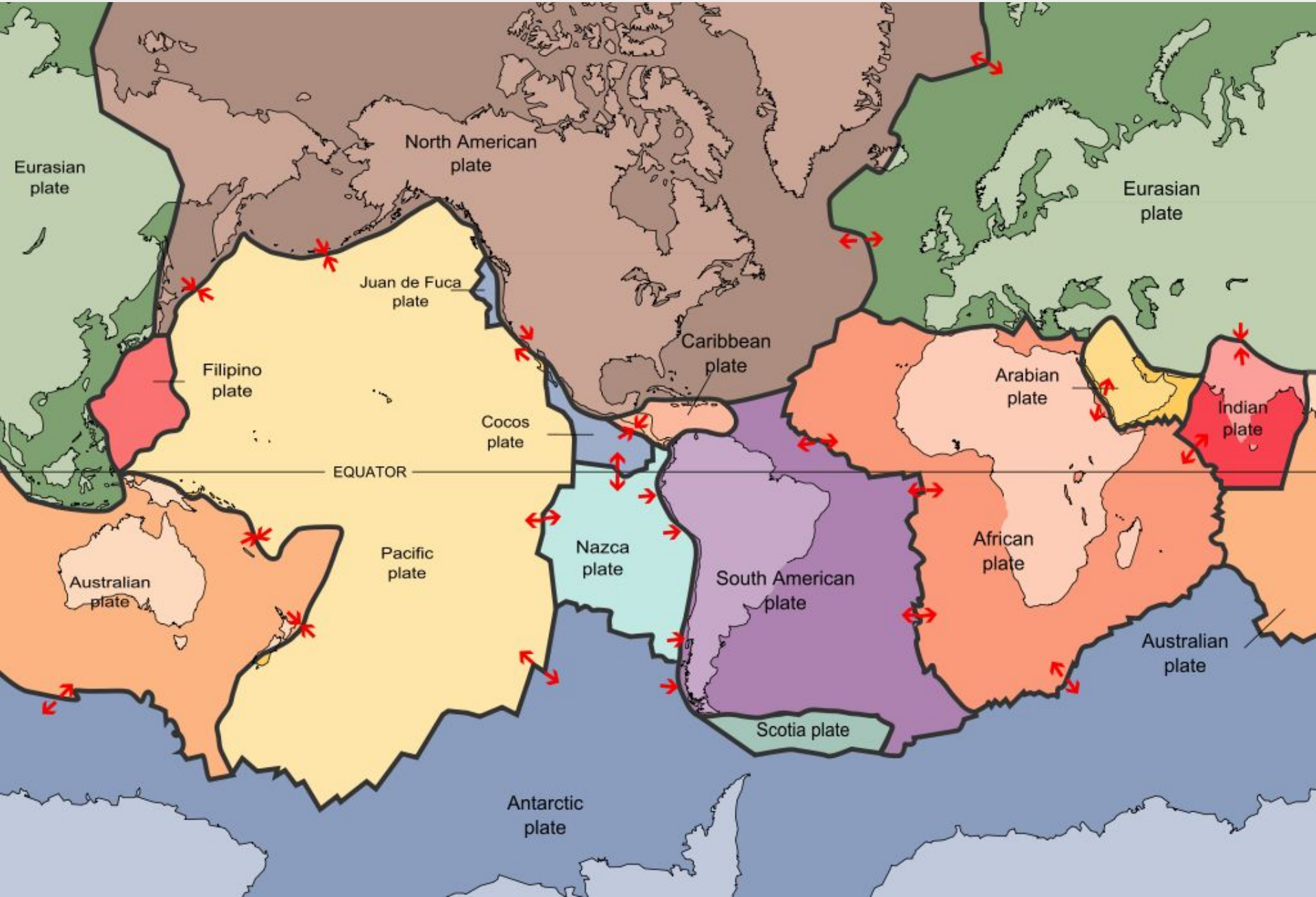
End of slide



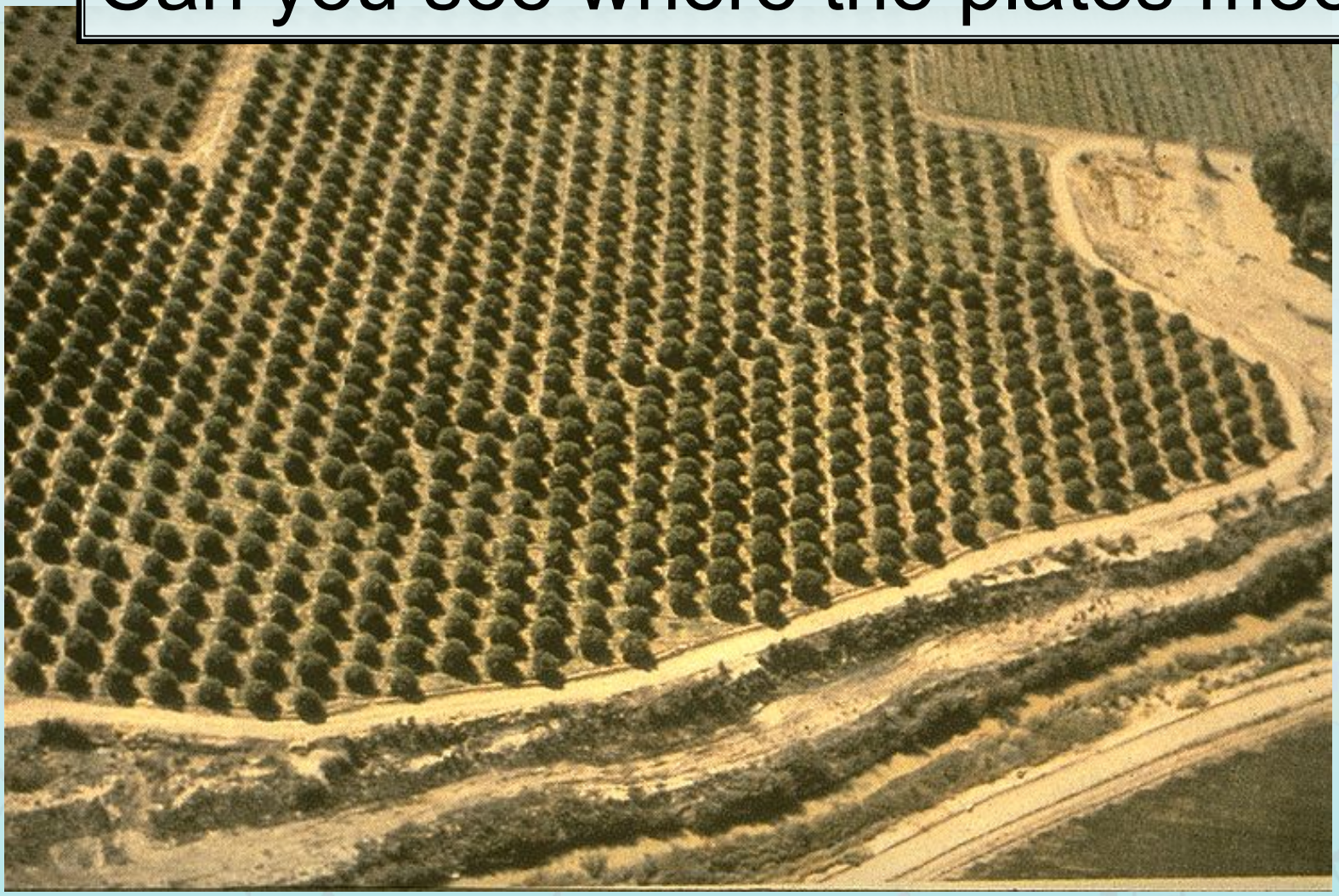
Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

End of slide

Find a Transform Boundary



Can you see where the plates meet?



Antarctic Plate

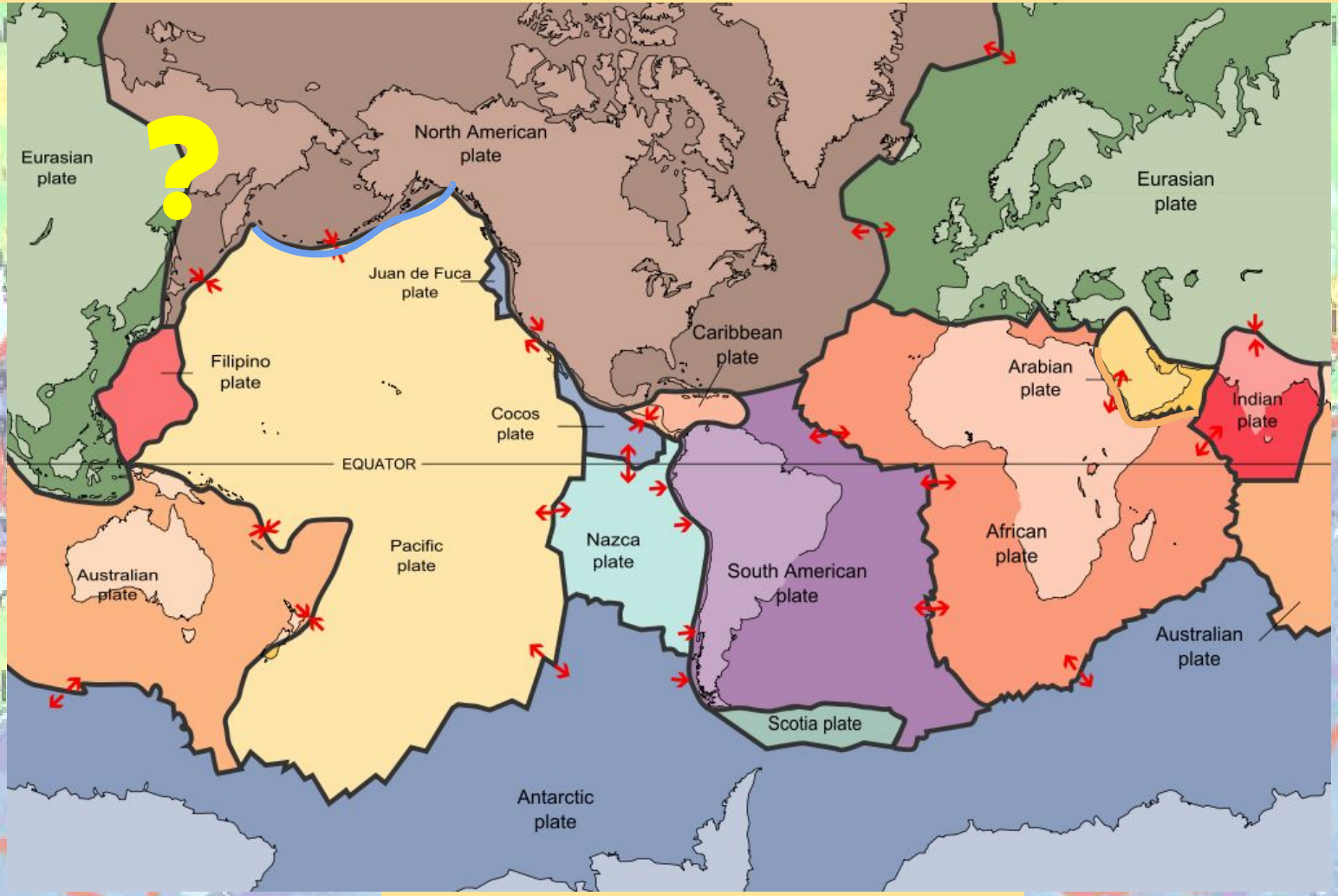
USGS

Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976

STOP!

End of slide

Plate Boundaries Worksheet



Key Example:

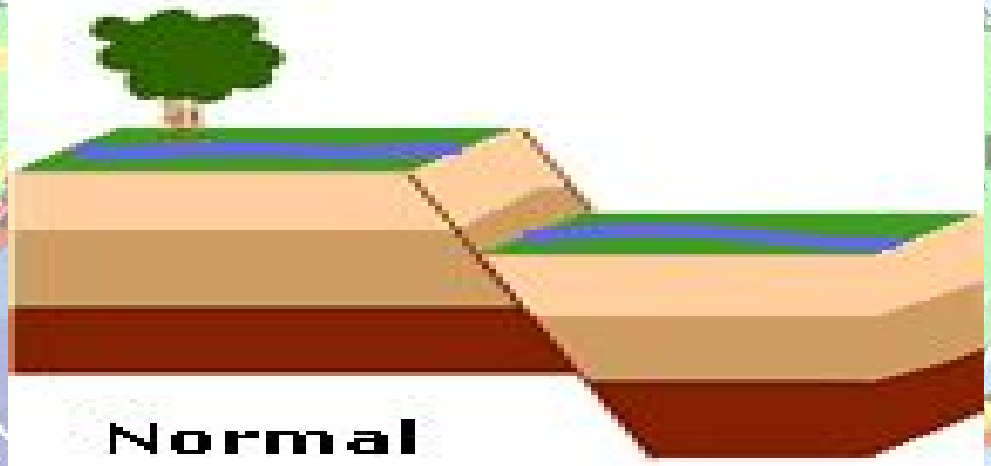
Convergent Boundary

Divergent Boundary

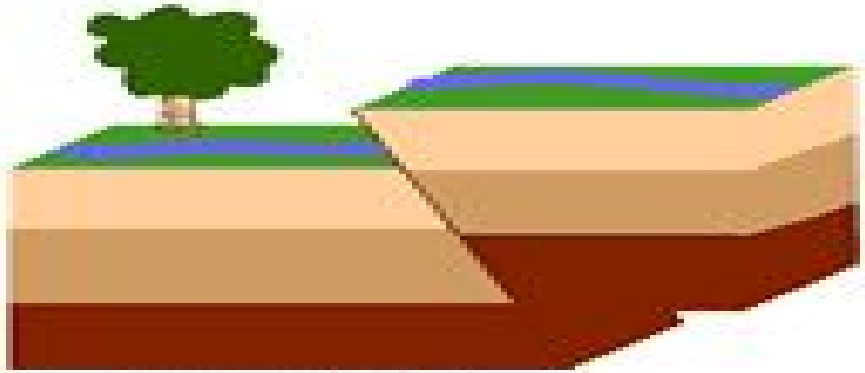
Transform Boundary

End of slide

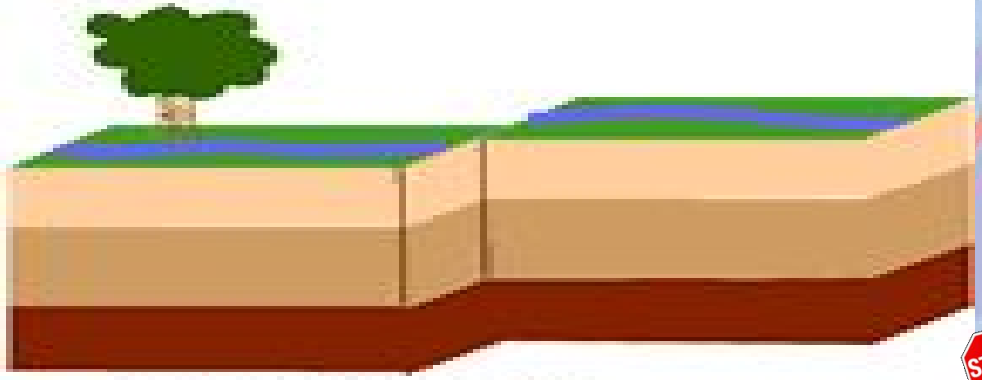
faults



Normal



Reverse



Strike-slip

End of slide

Fault:

