WHAT IN THE WORLD?

ITV SERIES

BILL NYE THE SCIENCE GUY
#112 and #212: The Crust and Earthquakes

GRADES 8-10

PREVIEWING ACTIVITIES

The students should be able to plot points of longitude and latitude on a world map.

Begin the lesson by asking how many students have felt an earthquake. Call on a few students and have them tell of their experiences. On a piece of paper, have the students predict how many earthquakes they think occur in a year (they will need to save this paper for the video). Compare answers with the class. Then have them note whether they believe earthquakes appear randomly or in a pattern on the earth.

Inform the students they will be collecting and plotting current earthquake data over the next week so they can analyze any patterns that occur. Before class, obtain the current earthquake data from the USGS National Earthquake Information Center. (http://wwwneic.cr.usgs.gov/neis/bulletin/bulletin.htm) Make an overhead of this information or one copy for each two students. Point out to the students how the information is presented (Date, Time, Latitude, Longitude, Depth, Magnitude, Q, and Comments on the Location). A sample of this information is included.

Note to teachers: Some of the earthquakes occur in the same location due to aftershocks. You be the judge as to how many earthquake dots you want placed in an area.

Give each student a map of the world and have them use a colored pencil to mark the locations of the earthquakes on their world map. Earthquakes can be divided into 3 categories: normal, strong magnitude, and deep. Have students make a key in the corner. For normal earthquakes, a dot can be used. Explain to the students that the number for magnitude is the strength of an earthquake. An earthquake with a magnitude 6 or greater can be marked with an "x." An earthquake deeper than 100 kilometers can be marked with an "o."

Note to teachers: For the next week, continue to obtain the earthquake data and have them plot 5 to 10 earthquakes each day. The best analysis in determining the location of plate boundaries is done with as many data points as possible.

OVERVIEW

In this lesson, the students will compare the different parts of the earth's exterior and interior, it's size, temperature, composition, and state of matter. Groups of students will create a model of the earth's interior and label the parts, using the radius to make circles for each layer.

The students will make a mixture that has properties of both solid and liquid to explore the "plastic-like" consistency of the mantle.

The upper two layers (crust and mantle) are further divided into the lithosphere and asthenosphere and this relationship is discussed in regard to plate tectonics. The students will create convection currents to observe how the plates move on the asthenosphere.

Pairs of students will collect clues such as rock types, key fossils, and climate. This information will help the students put the pieces of the "puzzle" together to determine how the continents used to be assembled to form Pangaea.

Each student will plot current earthquakes on a world map. The students will compare their maps with maps of the plates with the three types of plate boundaries to identify any relationships that occur.

ITV SERIES

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#112 and #212: The Crust
and Earthquakes

WHAT IN THE WORLD?

LEARNING OBJECTIVES

The students should be able to:

- Describe the four layers of the earth's interior
- Identify the lithosphere and the asthenosphere
- Explain how the plates are able to move (convection currents and the plastic-like consistency)
- Recreate the form of Pangaea
- Project what will happen to the continents in the future
- Analyze earthquake data and determine their relationship to plate tectonics
- Identify plate boundaries

FOCUS FOR VIEWING

Give the students these specific responsibilities while viewing the video segment:

Ask the students to compare the number of earthquakes they predicted would occur in a year to the number Bill Nye mentions.

Ask the students to watch what types of things happen during and after an earthquake.

VIEWING ACTIVITIES

BEGIN THE VIDEO Bill Nye #212 "Earthquakes" right after "Quake shake, No mixing required." Bill Nye is sitting at a desk.

PAUSE THE VIDEO after Bill Nye says, "…thousands of earthquakes a year." Ask the students what predictions they had for how many earthquakes occur in a year.

Remind students to watch for things that happen due to an earthquake. **RESUME THE VIDEO**.

STOP THE VIDEO when Bill says "…when the big pieces of the earth's crust..." Have students note what they saw. Some items they might point out are: fire, collapsing buildings, items on shelves falling, water gushing from pipes. Earthquakes last for only a few seconds. Ask the students if the amount of time an earthquake lasts corresponds to how much damage occurs.

EJECT this video, and **INSERT** the BILL NYE video #112 "The Crust". This should be set at the introduction of the video.

