

1. CONTRIBUTOR'S NAME: Johnny MacLean

2. NAME OF INQUIRY: DISCOVERING PLATE BOUNDARIES

3. GOALS AND OBJECTIVES:

a. Inquiry Questions: Where are the Earth's plate boundaries? What processes occur at plate boundaries? How are plate boundaries classified?

b. Ecological Theme(s): Physical ecology. Shaping landscapes through time.

c. General Goal: Students are introduced to plate tectonics in a discovery-based inquiry that utilizes observation and classification skills.

d. Specific Objectives: Use observation and classification skills in a cooperative group setting to integrate several types of map data, including seismic, volcanology, geographic, and chronologic data, to discover the locations of plate boundaries and the processes that occur there.

e. Grade Level: 7th (but can be used from 5th to college)

f. Duration/Time Required:

→ Prep time: 30

→ Implementing Exercise During Class: 2 to 3 hours (2-3 class periods)

→ Assessment: in class assessment

4. ECOLOGICAL AND SCIENCE CONTEXT:

a. Background (for Teachers): General plate tectonics background is necessary for teachers.

b. Background (to present to Students): This inquiry is to be done before any background information is presented to students.

5. MOTIVATION AND INCENTIVE FOR LEARNING:

It is fun to work in groups. Students discover new things, look at cool maps, and get to invent their own classification schemes, as opposed to just learning what other people have come up with.

6. VOCABULARY:

- Seismicity—the frequency or magnitude of earthquake activity.
- Volcanology—the study of volcanoes.
- Geochronology—the study of Earth through time.

7. SAFETY INFORMATION:

Be careful to observe students working in groups.

8. MATERIALS LIST (including any handouts or transparency masters):

1. Four 24" by 36" data maps mounted on the walls around the classroom, attached.
2. One B&W copy of the student instructions per student.
3. Two B&W transparencies of the 8.5" by 11" Plate Boundary Transparency Map per student.
4. Several sets of colored overhead transparency markers.

9. METHODS/PROCEDURE FOR STUDENTS:

a. Pre-investigation work: Explain the entire exercise thoroughly. Explain what each map represents, including the map legends.

b. Investigation work:

Day 1:

Students are broken into four Specialist Groups. Each group analyzes one of the four maps (seismicity, volcanology, topography/bathymetry, and age of seafloor). They should spend some time becoming familiar with their map, being sure to understand what the map portrays. They compare their map to the 8.5” by 11” Plate Boundary Transparency Map that is given to each student. By observing the features that the two maps have in common, the students decide on a classification scheme for the world’s plate boundaries. They should write descriptions for 3-5 different types of plate boundaries, and each should be a given number such as boundary type 1, boundary type 2, and etc. Their descriptions should be clear enough that someone unfamiliar with their map, and without help, could use their descriptions to find examples of each boundary type on the map. Descriptions should be based purely on their observations, and should include simple terms such as high or low topography, continuous or not, clustered or scattered volcanoes, shallow or deep earthquakes. The students should then color the plate boundaries on each of their 8.5” by 11” Plate Boundary Transparency Maps, using a different color for each type of boundary. This exercise can also be done using paper copies of the Plate Boundary Map. In such a case, the overlay part of the exercise would be replaced by a comparison exercise.

Day 2:

Students are broken into different groups than Day 1. Day 2’s groups are Plate Groups. Each Plate Group must have at least one seismologist, volcanologist, geographer, and geochronologist. Every member of the group is an expert on their field, but each member has only studied one type of data. The group should work their way around the four 24” by 36” maps posted around the room. Each expert will have the opportunity to explain the features of that map. They should first tell what the data are and how they are symbolized. They should point out the most important features shown on their map. They should then discuss each member’s classification scheme from Day 1. The goal for Day 2 is for the Plate Groups to come up with a new classification scheme for one major plate on a new 8.5” by 11” Plate Boundary Transparency Map that considers data from each of the four areas of specialty. Each Plate Group is assigned a different major plate by the teacher. An example of a plate boundary description is: plate boundary type A has shallow earthquakes right on the plate boundary, has sparse or no volcanoes, lies on a topographic high with deeper water to either side, and follows a line of young seafloor. In most cases the students will do this by bringing together the classification maps they did the first day. They can overlay their transparencies in order to correlate their plate boundary types (at least approximately) from data type to data type. Each student must produce a new classification scheme, and must color their map accordingly. Additionally, each Plate Group is to present their map and classification scheme to the class in a 5 minute presentation.

1) What evidence (data, samples) do students collect?

Observations of seismicity, volcanology, geography, and geochronology.

2) How do students present the evidence (data)?

Construct a classification scheme of plate boundaries.

3) What conclusions are drawn from the evidence students collect?

Plate boundaries follow seismicity, volcanology, certain topographic features, and certain geochronologic features.

10. ASSESSMENT:

Students turn in their new classification schemes based on only their specialty, as well as on all four sets of data. Their presentations can also be assessed. Assessment should be based on the students' ability to support their classification schemes based on their observations.

11. EXTENSION IDEAS:

This is an introductory activity. After this, any plate tectonic activity would be appropriate. A specific extension might be to use GoogleEarth to investigate some of the plate boundaries. Another extension might be to look at the geology around the Missoula Valley from the school yard to observe some extension-related faults (the Sentinel Fault caused Mount Sentinel and Mount Jumbo to rise high above the Missoula Valley).

12. SCALABILITY:

This exercise can be used from 5th graders to college students because it is based on observation skills. In fact, it sometimes works better with younger students because they are not biased by previous knowledge.

13. REFERENCES:

This exercise and all of its maps, etc., are taken or modified from Dale Sawyer's (Rice University) "Discovering Plate Boundaries" exercise, found on the following website: <http://terra.rice.edu/plateboundary/>

