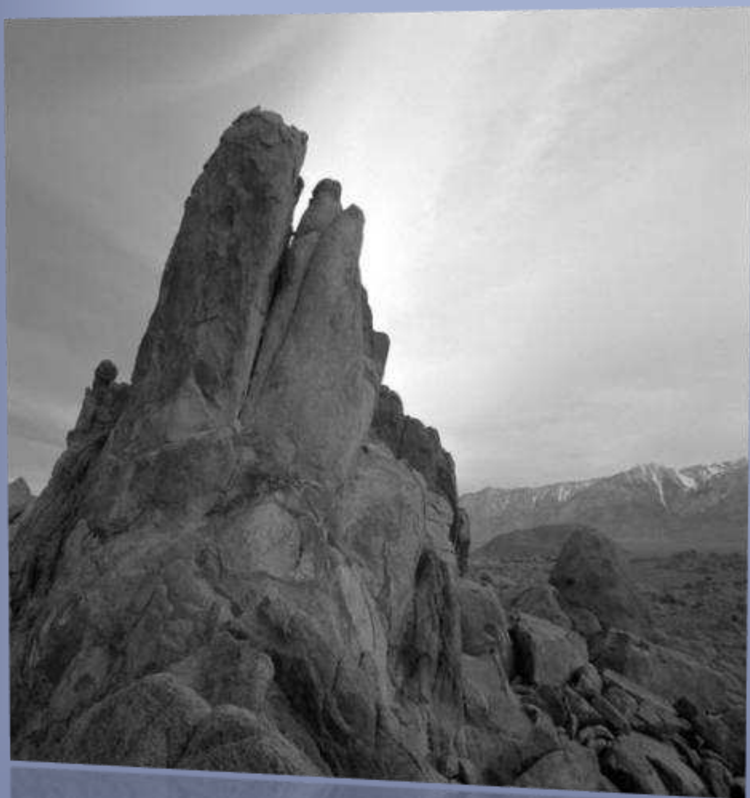


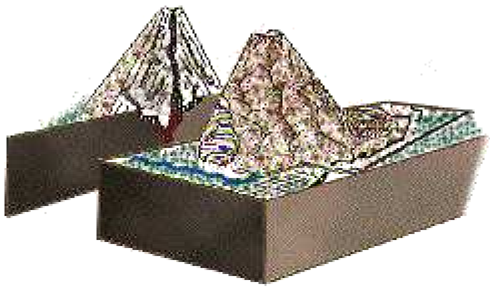
Sample Earth Science Projects

TWIN RIVERS UNIFIED SCHOOL DISTRICT

Earth Science:
Sample Projects and Activities

Qtr	Unit Topic	Projects	Description
2	Paper Models	-Volcanoes -Faults -Landforms (Ocean Trench, Earth)	In these projects, students create paper models of the different kinds of faults, stratovolcanoes, and other landforms. These models are from the USGS website.
3	Weather and Climate	-How to Build a Barometer -How to Build an Anemometer	In these projects, students build (and use) two weather instruments. Students will compare their instruments with actual weather forecasts and make associations with general weather conditions.
2	Earthquakes	-How to Build a Seismograph	This project requires adult help, as students need to nail pieces of wood together. The students follow an engineering process to create an effective model of a seismograph.
2	Geology	-Cupcake Geology -Layers of Cake Geology -Clay Layers	These projects are three variations of the same theme. Students use straw to collect core samples and predict the interior organization of layers of cake or clay.
2	Oceanography	-Mapping the Ocean Floor -A Watered-Down Topographic Map	Students create topographic maps and learn about sonar technology.
3	Atmosphere	-Layers of the Atmosphere Foldable	Students create a foldable that describes each layer of the atmosphere.

"Tell me and I'll forget; show me and I may remember; involve me and I'll understand."



CONSTRUCTING PAPER MODELS OF VOLCANOES

Introduction:
Model volcanoes replicate the shape and structure of a volcano on a small scale. Students can create model volcanoes for science projects, or teachers can create volcanoes for demonstration purposes. You can make model volcanoes to erupt through chemical reactions so that they replicate the eruption of an actual volcano.
To get you prepared for this project, review the different kinds of volcanoes:
Cinder cones are the smallest and are formed largely by the piling up of ash, cinders, and rocks, all of which are called pyroclastic ("fire-broken") material, that have been explosively erupted from the vent of the volcano. As the material falls back to the ground, it generally piles up to form a symmetrical, steep-sided cone around the vent. Sunset Crater in Arizona and Paricutin in Mexico are well-known examples of cinder cones.
Shield volcanoes are generally not explosive and are built by the accumulation of very fluid lava flows that spread out to produce a mountain with broad, gentle slopes. Shield volcanoes are the largest of all volcanoes, up to tens of kilometers across and thousands of meters high. Kilauea and Mauna Loa Volcanoes in Hawaii are classic examples of active shield volcanoes.
Stratovolcanoes are built up of lava flows interlayered with pyroclastic material; scientists believe that the layering represents a history of alternating explosive and quiet eruptions. Young stratovolcanoes are typically steep sided and symmetrically cone shaped. There are several active stratovolcanoes in North America. since 1980 Mount Saint Helens in Washington has become the most familiar. Other well known stratovolcanoes in the Unites States include Mount Rainier, Mount Shasta, Mr. Mazama (Crater Lake), and Redoubt Volcano in Alaska. Mount Fuji in Japan and Mount Vesuvius in Italy are other famous stratovolcanoes.

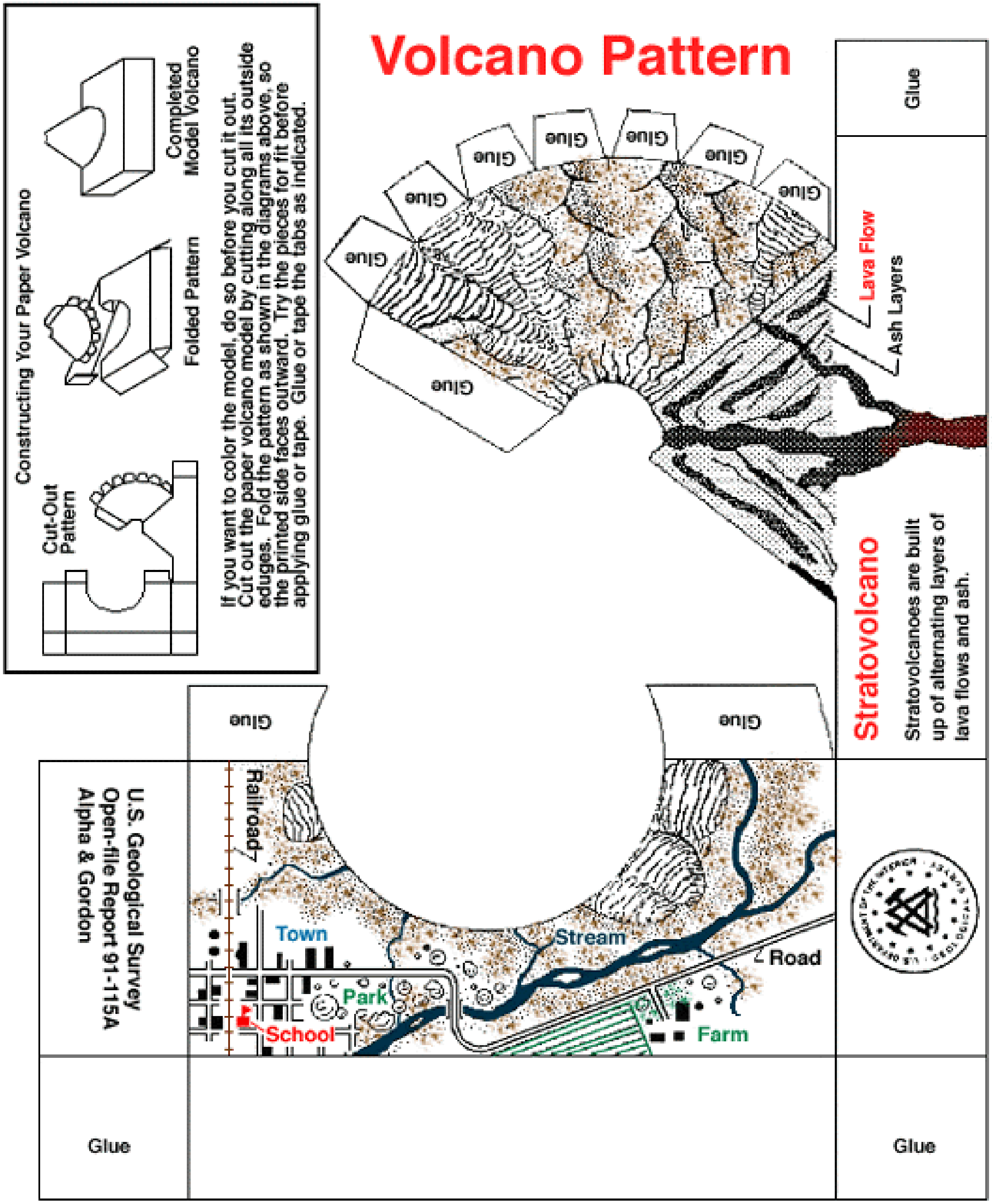
Materials:

- Volcano Pattern
- Cardstock or heavy paper
- Felt tip pens, acrylic paints, etc.
- Scissors

Procedure:

1. Download the volcano pattern and print it onto cardstock or heavy paper.
2. Identify and color the features represented on the model.
3. Cut and fold the model as indicated on the pattern.
4. Relate the internal structures represented by the model with the exterior shape and features of the volcano.

Volcano Pattern



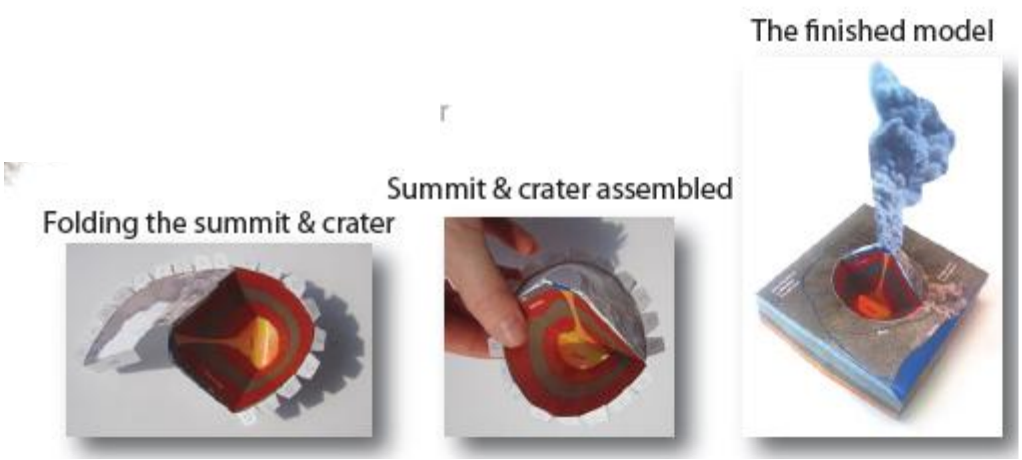
From: http://teams.lacoe.edu/documentation/classrooms/gary/earth/activities/volcano/pattern.html