Ask the students if they know why earthquakes occur. Focus the students on this video by telling them as a class we will look to the root of the problem by going all the way to the center of the earth.

On their sheet of paper with their earthquake prediction, ask the students to state how they believe scientists know what is below the earth's crust.

Ask the students to watch for the different layers of the earth so they can list them and note one feature about each layer.

VIEWING ACTIVITIES (continued)

BEGIN THE VIDEO with the introduction where Bill Nye says "See these little holes."

PAUSE THE VIDEO at the end of the introduction when Bill says "It's a crust, it's cool." Ask the students if the crust we walk on has always been the same. They should note that volcanos put lava on the surface and mountains are pushed up. Elicit other ideas as erosion or floods, etc.

Ask the students why they think a crust is important.

FAST FORWARD thru Bill's song and "Brought to you by moltan lava" to Bill saying "You and I live..." **RESUME THE VIDEO**.

PAUSE THE VIDEO after Bill says, "How do we know that?" Ask students what they wrote on their paper about how scientists know what's under the earth's crust. **RESUME THE VIDEO**.

PAUSE THE VIDEO after Bill has talked about all the layers on his big ball of earth and Bill says "...the crust is cool and hard as a rock." Ask students to name the layers and note something special about each. **RESUME THE VIDEO**.

PAUSE THE VIDEO when they place an egg in the boiling water. Ask the students how an egg might be both similar to and different from the earth. Points they might list are the egg shell is thin like the crust, there are layers, the mantle is smaller in proportion, there are only three layers in the egg verses four layers in the earth. **RESUME THE VIDEO**.

STOP THE VIDEO after Jena says to Bill, "Don't you have a show to get back to?"

Ask the students if we have ever reached the mantle. Have them think of reasons why we haven't.

Plasticity Lab

Provide each student with a "Structure of the Earth: Plasticity Lab" worksheet. Tell the students that in groups of two, they will be given supplies to simulate the plasticity of the earth's mantle. They will have fifteen minutes to create their material and answer the questions. Have newspaper laid out to help keep clean up to a minimum. When the activity is complete,

MATERIALS

- Internet access to obtain real time earthquake data

Per student:

- copy of world map
- colored pencils

Plasticity Lab

- Plasticity Lab worksheet (1 per student)

Per group of two:

- 2 beakers
- teaspoon
- 5-7 teaspoons cornstarch
- water
- food coloring
- stirring rod
- eyedropper
- newspaper

Model of the Earth

- computer with CD program: The Theory of Plate Tectonics (TASA Graphic Arts, Inc.)

Per group of four:

- large blue paper (1 square meter)
- large red paper (1 square meter)
- large brown paper (1 square meter)
- large yellow paper (1 square meter)

MATERIALS (continued)

- string
- pencils
- paper
- marker
- meter stick
- 2 pairs scissors
- tape

Per student:

- Earth's Interior handout
- earth science textbook

Convection currents

Per group of two:

- large beaker
- hot plate (optional)
- hot water
- food coloring
- ice cube

Pangaea

Per group of two:

- colored construction paper
- 2 sets of the continent
- colored pencils
- glue
- scissors
- Pangaea: Continental… Drift worksheet

VIEWING ACTIVITIES (continued)

have students share how they think the best way would be to move something big on this material.

Note to teachers: If you are short on time, you can make up the cornstarch mixture ahead of time and have approximately 50 milliliters in a beaker for each group of two.

Model of the Earth

Before this activity, go through the CD "The Theory of Plate Tectonics" Chapter 2: The Earth's Interior.

Give students the Earth's interior handout. Have students label each layer and note features of each layer such as: size, temperature, composition. They will also gather information about the lithosphere and asthenosphere.

Give each group of four students the materials for the Model of the Earth.

Provide the students with this information if they do not already have it (these number vary from resource to resource):

The radius for the inner core is 1216 kilometers. Outer core thickness is 2270 kilometers. Radius from the center is 3486 kilometers. Mantle thickness is 2885 kilometers. Radius from the center is 6371 kilometers. Crust thickness is from 5 kilometers (for the ocean floor) to 40 kilometers (for the continent with mountains). The radius from the center varies from 6376 to 6411 kilometers.