14. LIST OF EXPERTS AND CONSULTANTS

Dale Sawyer, Rice University

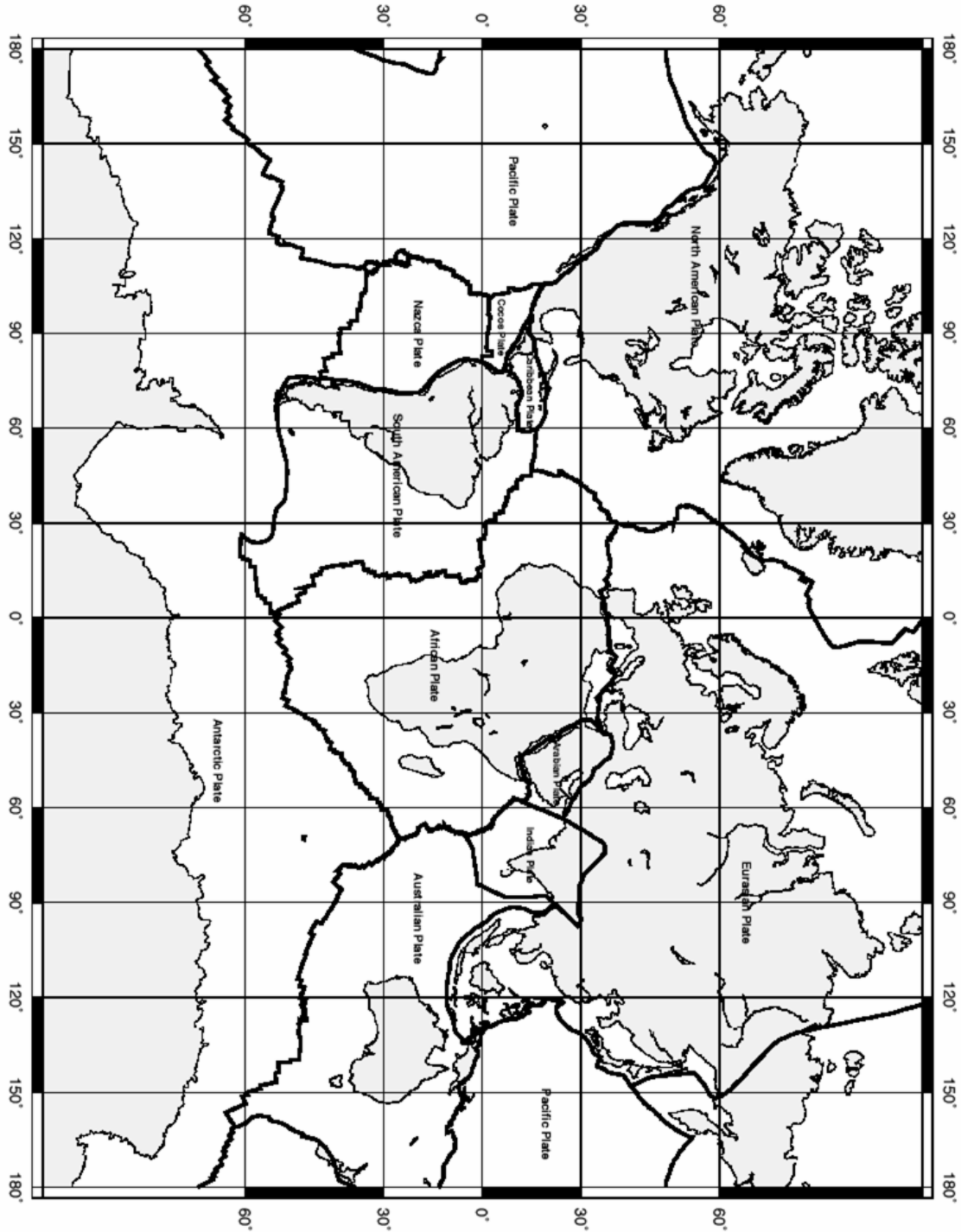
15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:

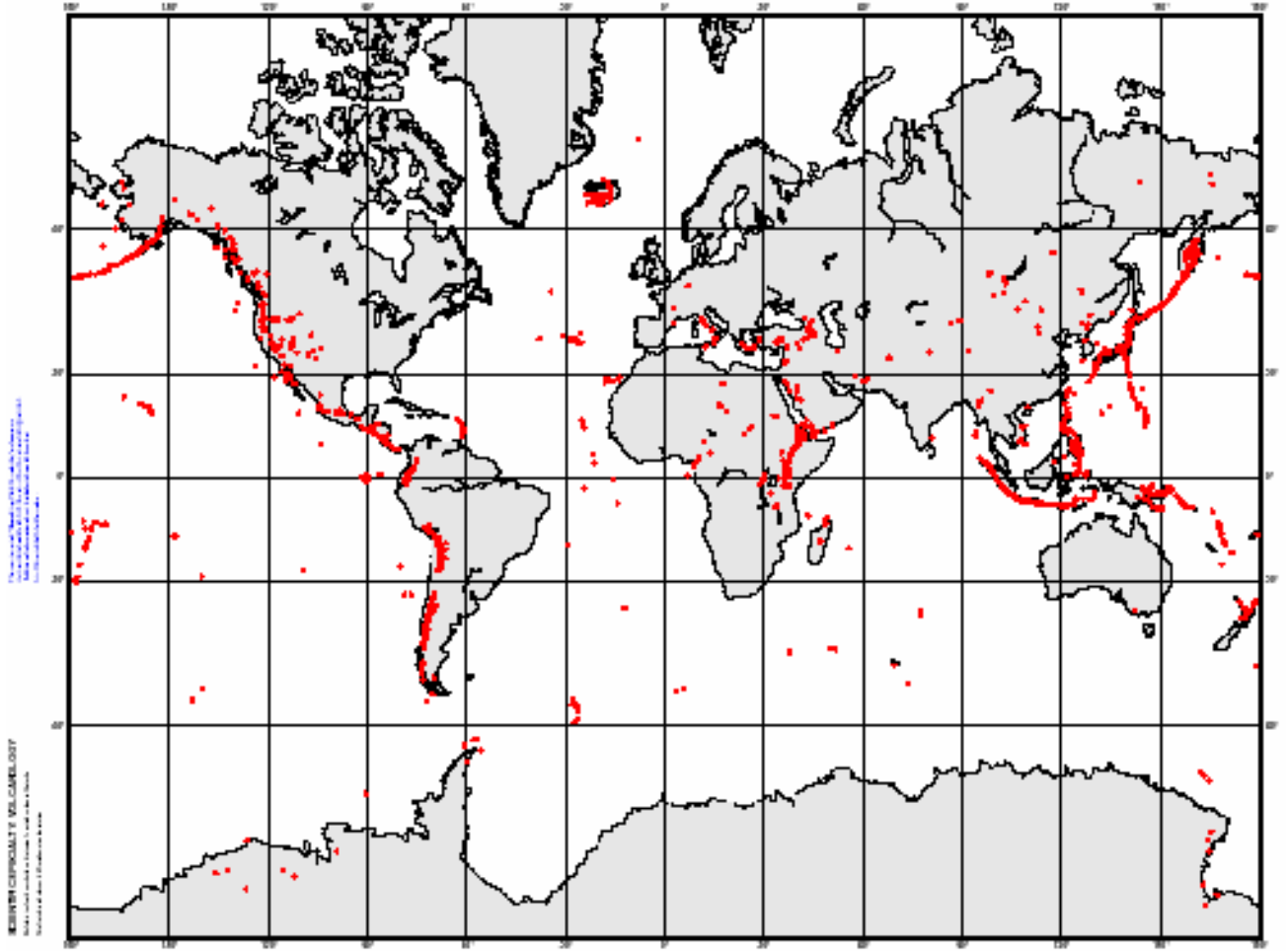
This inquiry went very well. The students began making connections between the different datasets, and they were engaged in peer-teaching. The exercise in making their own categories based on their observations was extremely powerful. This is a great way to start an earth science unit.

