# World Map of Plate Boundaries

## *"Where's Waldo"*-style geography

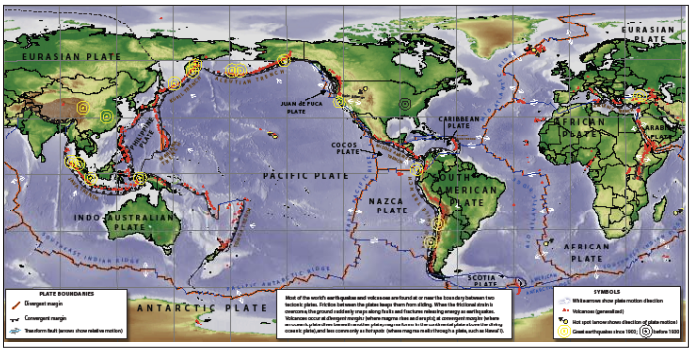
Mapping world plates helps students connect topography, earthquakes, volcanoes, and plates.

### Introduction

The plate tectonics mapping activity allows students to easily begin to identify basic tectonic processes on a global scale. As students become aware of plate movements, they begin to identify patterns that set the stage for deeper understanding of a very complex topic. The activity uses a simple "*Where's Waldo*" approach to identify tectonic symbols on a laminated World Plate Tectonic map.

### Objectives

- Determine where different types of plate boundaries are located
- Explain the different landforms found at different plate boundaries
- Identify patterns between volcano, earthquake, and landform locations and different types of plate boundaries.




### Procedure

Print and laminate the appropriate maps (see Materials) for use. Students work in pairs or small groups of 3 or 4 students using colored markers to circle tectonic features. The process of exploring the map and drawing with colored markers captures student interest and creates curiosity to discover why particular features are located where they are. As students work through simple questions on the activity sheet, they are then able to start the more challenging process of understanding the patterns and process that make up the fundamental principles of Plate Tectonics.

### Materials

- **Student worksheets**—SW-1 thru SW-3
- Washable pens
- **Maps:** The map (thumbnail at left), and in the student worksheets, is offered in several formats* for classroom use from SERC: https://serc.carleton.edu/ANGLE/educational_materials/activities/204690.html

  * If you don't have a large-format printer, the poster is available in tabloid-size pages that can be taped together.

  * The maps are also offered *without* tectonic boundaries to be used to see if students recognize features in the landscape.

### Supporting Resources

**Video lectures:**

Egg vs Earth www.iris.edu/hq/inclass/video/101

Tectonic Plates: www.iris.edu/hq/inclass/video/104

Asthenosphere: www.iris.edu/hq/inclass/video/102

Boundary types: www.iris.edu/hq/inclass/video/106

**Animations:**

3 Types of Plate Boundaries
www.iris.edu/hq/inclass/animation/492

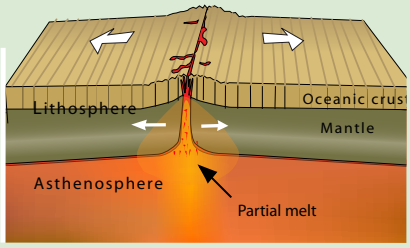
History of Plate Tectonics:
www.iris.edu/hq/inclass/animation/564

What drives Plate Tectonics:
www.iris.edu/hq/inclass/animation/557

**Interactive tectonic map; Dynamic Planet:**
http://volcano.si.edu/learn_dynamicplanet.cfm

## Divergent Boundaries & Spreading Zones

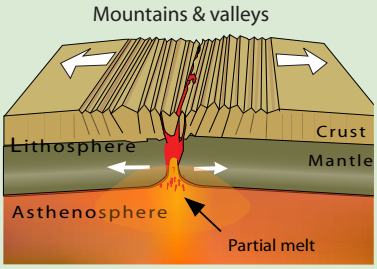
**Spreading center—Fast**




Divergent boundaries occur mostly along spreading centers where the magma rises forming new crust. (Ex. East Pacific Rise, Mid Atlantic Ridge.)