The students are to decide in their groups the size of the model they want to make. The restraint will be the size of the paper available (though students can be creative in how they cut the paper to make a bigger model).

To get the students started, use the following example for the last layer:

The largest radius for the crust is 6411 kilometers.

If their paper is 1 meter wide, the radius is 0.5 meters or 500 millimeters. Each kilometer would be 500 millimeters / 6411 kilometers or 0.078 millimeters. This information is used for all the other layers in the following way:

VIEWING ACTIVITIES (continued)

The inner core has a radius of 1216 kilometers. 1216 kilometers x 0.078 millimeters/kilometer = 94.84 millimeters. Repeat the calculation for each layer.

Measure the longest piece of string each group would need (the radius from the center of the earth to the crust) plus about 10 centimeters. This extra amount allows the students to tie a pencil to one end of the string. Using the string and their pencils, the students can create a circle by placing their finger on one end of the string in the center of their paper and using it as a large compass. Smaller circles for the inner layers can be created by changing the amount of string held down by their finger.

After the students have cut out the circles for all their layers, they can tape them together.

Then have them use the marker to label each layer and write down information about that layer. They can obtain this information from their science book or the CD. They can also be creative by cutting into the outer layer to show mountains and oceans.

After students have completed their models, have each group decide on one thing of interest they would like to share with the rest of the class about the model of the earth.

Note to teachers: The crust will be very very thin (a few millimeters at most). They will soon realize that to show the mountains and oceans is almost impossible. Students will have to write information on this layer on a separate piece of paper they can attach to their model. This will be a good way to get into the discussion of how little we know about most of our earth.

Note to teachers: Students may be asking how we know about all these layers if we have never seen them. You can show BILL NYE "The Crust" section starting with, "Here's a cool trick you can do." This is a simplistic view and it has some errors students can pick out, however, it does give a visual example.

MATERIALS (continued)

Where in the World ??

Per student:

- map of the world
- colored pencils
- Where in the World worksheet
- Plate Boundaries worksheet

VOCABULARY

Convection current - a circular current in a fluid such as, water, or molten rock; caused when the fluid is unevenly heated, so that part of it rises, and then cools and sinks, causing a circular movement.

Latitude - a distance north or south of the equator, expressed in degrees.

Longitude - a distance east or west of the prime meridian, expressed in degrees.

WHAT IN THE WORLD?

ACTION PLAN

Call the city to find out if they have an earthquake plan. Invite an emergency planner to come and talk with your class to discuss their job and what students can do as individuals and in school.

Make a booklet on how to prepare and survive an earthquake.

Create an earthquake survival kit.

Invite a geologist to your classroom to discuss the interior of the earth and why an iron core is important.

Visit a facility with a seismograph. Ask about any faults in the area and the potential for earthquakes.

VIEWING ACTIVITY (continued)

Convection Currents

Inform the students that the different layers of the earth are not stagnant, but move and interact with the other layers.

Tell the students they will be observing, recording, and determining how convection currents move. Have each pair of students place an ice cube into a beaker with warm to hot water.

Place one to two drops of food coloring on the ice cube. On a piece of paper, record all observations. Encourage the students to draw what they see.

Note to the teacher: If you have enough hot plates, students can place their beakers with cold water on the hot plates and then add the ice cube and food coloring.

After 5 minutes, ask the students to describe what occurred in their water. Have them look up and define on their paper **"convection current."**

Ask the students which layer of the earth would be similar to this experiment. (the mantle - in particular, the asthenosphere). Ask the students what effect this might have on nearby layers. This information will be explored when doing plate tectonics.

Note to Teachers: To show this in more depth and as a review, go through the CD "The Theory of Plate Tectonics" Chapter 16: The Driving Mechanism.

Ask students how much, if any, they think the earth we walk on is moving. **BEGIN THE VIDEO** BILL NYE "The Crust" at the word PANGAEA.

PAUSE THE VIDEO when Bill says "The earth's crust is built of plates - Plate Tectonics." Ask the students what this might mean if the crust is in sections (they can move around). Ask them what layer is under the crust (mantle). Have them describe what the mantle is like. From their labs they should mention "plastic-like, thick, gooey, has hot and cold areas so it moves, etc." **RESUME THE VIDEO**.