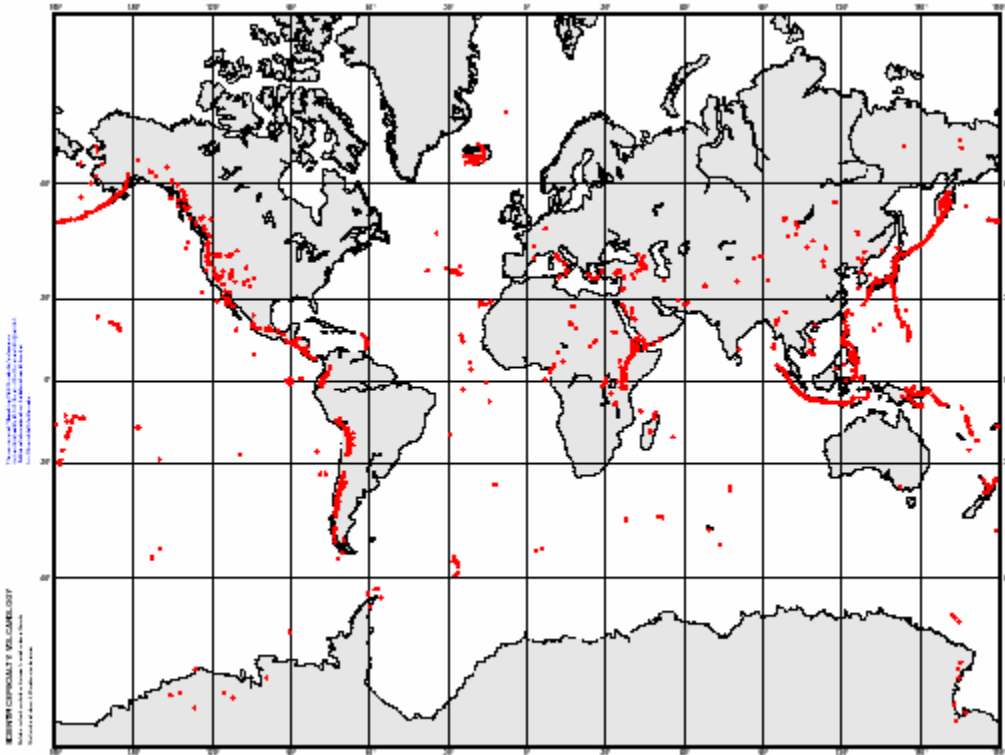
PLATE BOUNDARY MAP

This map is from Dietmar Mueller, Univ. of Sydney

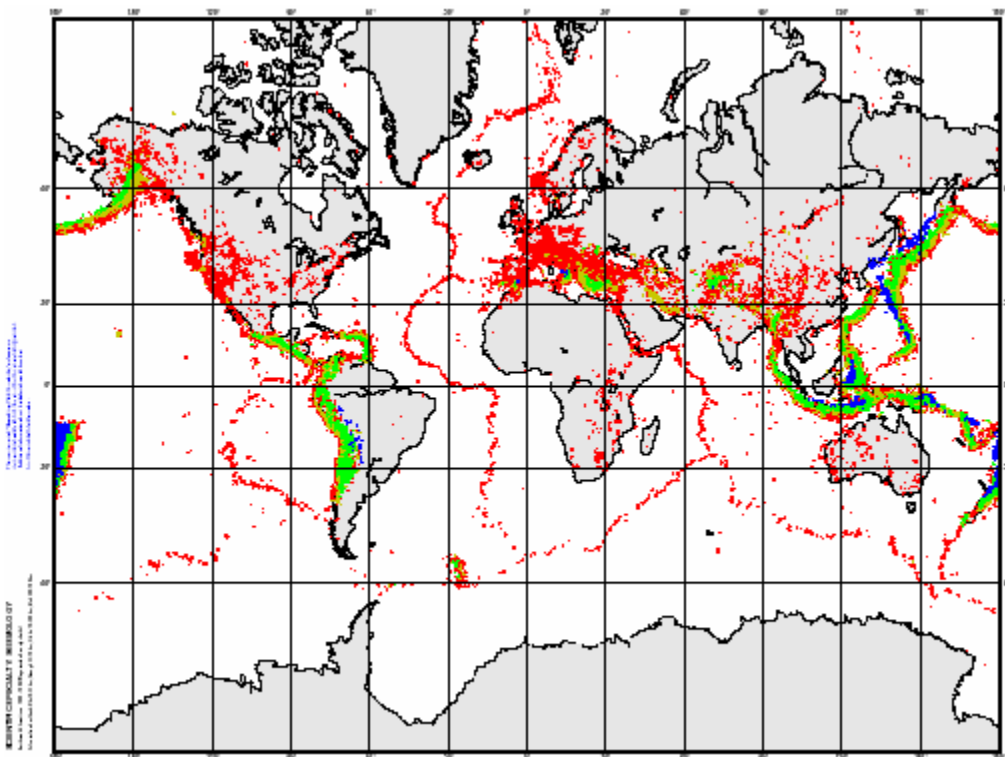
This map is part of "Discovering Plate Boundaries," a classroom exercise developed by Dale S. Sawyer at Rice University (dale@rice.edu). Additional information about this exercise can be found at <http://terra.rice.edu/plateboundary>.