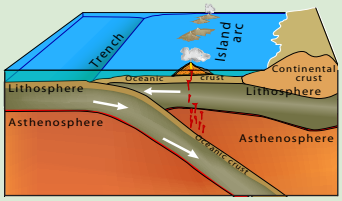
Spreading zones (no graphic) on continents create parallel mountains and valleys as the crust pulls apart (ex: Basin & Range, U.S. and the Great Rift Valley, Africa.)

**Spreading center—Slow**

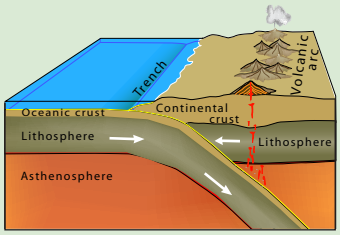



## Convergent Boundaries

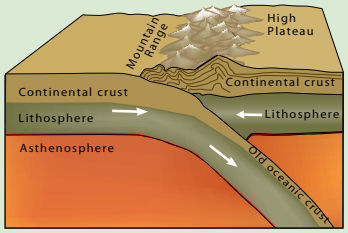
When two plates move toward each other, crust is destroyed as one plate dives (is subducted) beneath the other. The location where sinking of a plate occurs is called a subduction zone.




**Ocean-Ocean**—Ocean plate dives beneath another ocean plate; volcanic island chain forms above the zone (ex:. The Marianas)

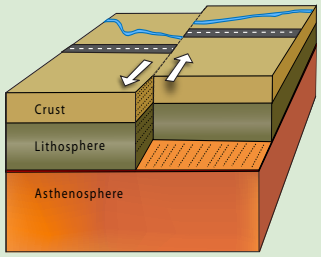



**Ocean-Continent:** Ocean plate dives beneath a continental plate. Volcanic mountain chain forms inland. (ex:. Cascade Range, Sumatra, Japan)



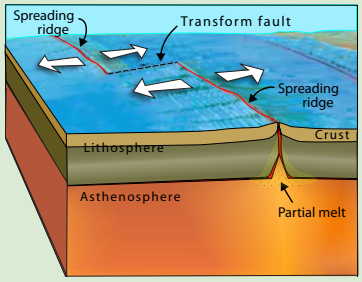

**Continent-Continent:** Two thick continental plates collide and buckle into high mountains. (ex: Himalaya Mountain Range.)