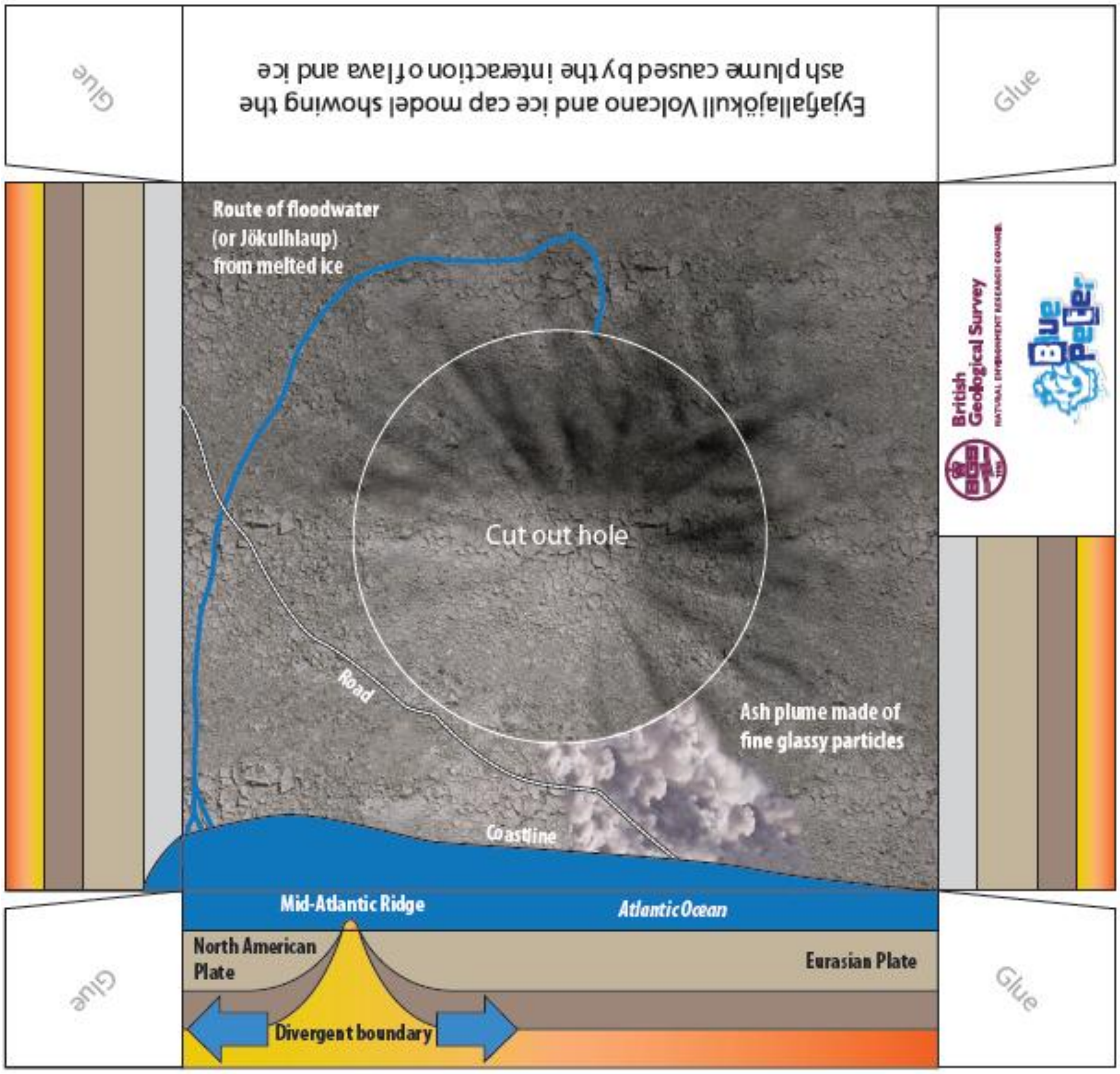
Iceland Volcano Paper Model

Instructions:

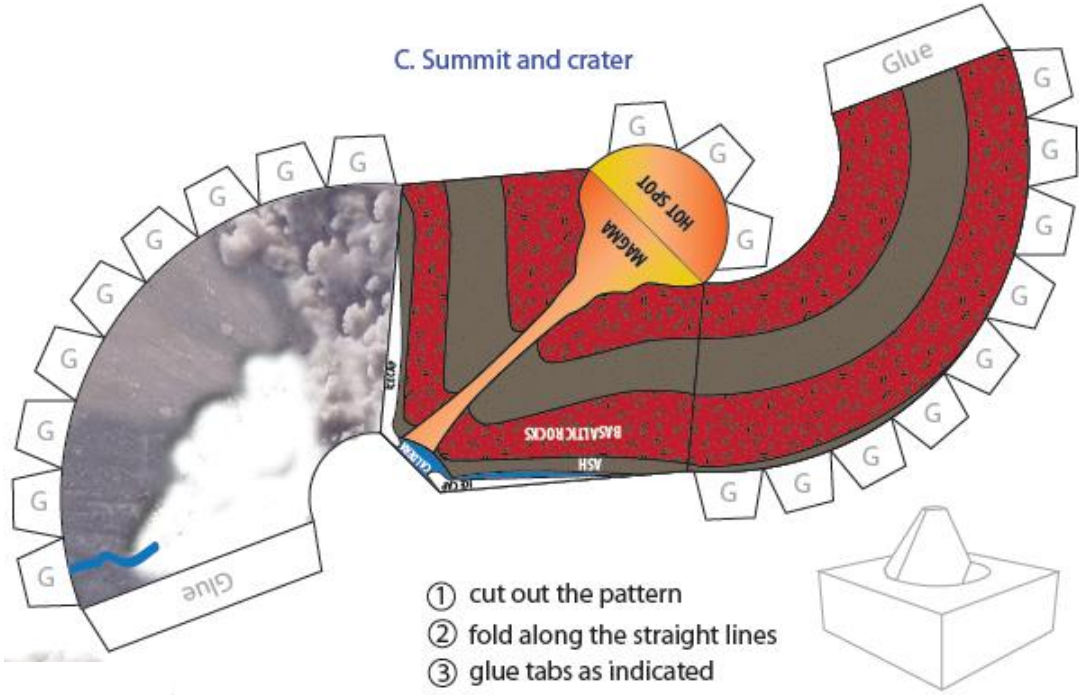
1. Cut around the 3 parts of the model:
   - A. Ash plume
   - B. Base
   - C. Summit and crater
2. ***Ash plume***: fold and glue the two halves together.
3. ***Base***: cut out the hole in the middle of the base.
4. ***Base***: fold along the thick black lines and glue tabs to make-up the model like a box lid. Allow to dry.
5. ***Summit and crater***: fold as shown in the images on page ____. Half the 'cone' points downwards.
6. Glue the summit and crater to the base as shown in the image on page ____.
7. Glue the ash plume to the summit and crater

Assembly Photos:

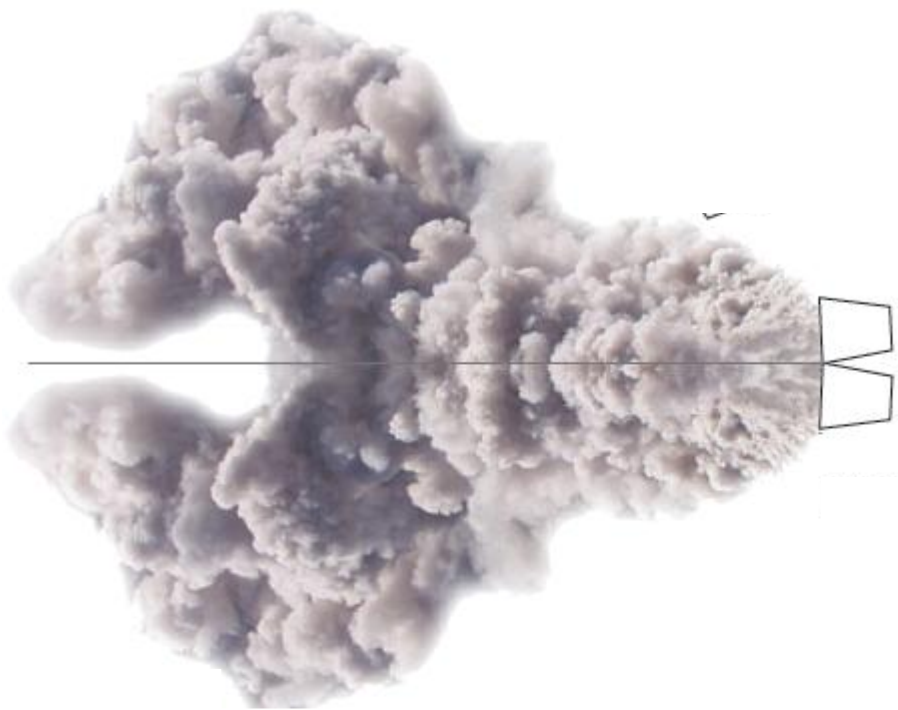



Eyjafjallajökull Volcano and ice cap model showing the ash plume caused by the interaction of lava and ice
Glue
Glue
Glue
Glue
Route of floodwater (or Jökulhlaup) from melted ice
Cut out hole
Road
Ash plume made of fine glassy particles
Coastline
Mid-Atlantic Ridge
Atlantic Ocean
North American Plate
Eurasian Plate
Divergent boundary
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
Blue Peter

C. Summit and crater



① cut out the pattern
② fold along the straight lines
③ glue tabs as indicated



Transform Fault Paper Models

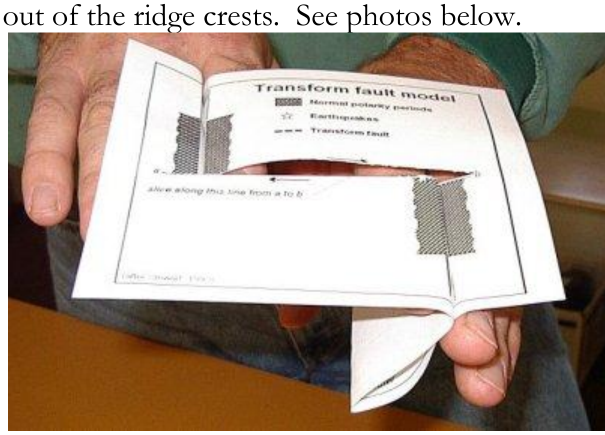
Introduction:
Transform Plate Boundaries are locations where two plates slide past one another. The fracture zone that forms a transform plate boundary is known as a transform fault. Most transform faults are found in the ocean basin and connect offsets in the mid-ocean ridges. A smaller number connect mid-ocean ridges and subduction zones.

(From: http://geology.com/nsta/transform-plate-boundaries.shtml)

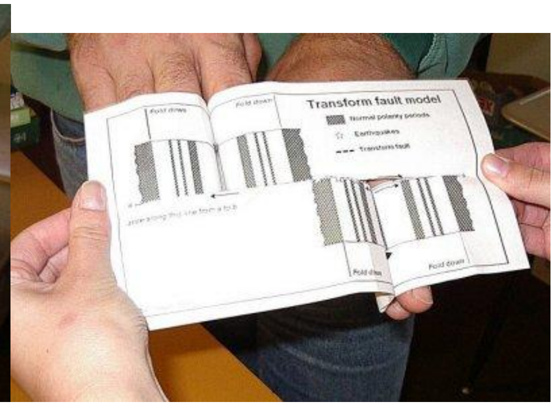
Materials:

- Templates for transform fault 1 and transform fault 2 (see next two pages)
- Scissors
- Blade (Have an adult make the cuts for you).

Instructions:
To prepare the model cut along the fracture zone from point a to point b with a razor blade. Fold the paper on either side of the fracture zone as indicated. Make 90º downward folds at the four locations marked Fold down, and 180º upward folds at the two locations marked Pinch together. The resulting model will now be about one-half as long as the original, and will have two folds of paper (the soon to be created sea floor) projecting down from the surface. Students must work in pairs to operate the model. One holds the ridge segments together by gently pinching each of the downward folds just below the surface. The other holds the paper at either end (adjacent to points A and B) and slowly pulls the new sea floor out of the ridge crests. See photos below.