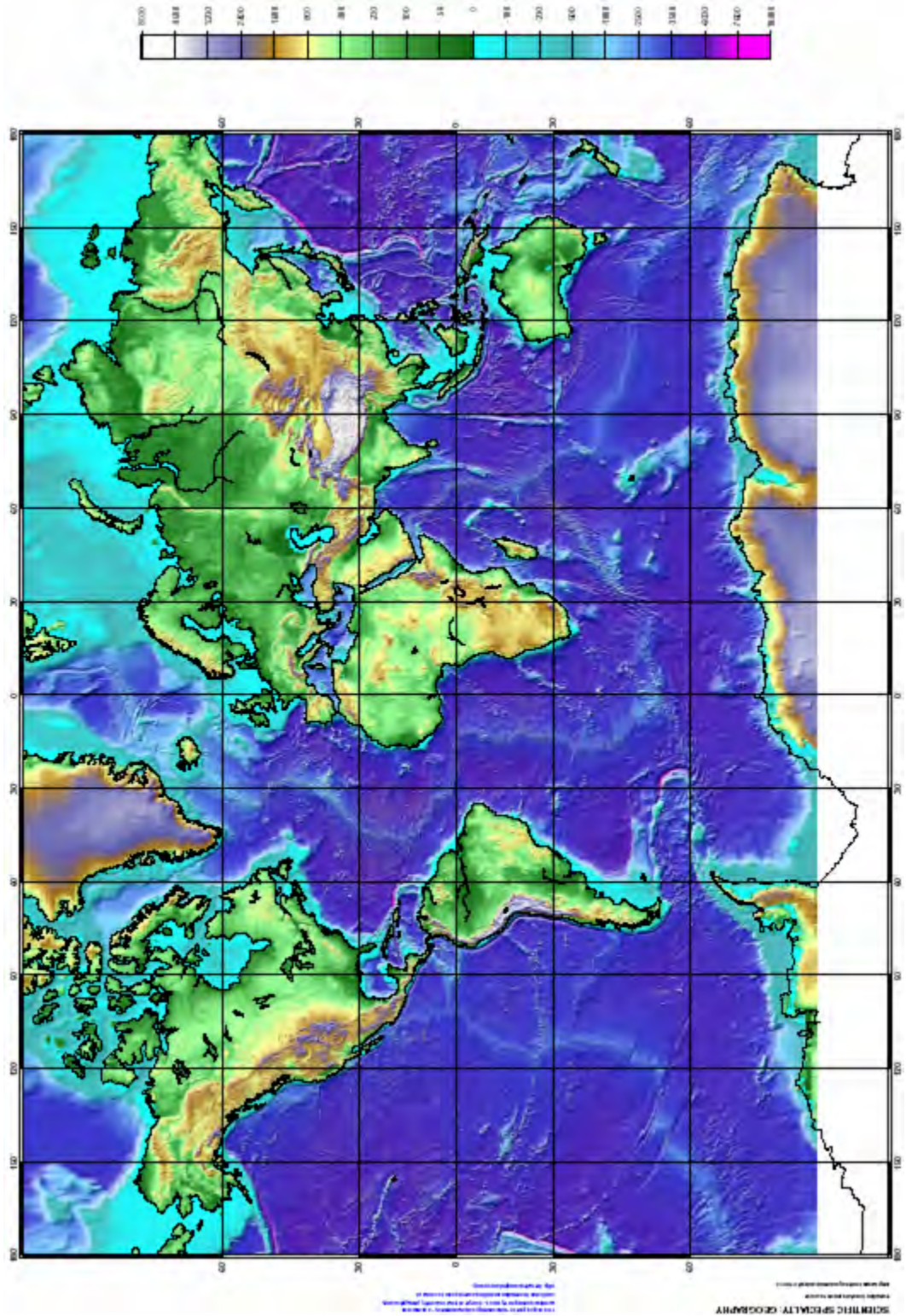




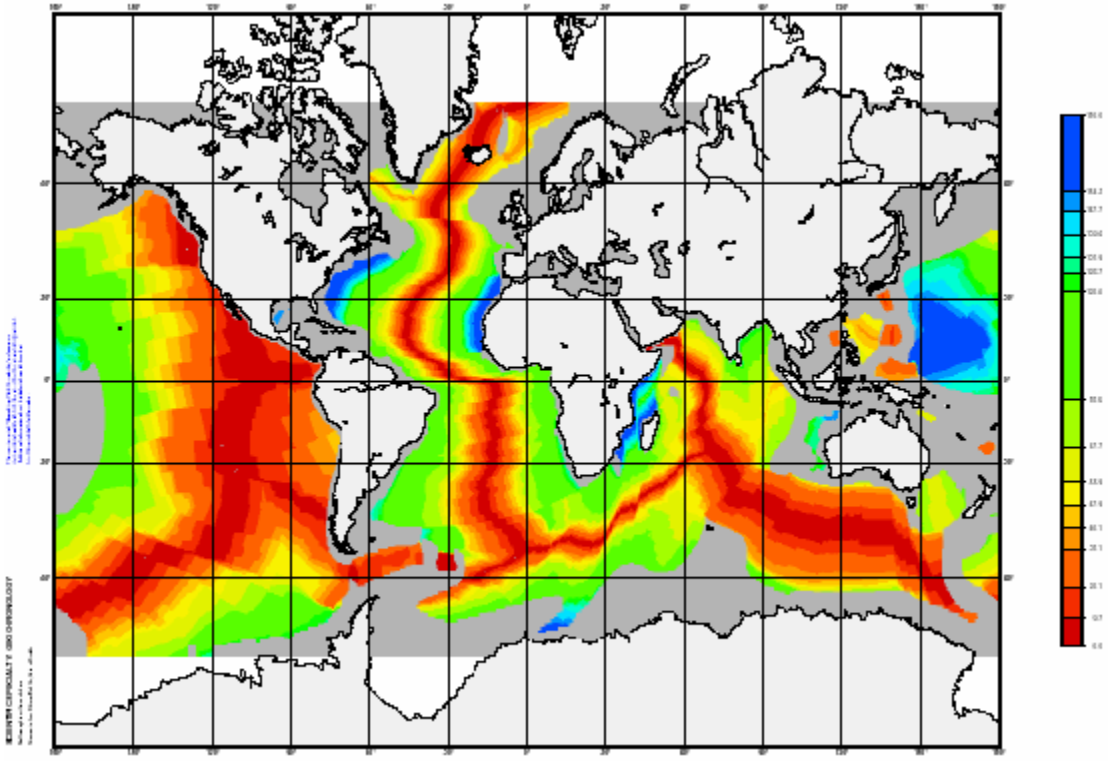
Volcanology



Seismology

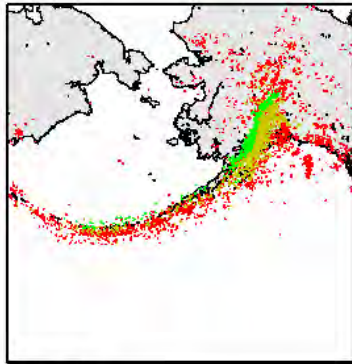


Topography



Sea Floor Age

WRAP-UP TRANSPARENCIES



Earthquakes

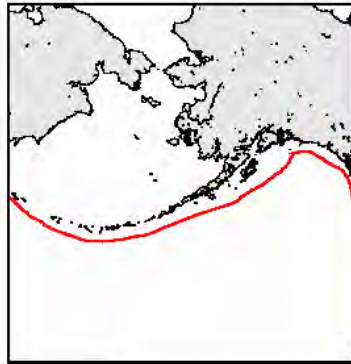
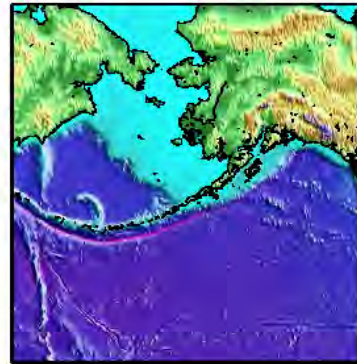
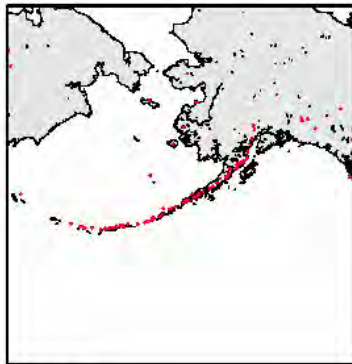


Plate Boundaries

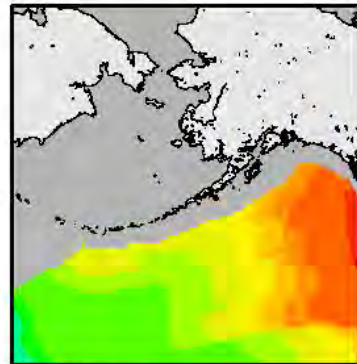


Topography



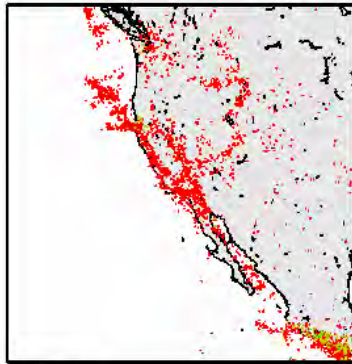
Volcanoes

**Convergent Plate Boundary
 Aleutian Arc**



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

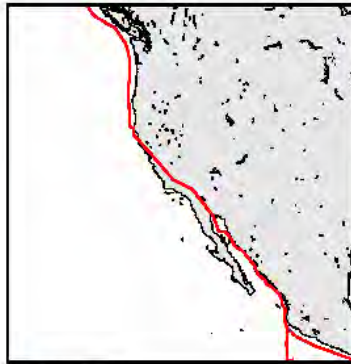
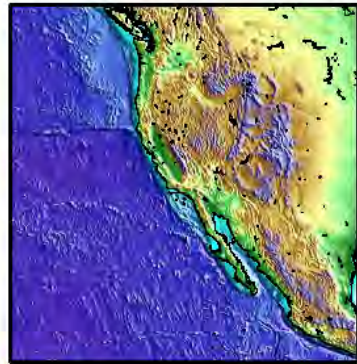
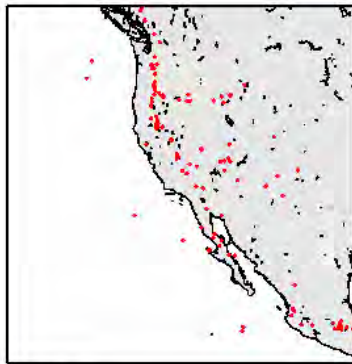


