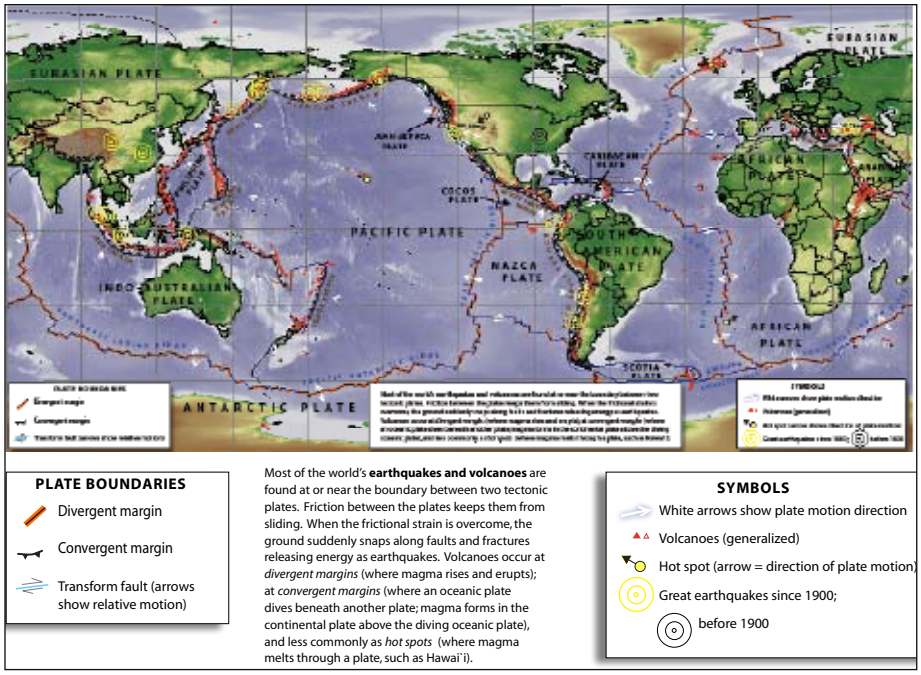
Activity—World Map of Plate Boundaries

"Where's Waldo"-style geography.

Mapping World Plates helps students connect topography, earthquakes, volcanoes, and plates.

Includes many maps for printing, and student worksheets. Color copies are in the folder:

4. ACTIVITIES_Earth & Tectonics > World Plate Boundaries



Science Standards

- Systems
- Cycles in Earth Science
- Evidence of Change
- Science, Technology & Society
- Predictability & Feedback
- Evolution of the Earth

Resources on this DVD & Internet for World Map of Plate Boundaries

VIDEOS: In the folder **3. VIDEOS_Earth & Tectonics >**
LECTURE_Egg Vs Earth_Butler.mov,
LECTURE_TectonicPlates_Butler.mov,
LECTURE_Asthenosphere_Butler.mov, and
LECTURE_BoundaryTypes_Butler.mov

Or online: **http://www.iris.edu/hq/programs/education_and_outreach/videos**

ANIMATIONS: Select animations are in the RESOURCES folder for this activity.
3. Animations_Earth & Tectonics > Plate Interaction_Converge Diverge Transform

Or online: **http://www.iris.edu/hq/programs/education_and_outreach/animations**

INTERNET: **This Dynamic Planet**, interactive tectonic map **http://www.minerals.si.edu/tdpmap/**

World Map of Plate Boundaries

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

Learn where volcanoes and earthquakes occur
Understand geography
Use critical thinking to find plate boundaries
Answer relevant discussion questions on worksheet

Procedure

Print the appropriate maps (see Materials) for use. Note that the maps in this document need to printed on legal-size paper!!

Students work in pairs or small groups of 3 or 4 students using washable markers to circle tectonic features. This hands-on activity captures the interest of all ability levels. 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.

The ***Discussion Questions*** in the activity are provided as a resource for teachers to engage student's growing understanding. The questions have been used in small groups, whole class discussion, research, as a writing assignment, and for evaluation.