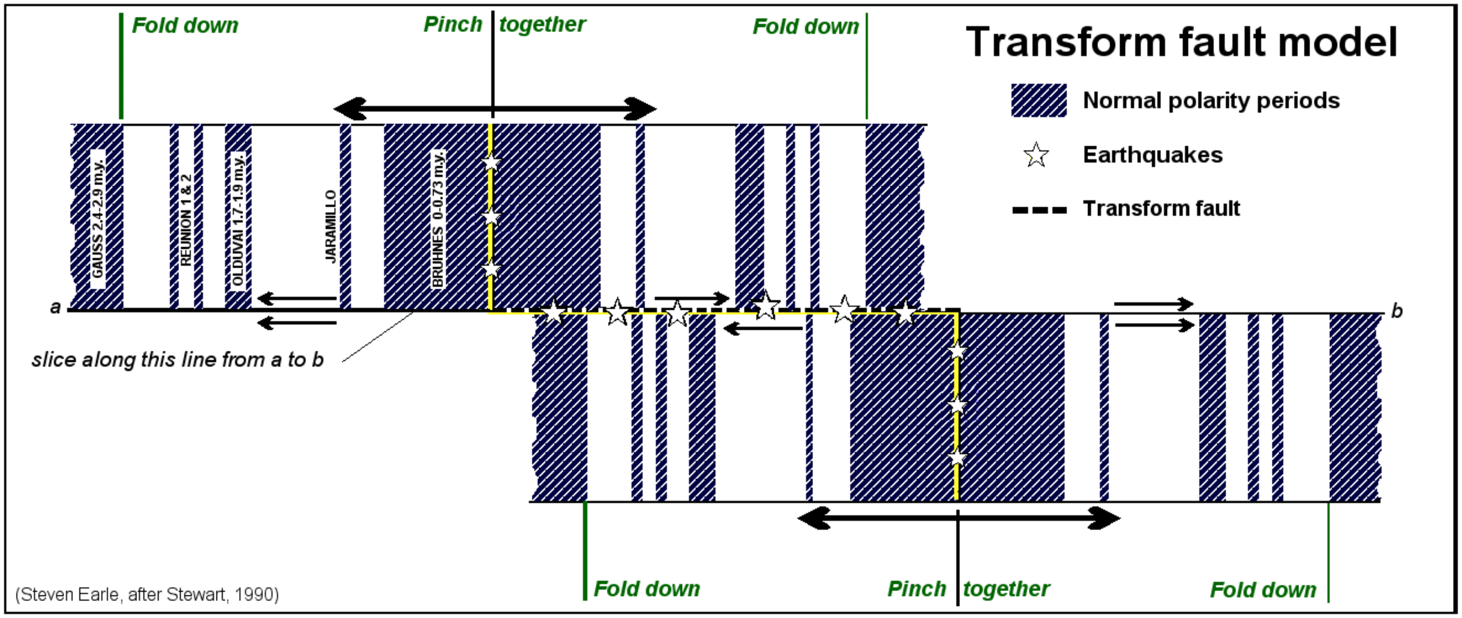


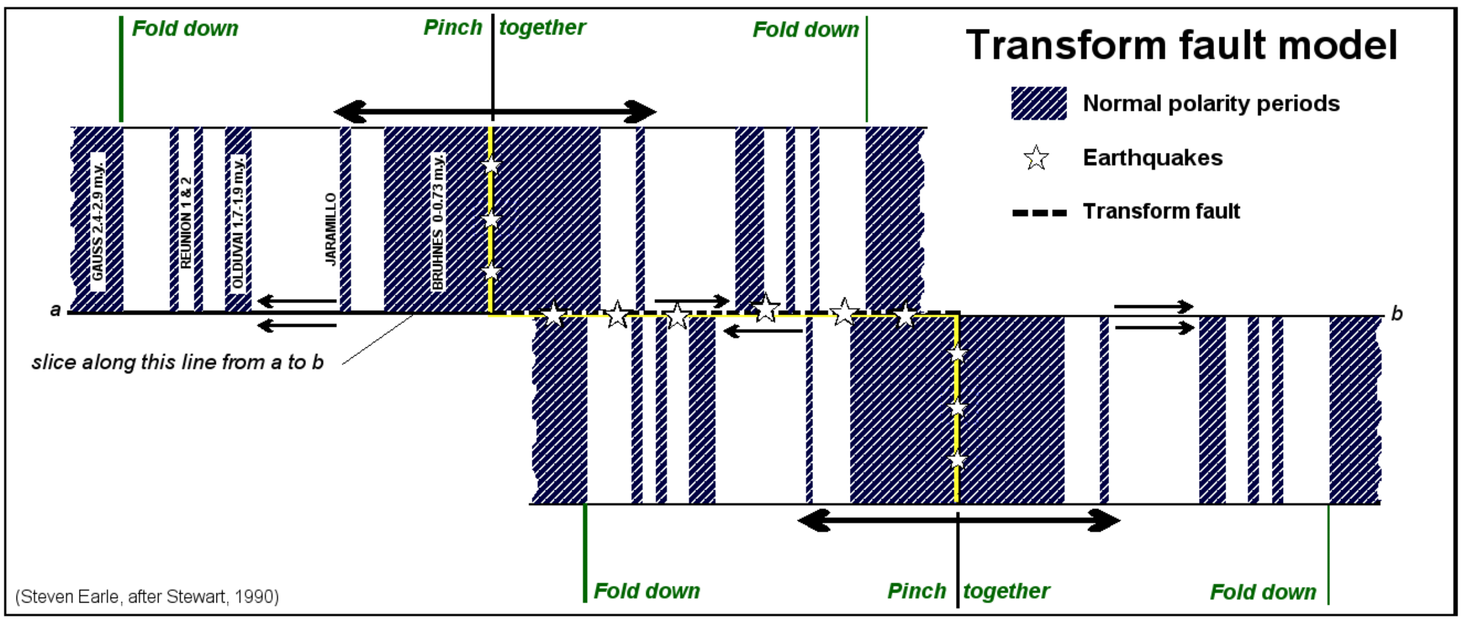
Folded transform fault paper model



Transform fault paper model being pulled apart

From: http://web.viu.ca/earle/transform-model/


Transform fault model
Normal polarity periods
Earthquakes
Transform fault
Fold down
Pinch
together
Fold down
GAUSS 2.4-2.9 m.y.
REUNION 1 & 2
OLDUVAI 1.7-1.9 m.y.
JARAMILLO
BRUHNES 0-0.73 m.y.
a
b
slice along this line from a to b
Fold down
Pinch
together
Fold down
(Steven Earle, after Stewart, 1990)


Transform fault model
Normal polarity periods
Earthquakes
Transform fault
Fold down
Pinch
together
Fold down
GAUSS 2.4-2.9 m.y.
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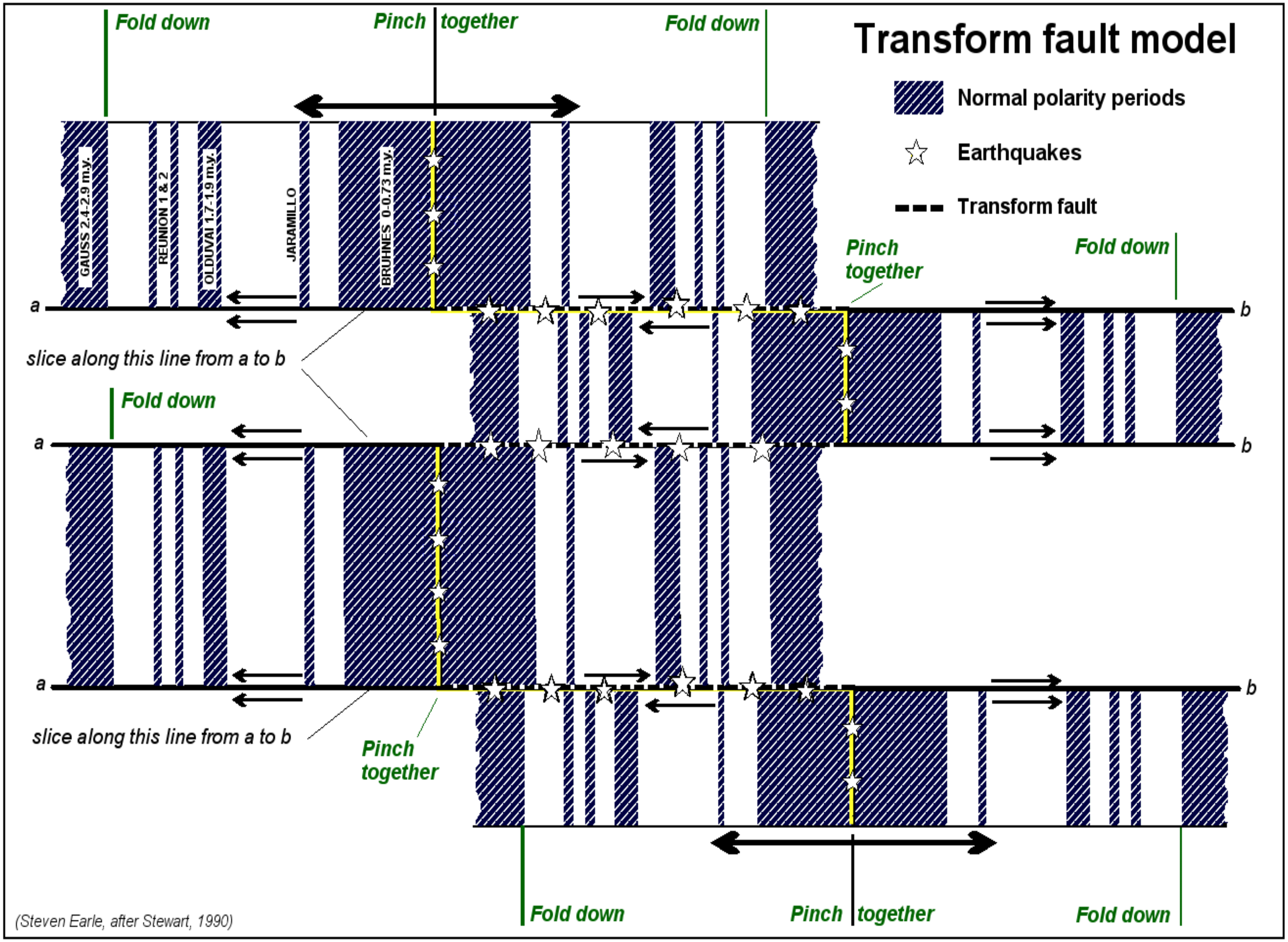
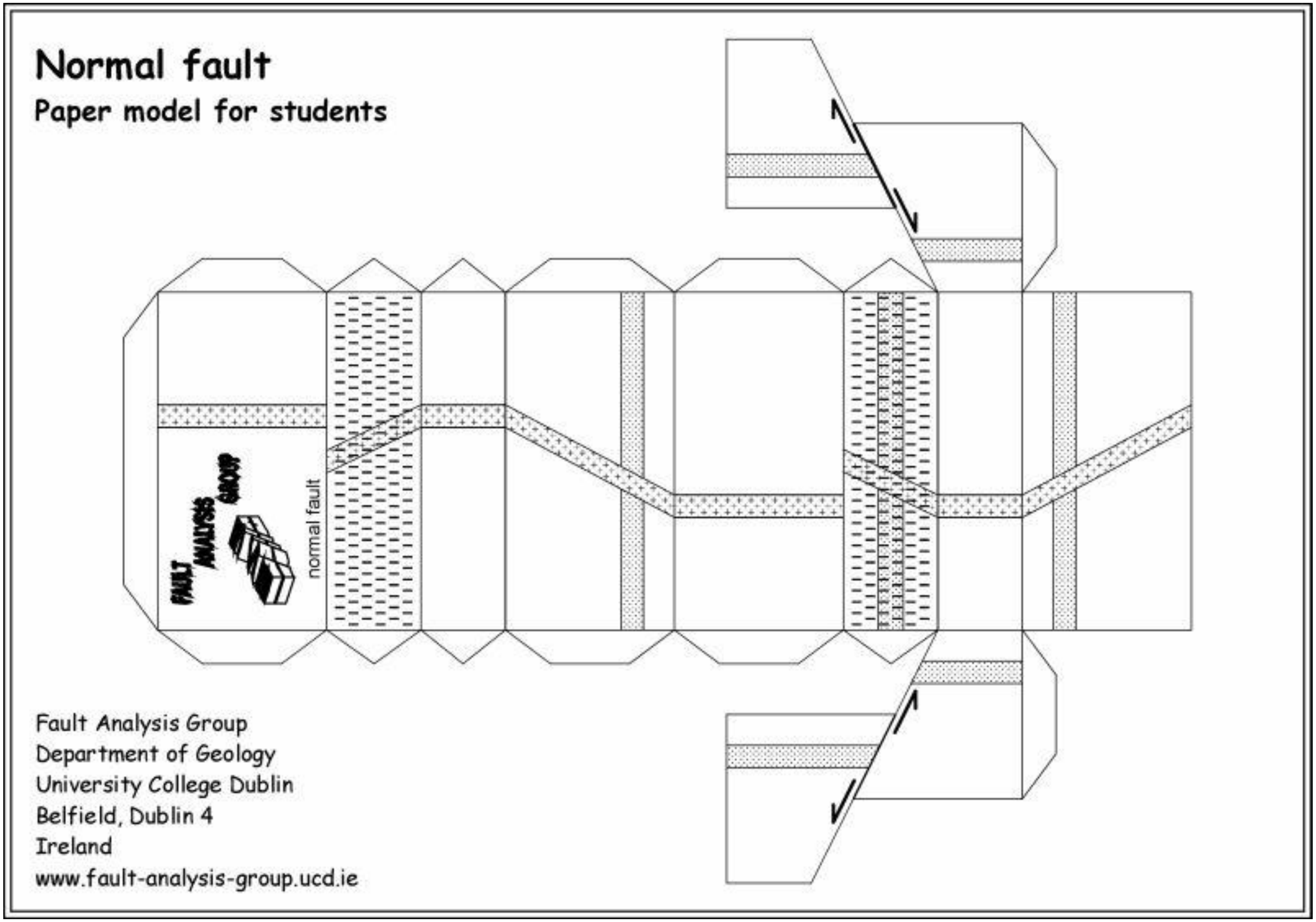
JARAMILLO
BRUHNES 0-0.73 m.y.
a
b
slice along this line from a to b
Fold down
Pinch
together
Fold down
(Steven Earle, after Stewart, 1990)