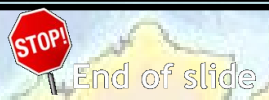
break in Earth's crust where rocks have slipped past each other

- often forms at plate boundaries
- It's what you see!
- **<u>may not break completely thru the plate</u>**

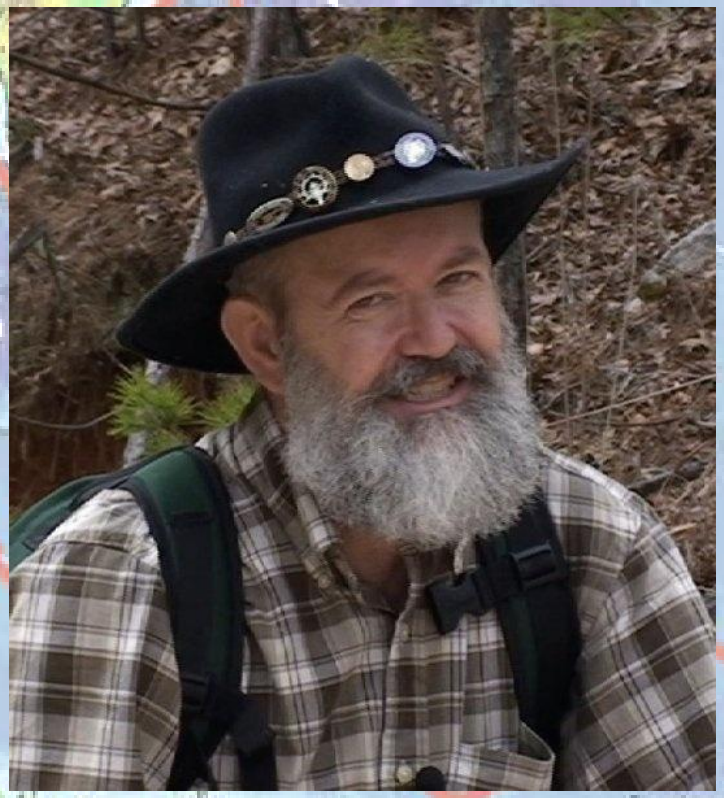
End of slide

3 types of fault:

1. Normal
2. Reverse
3. Strike-slip



Robert Krampf, the Happy Scientist: Faults

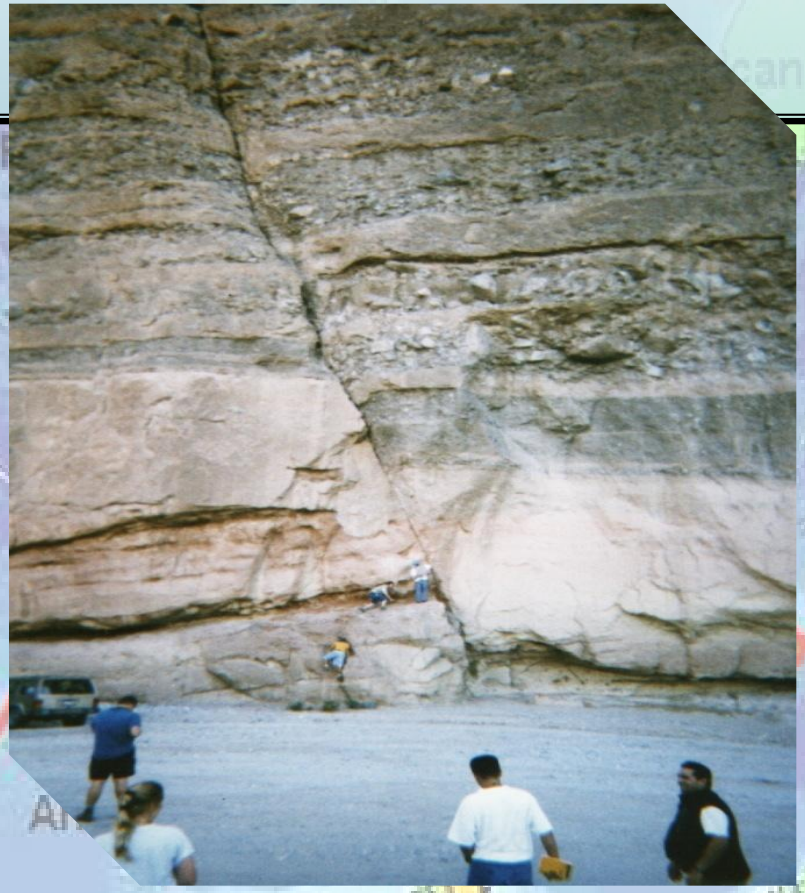


Arabian Plate
African Plate
Indian Plate
Caribbean
Cocos
South American Plate
Nazca Plate
Scotia
Antarctic Plate

End of slide

Normal fault:

occur where plates diverge (at a divergent boundary)



End of slide

Reverse fault:

occur where plates collide (at a convergent boundary)

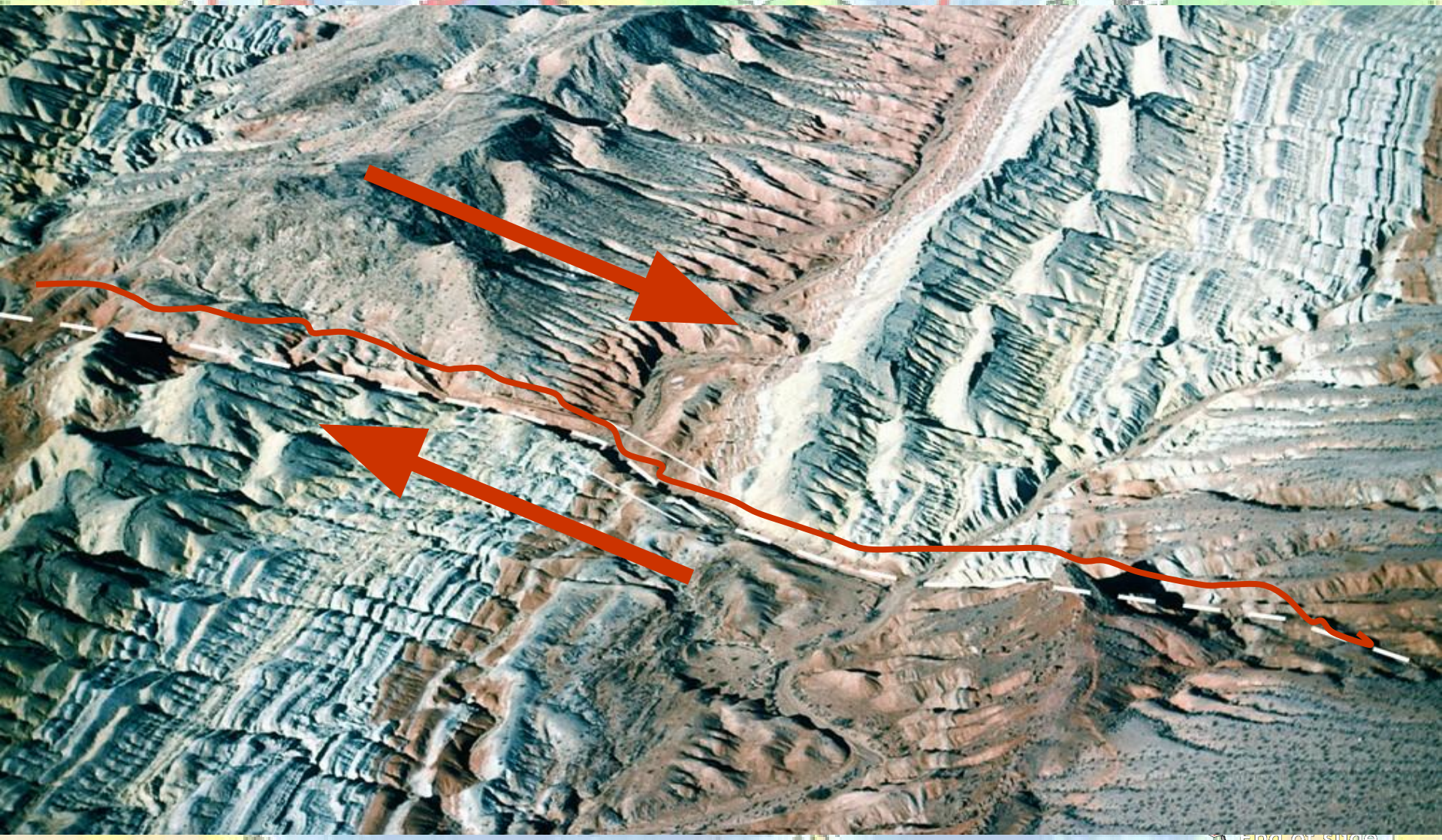
End of slide

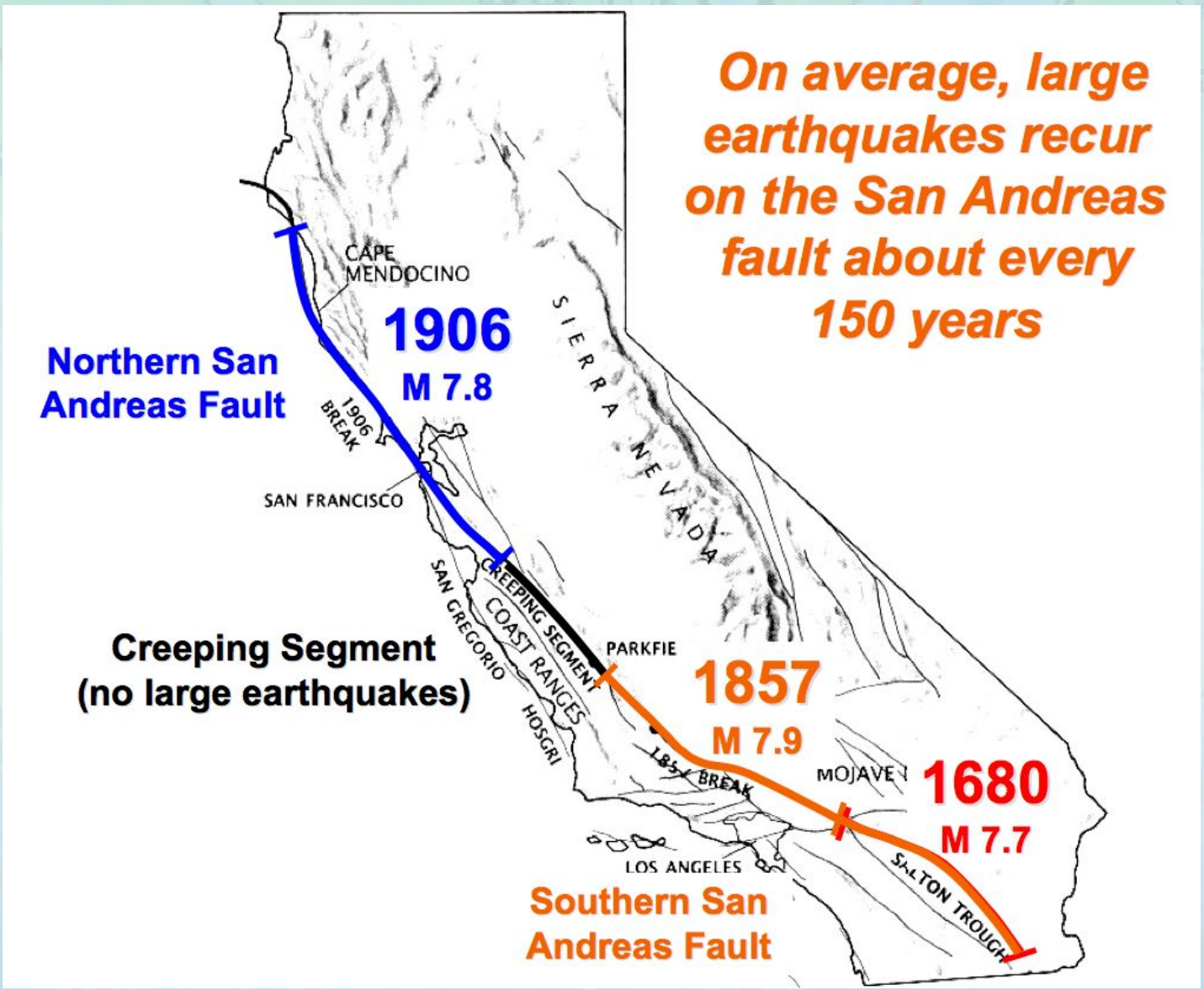
Strike-slip fault:

rocks slide past each other

sideways w/ little up or down motion (at a transform boundary)

Aerial view of a strike slip fault




On average, large earthquakes recur on the San Andreas fault about every 150 years
Northern San Andreas Fault
CAPE MENDOCINO
1906
M 7.8
1906 BREAK
SAN FRANCISCO
SIERRA NEVADA
Creeping Segment
(no large earthquakes)
SAN GREGORIO
COAST RANGES
CREEPING SEGMENT
HOSGRI
PARKFIE
1857
M 7.9
1857 BREAK
MOJAVE
1680
M 7.7
LOS ANGELES
SALTON TROUGH
Southern San Andreas Fault

End of slide

San Andreas Fault Clip

Covers over 800 miles!