Materials

Discussion Questions —On page 7.

Student work sheets—Begin on page 5 of this document; answers follow.
Word files of the worksheets are in the folder
RESOURCES For World Plate Boundaries
> **Word Docs for World Plate Boundaries**

Maps—The map on the next page is offered in several formats for classroom use. Since not everyone has access to a large-format printer we offer the poster as a 3-page, tabloid-size pdf file that can be printed and taped together. The maps are also offered ***WITHOUT tectonic boundaries*** to be used to see if students recognize features in the landscape.

1) Page size (next page) and on DVD in the folder:
RESOURCES For World Plate Boundaries
Maps for printing
> **WorldTectonicMap_PageSize.pdf**.

2) Poster (14x24) requires a plotter to print
WorldTectonicMap_POSTER 14x24.pdf

3) Poster (tabloid-size pages to be taped together)
WorldTectonicMap-Poster_3page11x17.pdf

4) ***WITHOUT tectonic features*** to be used to see if tectonic features show up in the landscape:
WorldTectonicMap_NoBoundaries8.5x14.pdf.
WorldTectonicMap_NoBoundaries11x17.pdf.

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

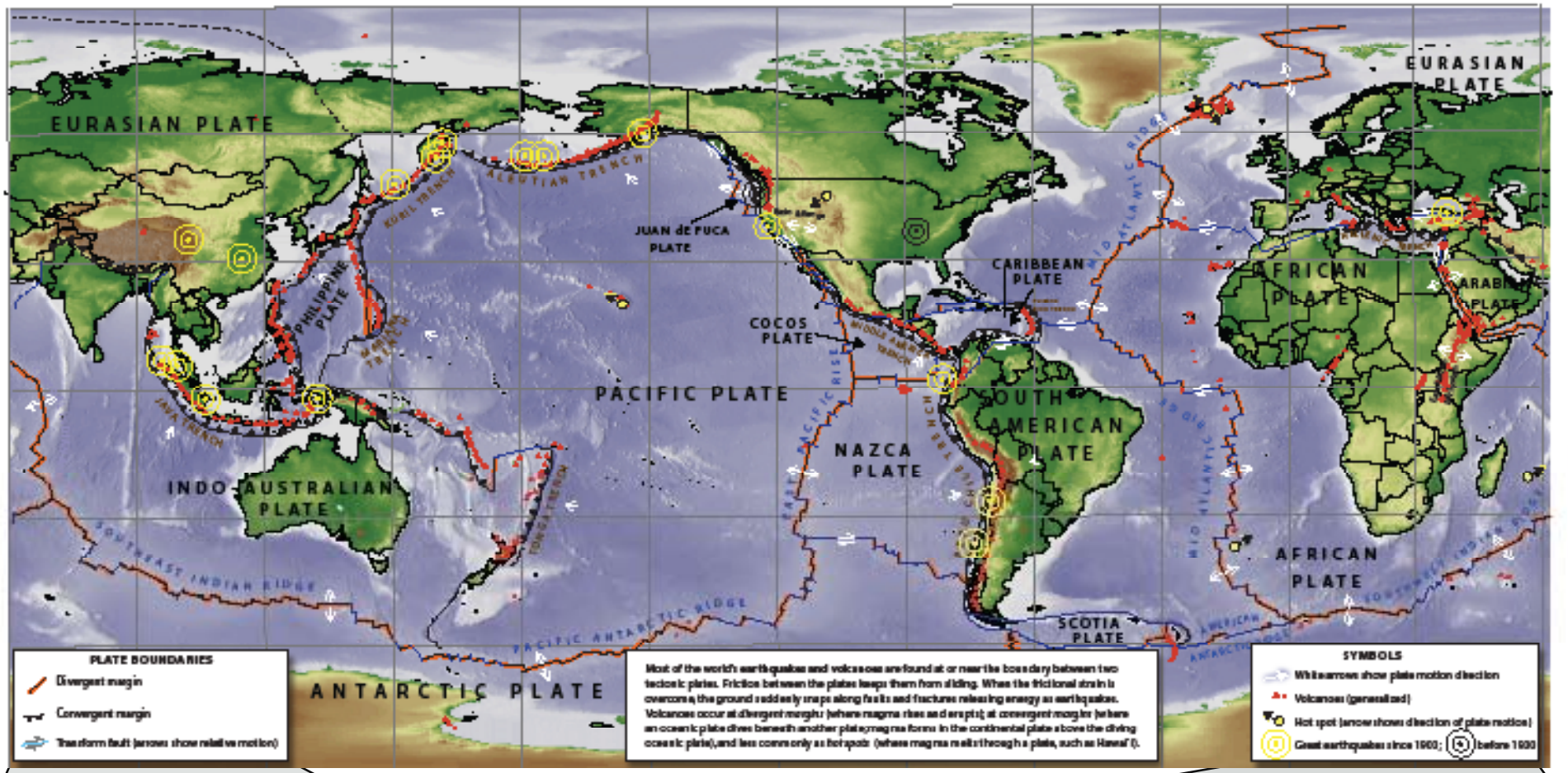


PLATE BOUNDARIES

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

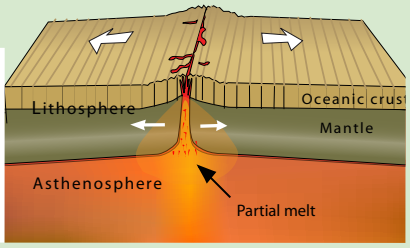