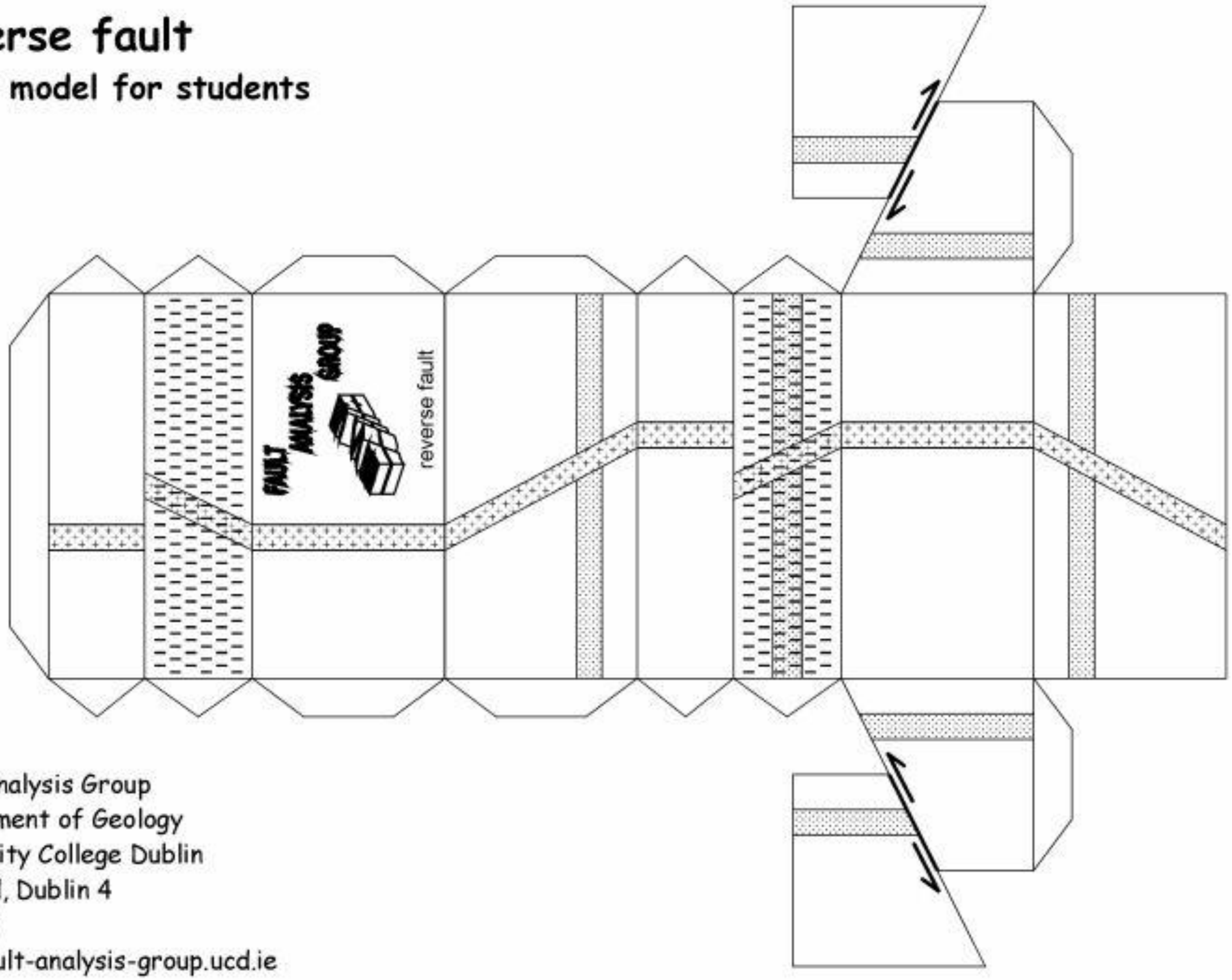

Transform fault model
Normal polarity periods
Earthquakes
Transform fault
Fold down
Pinch
together
Fold down
Pinch
together
Fold down
GAUSS 2.4-2.9 m.y.
REUNION 1 & 2
OLDUVAI 1.7-1.9 m.y.
JARAMILLO
BRUHNES 0-0.73 m.y.
a
b
slice along this line from a to b
Fold down
a
b
a
b
slice along this line from a to b
Pinch
together
Fold down
Pinch
together
Fold down
(Steven Earle, after Stewart, 1990)



From: http://www.fault-analysis-group.ucd.ie/papermodels/models/normal_fault.html

Reverse fault

Paper model for students

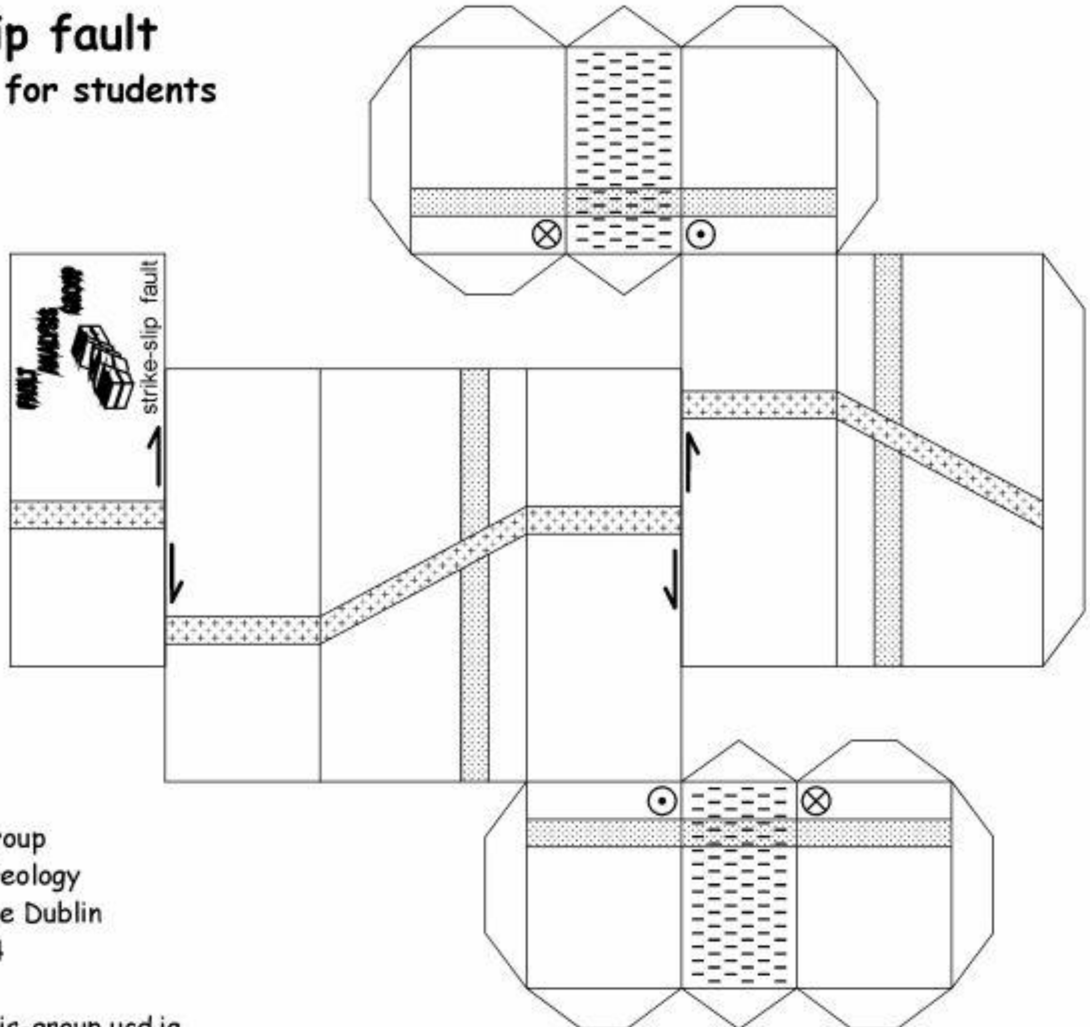


Fault Analysis Group
Department of Geology
University College Dublin
Belfield, Dublin 4
Ireland
www.fault-analysis-group.ucd.ie

From: http://www.fault-analysis-group.ucd.ie/papermodels/models/reverse_fault.html

Strike-slip fault

Paper model for students



Fault Analysis Group
Department of Geology
University College Dublin
Belfield, Dublin 4
Ireland
www.fault-analysis-group.ucd.ie

From: http://www.fault-analysis-group.ucd.ie/papermodels/models/strike_slip_fault.html

Creating a Paper Model of an Ocean Trench

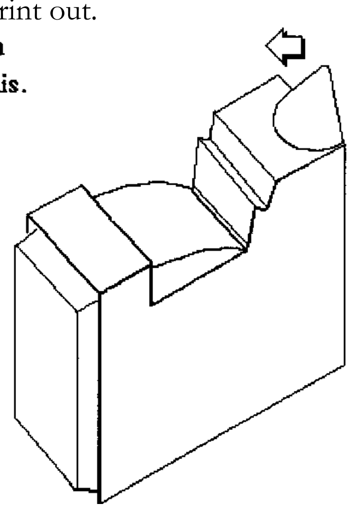
Introduction:
A deep-sea trench is a narrow, elongate, v-shaped depression in the ocean floor. Trenches are the deepest parts of the ocean, and the lowest points on Earth, reaching depths of nearly 7 mi (10 km) below sea level. These long, narrow, curving depressions can be thousands of miles in length, yet as little as 5 mi (8 km) in width. Deep-sea trenches are part of a system of tectonic processes termed subduction. Subduction zones are one type of convergent plate boundary where either an oceanic or a continental plate overrides an oceanic plate. A trench is formed where the oceanic plate dives below (is subducted by) the (less dense) overriding plate. They are associated with a certain type of volcanic chain called an island arc and with zones of high earthquake activity. The trenches can extend for thousands of kilometers parallel to the volcanoes of the island arcs located on the overriding plate. Examples include the Aleutian Islands, an arc bordered to the south by the Aleutian trench, and the Marianas, bordered by the Mariana trench, the deepest in the world. Along the western coast of South America, the Peru-Chile trench marks where the Nazca plate is being subducted beneath the South American plate. The volcanic activity and uplift of the Andes Mountains are a result of the subduction process.

Materials:

- Crayons
- Heavy Stock Paper
- 2 Print outs (Top and Bottom Parts of Trench)
- Paper Glue
- Scissors

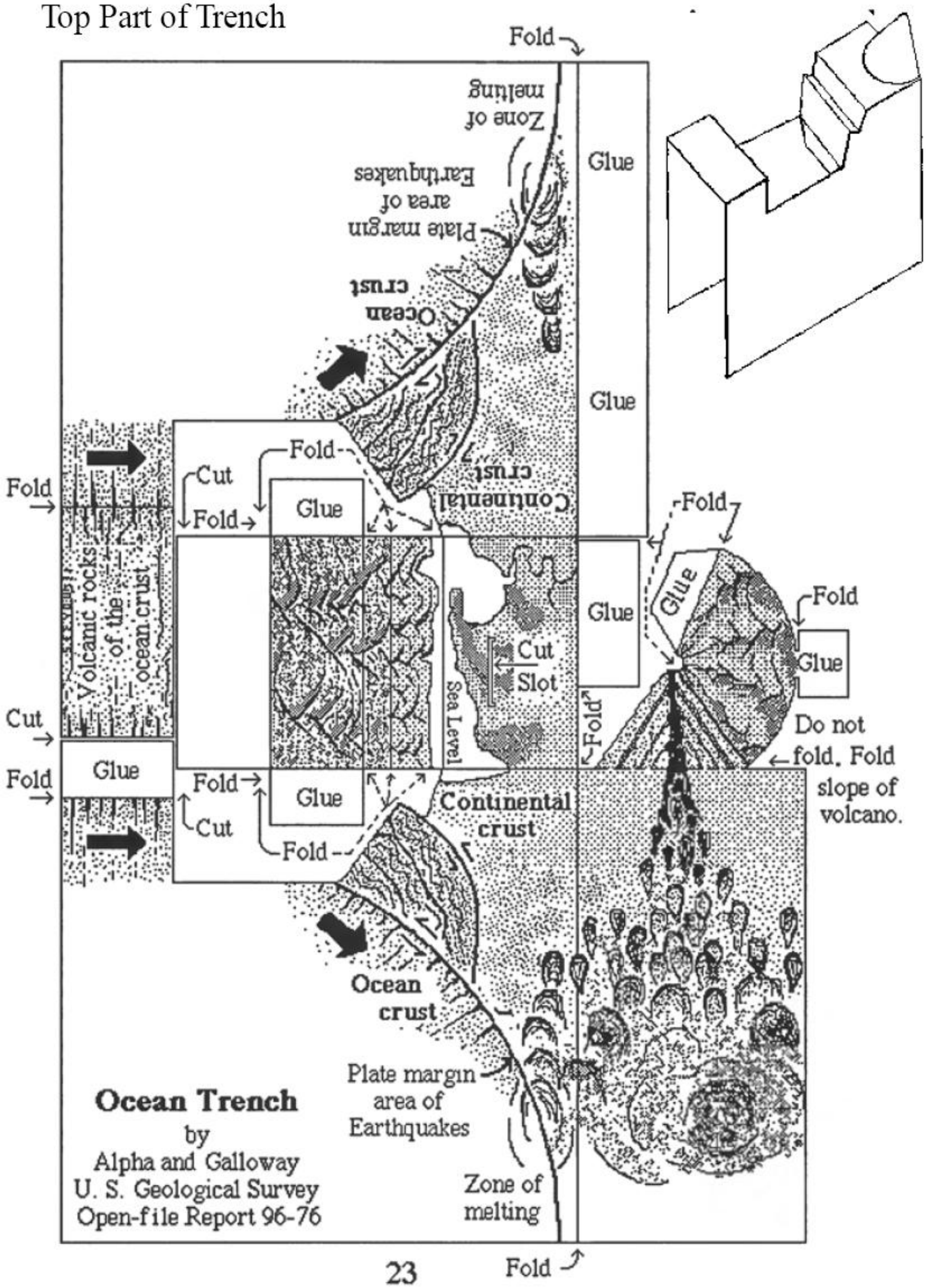
Instructions:
Glue both print outs of heavy stock paper. Cut along the indicated lines.
Assemble by following instructions on the print out.