Plate Boundaries

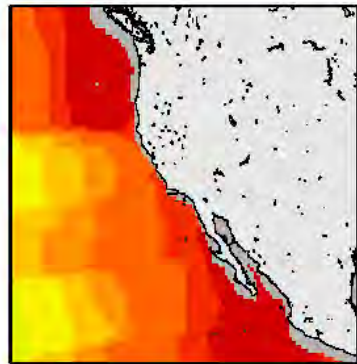


Topography



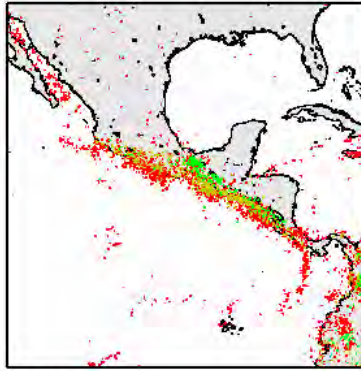
Volcanoes

**Transform Plate Boundary
 Western North America**



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

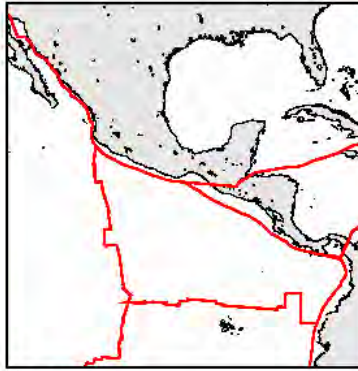
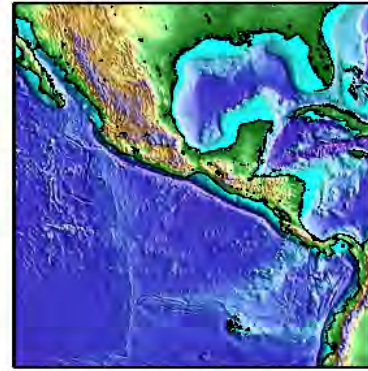
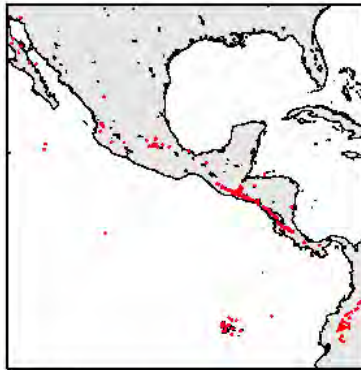


Plate Boundaries

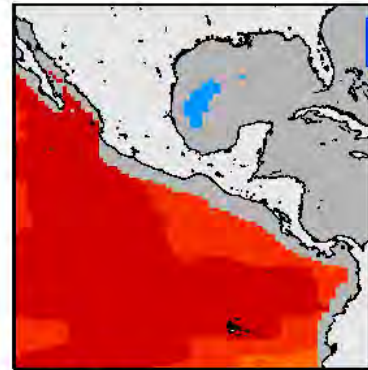


Topography



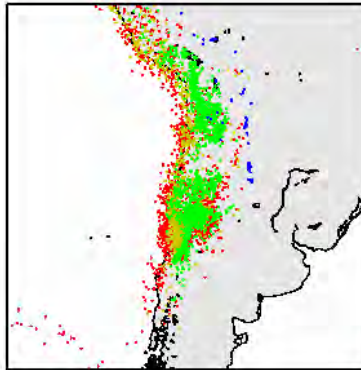
Volcanoes

**Convergent Plate Boundary
 Central America**
**Divergent Plate Boundary
 Western Pacific**



Seafloor Age

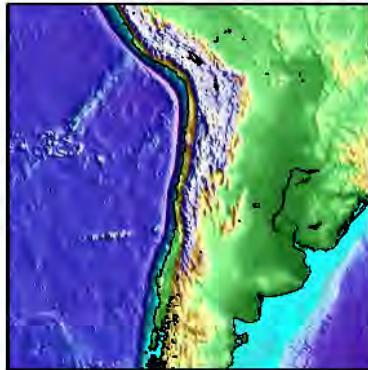
"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



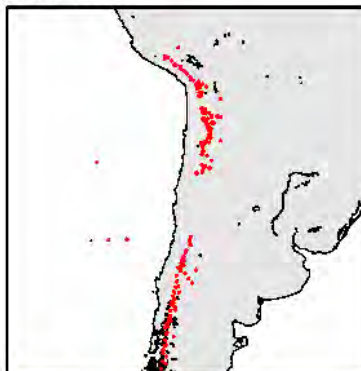
Earthquakes



Plate Boundaries

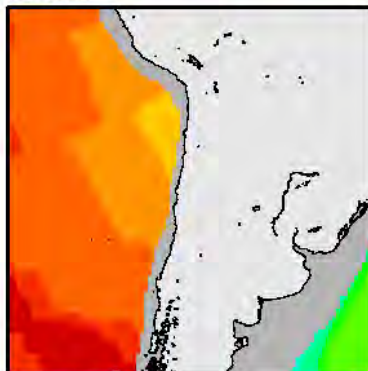


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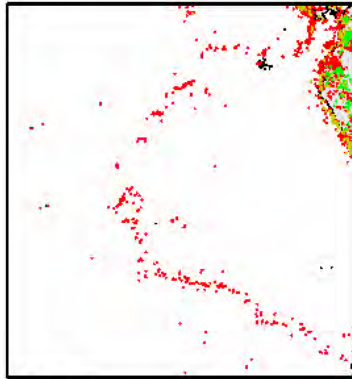
Volcanoes

**Convergent Plate Boundary
 Chile**



Seafloor Age

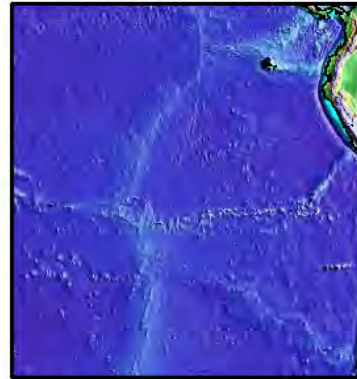
"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes



Plate Boundaries

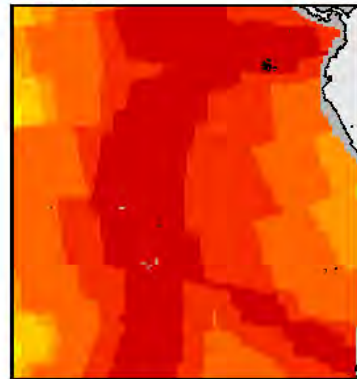


Topography



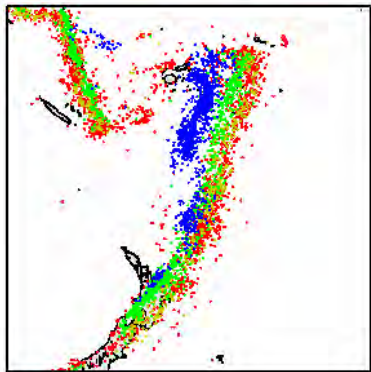
Volcanoes

**Divergent Plate Boundary
 East Pacific Rise**



Seafloor Age

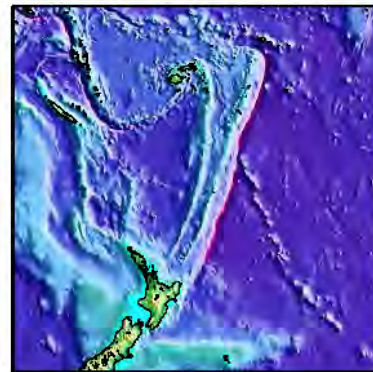
"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



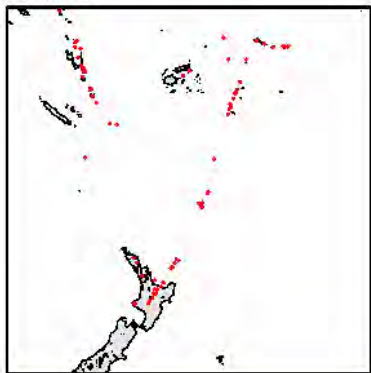
Earthquakes



Plate Boundaries

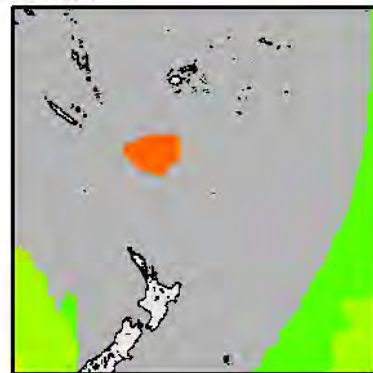


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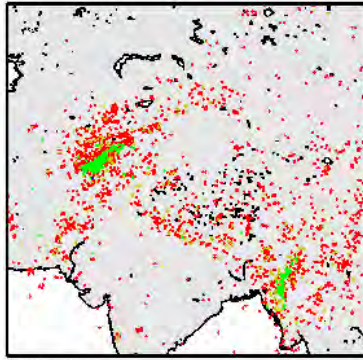
Volcanoes