Most of the world's **earthquakes and volcanoes** are found at or near the boundary between two tectonic plates. Friction between the plates keeps them from sliding. When the frictional strain is overcome, the ground suddenly snaps along faults and fractures releasing energy as earthquakes. Volcanoes 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

Divergent Boundaries & Spreading Zones

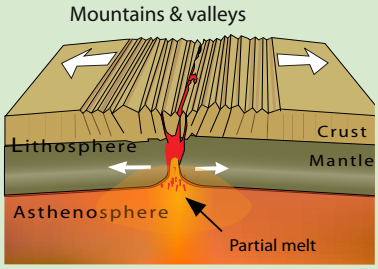
Spreading center—Fast



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

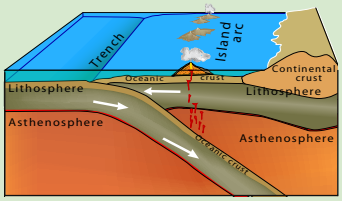
Spreading zones (no graphic) on continents create parallel mountains and valleys as the crust pulls apart (ex: Basin & Range, U.S. and the Great Rift Valley, Africa.)

Spreading center—Slow

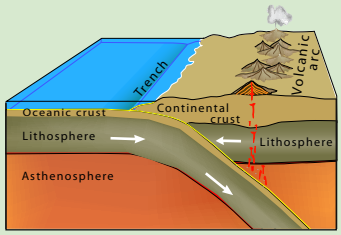


Convergent Boundaries

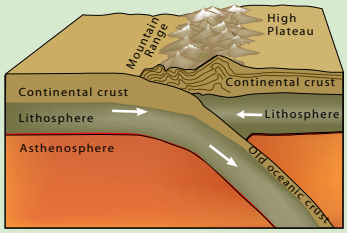
When two plates move toward each other, crust is destroyed as one plate dives (is subducted) beneath the other. The location where sinking of a plate occurs is called a subduction zone.



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

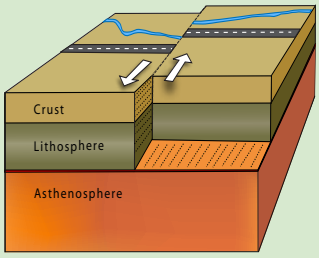


Ocean-Continent: Ocean plate dives beneath a continental plate. Volcanic mountain chain forms inland. (ex:. Cascade Range, Sumatra, Japan)



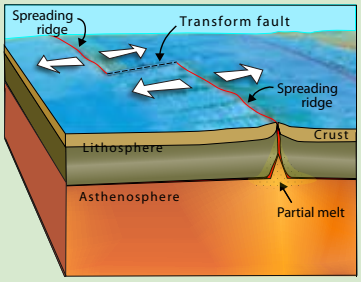
Continent-Continent: Two thick continental plates collide and buckle into high mountains. (ex: Himalaya Mountain Range.)