End of slide

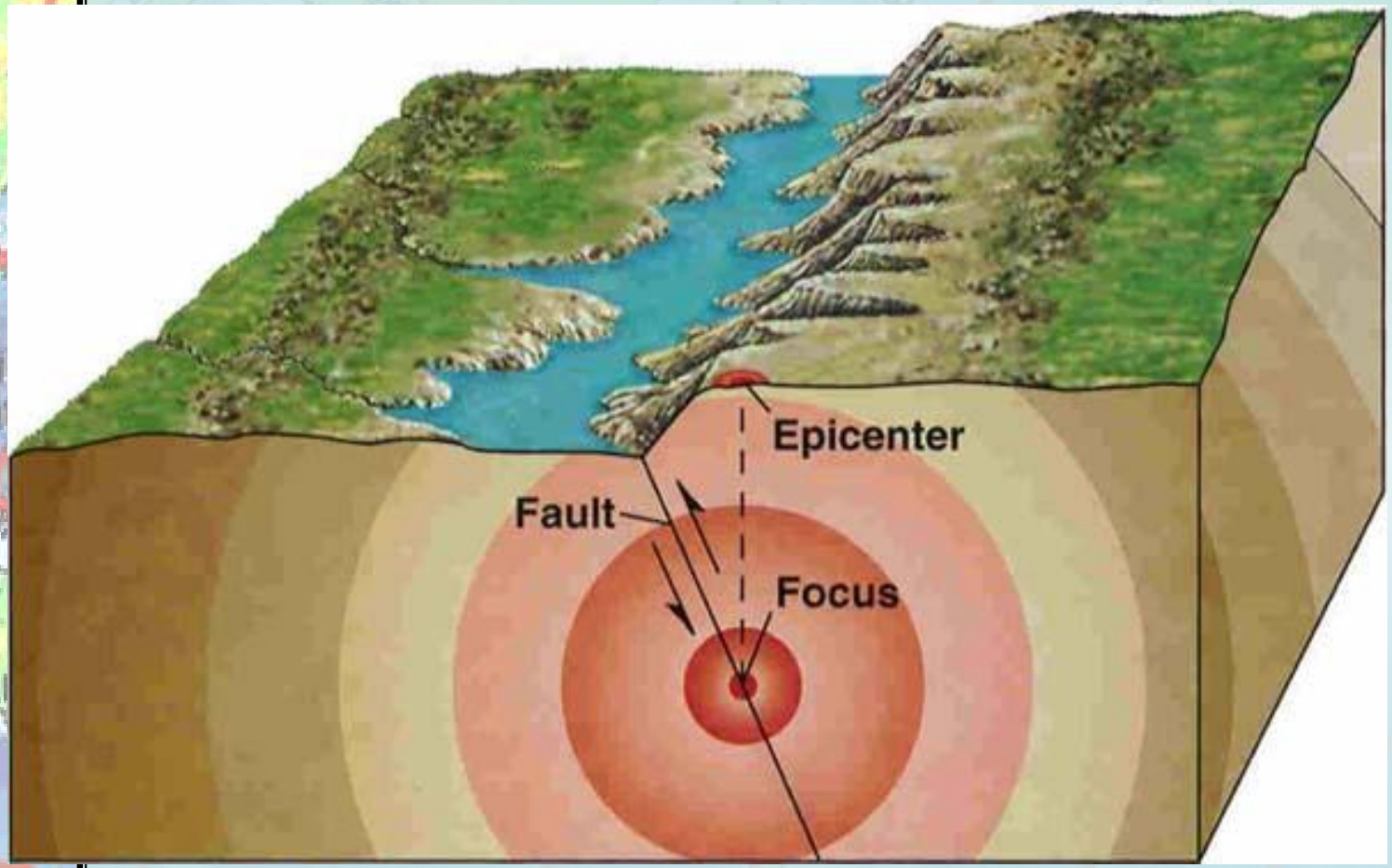
Earthquakes:

shaking/trembling resulting from movement of rock beneath the surface

Epicenter:

point <u>on surface</u> directly above the rock movement

Understanding earthquakes (3m)
Inside earthquakes (3m)



End of slide

Seismic waves:

vibrations that travel thru Earth carrying the energy released during an earthquake

- move like ripples in a pond
- change speed & direction depending on material traveled thru

End of slide

P waves:

(Primary waves)

- Push-pull motion
- Fastest & 1st to be felt

S waves:

(Secondary waves)

- Up & down and back & forth motion
- Cannot travel thru liquid (outer core)

End of slide

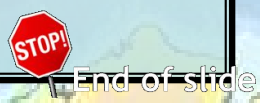
aftershock:

an earthquake that occurs after a larger earthquake

- can occur hours, days, or even months later

magnitude:

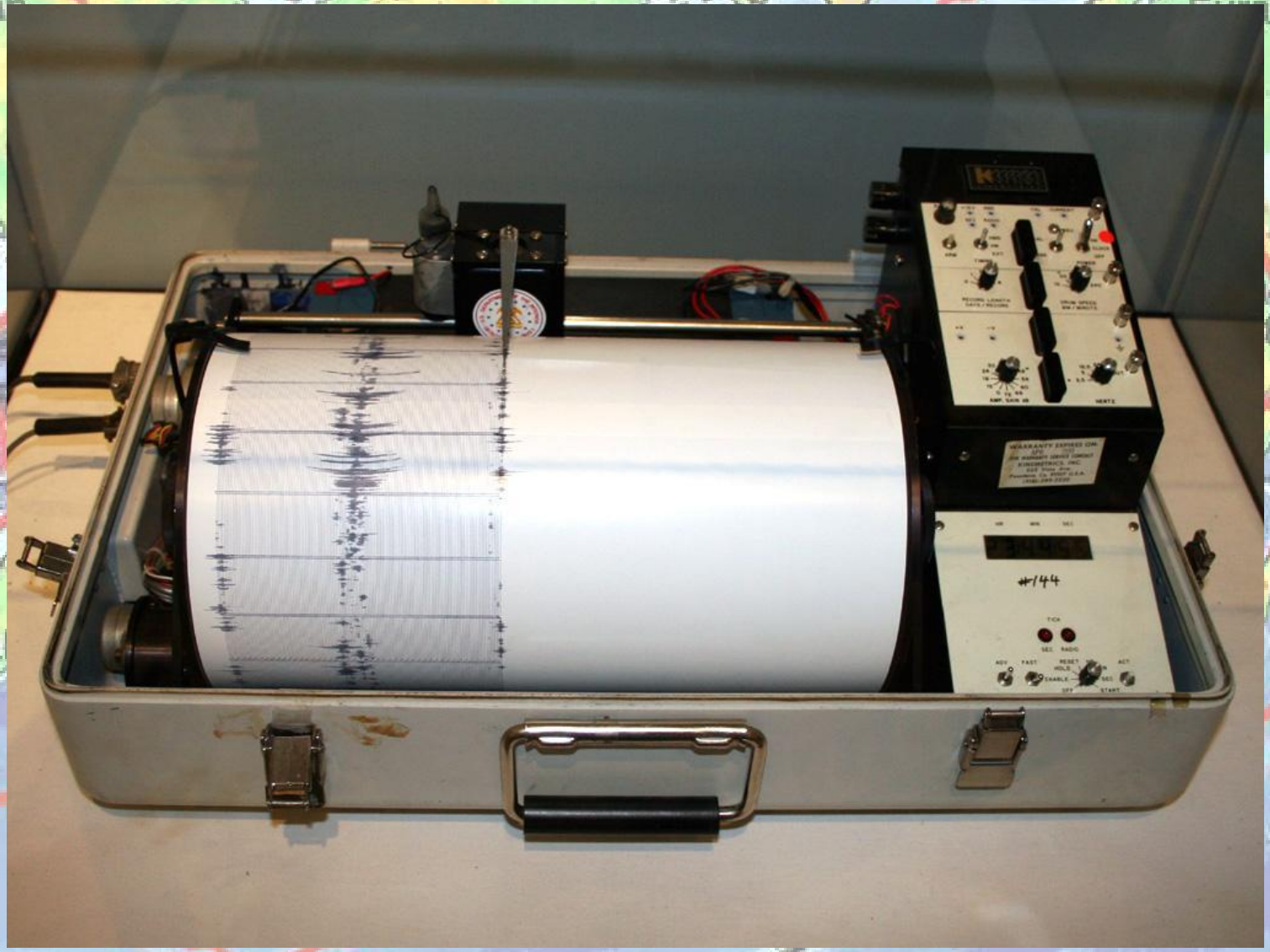
measurement of the earthquake's strength



seismometer:
(AKA seismograph)
instrument used to record the movements caused by seismic waves

Richter scale:
rating of the size of seismic waves based on ground motion

End of slide



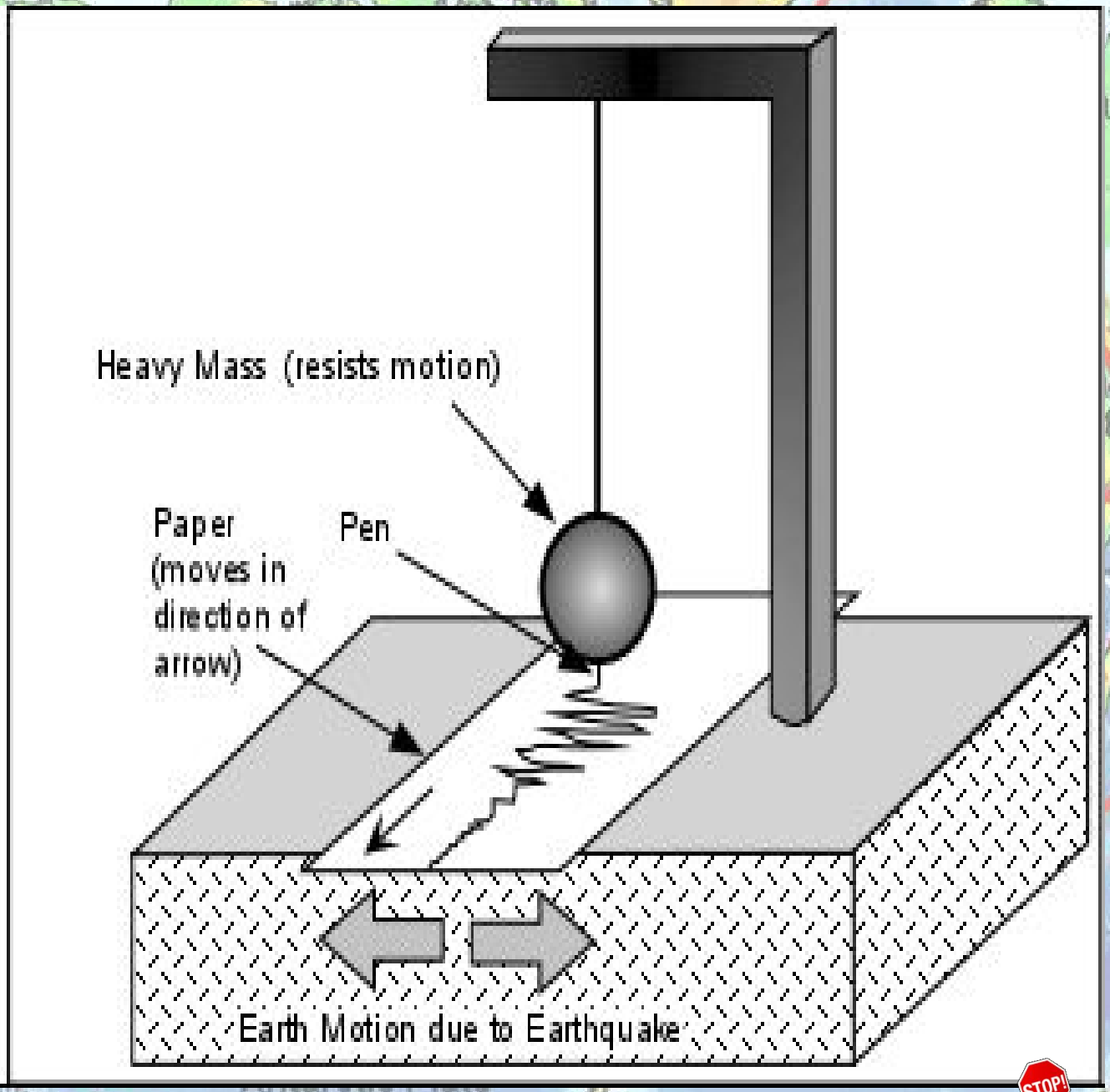
Eurasian Plate

Eurasian Plate

Indian Plate

Antarctic Plate

End of slide

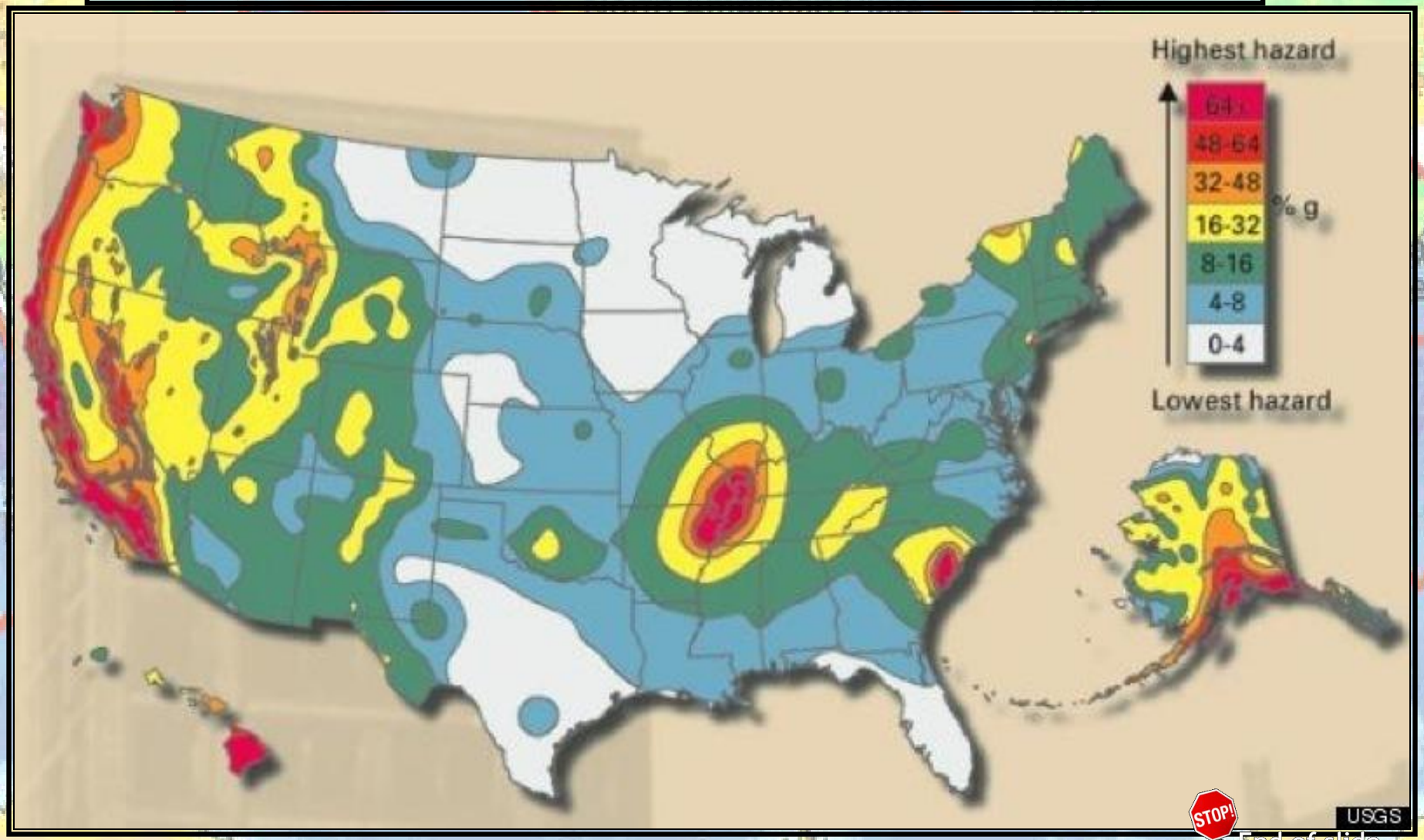

Heavy Mass (resists motion)
Paper (moves in direction of arrow)
Pen
Earth Motion due to Earthquake

End of slide

Richter scale no.	# of earthquakes per year	Typical effects of this magnitude
< 3.4	800 000	Detected only by seismometers
3.5 - 4.2	30 000	Just about noticeable indoors
4.3 - 4.8	4 800	Most people notice them, windows rattle.
4.9 - 5.4	1400	Everyone notices them, dishes may break, open doors swing.
5.5 - 6.1	500	Slight damage to buildings, plaster cracks, bricks fall.
6.2 6.9	100	Much damage to buildings: chimneys fall, houses move on foundations.
7.0 - 7.3	15	Serious damage: bridges twist, walls fracture, buildings may collapse.
7.4 - 7.9	4	Great damage, most buildings collapse.
> 8.0	One every 5 to 10 years	Total damage, surface waves seen, objects thrown in the air.