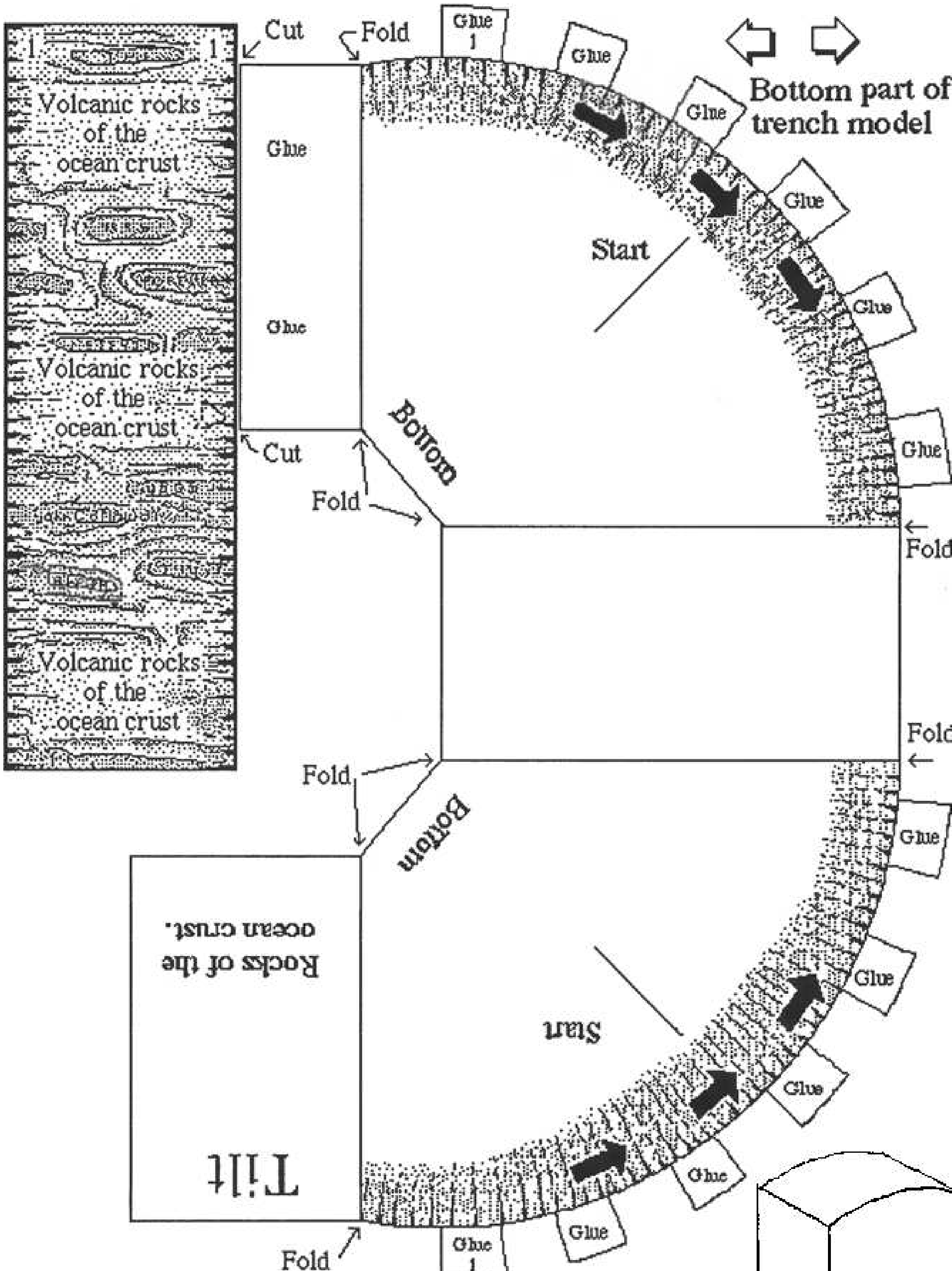
The finished ocean trench model should look like this.

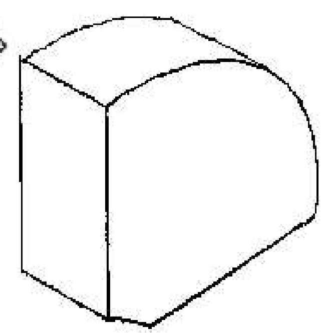


From: http://www.jclahr.com/alaska/aeic/taurho/trench%20final.pdf

Top Part of Trench




Bottom part of trench model
Cut
Fold
Glue 1
Glue
Glue
Glue
Glue
Volcanic rocks of the ocean crust
Volcanic rocks of the ocean crust
Volcanic rocks of the ocean crust
Glue
Glue
Start
Bottom
Cut
Fold
Fold
Fold
Fold
Bottom
Rocks of the ocean crust.
Tilt
Start
Glue
Glue
Glue
Glue
Glue
Glue 1
Fold



Constructing a Model of the Globe

Introduction:

The science of geology, or study of the Earth, depends on the use of maps. Accurate topographic maps that show the relief of a region, and geologic maps which show the kinds of rocks and land features present in an area, are the creation of skilled surveyors and navigators. Although the oldest maps date back to the Babylonians in 2300 BC, the art and science of mapmaking began to flourish in 15th century Europe. Exploration of the New World demanded better navigational tools and skilled draftsmen such as Netherlands cartographers Gerhard Kremer Mercator (b. 1512; d. 1594) and Abraham Ortelius (b. 1527; d. 1598) who published the first modern atlas. The invention of the compass for determining direction , the sextant for determining latitude, and the marine chronometer for determining longitude on long sea voyages greatly improved the art of navigation in the 16th and 17th centuries. Today, maps are largely transformations of aerial and satellite photography. Can you imagine a world without maps?

From: Ready-to-Use Earth and Astronomical Science Activities (5-12)

Materials:

- Old tennis ball
- Colored print out of the globe
- Glue
- Hard stock paper

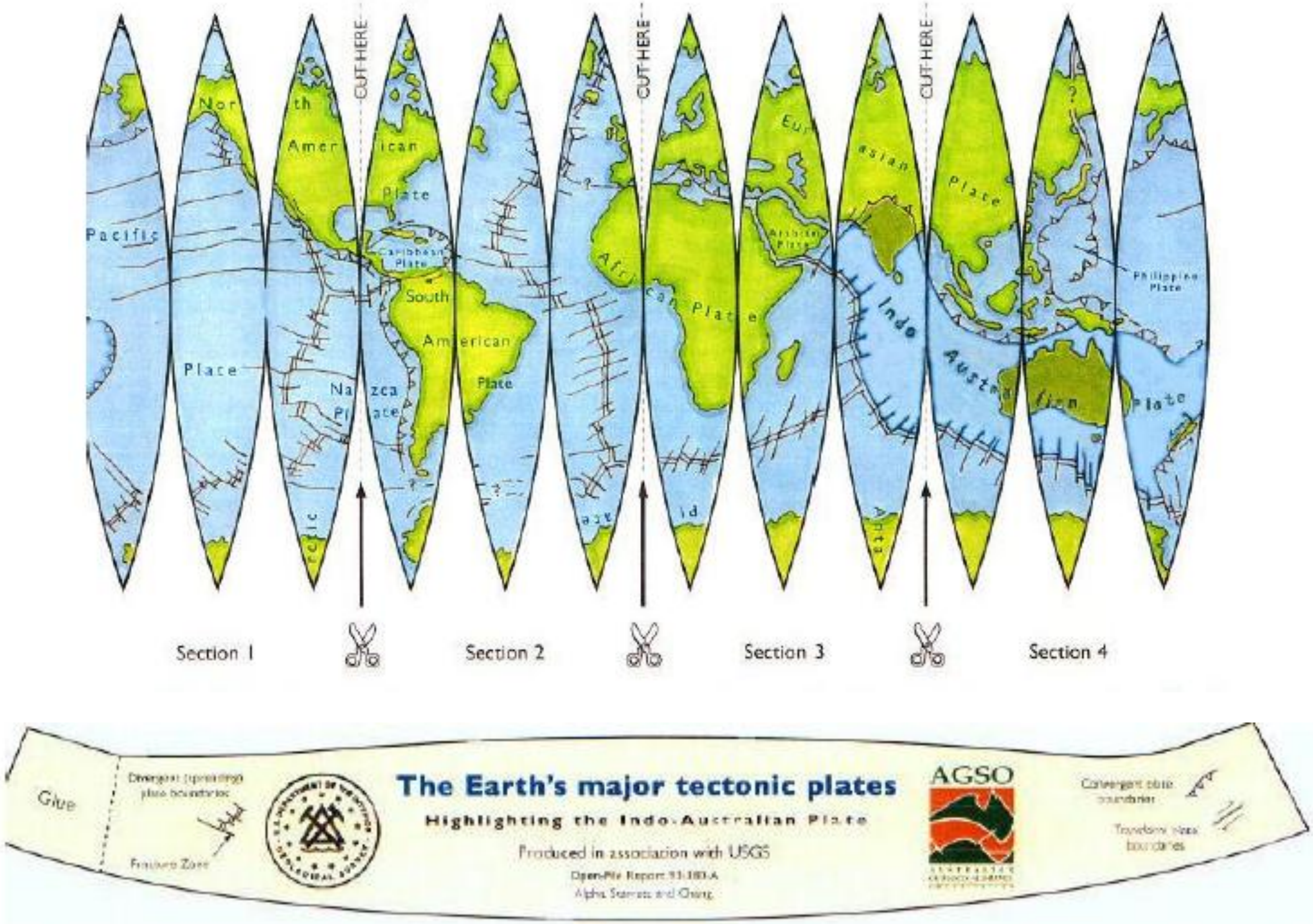
Steps:

1. Cut the map projection out in four sections, marking each section number on the back.

2. Glue sections in correct order onto the tennis ball.

3. Cut out the base pattern, paste it on hard stock paper, and glue its ends together to form the base.

From: USGS, http://volcanoes.usgs.gov/about/edu/dynamicplanet/ballglobe/index.php


CUT HERE
CUT HERE
CUT HERE
Pacific
Place
North American Plate
Caribbean Plate
Nazca Plate
South American Plate
African Plate
Eurasian Plate
Arabian Plate
Indo Australian Plate
Philippine Plate
Section 1
Section 2
Section 3
Section 4
Glue
Fracture Zone
The Earth's major tectonic plates
Highlighting the Indo-Australian Plate
Produced in association with USGS
AGSO
boundaries

Build a Home Made Barometer

Introduction:

Air pressure and differences in pressure are among the most important weather makers. For example, the centers of storms are areas of relatively low air pressure, compared to pressures around the storm. High air pressure generally brings good weather. Keeping track of how the pressure is changing is important for forecasting the weather.

Another importance of measuring air pressure is that differences in air pressure between places cause the winds to blow (air moves from high toward low pressure).

The instruments that measure air pressure are called barometers, from Greek words for weight and measure. Evangelista Torricelli invented the mercury barometer in 1643 and today's mercury barometers are much like those of the 17th century.

In this project, we will build a simple barometer that will allow us to detect changes in air pressure.