VIEWING ACTIVITIES (continued)

PAUSE THE VIDEO when Bill mentions the camp stove and then places the pieces of Africa and South America on the map saying, "we have models of tectonic plates." Ask the students why he would have it on a camp stove (because of the heat in the mantle). **RESUME THE VIDEO**.

PAUSE THE VIDEO after Bill says "Lets say this is the earth's crust" and you can see the whole earth on the molasses. Ask what was the first clue people had about the continents being together? (puzzle shape of South America and Africa) Ask the students if these two continents had been together a long time ago, what other clues might they look for? Examples are plants and animals the same, fossils, rocks. **RESUME THE VIDEO**.

PAUSE THE VIDEO after Bill says, "Consider the following." Ask the students how much North America is moving away from Europe each year (about 2 centimeters). Have the students calculate how far apart the two continents have moved in their lifetime (their age times 2).

Note to Teachers: This can be a good time to note and explain the phrase: "The present is the key to the past." We learn what happened in our past by watching what is currently happening.

Ask the students what was the very first clue people saw that showed at one time the continents were close together. Tell them there are numerous other clues scientists found later to verify this theory of plate movement.

Pangaea Continental .... Drift

Before this activity, use the CD "The Theory of Plate Tectonics" and go through together Chapter 3 Continental Drift and Chapter 4, Fit of the Continents.

Provide each student with a worksheet on Pangaea. The goal of each pair of students is to try and recreate Pangaea as it looked 200 million years ago. The CD program "The Theory of Plate Tectonics" will need to be available to them to gather clues on which continents used to be close together. They should go into Chapters 5, 6 and 7. Have the class read aloud the directions. Inform the class they will have two days to complete this puzzle.

EXTENSIONS

English: Use the Internet to gather information and write a report about earthquakes. Topics can include the strongest, the deepest, the most damage caused, etc. http://wwwneic.cr.usgs.gov/neis/bulletin/bulletin.htm

Social Studies: Invite a psychiatrist to discuss the emotional feelings people have after an earthquake.

Math: Determine how many years it took for the Atlantic to be its present size if it is moving at 2 centimeters per year.

History: Who were the people that stated the theories of continental drift and plate tectonics?

How were they and their theories viewed at the time?

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WHAT IN THE WORLD?

VIDEO AVAILABLE FROM

Can be taped off-air. Consult your local PBS station for broadcast schedule.

CD-ROM "The Theory of Plate Tectonics", Interactive Educational Computer Software available from:

Tasa Graphic Arts, Inc.
9301 Indian School Rd NE
Stuite 208
Albuquerque, NM 87112-2861
1-800-293-2725.

Single User: $59.00, Multi User: $155.00, Lab Pack of 5: $177.00.

VIEWING ACTIVITIES (continued)

Conclude this hands on activity by using the CD "The Theory of Plate Tectonics," Chapter 17, Plate Tectonics into the Future. Before viewing, ask the students where they see changes occurring in 50 million years.

Use the CD "The Theory of Plate Tectonics" to show the students the three types of plate boundaries. Use Chapters 9 to 12. They can take notes on the handout "Plate Boundaries."

Refocus the students by telling them we will see what happens at one type of plate boundary. Ask them to determine which of the three types it might be that Bill is showing (convergent, divergent, or transform).

RESUME THE VIDEO at the words TECTONIC PLATES.

PAUSE THE VIDEO when Bill asks, "So what happens when two tectonic plates bump into each other?" Ask the students to list as many things as they can think of that might happen and under what conditions (ocean floor to ocean floor, continent to continent, ocean to continent). **RESUME THE VIDEO**.

PAUSE THE VIDEO when Bill says, "...always cracks." Ask the students what happens at the cracks (volcanos and earthquakes). **RESUME THE VIDEO**.

PAUSE THE VIDEO after Bill eats the cookie.

Where in the World?

Inform students they are now going to make use of all the work they have put into gathering and plotting earthquake information. They will examine their earthquake maps and compare them with other maps to identify any relationships. Pass out the handout "Where in the World?"

Conclude this activity with the CD "The Theory of Plate Tectonics," Chapter 15, Plate Tectonics and Earthquakes. First ask the students to identify where deep earthquakes appeared on their maps. See if they correspond with the program.

Refocus the students to the video by asking them what they can do before, during, and after an earthquake.