End of slide

This map courtesy of the U.S. Geological Survey (USGS) shows the major earthquake hazard areas within the United States based on fault lines:



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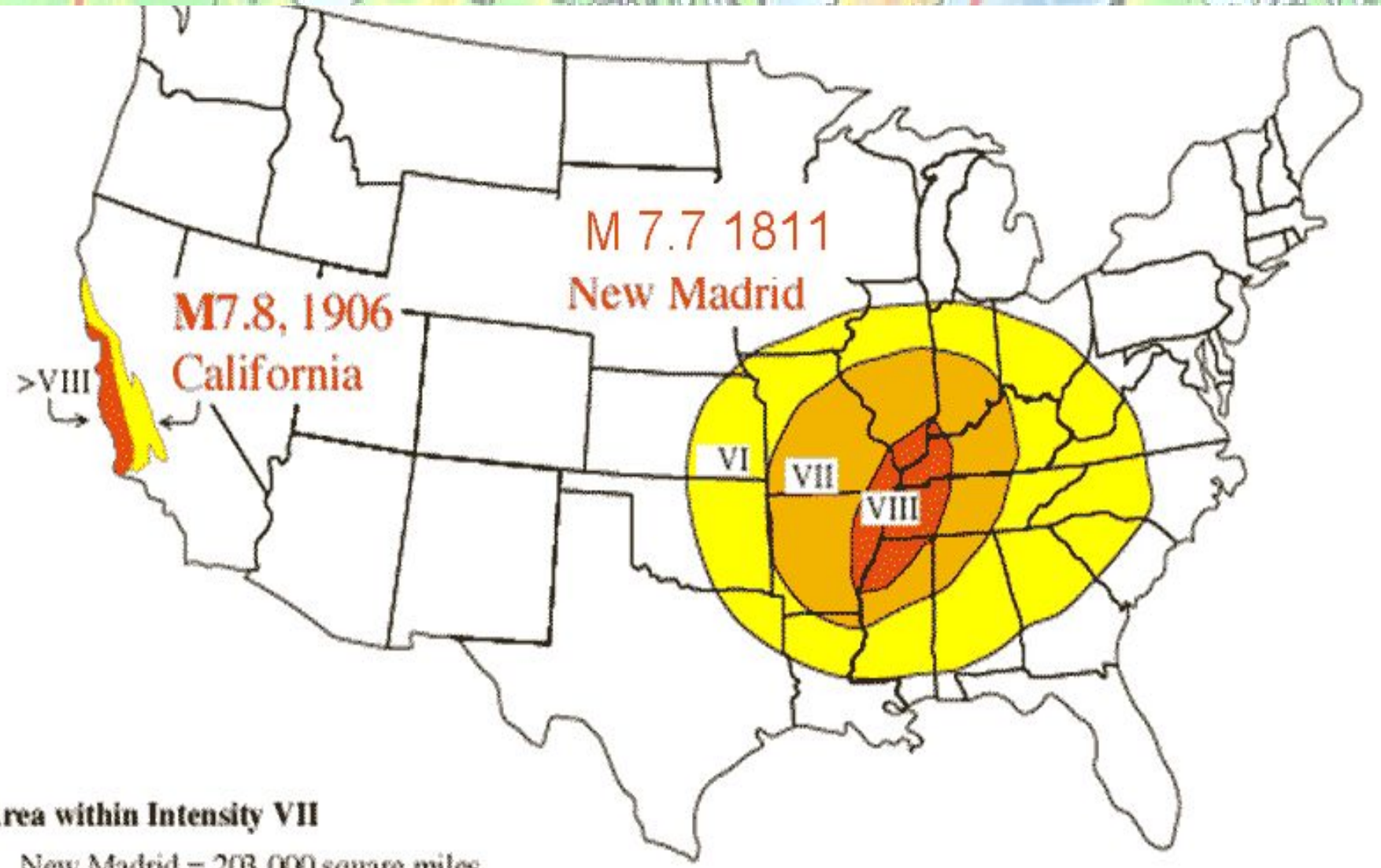


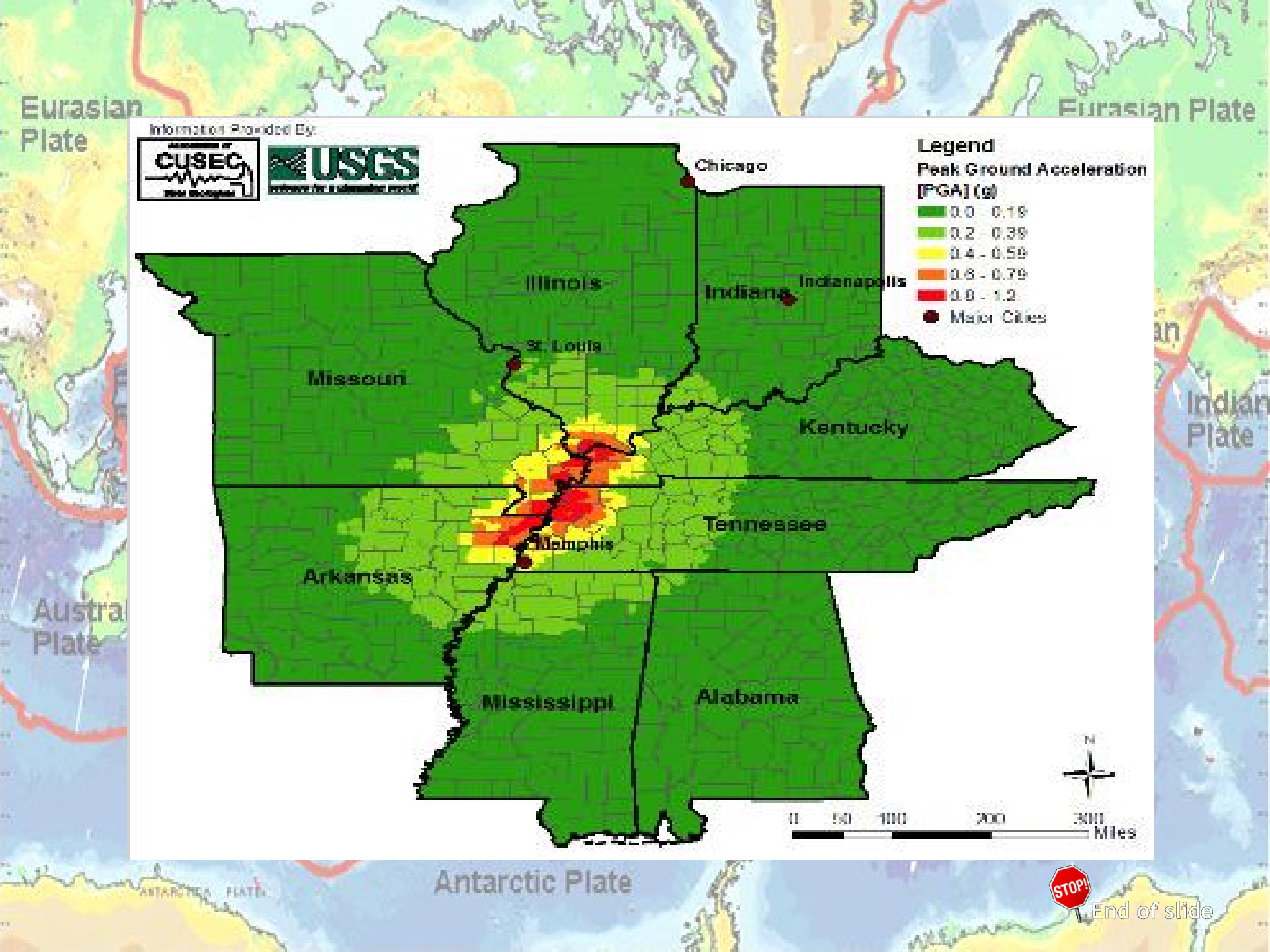
Area within Intensity VII

New Madrid = 203,000 square miles

San Francisco = only 12,000 square miles!

End of slide

Intensity VII: moderate damage to non-engineered buildings


Eurasian Plate
Eurasian Plate
Information Provided By:
CUSEC
USGS
Chicago
Illinois
Indiana
Indianapolis
St. Louis
Missouri
Kentucky
Tennessee
Memphis
Arkansas
Mississippi
Alabama
Legend
Peak Ground Acceleration [PGA] (g)
0.0 - 0.19
0.2 - 0.39
0.4 - 0.59
0.6 - 0.79
0.8 - 1.2
Major Cities
N
0 50 100 200 300
Miles
Indian Plate
Antarctic Plate
STOP!
End of slide

End of slide

Eurasian Plate

Eurasian Plate

Indian Plate

Australian Plate

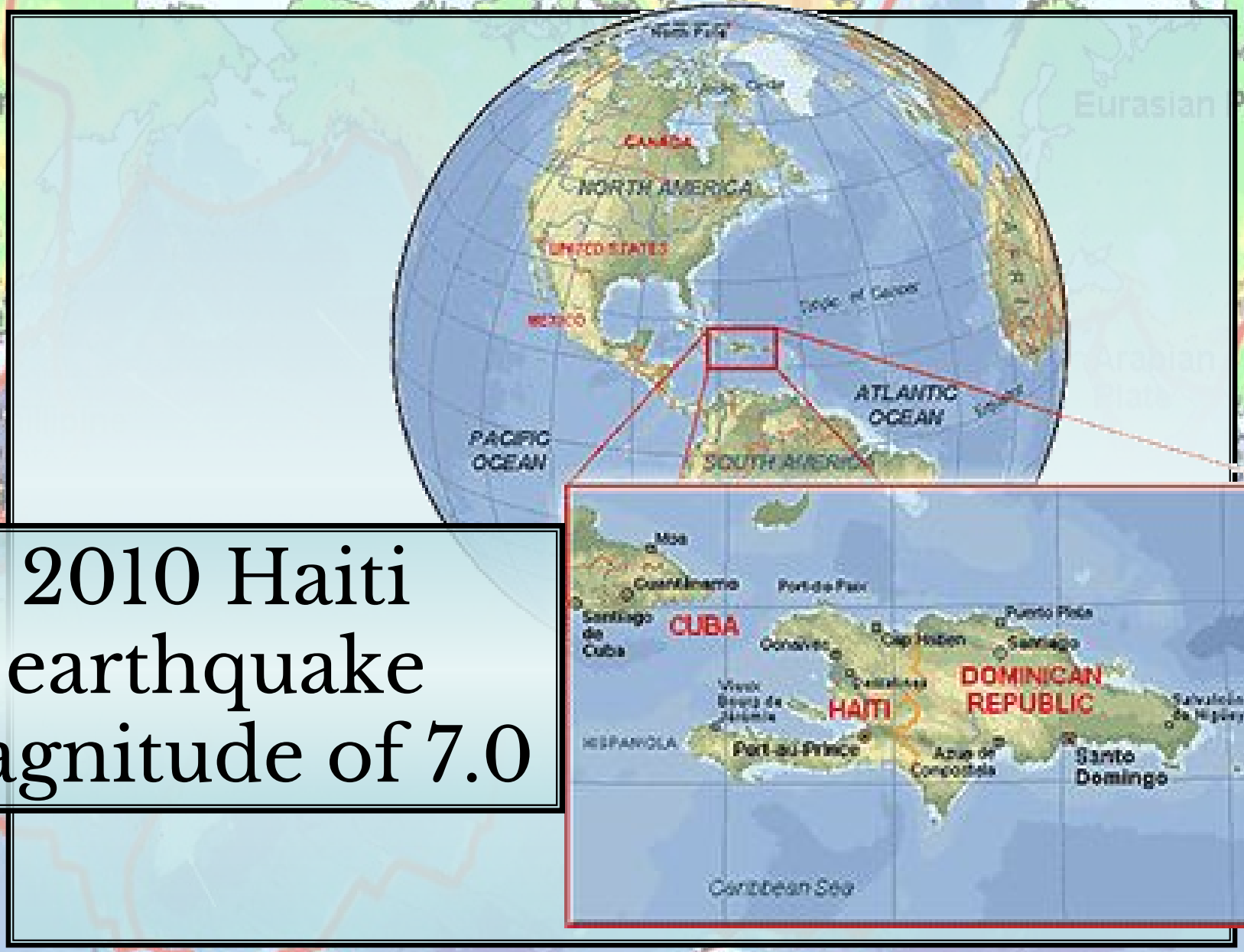
Antarctic Plate

End of slide

A portion of the Hanshin Expressway is twisted down on its side in Nishinomiya after a powerful earthquake rocked the western Japanese city on January 17, 1995. Thousands were injured and 1,300 killed.

End of slide

2010 Haiti earthquake magnitude of 7.0



Eurasian Plate

Antarctic Plate

End of slide

Antarctic Plate

End of slide

Antarctic Plate

End of slide

A powerful earthquake hit the impoverished country of Haiti on Tuesday, collapsing the presidential palace and numerous other critical government buildings and raising fears of substantial casualties in what a witness called “a major, major disaster.”

ews

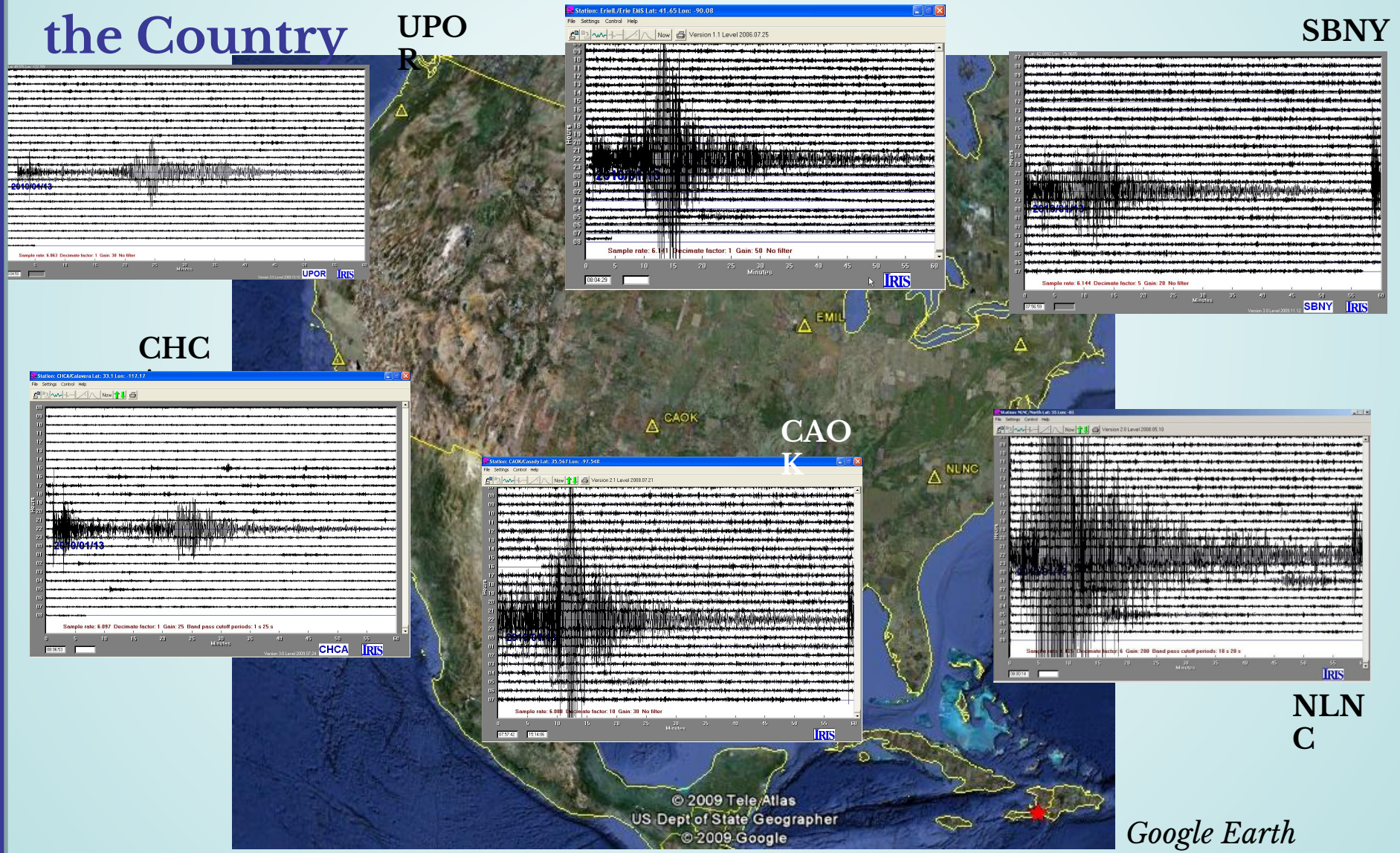
Before and After Earthquake
Presidential Palace in Port-au-Prince, Haiti

IRIS Teachable Moments

Magnitude 7.0 HAITI
Tuesday, January 12, 2010 at 21:53:09 UTC

Haitian earthquakes seismic wave path across the US.