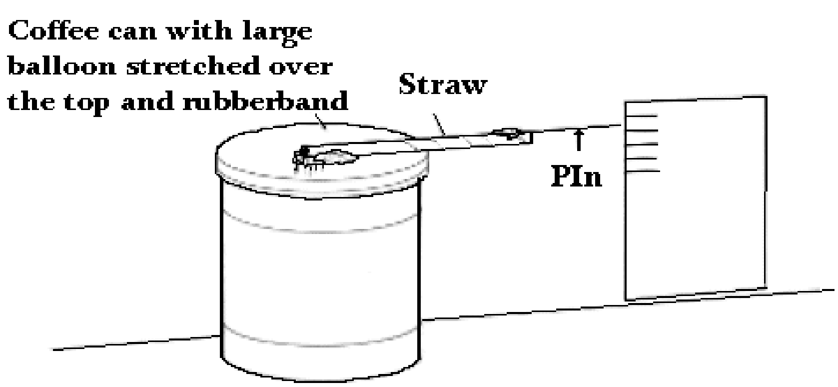
From: http://www.usatoday.com/weather/wbaromtr.htm

Materials:

An empty coffee can
A large balloon
A large rubber band, one that will fit snugly around the coffee can
A pin
Glue
Straw
Paper

Procedure:

1. Cut a large piece of the balloon and stretch it over the coffee can.
2. Hold the balloon in place with a rubber band stretched around the can, over the balloon. Make sure there is a tight seal around the rubber band.
3. Use a little glue (not hot melt) and attach the straw to the piece of balloon over the can. Then use a little more glue and attach the pin to the other end of the straw (see diagram below.)



4. Take a piece of paper and place some regularly spaced lines on it.
5. Set up the can and paper as shown in the diagram.

6. Make several daily recordings of pressure for about a week. Make notes about the weather when you take the readings.
7. Compare the readings of a real, commercially-available barometer outside with those of a barometer inside. (Alternatively, use the newspaper or web-based weather forecasts to obtain true pressure readings).

DATA TABLE:

Day	Home Made Barometer Reading	Actual Barometer Reading	Description of Day's Weather
1			
2			
3			
4			
5			

Questions:

1. Explain how this barometer works:

2. Why is it important to make sure that the balloon is affixed tightly (no air leaks) to the coffee can?

3. Study the data you have collected. What is the relationship between the…
   a. your barometer readings and actual barometer readings?

   b. current weather conditions and your barometer readings?

4. If you were to redesign the barometer, what improvements would you make and why?

How to Make a Homemade Anemometer

Introduction: An anemometer is a device that measures wind speed. There is a variety of specific types of anemometers, with the simplest being a cup anemometer. This type of anemometer consists of cups on horizontal axes that the wind pushes around a single vertical axis. A cup anemometer was first made in 1846 and is the easiest anemometer to make at home.

Materials:

- ●Scissors
- ●2 straight plastic straws
- ●Stapler
- ●5 small paper cups
- ●Sharpened pencil
- ●Timer
- ●Ruler
- ●Push pin
- ●Calculator

Procedure:

1. Take four of the paper cups. Using the hole punch, punch one hole in each, about 1.5 cm below the rim.
2. Take the fifth cup. Punch four equally spaced holes about 1cm below the rim. Then punch a hole in the centre of the bottom of the cup.
3. Take one of the four cups and push a straw through the hole. Fold the end of the straw, and staple it to the side of the cup across from the hole. Repeat this procedure for another one-hole cup and the second straw.
4. Now slide one cup and straw assembly through two opposite holes in the cup with four holes. Push another one-hole cup onto the end of the straw just pushed through the four-hole cup. Bend the straw and staple it to the one-hole cup, making certain that the cup faces in the opposite direction from the first cup. Repeat this procedure using the other cup and straw assembly and the remaining one-hole cup.
5. Align the four cups so that their open ends face in the same direction (clockwise or anticlockwise) around the centre cup. Push the straight pin through the two straws where they intersect. Push the eraser end of the pencil through the bottom hole in the centre cup. Push the pin into the end of the pencil eraser as far as it will go. Your anemometer is ready to use.

NOTE: Your anemometer is useful because it rotates at the same speed as the wind. This instrument is quite helpful in accurately determining wind speeds because it gives a direct measure of the speed of the wind. To find the wind speed, determine the number of revolutions per minute. Next calculate the circumference of the circle (in meters) made by the rotating paper cups. Multiply the revolutions per minute by the circumference of the circle (in meters per revolution), and you will have the velocity of the wind in meters per minute.
The anemometer is an example of a vertical-axis wind collector. It need not be pointed into the wind to spin.

Test your anemometer by collecting wind speeds at different times of the day throughout the week. Watch or research actual wind speeds for your area from weather forecasts.

Data Table:

Day and Time	Revolutions per Minute	Calculated Wind Speed	Actual Wind Speed
1			
2			
3			
4			
5			
6			

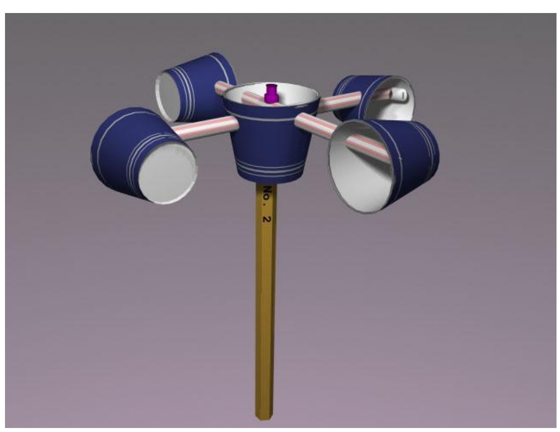
Questions:

1. Did wind speeds change according to time of day?

2. How did your measurements compare with the actual wind speeds from weather forecasts?

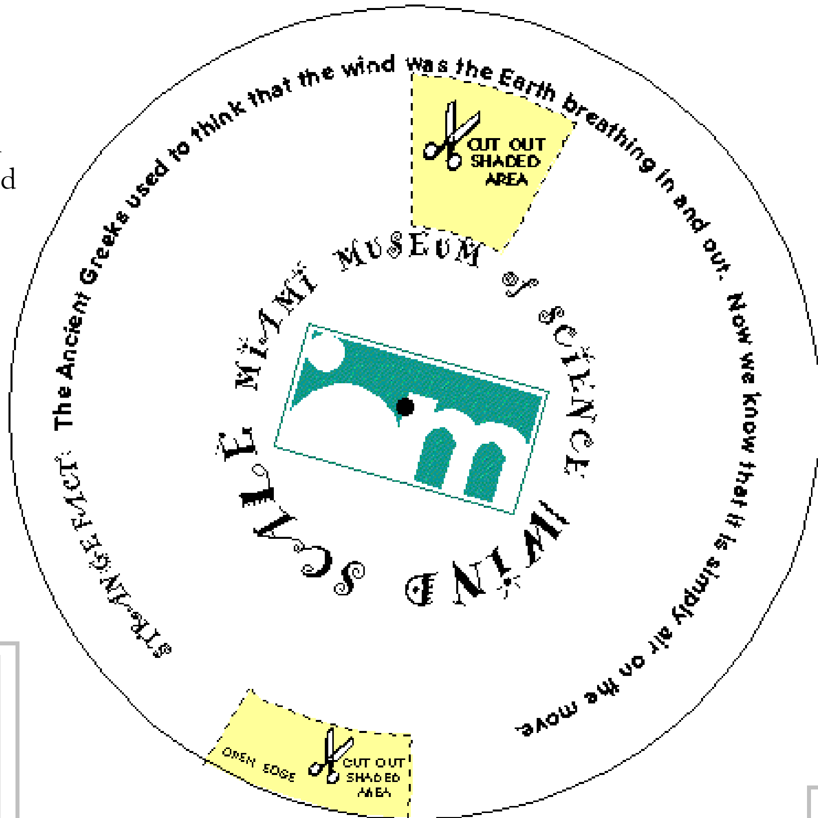
3. How is wind speed related to weather?

4. If you could redesign your anemometer, what improvements will you make? Identify at least three.

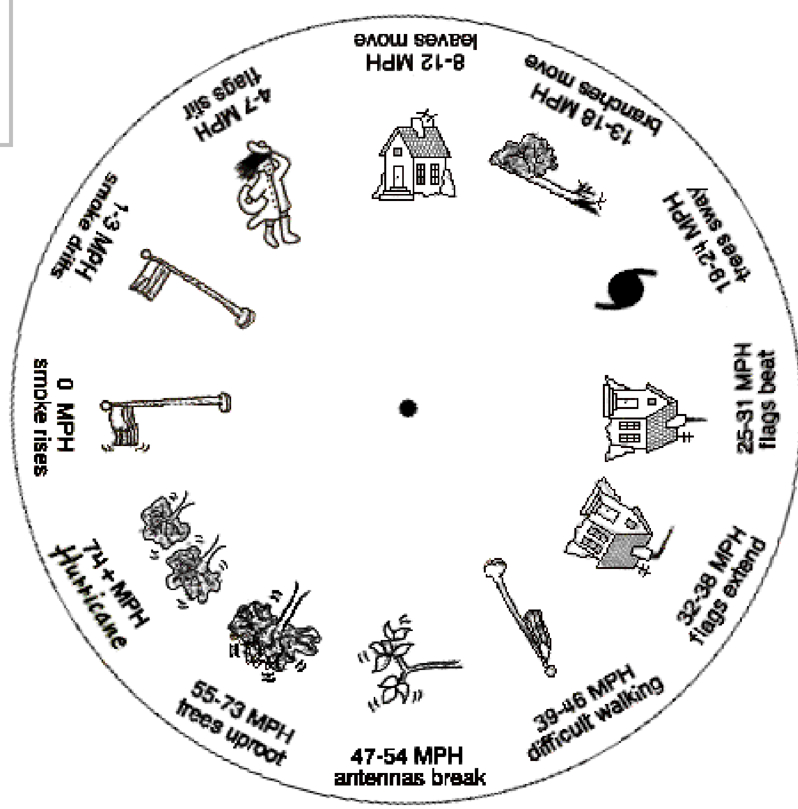


Extension: Create a Beaufort Wind Scale Measuring Device

Glue both circles on hard stock paper, and then cut the circles out.



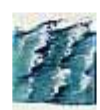
1. Connect the two circles together using a one-hole fastener. Make sure the first circle can rotate.



2. Use the Beaufort Scale Measuring Device and the table below to determine the force of the wind speeds you recorded in your data table.

The Beaufort Scale

In the Beaufort Scale, wind strengths are divided into 12 forces:

Force	**Symbol**	**Name**	**Description**	**Approximate Speed (mph)**	**Image**
Force 0		Complete calm	No motion. Smoke rises straight up	<1	
Force 1		Light air	Smoke drifts	1-3	
Force 2		Light breeze	Wind felt on face. Leaves rustle. Weather is usually clear	4-7	
Force 3		Gentle breeze	Leaves and twigs move. Light flags flap	8-12	
Force 4		Moderate breeze	Small branches move	13-18	
Force 5		Fresh breeze	Bushes and small trees sway. Crests are common on sea and known as "white horses"	19-24	
Force 6		Strong breeze	Wind whistles in electricity and telephone wires. Hard	25-31	

			to use umbrellas		
Force 7		Near gale	Whole trees sway and it becomes hard to walk in the wind. Sky may be dark and stormy	32-38	
Force 8		Gale	Now very difficult to walk and tree twigs start to break	39-46	
Force 9		Strong gale	Tiles and chimneys blown from roofs and branches may snap. Sky may be covered in thick cloud	47-54	
Force 10		Storm	Trees are uprooted and severe damage is caused to buildings	55-63	
Force 11		Violent storm	Widespread damage is caused to buildings	64-72	
Force 12		Hurricane	Severe devastation is caused	73+	

From: http://www.rcn27.dial.pipex.com/cloudsrus/beaufort.html
http://www.rcn27.dial.pipex.com/cloudsrus/makeanemom.html
http://www.ehow.com/how_5412635_make-homemade-anemometers.html

BUILD YOUR OWN SEISMOGRAPH

Introduction:

A seismograph is an instrument that detects and records ground motion. Ground motion can be caused by something man-made, such as a mine blast or a nuclear explosion; or by natural events, such as landslides, volcanic activity, or most often, earthquakes. Whenever any of these events occur, seismic waves are created, and it is these waves that a seismograph picks up.

There are two main types of seismic waves: body waves, which can travel through the inner layers of the earth, and surface waves, which can only travel on the surface. Body waves are the fastest and have the highest frequency. The first type of body wave is called the primary or P-wave. It pushes and pulls the solid rock or liquid matter that it is moving through, and people feel it as back-and-forth or side-to-side motion. The second type of body wave that you feel in an earthquake is called the secondary or S-wave. S-waves cannot move through liquids, only through solid rock. They move rock particles perpendicular to the direction the wave is traveling in.

This project requires adult help, so please have them around when you work on your project!