**Convergent Plate Boundary
 Fiji/Tonga**



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

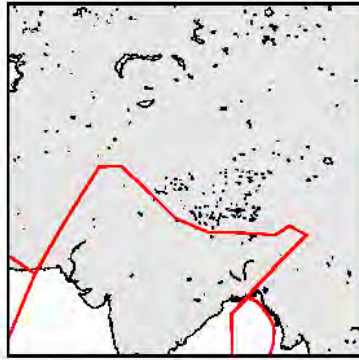
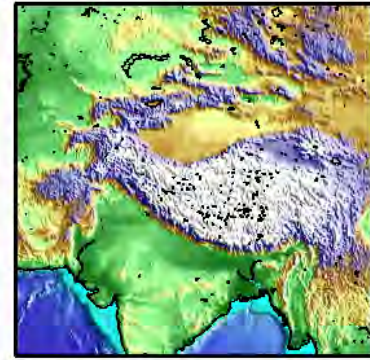
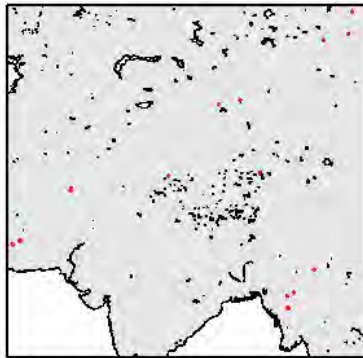


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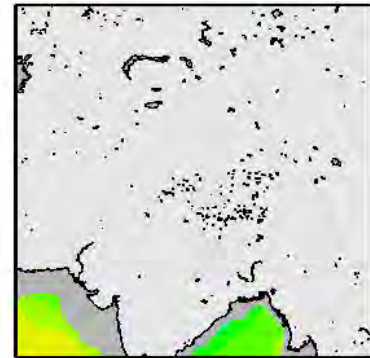


Topography



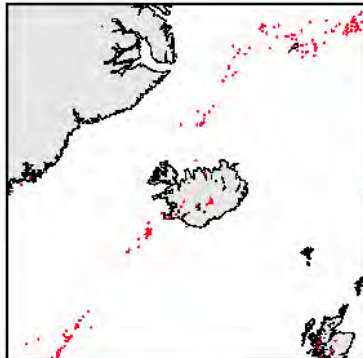
Volcanoes

**Convergent Plate Boundary
 India/Tibet**



Seafloor Age

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Earthquakes

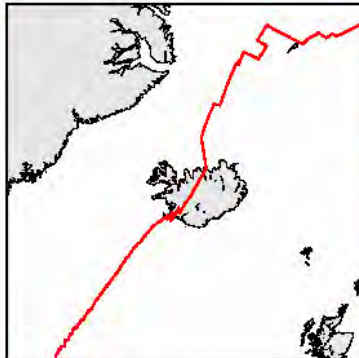
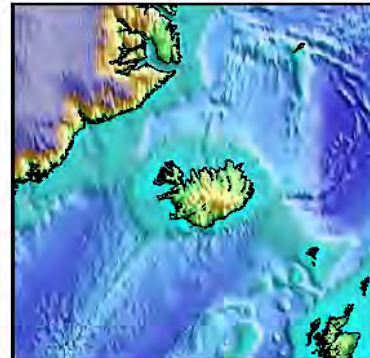
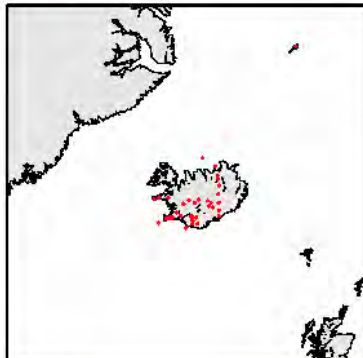


Plate Boundaries

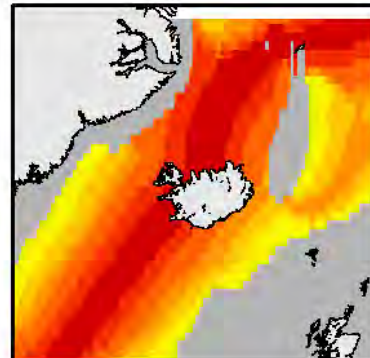


Topography

**Divergent Plate Boundary
 Iceland and Mid-Atlantic Ridge**

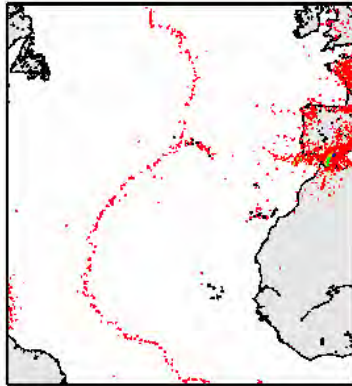


Volcanoes



Seafloor Age

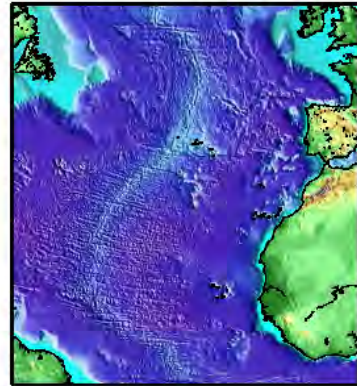
"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



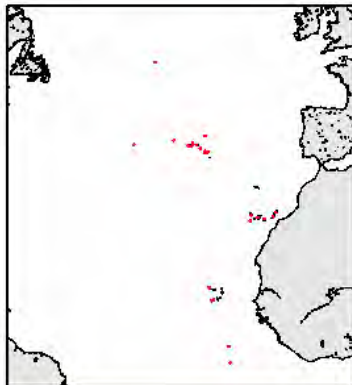
Earthquakes



Plate Boundaries

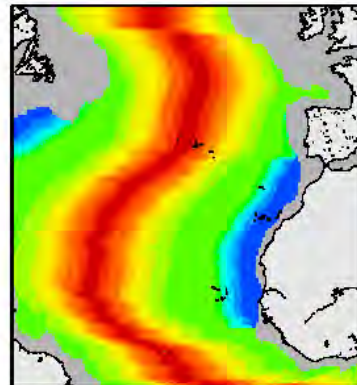


Topography



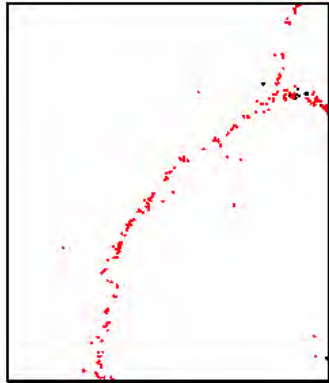
Volcanoes

Divergent Plate Boundary
Mid-Atlantic Ridge



Seafloor Age

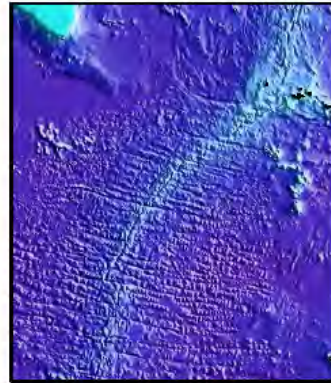
"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