VIEWING ACTIVITIES (continued)

RESUME THE VIDEO with Bill saying, "There are thousands of earthquakes in the world."

STOP THE VIDEO after Bill has laid out his survival kit and the aftershocks start.

POST VIEWING ACTIVITY

Have the students list what they can do before, during, and after an earthquake. Ask them what is needed in a survival kit and what things they would add.

Lesson plan develped by A. L. Hanson, Les Bois Junior High School, Boise, Idaho.

Structure of the Earth: Plasticity Lab

Name _____

Purpose: In this lab you will simulate the plasticity of the earth's mantle.

Materials:

cornstarch
water
2 small beakers
stirring rod or spoon
eyedropper
food coloring
newspaper

Procedure:

1. Do ALL work over the newspapers.
2. Put about 5 teaspoons of cornstarch in one beaker.

   Put 20 milliliters of water in the second beaker
3. Pour the water into the cornstarch. Add one or two drops of food coloring.

   Stir. You have the correct mixture when the cornstarch is difficult to stir.

   If needed, use the eyedropper to add more water.

Data:

1. Describe the mixture.

   Is it a solid or liquid or what? Explain your choice.

2 How does this mixture react when handled?

   Push your finger in the mixture fast - what happens?

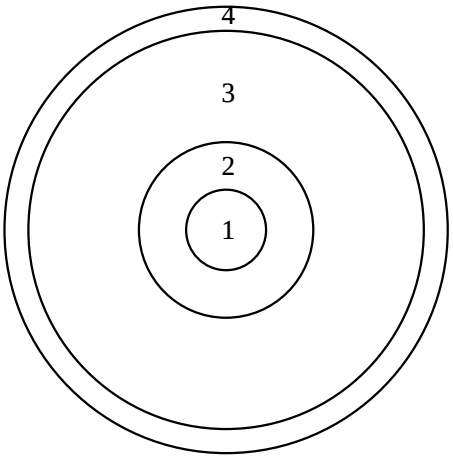
   Push your finger in slow - what happens?

Conclusion:

1. How is the mixture similar to the earth's mantle?

Earth's Interior

Name _____



Layer Name & Description

1) _____

_____

_____

_____

2) _____

_____

_____

_____

3) _____

_____

_____

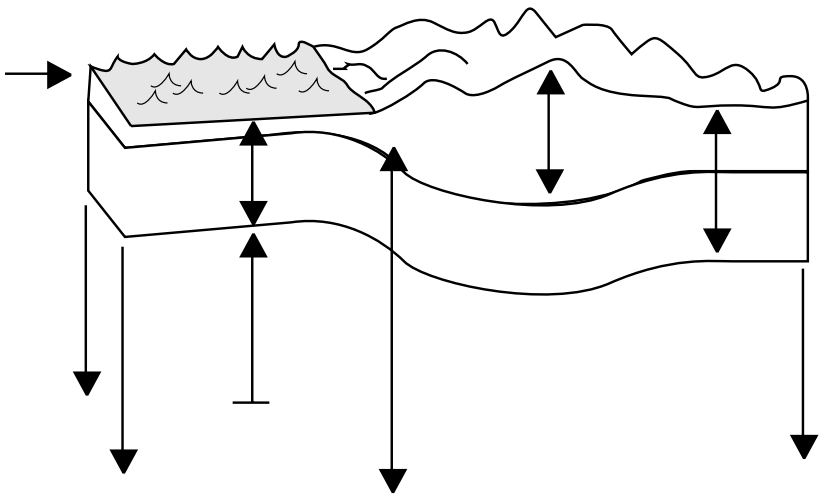
_____

4) _____

_____

_____

_____



Pangaea: Continental ..... Drift

Name _____

Background Information:
According to the theory of plate tectonics and continental drift, all of the land masses were once joined together forming the super continent Pangaea. The breakup of Pangaea is thought to have occurred about 200 million years ago. According to this theory, the continents are still moving today.

Strategy: You will reconstruct a model of Pangaea as it looked 200 million years ago.