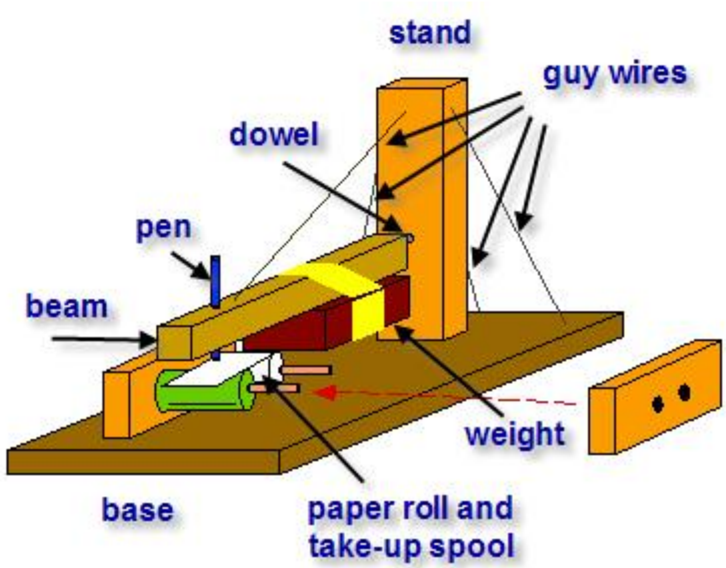
Materials and Equipment

- Wood base, 10" x 24" x 0.5"
- Wood stand, 2" x 4" x 12"
- Wood support blocks, approximately 2" x 4" x 8" (2)
- Wood beam, 1" x 1" x 20"
- Wood dowels, diameter = 0.25", length = 10"; one dowel must slide through center of adding machine paper roll (2)
- Brick or other compact heavy weight
- Strong wire or non-elastic thick rope or twine (7 feet total)
- Roll of adding machine paper, width >= 2"
- Smooth-sided can with lid and base (similar dimensions as paper roll)
- Round-headed screw, or bolt or nail; 1" long
- Pen
- Various sizes of nails
- Strong tape (masking, strapping, or duct) for attaching weight
- Lab notebook

Experimental Procedure

A. Building the Seismograph

Build the seismograph according to the diagram below.



B. Here are some important steps and/or modifications you may need to consider:
1. If you have a drill, you can mount the two wood dowels in holes drilled through the two wood support blocks. If you do not have a drill, saw two slots into the upper edge of each wood support block and then drop the dowel into these slots.
2. The pen must write easily when pulled down onto the paper roll by the brick. Cap it when not in use. You may try substituting a soft lead pencil, a charcoal pencil, a crayon, etc. Fasten the wood stand securely to the wood base by nailing upward from underneath the wood base. The wire (or cord) attached to the back and side of the wood stand will help to keep it stable.
3. Fasten the screw securely into one end of the wood beam. This screw will rest against the wood stand so that the wood beam hangs level over the base. To help the screw stay in place and not slip off of the wood stand, drill or carve a small hole 1/4-inch deep out of the stand and slightly larger in diameter than the screw head. The head of the screw can sit in this hole and press against the wood stand.
4. Both the adding machine paper roll and the smooth can should be able to rotate. The smooth can rotates when you crank the nail at one end of its wood dowel; the paper roll can turn either with its wood dowel or separately from the dowel. Tape down the end of the paper roll onto the can so that when you crank the can, the paper should wind up around the can and cause the paper roll to rotate as it feeds paper to the can.
5. If you want to be creative, see if you can devise a way to make the paper roll feed onto the smooth can automatically so that you do not have to crank the can by hand. You might try buying a miniature battery-operated motor that can turn the wood dowel of the can.

C. Testing the Seismograph

Here are some ideas for testing the seismograph. You can probably think of other ideas on your own. Have a helper jump up and down on the floor near the seismograph.

a. How does the seismogram change as the jumping person moves farther away? Make measurements with the person at a distance of 0.5, 1, 2, 4, 8, and 16 meters away from the seismograph. Make a graph of seismogram peak height (in cm, y-axis) vs. distance of your helper from the seismograph (in m, x-axis). You could also use the seismograms themselves on your display board.

b. How does the seismogram change if the person jumping is heavier or lighter? Pick a distance from your first experiment where the pen moved noticeably, but did not cover its full range of motion on the paper. Make a series of seismograms with helpers of different weights jumping up and down at that fixed distance from the seismograph.

c. How does the seismogram change when you vary the substrate on which it is standing? For example, compare placing the seismogram on a wooden floor vs. a concrete slab (like your garage floor), or on a table vs. directly on the floor, or on your lawn vs. a hard-surfaced playground.

Variations

- What do you think will happen if you use a lighter weight on the horizontal rod of your seismograph? If you use a heavier weight?
- Another way to test the seismograph would be to drop a box containing objects with increasing mass at different distances from the seismograph. For example, you could use 20-pound sacks of dry rice, or an increasing number of books. Use a bathroom scale to measure the weight of the box. You can also try this test on different substrates (wood floor vs. concrete slab).
- Advanced: Can you think of ways to improve the seismograph? Or can you think of different way to measure seismic waves? Draw a clear diagram that shows and labels all parts. Then write a paragraph explaining how your design works. Here are some important considerations as you are coming up with your design:
    - Is it made of common inexpensive materials found in a local store?
    - Will it be able to determine the relative magnitude (size) of each vibration it measures?
    - Will it be able to measure vibrations continuously for at least 1 minute?
    - Will it be able to measure even slight vibrations (such as a person jumping up and down next to your seismograph)?

    Gather the materials you need and build the seismograph you designed. Be prepared to show other students how your device works (UC Regents, 1995).

From: http://www.sciencebuddies.org/science-fair-projects/project_ideas/Geo_p017.shtml

CUPCAKE GEOLOGY- SIMULATING CORE SAMPLE DRILLING

Background:
Geologists take core samples of the earth to find out what is beneath the surface. By examining the soil profiles, geologists can interpret what a cross section probably looks like based on the information obtained from the samples. Sampling is an important method used to gather data.

Question:
How can soil profiles be used to show the interior of the earth?

Materials:
Cupcakes, paper plates, clear plastic straws, plastic knives

Procedure:

1. Inspect your cupcake. Do not touch, peel, or eat! Draw a picture of the outside of the cupcake.

2. Draw a cross section of what you think the interior of the cupcake looks like.

3. Using the straw, collect 5 core samples from different locations on top of your cupcake. Remove each sample from the straw by placing a finger and thumb above the sample, squeeze the straw, and then pull down. The sample will easily come out. Place the samples side by side on the plate and number them one through five.

Gather data:

Sample 1	Sample 2	Sample 3	Sample 4	Sample 5

Analyze data:

4. Using the information from the soil profiles above, draw a cross section of what you now think the interior looks like.

5. Peel the cupcake and cut in half using the plastic knife. Draw and color an accurate cross section of your cupcake.

DRAWINGS:

1. Cupcake Exterior

2. Prediction: Cupcake Interior

3. Interior of Cupcake according to Core Samples

4. Accurate Cross-Section

Questions:

1. How did using core samples help to get a more accurate picture of the interior?

2. How is this lab similar to what geologists do in their work?

Teacher Notes:

- For added complexity, you may inject different colored frosting inside the cupcake before giving it to students.
- You may also prepare different layered cakes and give students cut servings (cover the sides with wax paper).

Core Sample Drilling

Introduction:
In this activity, a layered cake with the top decorated to resemble a grid is created. The class is assigned a section of the grid to "sample" and at the end the whole class comes together with a representation of interior layers of the cake.

Anticipated Learning Outcome: Students will interpret "core samples" to determine rock structures beneath the land surface.

Teacher Preparations (See last page for a more detailed description):

- Multiple-layer cake prepared according to the following instructions:

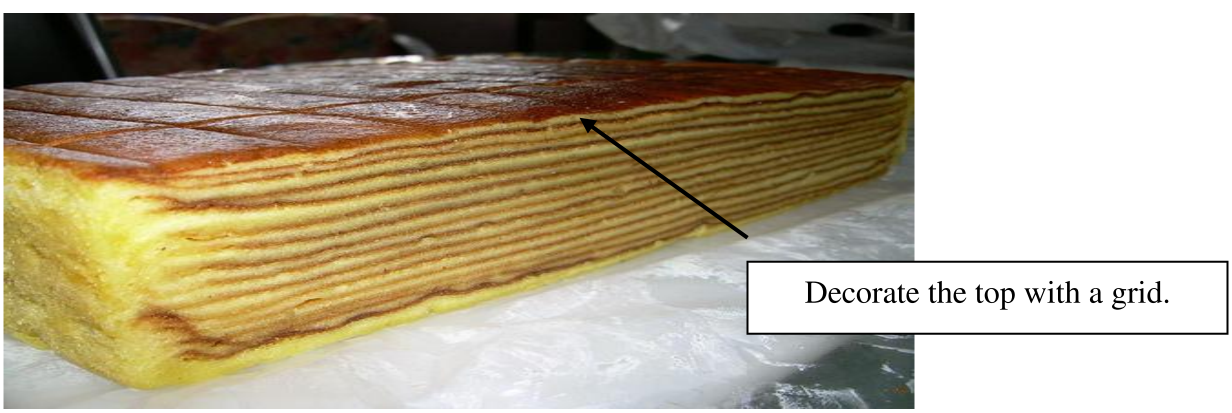
Use moist pound cake (or other dense, coherent cake) mix. (One mix is sufficient for whole class activity if layers are made thin enough.)

Bake four to six thin cakes, (each between 0.5 and 2.0 cm thick), each a different color (mix in food coloring before baking). Use square or rectangular pans.

Stack the cakes in any order. Apply icing (of any kind) between the layers but not on the top or sides of the cake. You may decide to introduce variations such as almond pieces, marshmallows, etc. Check for any student allergic to nuts.

Decorate the top by drawing lines until a grid is formed. Use toothpicks to identify corners of the grid.

- Knife for cutting cake
- Three transparent plastic tubes (diameter between 1 and 2 centimeters) at least as long as the cake is high. Clear drinking straws could be used, but tubes of wider diameter (those used for tapioca drinks or milk shakes) produce better results.



Name:____________________________ Period Number: _______________
Date:________________

Layers of Cake Geology: An Exercise to Simulate Core Sample Drilling

Introduction: In this activity, a layered cake, heavily frosted top and sides, will be used to simulate a series of rock layers. As a geologist, you will 'sample' a section of the cake by using thick plastic straws. Based on the core samples your group collects, you should be able to predict what the interior of the cake looks like. At the end, the whole class will compare data to determine whole cake layer structure.

Instructions:

1. You or your group should be supplied with a straw, journal pages, colored pencils, and a ruler. (Straws can be cut to a length slightly higher than the cake.)

2. Look at the layer cake (provided by your teacher). How can you learn more information about the cake without peeling the foil back or cutting the cake open? Draw what you think the inside of the cake looks like in your journal. What type of cake is under the icing? Is there a filling inside? Make your best hypothesis.

3. The surface of the cake should have a grid outlined on it with toothpicks (your teacher should have it prepared this way). Notice where "North" is located on the cake. You or one person from your group should use the straw to "drill" into the cake. Hold the straw vertically (up and down), and push it straight down into the cake. By placing your thumb or finger on the top of the straw as you pull it out, you should get a "core sample" with your straw. Your sample will show the different layers inside of the cake. Be sure to record where on the cake you have drawn your sample (using the grid).

4. On your journal page, draw the core sample. What kinds of layers are in the cake? Describe the composition of your layers. Was your hypothesis correct?

5. Compare your core sample with others in the class. Is the cake the same throughout? Once each student or group is finished analyzing their core samples, cut the cake and see how it compares to the samples. Did the core samples adequately represent the composition of the whole cake? (The teacher may decide whether students may eat the cake after this activity.)

NAME: ____________________________
PERIOD NO. ___ DATE: ____________

Layers of Cake Geology

1. **HYPOTHESIS:**
Draw what you expect to see (remember to label important information):

2. Written description of your hypothesis:

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Reasons for this prediction:

2. ANALYSIS

Where is your sample from? (coordinates of "core sample")

Draw your "core sample," labeling different layers:

Describe the layers in your "core sample." How are the layers similar? How are they different?

Was your hypothesis correct? Why or why not?

How do you think this is like collecting core samples of sediment from the ocean floor? How is it different?

From:
http://oceandrilling.coe.tamu.edu/curriculum/Sediments/activity2.htm

Teacher Pages…

Preparation Instructions

Materials:

-2 pkgs White Cake Mixes
-1 pkg Chocolate Frosting
-1 Rectangular Foil Baking Pan
-Food Coloring
-Toothpick (or Tube Icing)

Directions:
Make a layer cake with at least three layers of colored batter. Mix 2 cake mixes together. Take approximately 1/3 of the batter and set aside. Take the remaining 2/3 of the batter and divide in 3 or 4 (depending on number of colors used) small bowls to color. Add a different food coloring to each bowl so that the color will show up in the batter. Layer all of the colors of batter together in a baking pan. Use different patterns and thickness for different layers. Also, leave some parts colorless.

Baking time and temperature will have to be estimated depending on cake mixes used. Temperature should be 25 degrees lower than directions on the mixes and time will probably be 10-20 minutes longer since you are using two mixes. Check the center of the cake with a toothpick for doneness to be sure. Toothpick should be clean and the cake should have its sides just pulling away from the pan. Once the cake is cooled, frost the cake in the pan to make sure all of the cake and colors are covered by the icing.