## Transform Boundaries



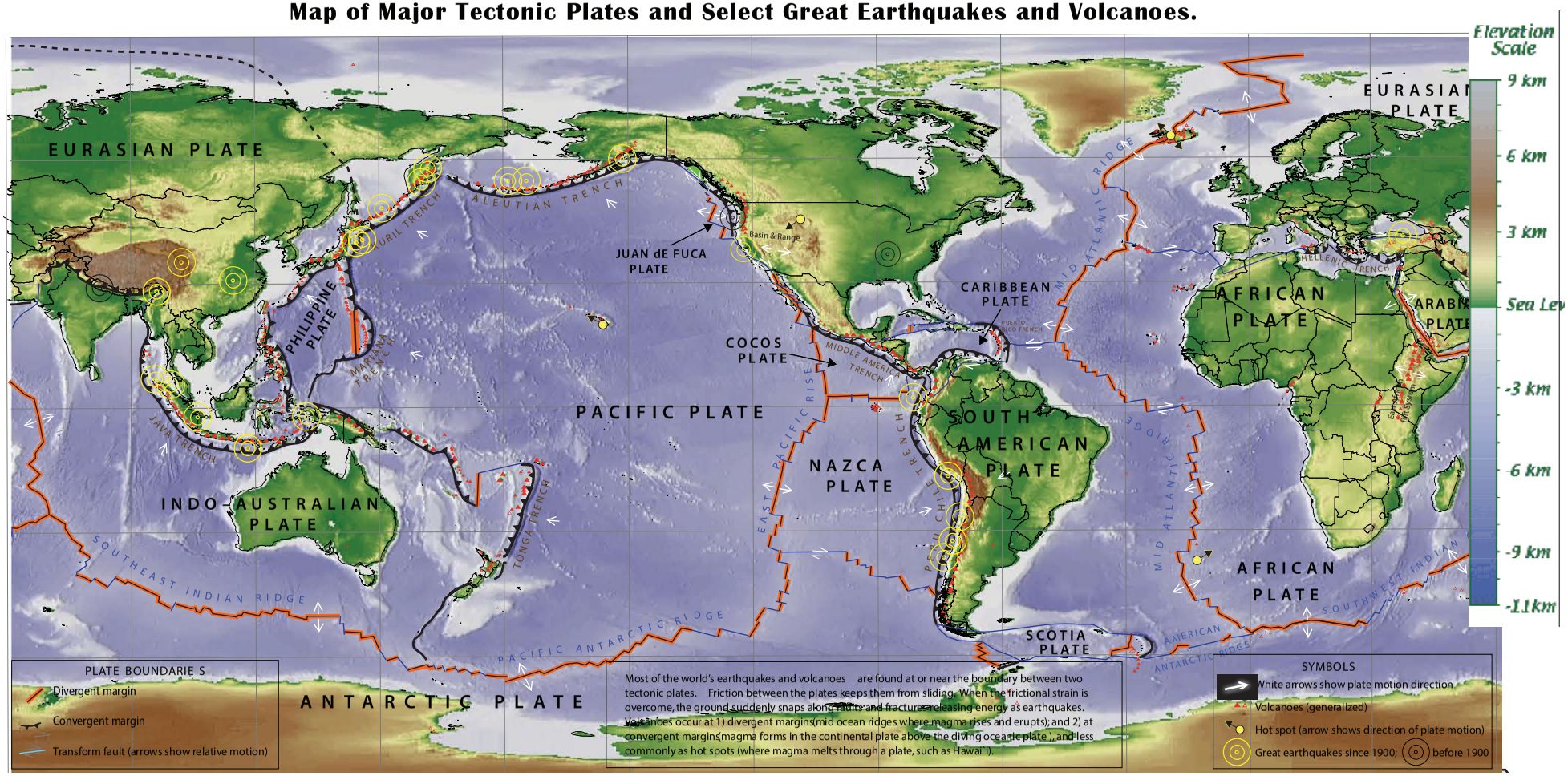

**Strike slip faults** result from two plates moving horizontally in opposite directions (ex: San Andreas Fault, California).

As surrounding plates are driven by deep forces to move apart or crunch together, the in-between areas are pushed around on the surface. This forces them to slide past each other horizontally.




**Transform faults** are where two plates are moving away from a spreading ridge and fracture zones develop (ex: ocean floor)

# Map of Major Tectonic Plates and Select Great Earthquakes and Volcanoes.




## PLATE BOUNDARIES

- Divergent margin
- Convergent margin
- Transform fault (arrows show relative motion)

Most of the world's earthquakes and volcanoes are found at or near the boundary between two tectonic plates. Friction between the plates keeps them from sliding. When the frictional strain is overcome, the ground suddenly snaps along faults and fractures releasing energy as earthquakes. Volcanoes occur at divergent margins (where magma rises and erupts); at convergent margins (where an oceanic plate dives beneath another plate; magma forms in the continental plate above the diving oceanic plate), and less commonly as hot spots (where magma melts through a plate, such as Hawai`i).