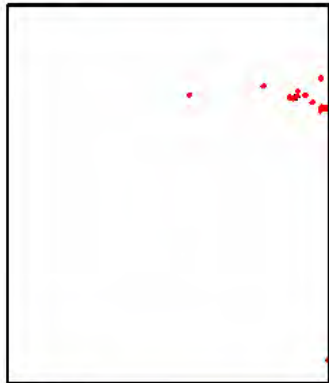
Earthquakes



Plate Boundaries



Topography



Volcanoes

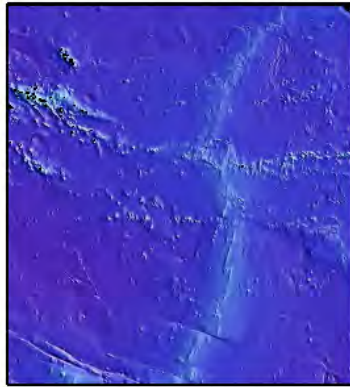
**Divergent Plate Boundary
Mid-Atlantic Ridge**



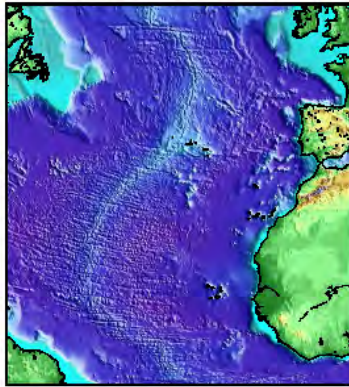
Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>

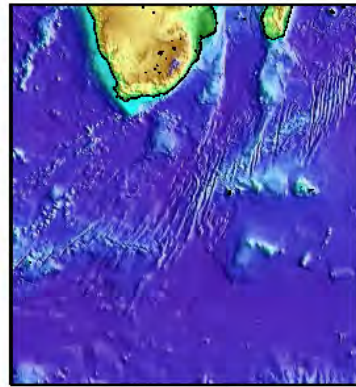
Divergent Plate Boundaries - Varying Spreading Rate



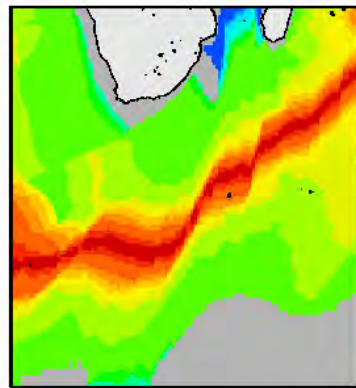
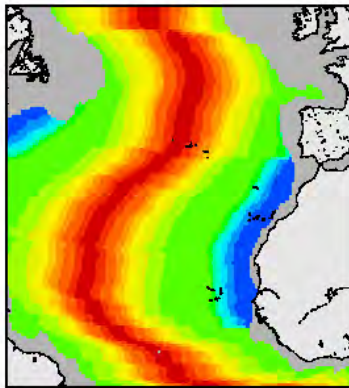
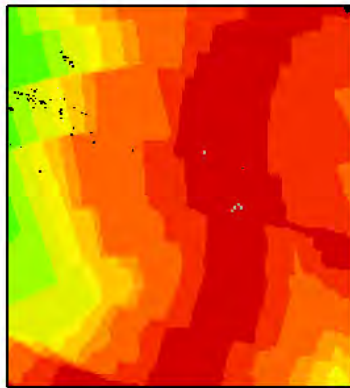
East Pacific Rise - Very Fast Spreading



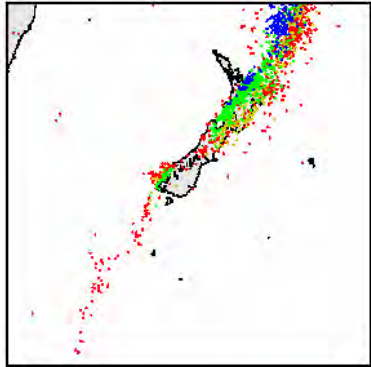
Mid Atlantic Ridge - Slow Spreading



Southwest Indian Ridge - Very Slow Spreading



"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

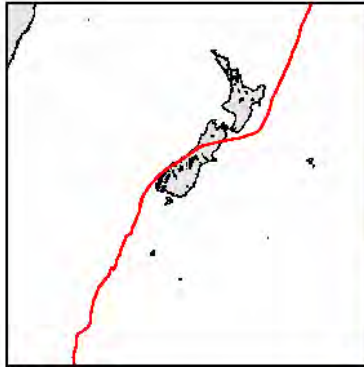
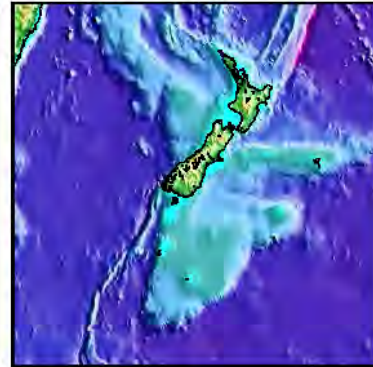


Plate Boundaries

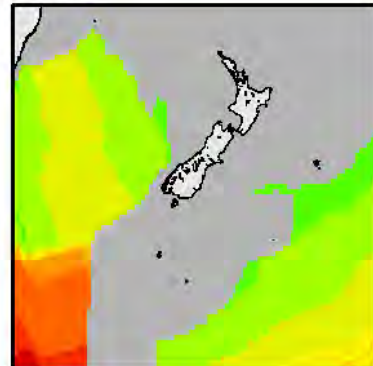


Topography



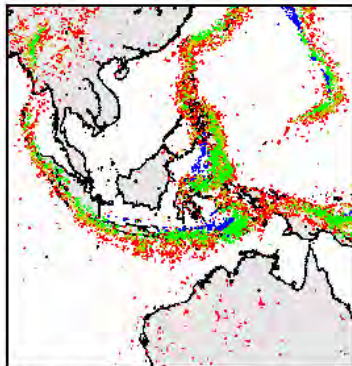
Volcanoes

**Transform Plate Boundary
 New Zealand**



Seafloor Age

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Earthquakes

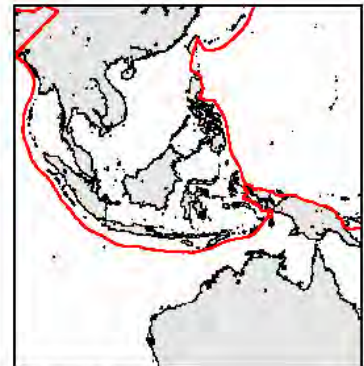
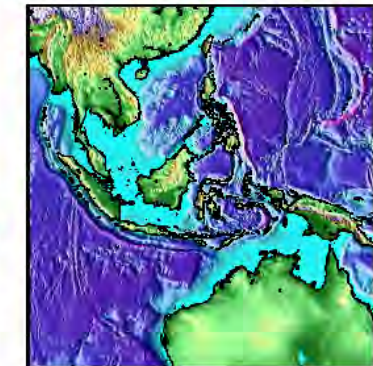
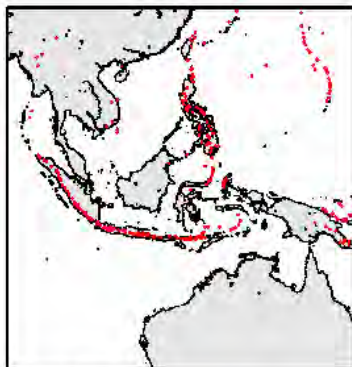