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)

Name_____

Period_____ Date_____

PLATE TECTONICS MAPPING ACTIVITY

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

Divergent margins and spreading centers (draw in black)	
Convergent margins - subduction zone (draw in blue)	
Transform faults – strike-slip faults (draw in green)	
Hot Spot (draw in red)	

2. Use the correct color of washable marker to locate each tectonic feature on the map.

   a. Circle the name of the Divergent boundary systems in black. (Ridges and Rises) Number found _____

   b. Circle the Convergent margins in blue. (students may circle individual trenches) Number found _____

   c. Circle the Transform fault symbols (and their faults) in green. Number found _____

   d. Circle the Hot Spots in red. Number found _____

3. What is the name of the small crustal plate off the Oregon coast that is subducting under the North American plate? _____

4. Where are most of the earthquakes and volcanoes located?

   Check one: a. crustal plate margins _____ b. interior of a crustal plate _____

Answer the following questions about Plate Tectonic Processes using the diagrams with the map.

5. Divergent margins and continental spreading centers:

   a. New crust forms at plate margins as _____ rises creating ridges under oceans such as the _____ and the _____.

b. Continental spreading centers include the

_____ in the US and the _____ in Africa.

6. Convergent margins – subduction zones:

Identify the land form (geomorphology) created at each type of Convergent Boundary and provide an example.

a. Ocean-Ocean _____

b. Ocean-Continent _____

c. Continent-Continent _____

7. Transform faults – strike slip faults

a. Sometimes tectonic plates shift past each other horizontally _____ directions at their boundary.

b. One example of a strike slip fault near San Francisco is the _____.

8. Earthquakes:

a. Most earthquakes occur near plate _____.

b. _____ keeps the plate edges from sliding smoothly past each other.

c. The longer the plates remain stuck, the more strain builds and the more violent

the snap and resulting _____.

9. Volcanoes:

a. Magma rises to the surface from inside the earth mainly at _____

and _____.

b. Around the rim of the Pacific Ocean, the 40,000 km long _____ of _____

is especially active.

10. Hot Spots:

a. In a few places _____ melts through a tectonic plate.

b. Each hot spot likely marks the top of a plume of _____ rock that rises from deep in the earth.

Discussion Questions: (*italics* are guiding ideas on a few random questions.)

Discussion questions can be used in a whole group setting, or selected questions may be assigned to table groups to answer and then shared with the class.

1. Does the location of earthquakes and volcanoes show a pattern? If so, what tectonic process may be responsible? (*compression, extension, shearing*)

2. Generally speaking, where are the oceanic ridges located with respect to the landmasses? (*in the middle of the ocean: heavy thin crust sinks and water fills low areas.*)

3. Where do you find the mountain ranges with respect to the oceanic ridges? Use examples. (*the ocean-floor ranges are on the crest of the spreading ridges where heat provides the buoyant lift; they sink as they cool.*)

4. Are there any places on Earth where the mid-oceanic ridges meet the continent?

5. What are seamounts?

6. Most of the Pacific Ocean is on what plate?

7. What is the compass orientation of the Hawaiian Islands and many of the other smaller ridges within the Pacific Ocean? Is this significant? (*the islands are moving away from the hotspot in the direction the plate is traveling. Thus the line of the youngest islands is oriented west-northwest as they move towards Japan)*