## SYMBOLS

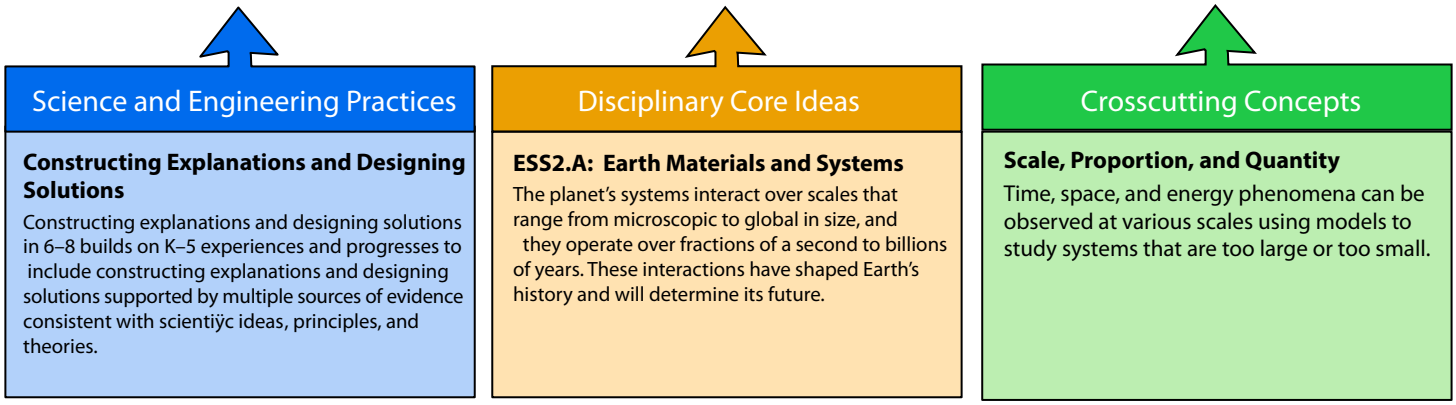
- White arrows show plate motion direction
- Volcanoes (generalized)
- Hot spot (arrow = direction of plate motion)
- Great earthquakes since 1900;
- Before 1900

# APPENDIX—NGSS SCIENCE STANDARDS

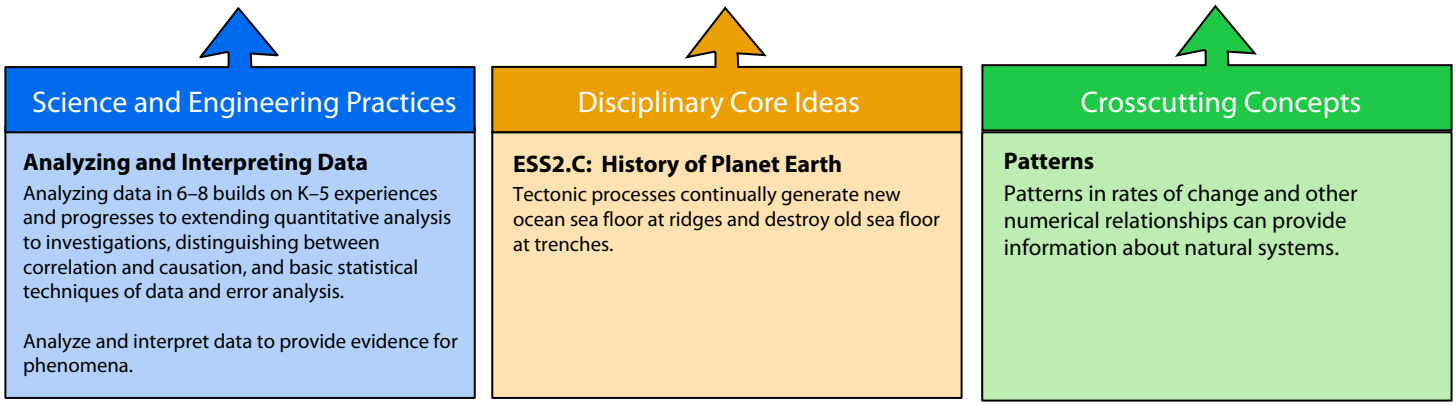
Touch the url links to get more information.

### Earth's Systems

**MS-ESS2-2** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=224




**MS-ESS2-3** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=225



Name _____

## Introduction to Plate Tectonics: Map Activity

*Use the map provided, along with your science notebook, to answer the questions below*

1. Draw the map symbol for each tectonic feature in the chart below:

| | |
|---|---|
| Divergent plate margins and spreading centers | |
| Convergent plate margins - subduction zone | |
| Transform faults – strike-slip faults | |
| Hot Spot | |
| Great earthquakes ("great" = really big) | |

2. Use the correct color of washable marker to locate each tectonic feature on the map.
    a. Circle the Divergent margins and spreading centers in black.
    b. Circle the Convergent margins in blue.
    c. Circle the Transform faults in green.
    d. Circle the Hot Spots in red.

3. Examine the divergent plate margins and continental spreading centers.
    a. How does new crust form?

    b. List the names of 2 divergent plate margins found on the map.