Seismic Waves Cross the Country

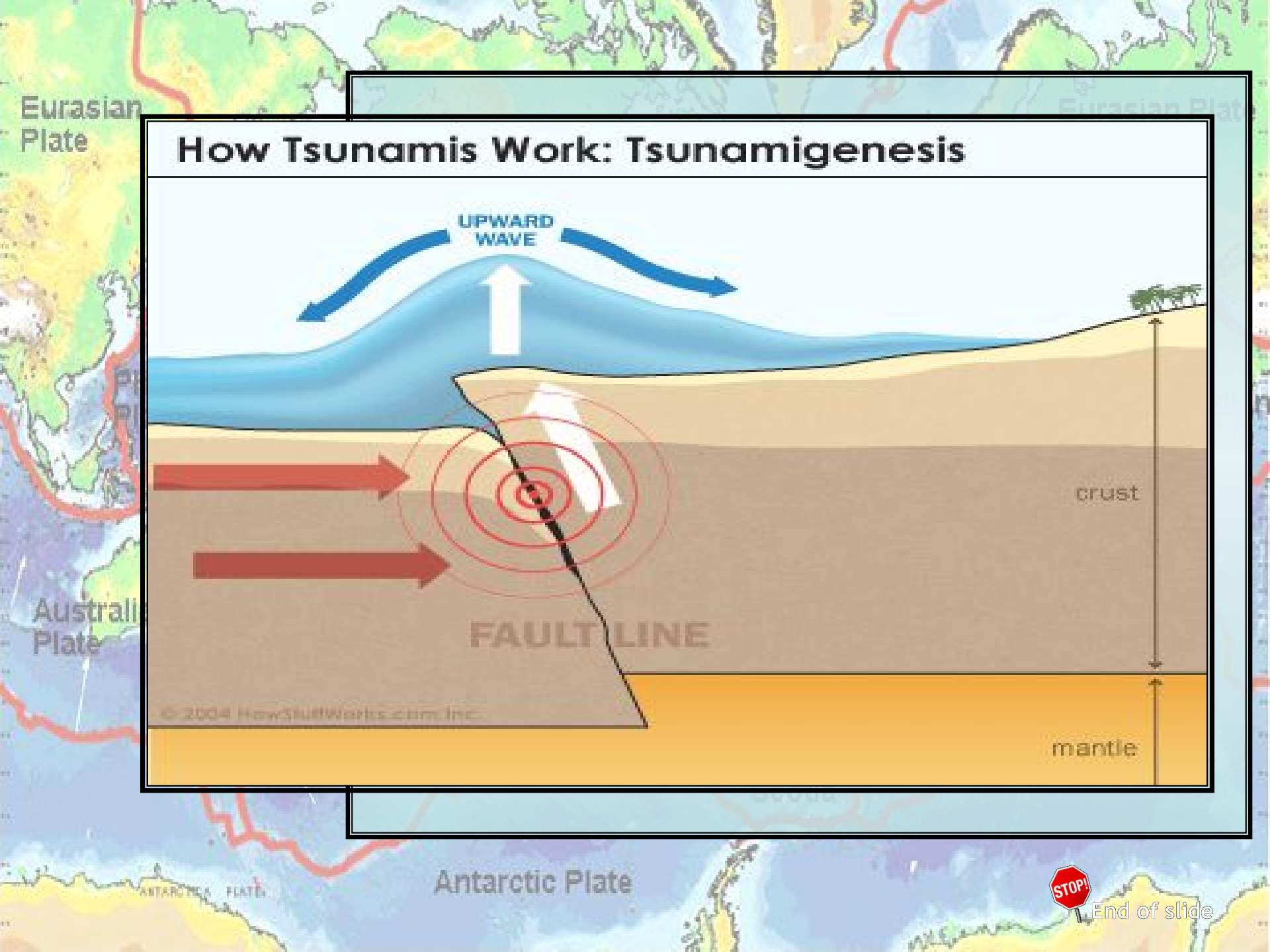


tsunami:

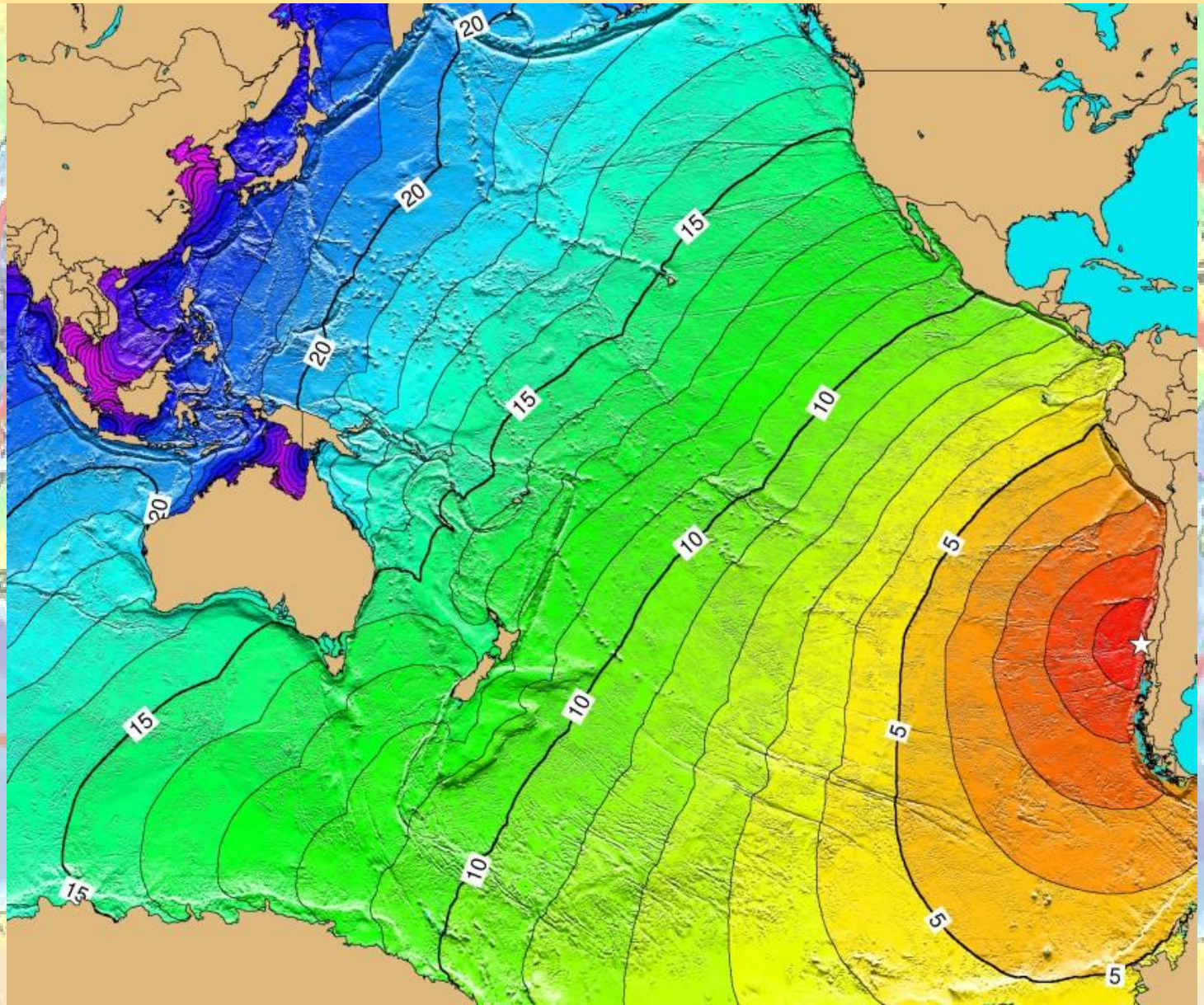
large waves created by a large undersea earthquake or undersea volcano

- can reach 100 feet high
- Recent technology allows us to predict and better warn coastal residents of this type of disaster.

Tsunami 101: National Geographic 3m


Eurasian Plate
Australi Plate
Antarctic Plate
How Tsunamis Work: Tsunamigenesis
UPWARD WAVE
crust
FAULT LINE
mantle
© 2004 HowStuffWorks.com, Inc.
STOP!
End of slide

Numbers represent minutes it takes for waves to travel from epicenter through the ocean.



End of slide

On December 26, 2004, an earthquake with an estimated magnitude of 9.1 struck the coast of Sumatra, Indonesia. US Geological Survey Statistics: 227,898 people were killed or listed as missing and presumed dead. 1.7 million people were displaced in 14 countries in Southeast Asia.

End of slide

January 1, 2004

BEFORE

December 26, 2004

AFTER

End of slide


STOP!
End of slide


STOP!
End of slide

volcano:

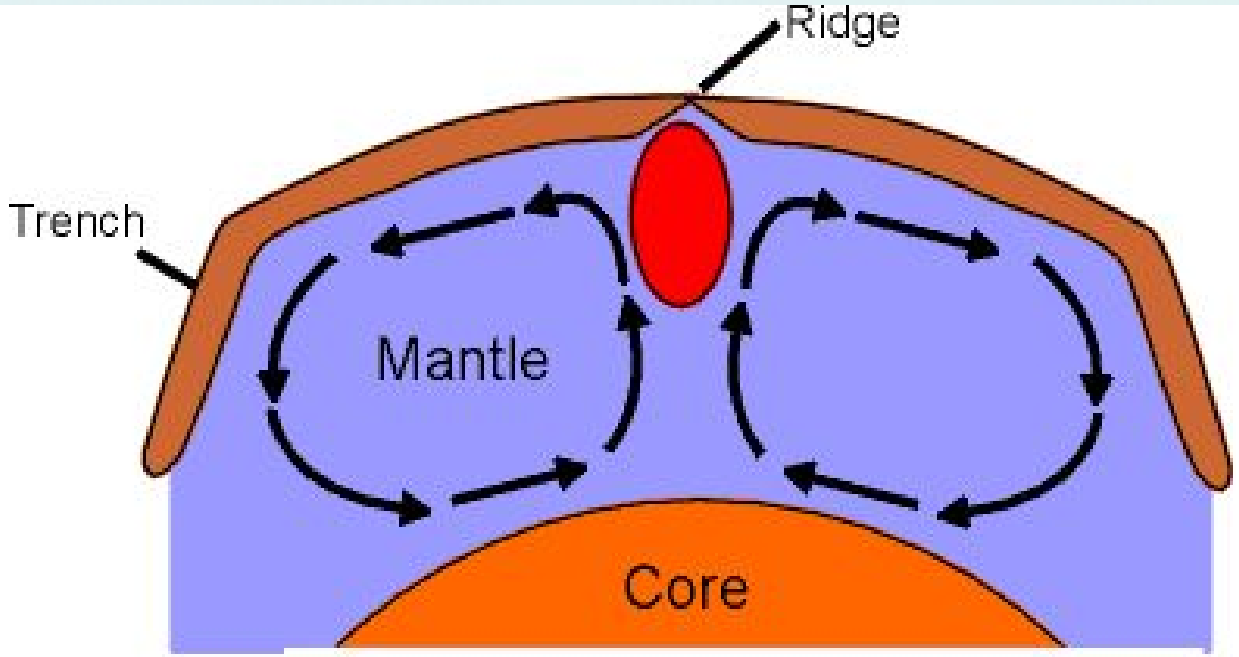
weak spot in the Earth's crust where molten material (magma) comes to the surface