Plate Boundaries

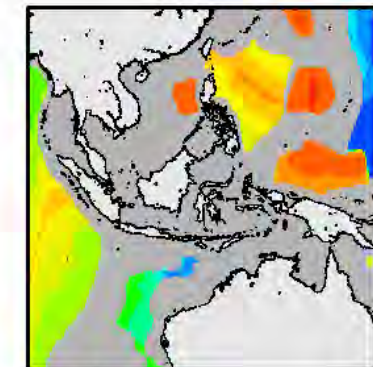


Topography

**Convergent Plate Boundary
 Southeast Asia**

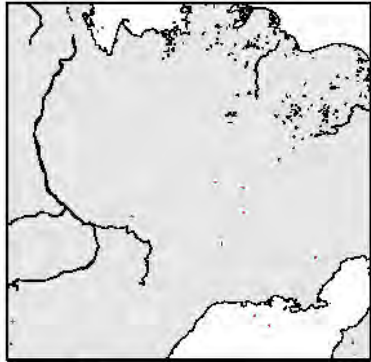


Volcanoes



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

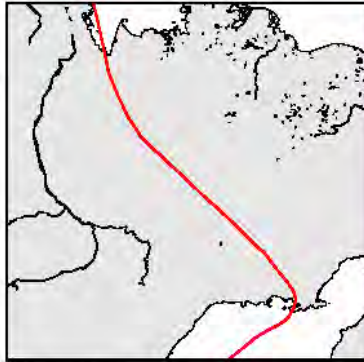
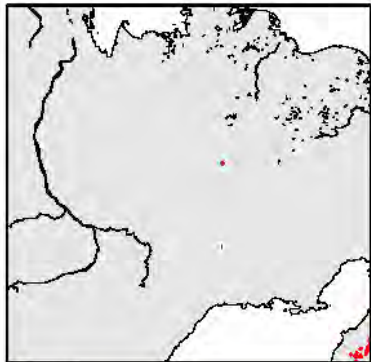


Plate Boundaries

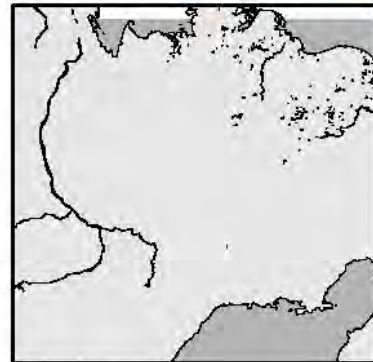


Topography



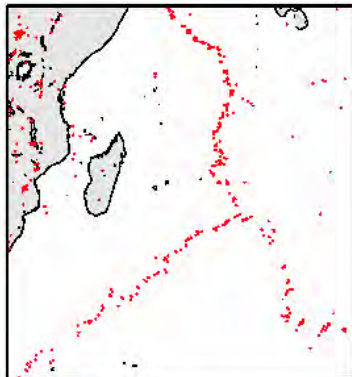
Volcanoes

**Transform (?) Plate Boundary
 North American/Eurasian Plates**



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

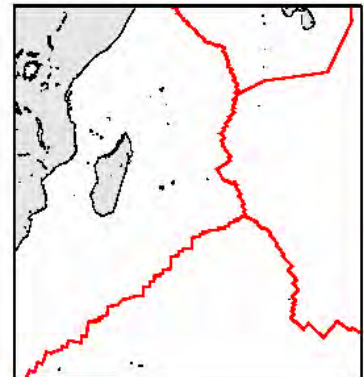
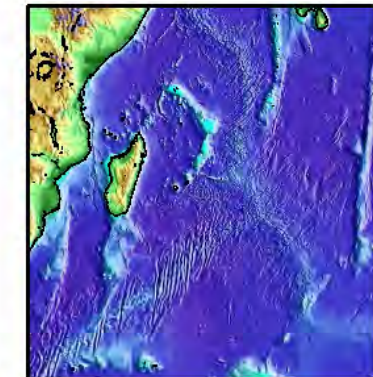
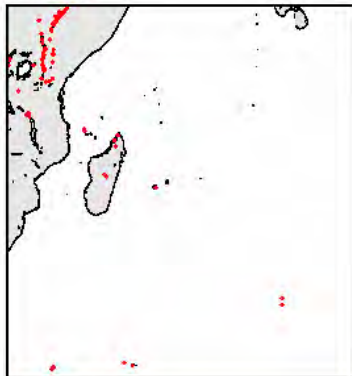


Plate Boundaries

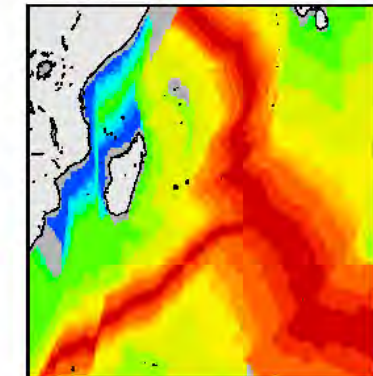


Topography



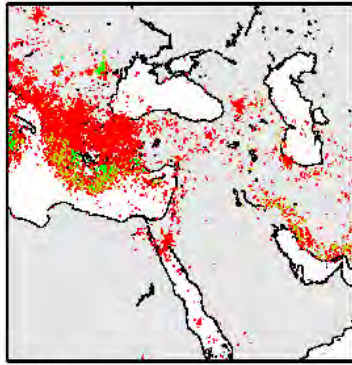
Volcanoes

**Divergent Plate Boundary
 Southwest Indian Ridge**



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>



Earthquakes

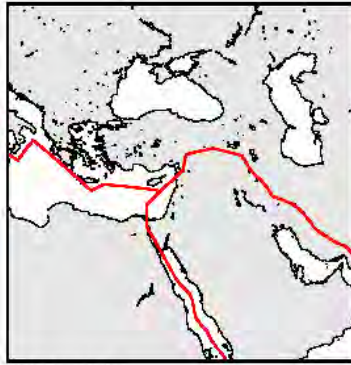
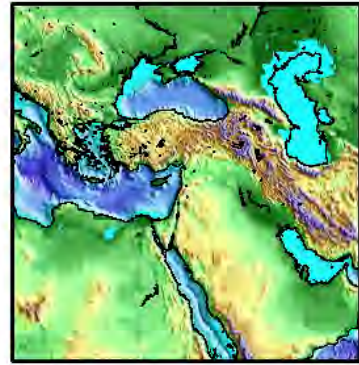
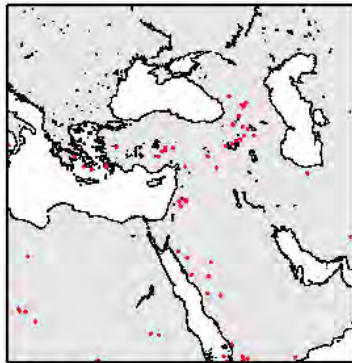


Plate Boundaries

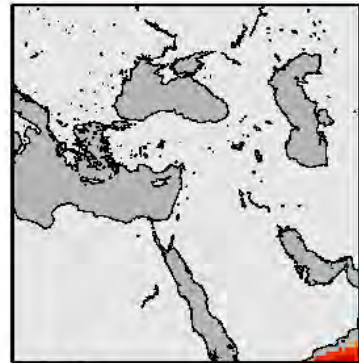


Topography



Volcanoes

Mix of Plate Boundaries
Middle East



Seafloor Age

"Discovering Plate Boundaries," a classroom exercise by Dale S. Sawyer, <http://terra.rice.edu/plateboundary/>