Procedure:

1. Use the CD program Plate Tectonics to gather clues on rocks, fossils, and climate.
2. Draw symbols on your continent pieces to show where these rocks, fossils, and climate occurred.
3. Cut out the continent pieces.
4. Try to fit the continents into one large landmass like a puzzle. Use the clues you gained, like shape, rock, fossil, and climate information to determine which continents were close together.
5. When you have the best fit, neatly glue the continents to a piece of paper.
6. Make a legend in the corner of your paper to identify the rocks, fossils, and climate.
7. Make a title for your map.

Questions and Conclusions:

1. Which two continents have the best fit? _____
2. Why isn't the fit perfect since the continents were once part of pangaea? Give at least two reasons.
   _____
   _____
   _____
3. Who first suggested the theory of continental drift? _____
4. Scientists theorize that the continents are still drifting apart. What will be the eventual position of North America with respect to Eurasia?
   _____
5. How did the Atlantic Ocean form? _____
6. Pangaea was during what Era? _____ Period? _____
7. The plates are composed of the crust and the very upper part of the mantle. This is called the _____. This floats and moves on the plastic-like _____ which is the next upper part of the mantle.

Continents


Greenland
Eurasia
North America
India
Africa
Madagascar
South America
Australia
Antarctica

Where in the World?
Earthquake and Plate Boundary Map

Name _____

Purpose:

To compare current earthquake data with major plate boundaries to determine any relationships.

Procedure:

1. Using an earth science book, find a map with plate boundaries.
2. Color in the different plates on your earthquake map.
3. Identify each of the 3 types of boundaries (transform, divergent, convergent) with a different line.
4. Provide a key to identify the different plates and the different boundaries.

Questions and conclusions:

1. Is there any relationship between earthquakes and plate boundaries?

   _____

2. Are there any differences between the type of boundary and earthquakes?

   Transform? _____

   Divergent? _____

   Convergent? _____

3. What type of boundary occurs between the:

   North American plate and the African plate? _____

   Nazca plate and the South American plate? _____

4. Which direction is the:

   South American plate moving? _____

   Indo-Australian plate moving? _____

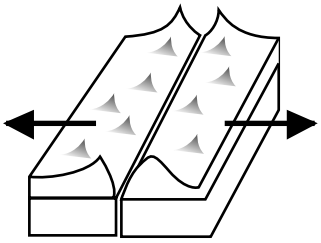
5. Subduction is occurring between the Nazca plate and the _____ plate.

   Which of the two plates above is being subducted? _____

Plate Boundaries

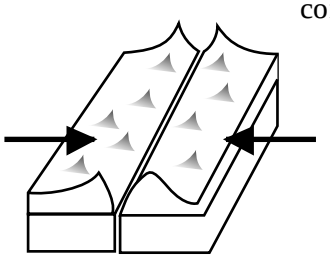
Name _____

a) Ocean and ocean

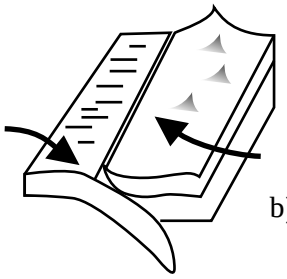


b) Ocean and continent

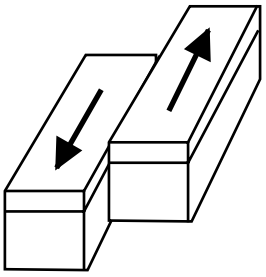
a) Continent and continent



a) Ocean and ocean



b) Ocean and continent



USGS

National Earthquake Information Center

World Data Center A for Seismology

Geologic Hazards

| Products & Services | Current Earthquakes | Earthquake Information | Earthquake Search | Earthquake Links | Station Book |

The following near-real-time Earthquake Bulletin is provided by the National Earthquake Information Service (NEIS) of the U. S. Geological Survey as part of a cooperative project of the Council of the National Seismic System. For a description of the earthquake parameters listed below, the availability of additional information, and our publication criteria, please finger qk_info@gldfs.cr.usgs.gov.
Updated as of Wed Feb 4 09:30:23 MST 1998.