- magma rises to the surface thru convection currents

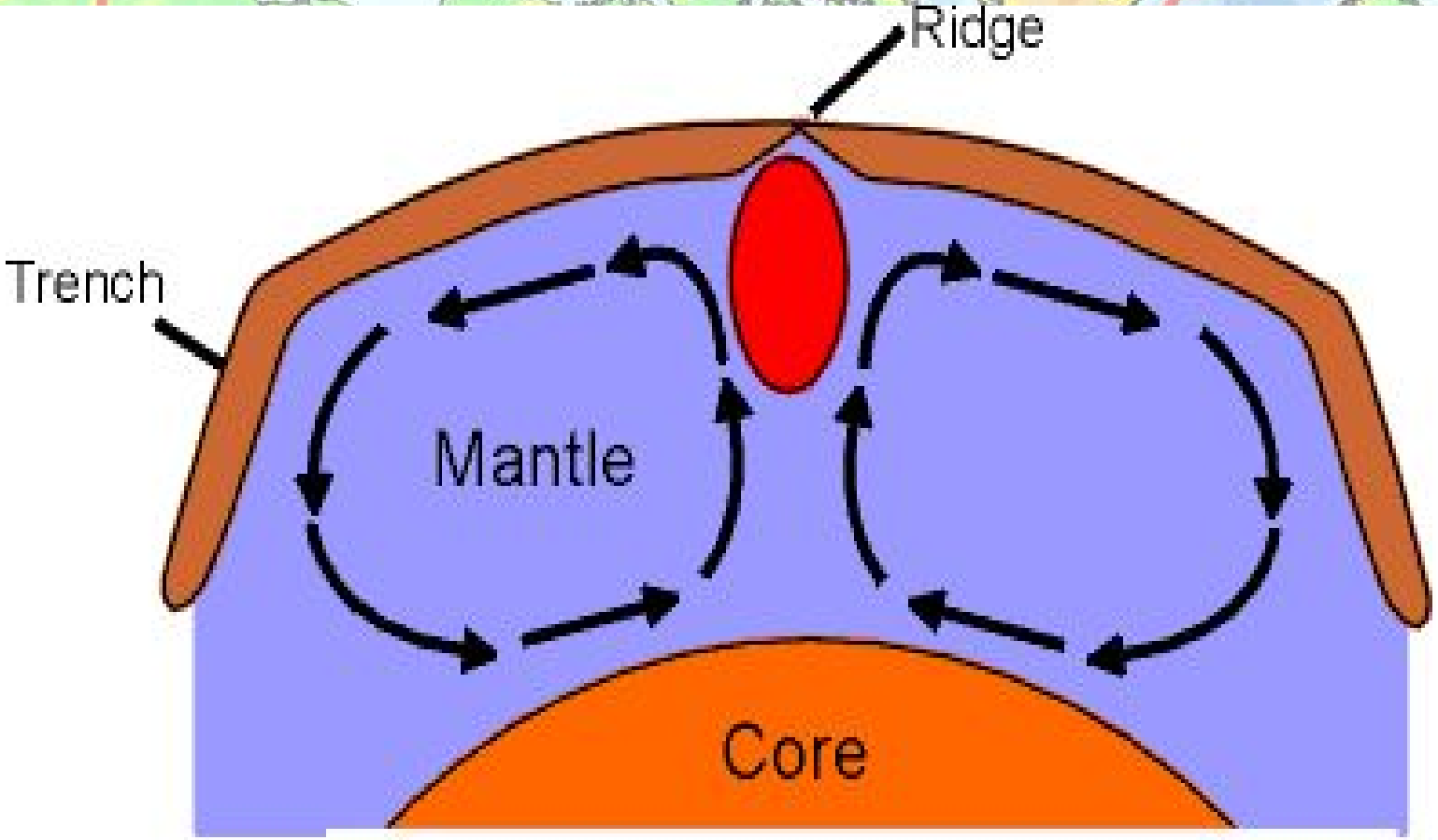
lava

mag

- c



Convection Model



Convection Model

National Geographic: How Volcanoes Form

Ring of Fire:

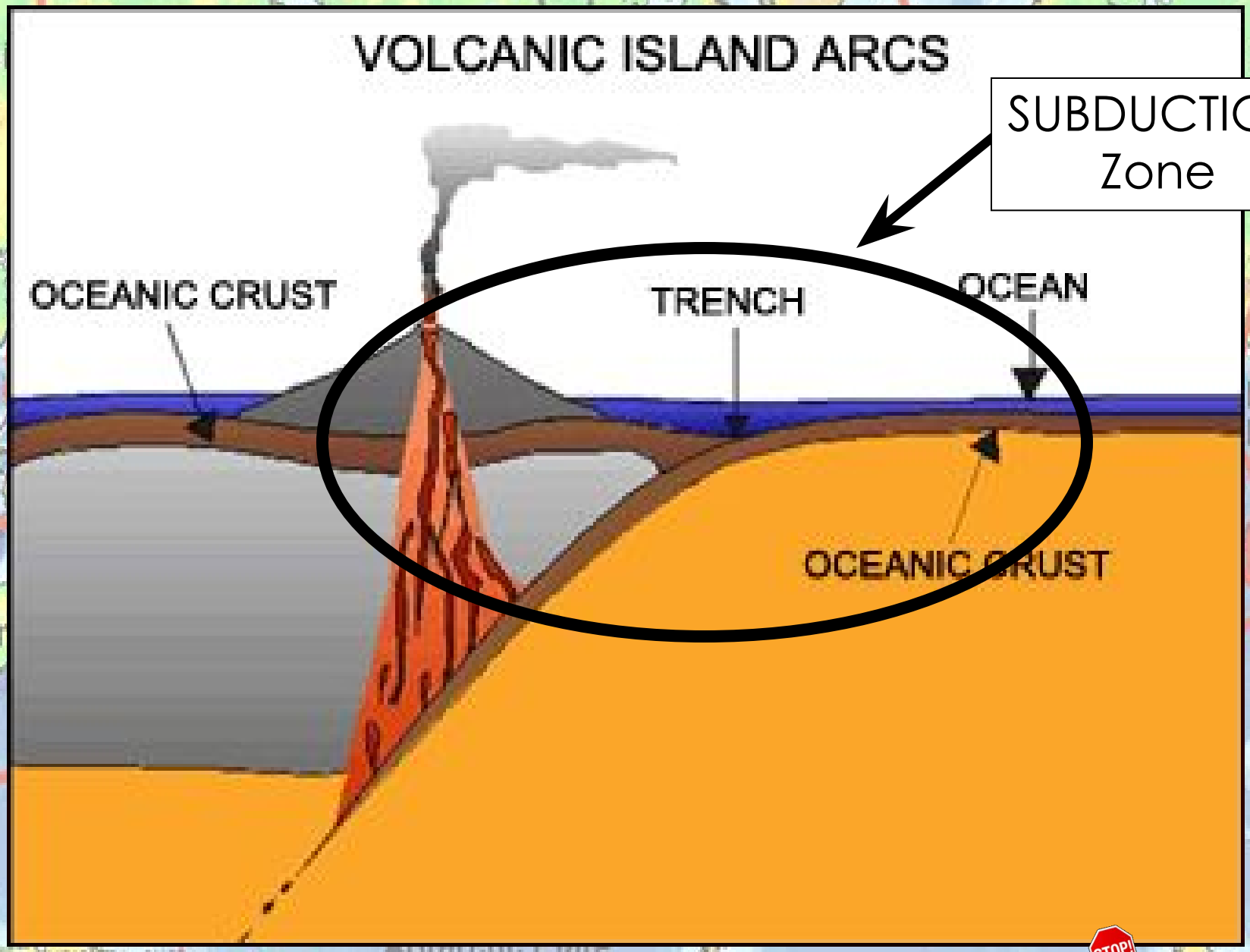
volcanic belt formed by the many volcanoes that outline the Pacific Ocean

- most form along **divergent** or **convergent** plate boundaries

- Exception: ***hot spot*** volcanoes occur when magma melts thru the crust like a blow torch
  - NOT on a boundary
  - *Example*: Hawaiian Islands

End of slide

VOLCANIC ISLAND ARCS



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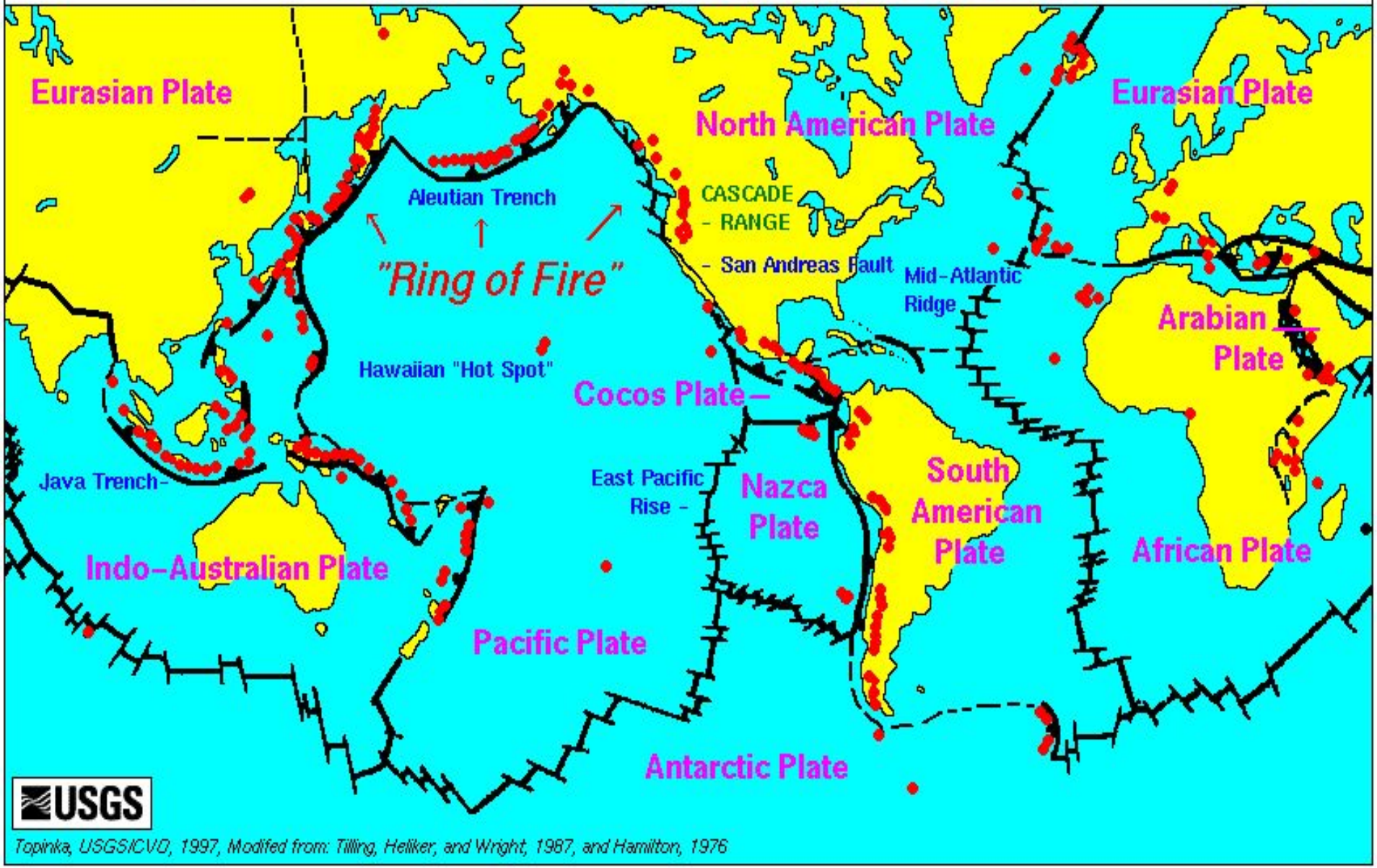
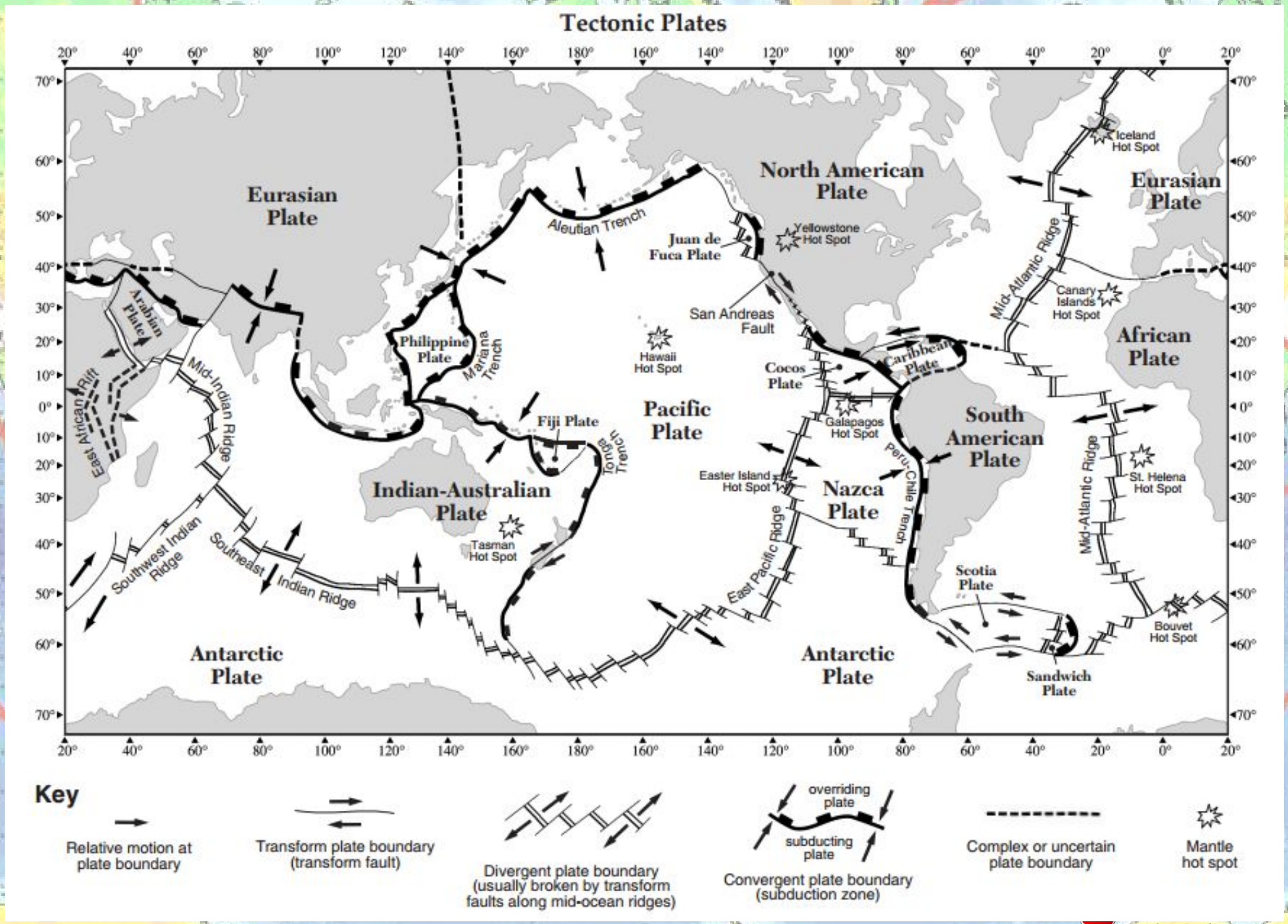
Active Volcanoes, Plate Tectonics, and the "Ring of Fire"



Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976


Tectonic Plates
Eurasian Plate
North American Plate
Eurasian Plate
African Plate
South American Plate
Pacific Plate
Indian-Australian Plate
Nazca Plate
Antarctic Plate
Antarctic Plate
Scotia Plate
Sandwich Plate
Caribbean Plate
Cocos Plate
Philippine Plate
Arabian Plate
Juan de Fuca Plate
Aleutian Trench
Yellowstone Hot Spot
Iceland Hot Spot
Canary Islands Hot Spot
Mid-Atlantic Ridge
San Andreas Fault
Hawaii Hot Spot
Mariana Trench
Fiji Plate
Tonga Trench
Galapagos Hot Spot
Peru-Chile Trench
Easter Island Hot Spot
East Pacific Ridge
St. Helena Hot Spot
Bouvet Hot Spot
Tasman Hot Spot
East African Rift
Mid-Indian Ridge
Southwest Indian Ridge
Southeast Indian Ridge
Key
Relative motion at plate boundary
Transform plate boundary (transform fault)
Divergent plate boundary (usually broken by transform faults along mid-ocean ridges)
overriding plate
subducting plate
Convergent plate boundary (subduction zone)
Complex or uncertain plate boundary
Mantle hot spot