4. Examine the transform faults on the map.
    a. What type of motion occurs at transform faults?

b. List the name of a major transform fault found on the map.

5. There are three different types of convergent plate margins, with each creating different types of landforms. Describe and give an example of each:
    a. Ocean-Ocean:

    b. Ocean-Continent

    c. Continent-Continent

6. Earthquakes:
    a. Along which type of plate margin do the largest earthquakes occur?

    b. How many great earthquakes have occurred since 1900? Of those, how many occurred in Alaska?

7. Volcanoes:
    a. Along which type of plate margin do most volcanoes occur?

    b. Why do you think the Pacific Rim (margin of the Pacific Ocean) is called the Ring of Fire? (Note: what kind of plate margin surrounds much of the Pacific Ocean?)

8. Hot Spots:
    a. What is a hot spot? How many hot spots are on the map?

    b. List the names of 2 hot spots.

9. To conclude, describe 3 connections you have observed between Earth's landforms/features/earthquakes and tectonic plates?
    a.

    b.

    c.

Name _____

# Introduction to Plate Tectonics: Map Activity

*Use the map provided, along with your science notebook, to answer the questions below*

1. Draw the map symbol for each tectonic feature in the chart below:

| | |
|---|---|
| Divergent plate margins and spreading centers | |
| Convergent plate margins - subduction zone | |
| Transform faults – strike-slip faults | |
| Hot Spot | |
| Great earthquakes ("great" = really big) | |

2. Use the correct color of washable marker to locate each tectonic feature on the map.
    a. Circle the Divergent margins and spreading centers in black.
    b. Circle the Convergent margins in blue.
    c. Circle the Transform faults in green.
    d. Circle the Hot Spots in red.

3. Examine the divergent plate margins and continental spreading centers.
    a. How does new crust form?
    As the sides move apart, magma comes up from below and solidifies on the edges of the crack, adding new crust

    b. List the names of 2 divergent plate margins found on the map.
    Many options – pull from map

4. Examine the transform faults on the map.
    a. What type of motion occurs at transform faults?
    One side slipping past the other horizontally

b. List 2 places you found longer transform faults found on the map.
Several options – pull from map

5. There are three different types of convergent plate margins, with each creating different types of landforms. Describe and give an example of each:
   a. Ocean-Ocean:
   A long string of volcano islands – ex. Aleutians in Alaska

   b. Ocean-Continent
   String of volcanoes on land parallel to the ocean shore – ex. South American

   c. Continent-Continent
   High topography on one side of the boundary. The Himalaya in central Eurasia are really the main example on Earth that students will find on this map. Iran, north of the Arabian plate is another place.

6. Earthquakes:
   a. Along which type of plate margin do the largest earthquakes occur?
   Convergent boundaries have the most (but they do happen in a few other places too)

   b. How many great earthquakes have occurred since 1900? Of those, how many occurred in Alaska?
   23 total; 3 in Alaska

7. Volcanoes:
   a. Along which type of plate margin do most volcanoes occur?
   Convergent (ocean-ocean and ocean-continent)
   Note: also some along continental divergent rifts and in scattered other places such as hot spots
   b. Why do you think the Pacific Rim (margin of the Pacific Ocean) is called the Ring of Fire? (Note: what kind of plate margin surrounds much of the Pacific Ocean?)
   Lots of volcanoes and earthquakes

8. Hot Spots:
    a. What is a hot spot? How many hot spots are on the map?
    Place where magma comes up from deep in the earth
    5 are shown on the map (note to teachers: there are probably more but scientists still have a variety of debates about them)

    b. List the names of 2 hot spots.
    ex. Iceland, Hawaii, Yellowstone, 2 on southern African Plate