DATE-(UTC)-TIME yy/mm/dd hh:mm:ss	LAT deg.	LON deg.	DEP km	MAG	Q	COMMENTS
98/02/01 02:42:11	44.00N	147.37E	33.0	4.8Mb	C	KURIL ISLANDS
98/02/01 06:46:40	40.45N	142.67E	33.0	4.4Mb	C	NEAR E COAST OF HONSHU, JAPAN
98/02/01 08:36:44	20.98S	67.70W	203.5	4.6Mb	C	SOUTHERN BOLIVIA
98/02/01 08:53:16	38.00N	112.63W	5.0	3.0Ml	A	UTAH
98/02/01 09:06:36	28.29N	139.35E	497.6	4.7Mb	B	BONIN ISLANDS REGION
98/02/01 14:19:07	37.99N	112.58W	5.0	3.2Ml	A	UTAH
98/02/01 18:22:58	40.27N	128.00W	5.0	3.7Ml	C	OFF COAST OF N CALIFORNIA
98/02/01 18:49:55	40.44N	128.71W	10.0	3.9Ml	C	OFF COAST OF N CALIFORNIA
98/02/01 21:29:04	37.94N	112.56W	5.0	3.7Ml	A	UTAH
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98/02/02 02:12:17	27.13S	69.46W	94.7	4.7Mb	B	NORTHERN CHILE
98/02/02 21:10:57	38.80N	122.76W	2.2	3.3Ml		NORTHERN CALIFORNIA
98/02/03 02:09:12	0.25N	16.74W	10.0	4.7Mb	B	NORTH OF ASCENSION ISLAND
98/02/03 03:01:59	15.94N	96.11W	33.0	6.1Ms	A	NEAR COAST OF OAXACA, MEXICO
98/02/03 07:17:52	15.93N	96.13W	33.0	4.8Mb	A	NEAR COAST OF OAXACA, MEXICO
98/02/03 09:05:55	51.09N	178.83E	40.7	4.9Mb	B	RAT ISLANDS, ALEUTIAN ISLANDS
98/02/03 12:44:17	38.02N	112.67W	5.0	3.2Ml	A	UTAH
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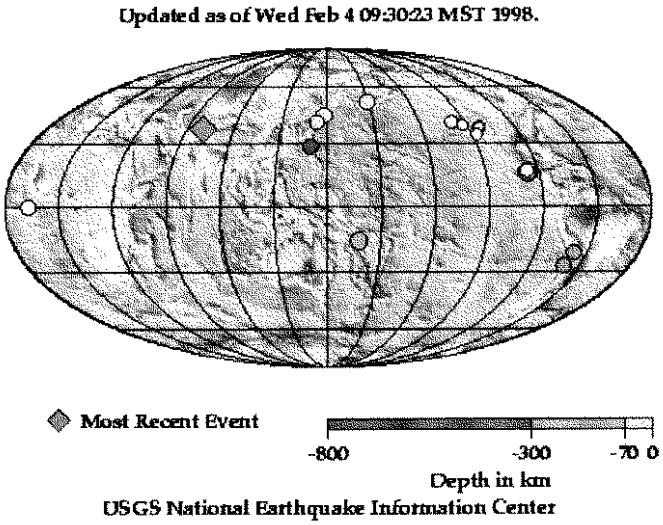
98/02/04 13:18:46	15.33S	167.56E	113.1	5.3Mb	B	VANUATU ISLANDS
98/02/04 14:33:21	37.07N	70.20E	33.0	6.1Ms	A	AFGHANISTAN-TAJIKISTAN BORD



Current Earthquake Maps

Explanation of earthquake parameters:

DEP Depth in kilometers

MAG Magnitude, with method used to calculate it:
- Ml local, the original Richter magnitude
- Lg mblg or Mn, local or regional magnitude for the area east of the Rocky Mountains
- Md duration
- Mb body wave
- Ms surface wave
- Mw moment

Q Location Quality: A is good, B is fair, C is poor, D is bad

UTC Coordinated Universal Time
In the United States, to convert to your local time,
find your time zone and subtract the number of hours listed.
- EST = UTC - 5 hours
- CST = UTC - 6 hours
- MST = UTC - 7 hours
- PST = UTC - 8 hours
- AST = UTC - 9 hours
- Hawaii = UTC - 10 hours

More Earthquake Information from the USGS

- Northern California Earthquake Data Menlo Park, California
- Pasadena Field Office Pasadena, California
- Albuquerque Seismological Laboratory Albuquerque, New Mexico

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WHAT IN THE WORLD?