End of slide

Mt. St. Helens in WA

Mt Vesuvius

Eurasian Plate

Indian Plate

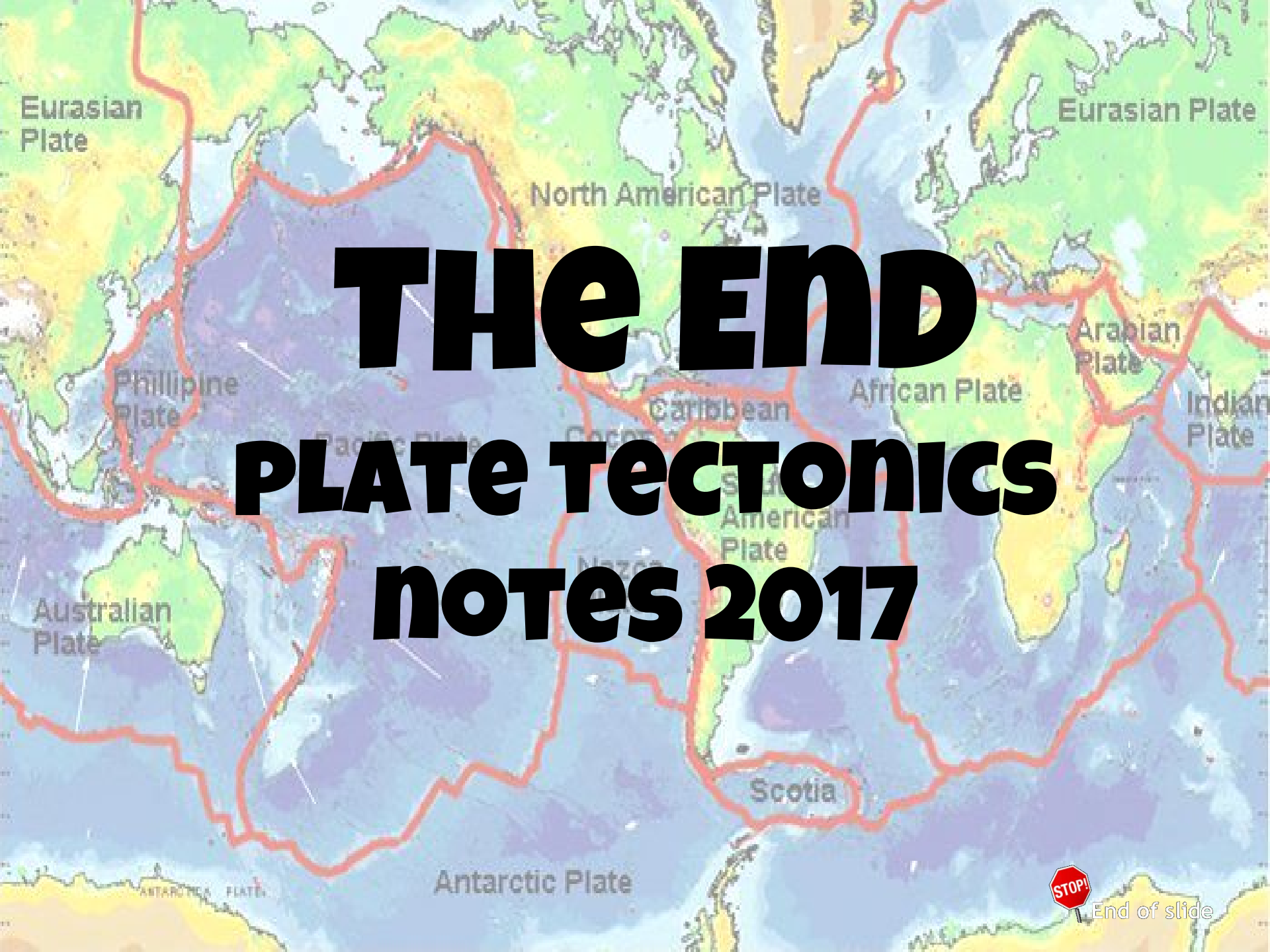
Antarctic Plate

End of slide

Pompeii

The Lost City of Pompeii Video

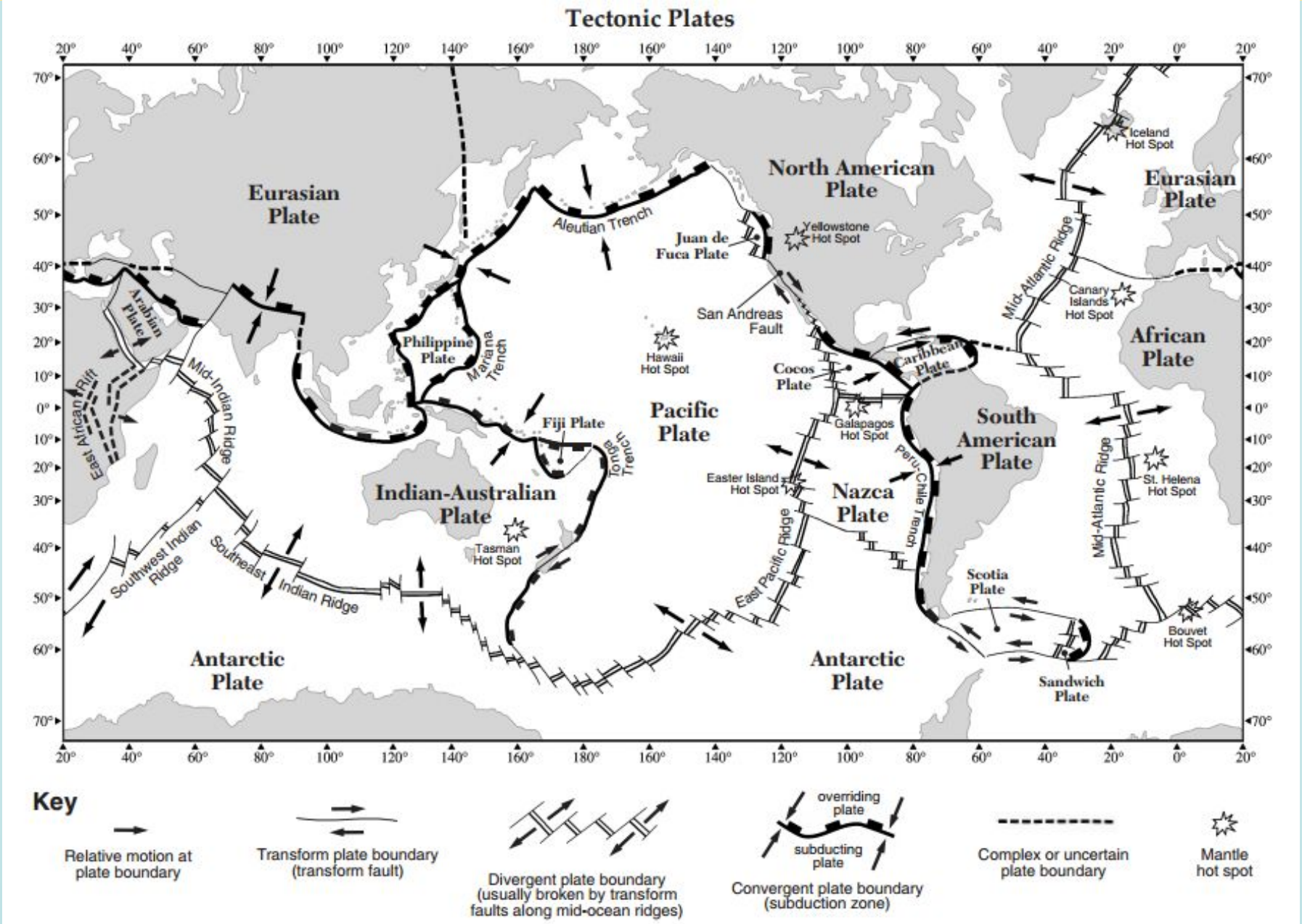
Pompeii



The End

Plate Tectonics Notes 2017

Plate Boundaries Practice Worksheet



2010 Iceland Volcano Eruption

Antarctic Plate

End of slide

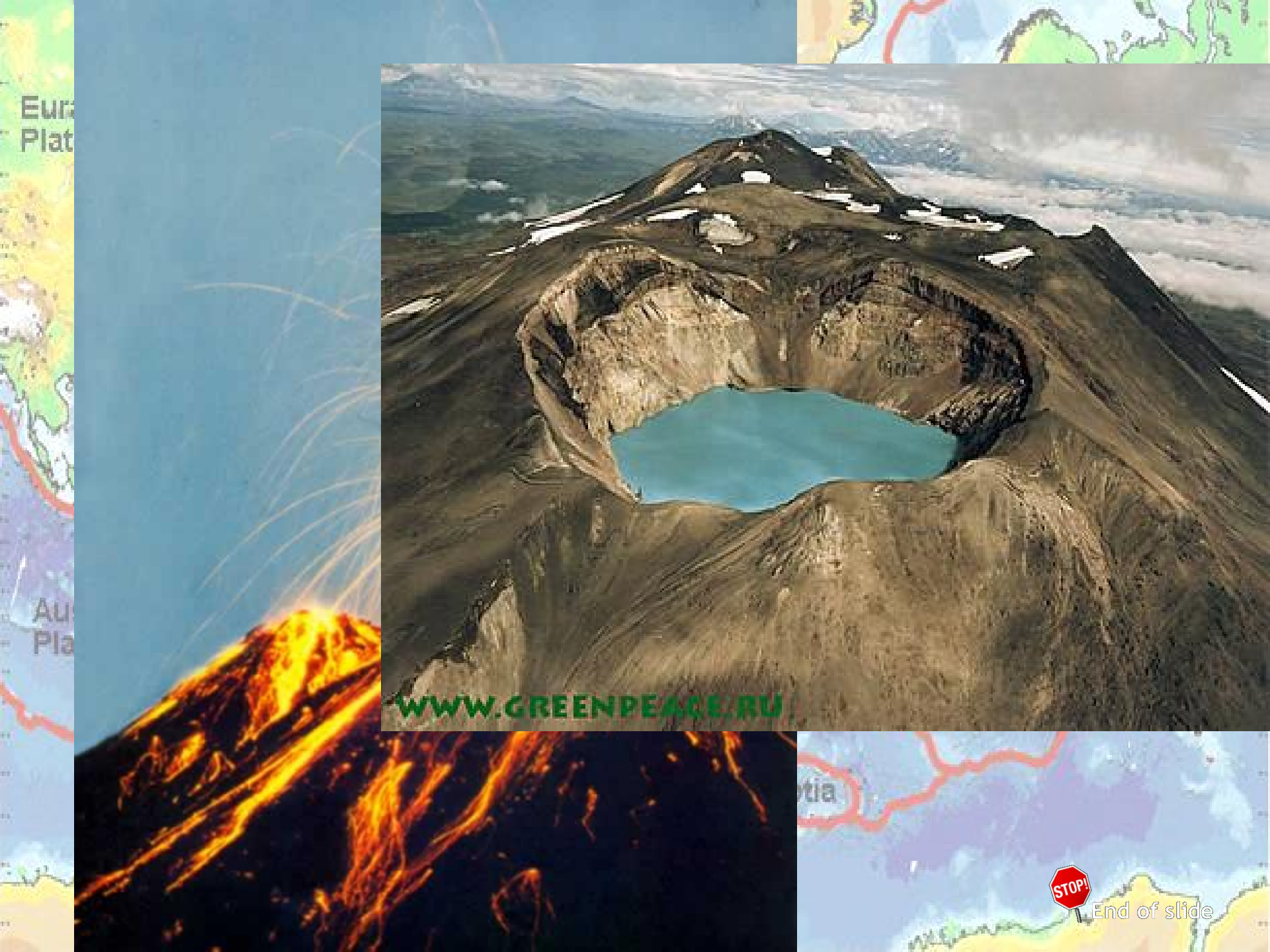
End of slide


STOP!
End of slide

End of slide

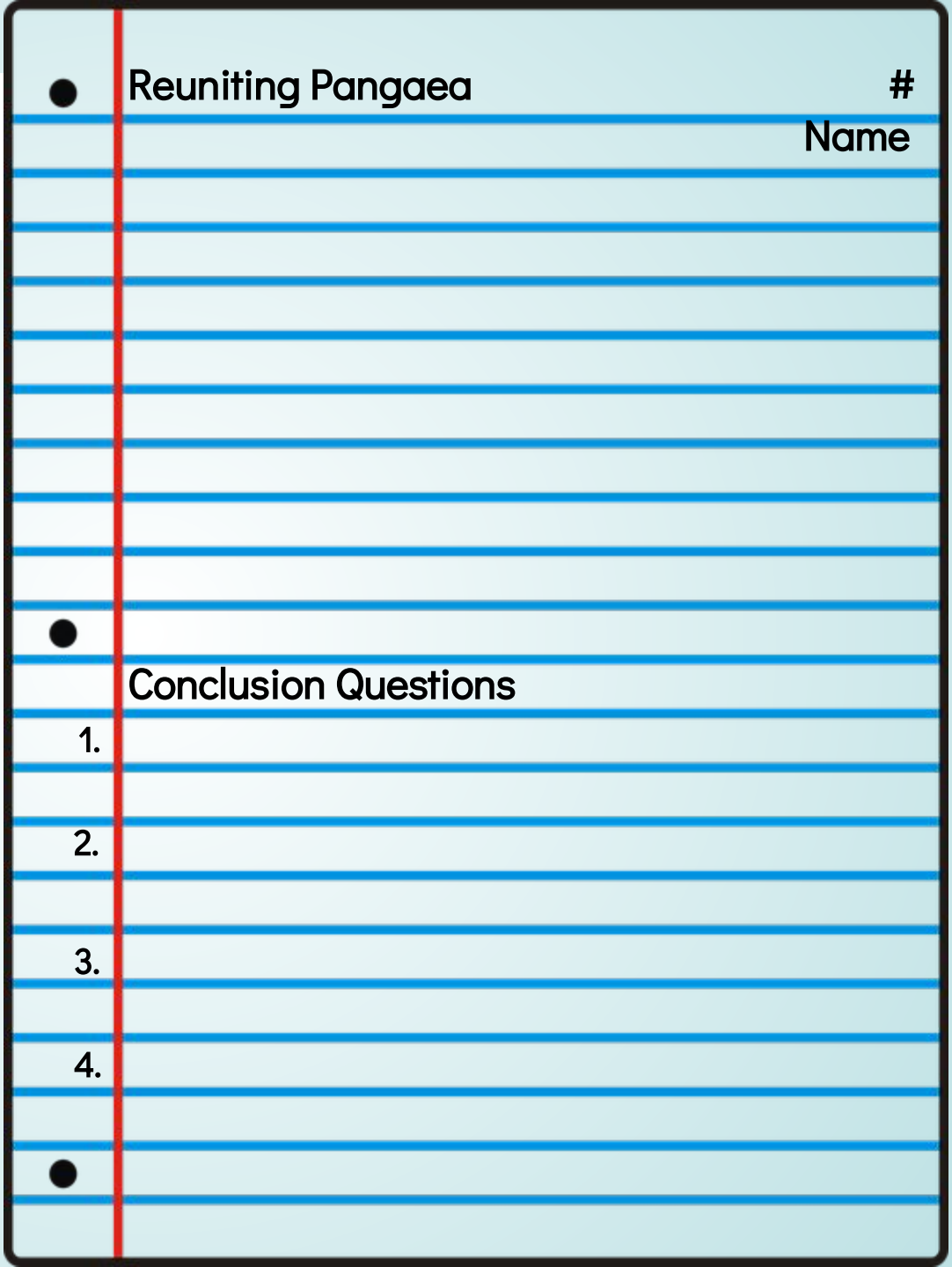
End of slide


STOP!
End of slide


WWW.GREENPEACE.RU
STOP!
End of slide

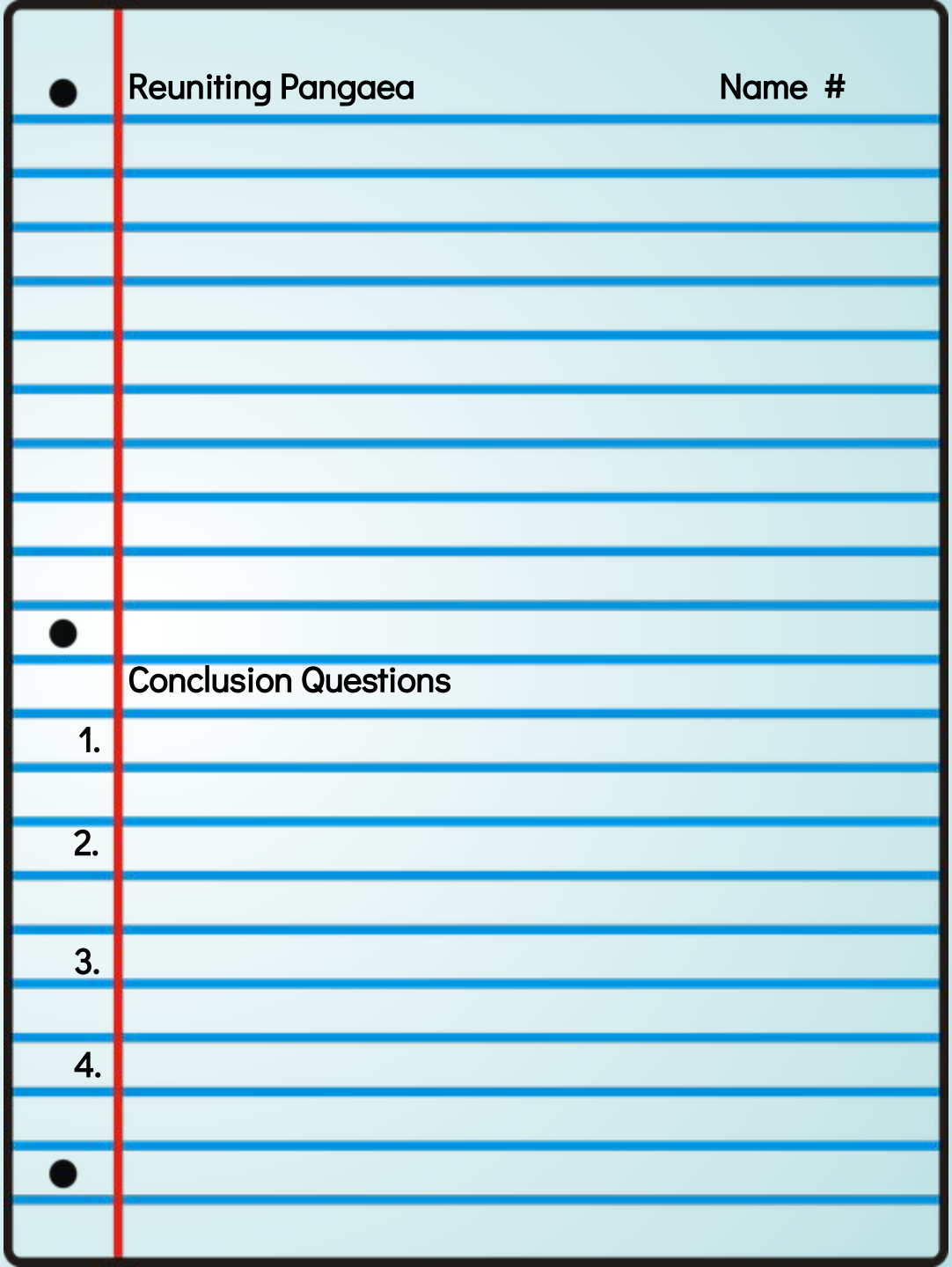
Bell Ringer

1. Make sure you have your colored pencils and a regular pencil. If you do not have any I have some you can borrow.
2. Get out a piece of notebook paper and make it look like the sheet to the right.

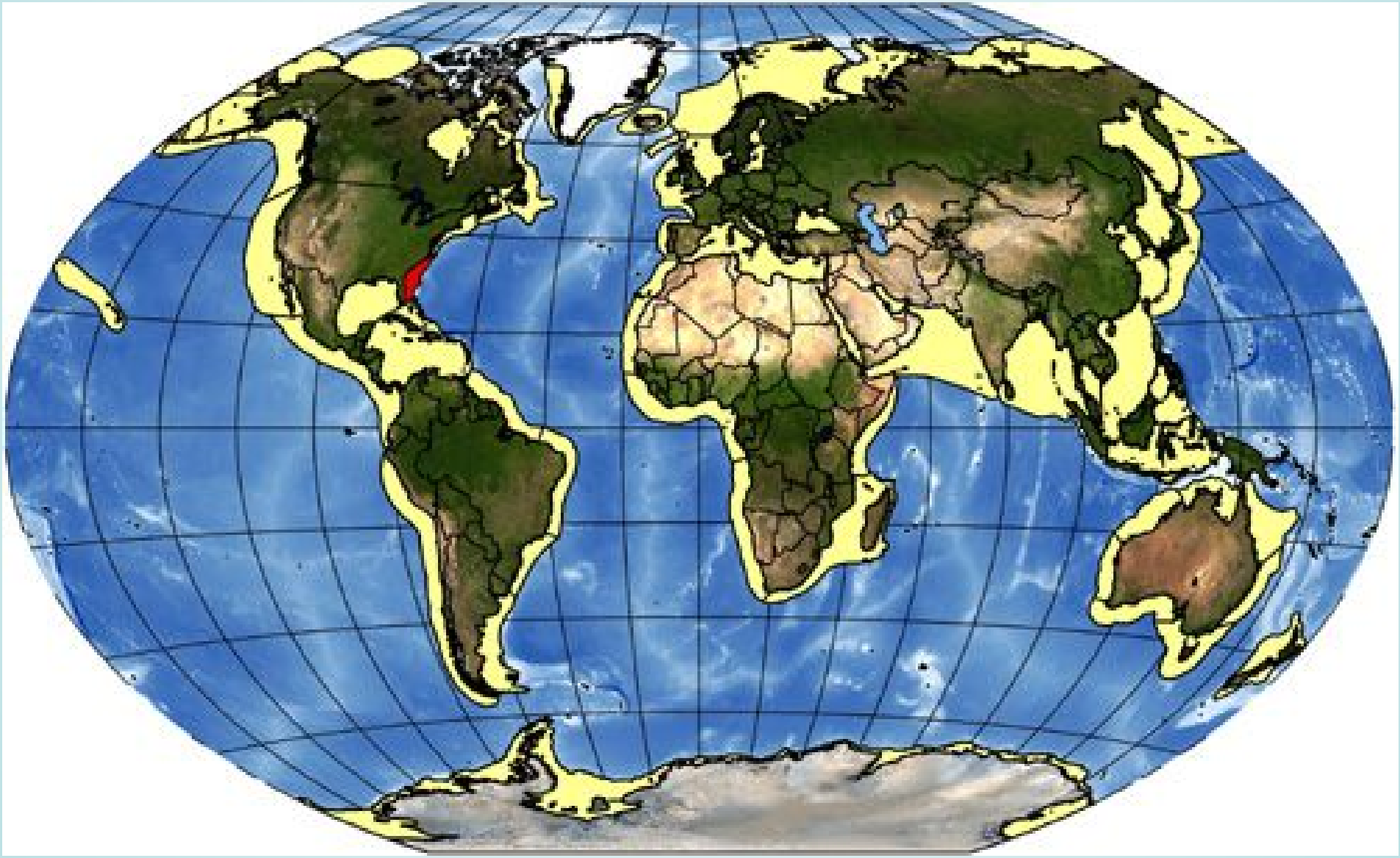


Reuniting Pangaea Activity

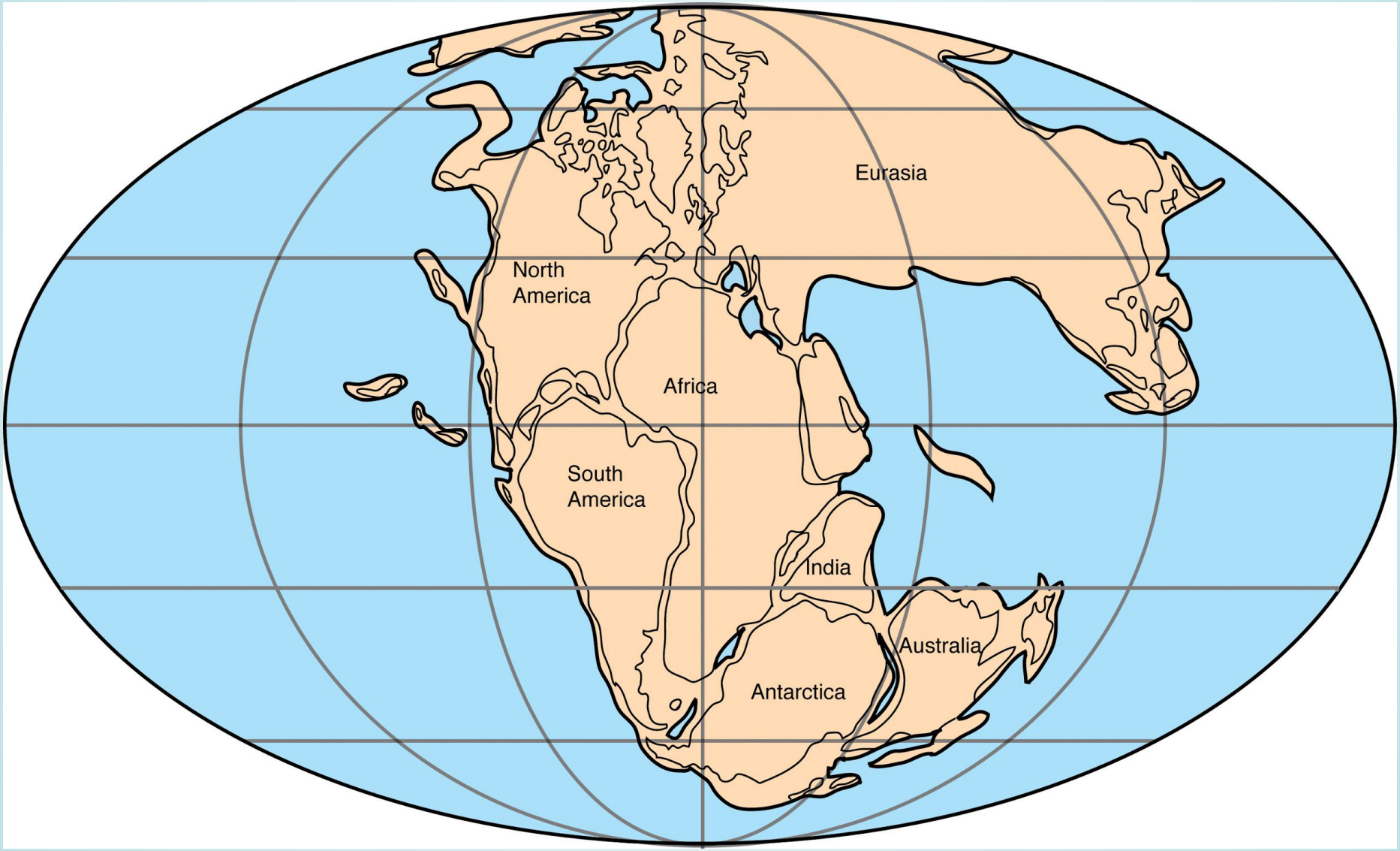
1. Set your paper up like the one to the right.
2. Complete the top portion of the Reuniting Pangaea worksheet. Glue down Pangaea onto the top portion of your notebook paper.
3. Answer the conclusion questions at the bottom of your notebook paper. USE COMPLETE SENTENCES.
4. This will be taken for a grade. You will be told what to do with this at the end of class.
5. CLEAN UP YOUR AREA.



Alfred Wegener– Continental Shelf



Alfred Wegener– Continental Shelf



Evidence Key

Color Your Map	BROWN	BLUE	GREEN	RED	YELLOW

Reuniting Pangaea

Materials:
- Landmass Handout
- Colored pencils
- Interactive Science Notebook
- Scissors
- Glue

1. Look at the Landmass Handout. Visually identify each landmass on your paper.
2. Look at the evidence discovered and use colored pencils to transfer the evidence to the correct landmass on your handout. As you are coloring, make a key for the evidence.
3. After collecting all of the evidence from all 5 maps, cut out the landmasses along the lines. Dispose of your trash and remember to keep your key.
4. Experiment with the cut-out landmasses and try to logically piece the continents together so that they form a giant supercontinent. Do not be concerned if the pieces do not fit exactly.