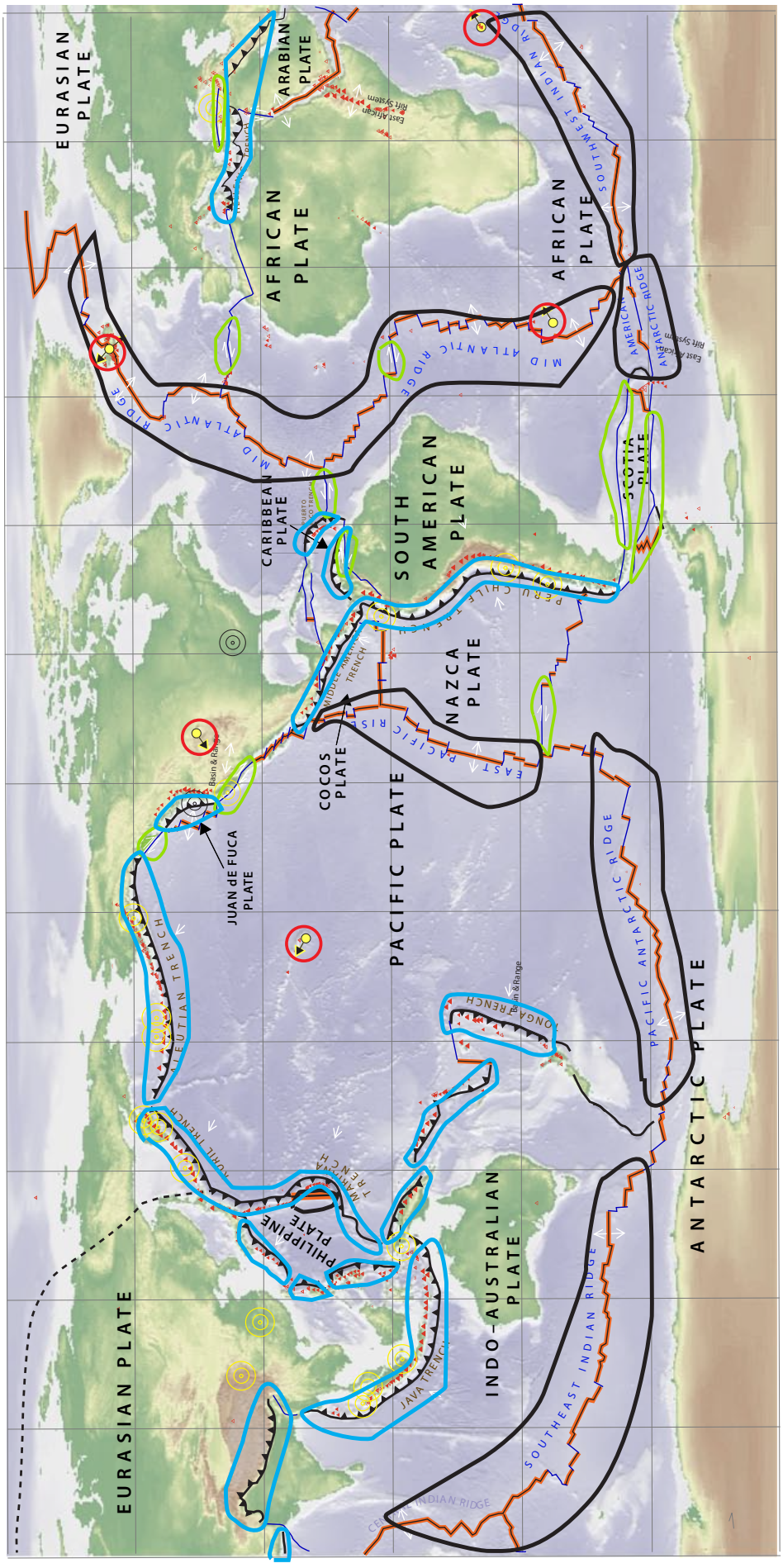
9. To conclude, describe 3 connections you have observed between Earth's landforms/features/earthquakes and tectonic plates?
    a.
    answers could include:
    most volcanoes are found along the edges of plates at convergent margins
    most great earthquakes are found along the edges of plates at convergent margins
    the highest topography is most near convergent margins
    most transform faults are under the oceans
    most spreading ridges are under the oceans

    b.

    c.

# Teacher Answer Key

*Answer sheet for Student Questions page one.*




***NOTE***: The Basin & Range and East African Rift System are spreading centers that are not yet divergent margins, but are noted here with divergent arrows. This simplified map generalizes the zones of deformation surrounding the different boundaries.