8. In what compass direction is the Pacific Plate moving? (*see previous question)*

9. Name the biggest and longest mountain range in the world. What is it? (*Trick question. It is a mid-ocean ridge.)*

10. Name an island chain that has been formed by a "hot spot". (*see question 7 above. The Hawaiian Islands.)*

11. What island in the North Atlantic Ocean is splitting apart? What is causing the split? (*Iceland is a hotspot that is straddling the Mid-Atlantic spreading ridge. The spreading ridge is causing the split. If it were just a hotspot it would just build a big edifice.)*

12. Where is magma rising to the surface and forming ocean crust? (*At spreading ridges)*
    Where is the oceanic crust sinking back into the mantle? (A*t subduction zones)*

13. Some people have referred to the process in the above question as a cycle. Why would it be considered a cycle? (*Rock is formed at the spreading ridge; gets destroyed at subduction zones. The subducted rock eventually gets absorbed into the mantle and gets caught in the very slow circulation of rock in the mantle which can melt as it rises to the top again.)*

14. What are the attributes of a cycle?
    Can you describe another cycle that could compare with the example described above.

15. Why is it that the Pacific Ocean floor is no older than about 200 million years and yet the continents are much older? (*The ocean floor is being created constantly. It is made of heavy rock that tends to subduct when it meets continental rock. The continents are made of older rock that is more buoyant .*

16. The continental margins of the East and West Coast of the United States are very different. Describe the differences. Are there tectonic differences?

17. Where would you expect to find igneous, sedimentary and metamorphic rocks?

Teacher Answer Key

PLATE TECTONICS MAPPING ACTIVITY

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

Divergent margins and spreading centers (draw in black)	
Convergent margins - subduction zone (draw in blue)	
Transform faults – strike-slip faults (draw in green)	
Hot Spot (draw in red)	

2. Use the correct color of washable marker to locate each tectonic feature on the map.

   a. Circle the name of the Divergent boundary systems in black. (Ridges and Rises) Number found __7__

   b. Circle the Convergent margins in blue. (students may circle individual trenches) Number found __16 +__

   c. Circle the Transform fault symbols (and their faults) in green. Number found __10__

   d. Circle the Hot Spots in red. Number found __5__

3. What is the name of the small crustal plate off the Oregon coast that is subducting under the North American plate? __Juan de Fuca__

4. Where are most of the earthquakes and volcanoes located?

   Check one: a. crustal plate margins __X__ b. interior of a crustal plate _____

Answer the following questions about Plate Tectonic Processes using the diagrams with the map.

5. Divergent margins and continental spreading centers:

   a. New crust forms at plate margins as __magma__ rises creating ridges under oceans such as the __Mid-Atlantic Ridge__ and the __East Pacific Rise__.

Teacher Answer Key

b. Continental spreading centers include the

_Basin and Range__ in the US and the _East African Rift System_ in Africa.

6. Convergent margins – subduction zones:

Identify the land form (geomorphology) created at each type of Convergent Boundary and provide an example.

a. Ocean-Ocean _____Volcanic Island Chain (Mariana trench)_____

b. Ocean-Continent ___Volcanic Mountain Ranges (Cascade Mountain Range)__

c. Continent-Continent _Folded Mountain Ranges_(Himalaya Mountain Range)___

7. Transform faults – strike slip faults

a. Sometimes tectonic plates shift past each other horizontally _in opposite_____ directions at their boundary.

b. One example of a strike slip fault near San Francisco is the _San Andreas Fault_.

8. Earthquakes:

a. Most earthquakes occur near plate _boundaries__.

b. __Friction___ keeps the plate edges from sliding smoothly past each other.

c. The longer the plates remain stuck, the more strain builds and the more violent the snap and resulting _ground movement__.

9. Volcanoes:

a. Magma rises to the surface from inside the earth mainly at _spreading centers_. and __hot spots_____.

b. Around the rim of the Pacific Ocean, the 40,000 km long _Ring__ of _Fire__ is especially active.

10. Hot Spots:

a. In a few places _magma___ melts through a tectonic plate.

b. Each hot spot likely marks the top of a plume of __molten_____ rock that rises from deep in the earth.

Teacher Answer Key

Answer sheet for Student Questions page one.