5. When you are satisfied with the "fit" of the continents, discuss the significance of the evidence with your group. Explain your decision and reasoning on the evidence.
6. Answer the conclusion questions, then glue the half sheet in your science notebook.
7. Your teacher will post the Landmass Model Key for you to see the correct arrangement of the landmasses. Glue your arranged landmass pieces and the key into your science notebook.

Reuniting Pangaea Conclusion Questions

1. **How does your arrangement of the landmasses compare with those of other classmates?**
2. **What is the primary evidence you used in arranging your landmasses?**
3. **Would it be easier or harder to arrange your landmasses if you had less evidence?**
4. **What additional evidence would be helpful in the arrangement of the landmasses?**

Historical Timeline Activity

1. Read the sentence strips provided.
2. Use context clues as you sequence the strips to creat… timeline representing the historical development of th… tectonic theory.

Answer the following questions in your science noteboo…

1. What do you think about Alfred Wegener's contribution to our understanding of how Earth works?
2. What did Mr. Wegener name his theoretical "supercontinent"? Why did he choose that name? Go back to your puzzle of the landmasses and record an appropriate title.
3. Explain why the continents do not fit exactly like pieces of a jigsaw puzzle.
4. Which of the two landmasses seem to fit together the best? Explain your answer.
5. Describe five examples of evidence that Alfred Wegener used to support the theory of continental drift.

Timeline

Write a summary describing the historical evidence that supports the plate tectonic theory.

Earth's Interior

1. Read the text and answer the questions as you read. Keep this assignment in your binder.
2. Work on your Reuniting Pangaea or Alfred Wegener Activity.
3. Read or work quietly.

After the Quiz

1. Check your spelling.
2. Turn your test over.
3. You may draw on the back of your quiz or read a book.