With a toothpick or with the tube icing, make a grid on the cake and indicate which direction is north. This can be done immediately before the activity is started in the classroom. Students will know where their sample is from by referring to the grid on the cake.

From: http://oceandrilling.coe.tamu.edu/curriculum/Sediments/activity2.htm

Layer upon Layer: Simulation of Core Drilling (Clay Activity)

Teacher Preparation Instructions:

Materials:

-clay or Playdoh® in several colors
- large spices (not powdery- for example: parsley, course pepper, whole cloves)
-a thick tray or container for the layers

Directions:
Using the Playdoh® or clay of several colors, make a series of different colored layers. Within some of the layers, mix small spices such as course pepper, dried parsley, and/or sesame seeds. These small items will simulate different textures found in different layers of real-world sediments and fossils. Have some layers not cover the entire container. You can fold or indent the clay layers as needed to simulate faults or other conditions in the sediment layers.

Description of Activity (Student set of Instructions):
1. Each group or student should have a plastic straw (with a large diameter) and a single edge razor (or exact-o knife or small, sharp scissors).
2. Make a hypothesis about the different layers of clay. What will the layers look like? What do you think you will find? You may draw your hypothesis on a journal page.
3. Each student or one person from each group should take a core sample of the clay layers with the straw. (Stick the straw straight down into the clay layers and pull up. The clay layers should be captured by the tube, giving you a core sample.) Using the razor or knife, carefully cut away the straw from the clay. You will be left with a long, round core sample of the different layers.

4. Draw the layers that you see. What is different about the layers? Which one was laid down first? Which one is newest?
5. The student or groups may compare samples from different parts of the clay layers. Is the clay the same throughout? Have students share what they see/found in their core samples.

Layer upon Layer: Simulation of Core Sample Drilling

Name:_________________________

Date:

1. HYPOTHESIS:

Draw what you expect to see (remember to label important information):

Written description of your hypothesis:

Reasons for this prediction:

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2. ANALYSIS

Draw your "core sample," labeling different layers:

Describe the layers in your "core sample." How are the layers similar? How are they different? Which one was laid down first? Last?

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Was your hypothesis correct? Why or why not?

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How do you think this is like collecting core samples of sediment from the ocean floor? How is it different?

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From: http://oceandrilling.coe.tamu.edu/curriculum/Sediments/mudex2.doc

MAPPING THE OCEAN FLOOR

I. Background Information:

The ocean floor can be mapped by *sounding:* sound is sent from a ship's transmitter to the ocean bottom at an angle. The sound bounces back to the ship at the same angle and is picked up by a receiver. The speed of sound in sea water is about 1,507 meters per second. By using this information and applying a formula, ocean depth can be measured and mapped. In this activity your students will use data to map a section of the ocean floor. In this activity, you will use a formula to solve a problem. Then, you will use a two-dimensional coordinate grid to represent data points and to graph a simple figure that communicates the concept of ocean depth. Have fun plotting!

II. Materials:

- copies of ***Mapping the Ocean*** data sheet on page 20 and ***Mapping the Ocean*** funsheet
- pencil and paper
- calculators

III. Teacher Instructions:

ANSWERS

distance	time	depth (m)	depth (km)
10	0.13	100	0.1
20	0.27	200	0.2
30	0.53	400	0.4
40	2.65	2,000	2.0
50	2.65	2,000	2.0
60	2.92	2,200	2.2
70	4.25	3,200	3.2
80	4.25	3,200	3.2
90	2.65	2,000	2.0
100	1.86	1,400	1.4
110	1.33	1,000	1.0
120	3.98	3,000	3.0
130	4.51	3,400	3.4
140	6.10	4,600	4.6
150	6.90	5,200	5.2
160	8.49	6,400	6.4
170	14.60	11,000	11.0
180	6.64	5,000	5.0
190	7.96	6,000	6.0
200	7.43	5,600	5.6

1. Describe the process of how the ocean floor can be mapped using sounding. Write the formula for measuring ocean depth on the board.
2. Distribute Mapping the Ocean data sheet and funsheet to each student. Explain that they are looking at data that was gathered from a ship that was moving straight out from shore. Every 10 km the ship stopped to collect sounding data.
3. Students use the sounding formula and the time information given to determine the depth of the ocean at each data point. They record these depths on the data sheet. (Suggestion: ask students to round their calculations to the nearest 100 meters.)
4. Next, students map the ocean floor on the Mapping the Ocean funsheet. They locate the distance from shore across the x axis, and then plot the correct depth (rounded to the nearest 100 meters) on the y axis.

Name ____________________

Mapping the Ocean

data sheet

FORMULA FOR MEASURING OCEAN DEPTH

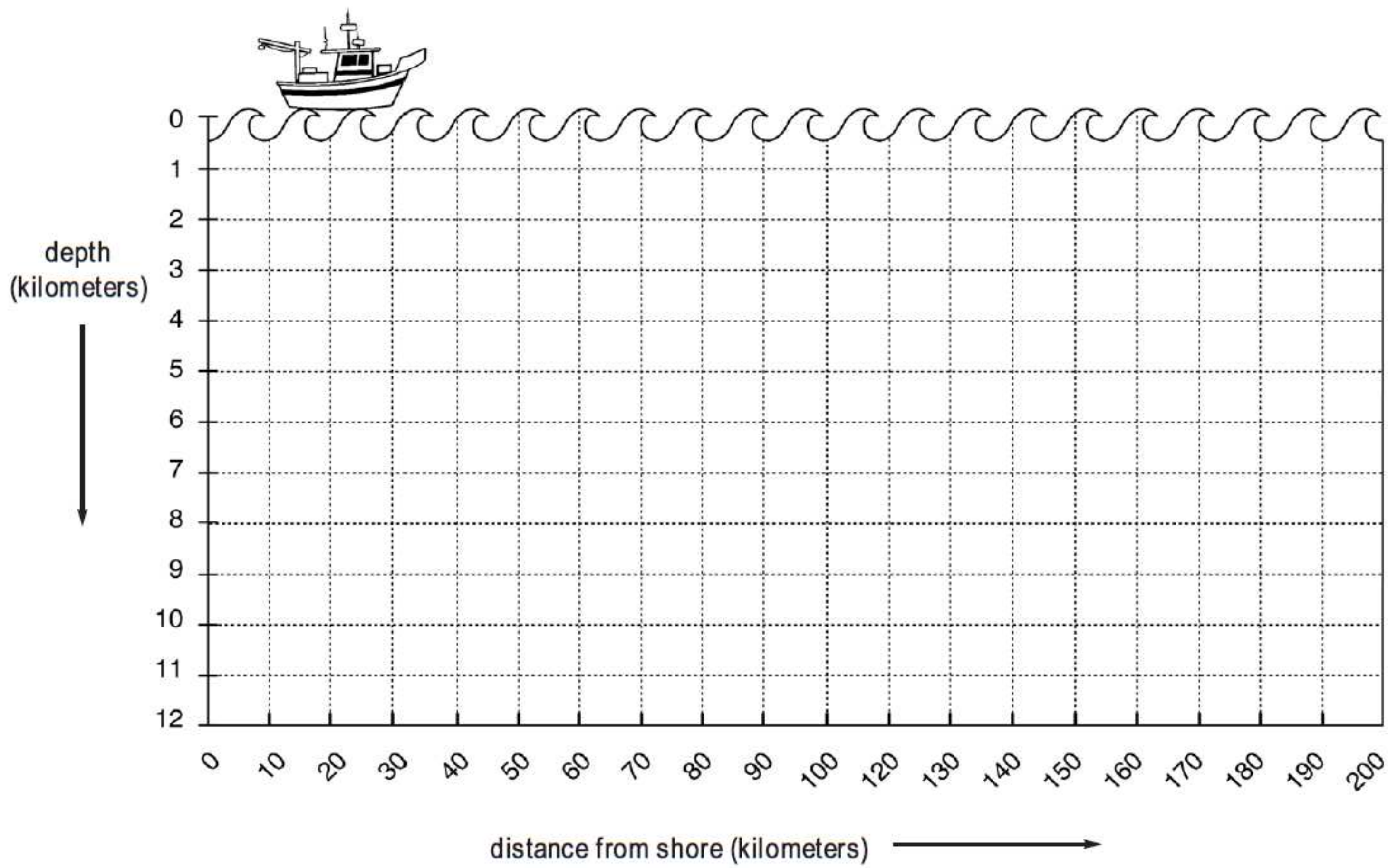
$$D = V \times \tfrac{1}{2} T$$

D = depth (in meters)
T = time (in seconds)
V = speed of sound in water = 1,507 meters per second

distance from shore (km)	time (sec)	depth (m)	depth (km)
10	0.13		
20	0.27		
30	0.53		
40	2.65		
50	2.65		
60	2.92		
70	4.25		
80	4.25		
90	2.65		
100	1.86		
110	1.33		
120	3.98		
130	4.51		
140	6.10		
150	6.90		
160	8.49		
170	14.60		
180	6.64		
190	7.96		
200	7.43		

Name ____________________

Mapping the Ocean



A Watered-Down Topographic Map

FOCUS
Bathymetric and topographic contour mapping

FOCUS QUESTIONS
How can a two-dimensional map be created showing the three-dimensional nature of a landform?
What are topographic maps and bathymetric charts?

LEARNING OBJECTIVES

- Students will create a bathymetric map of a model underwater feature.
- Students will interpret a simple topographic or bathymetric map.
- Students will explain the difference between topographic and bathymetric maps.
- Students will create models of some of the undersea geologic features studied in ocean explorations.

MATERIALS PER GROUP OF FOUR STUDENTS
_ A square quart plastic food storage container at least 7 cm deep
_ 500-700 ml of water in measuring cup or bottle
_ Small plastic funnel
_ 10 cm plastic ruler (can be made by photocopying a ruler repeatedly on an overhead acetate)
_ Overhead projector acetate cut to fit food container top
_ Felt tip waterproof marker
_ 12 inches of masking tape
_ Scissors
_ Two sticks of modeling clay – two colors
_ Student Handouts

AUDIO/VISUAL MATERIALS
_ Overhead projector

TEACHING TIME
Two 45-minute periods

SEATING ARRANGEMENT
Cooperative groups of up to four students

KEY WORDS

Topographic	Bathymetric	Contour line
Contour interval	Relief	Elevation
Depth	Submarine canyon	Seamount
Ridge/bank	Rift/mid-ocean ridge	Continental shelf

Background Information for the Teacher:

This activity serves two purposes: it introduces your students to contour maps—both bathymetric and topographic—and it introduces them to the geologic features that many explorers study. Bathymetric mapping is a major part of many of the OE expeditions since our understanding of the ocean floor starts with knowing what it looks like. We do not know much at this point.

Topographic maps are tools used by anyone in need of knowing his/her position on Earth in relation to surrounding surface features. A topographic map is a two-dimensional map portraying three-dimensional landforms. Geologists, field biologists, and hikers are just a few who routinely use topographic maps.

Bathymetric maps (also called charts) are topographic maps of the bottom features of a lake, bay or ocean. They are very similar to topographic maps in their terminology and interpretation. The primary difference is that bathymetric maps show depth below sea level while topographic maps show elevation above sea level. Another difference is the limited data available to create a bathymetric map when compared to a topographic map. The skill needed to see two dimensions on a map and visualize three dimensions can be a difficult for students. Interpreting familiar topographic maps provides practice in this skill. This exercise will build an understanding of the relationship between a two-dimensional representation and a three-dimensional landform. Both topographic and bathymetric maps use contour lines to show elevation or depth. Contour lines are imaginary lines connecting points of the same elevation or depth. A contour interval is the predetermined difference between any two contour lines. A contour interval of 100 feet means that the slope of the land or sea bottom has risen or declined by 100 feet between two contour lines. A map that shows very close contour lines means the land is very steep. A map that has wide spacing between contour lines has a gentle slope. The smaller the contour interval, the more capable a map is of depicting finer features and details of the land. A contour interval of 100 feet will only pick up details of features larger than 100 feet. It also means that a seamount could be 99 feet higher in elevation than the map depicts.

Because one cannot usually easily see beneath the water, the difference between what is mapped and the reality of what actually exists is greater on bathymetric maps. With the advent of new, more sophisticated ocean floor sensing technology, bathymetric maps are becoming much more detailed, revealing new information about ocean geology.

Teacher Instructions:

1. Distribute the plastic food storage containers and sticks of clay to each group, along with a card describing an underwater feature (these same features also occur on dry land). Each group should read the card and build a clay model to match the description written on the card. The model may not extend above the top of the container. For ease of construction, they may assemble them on the desk and then install them in the container. Allow them to consult the OE web site or CD or oceanography texts if they need help visualizing the descriptions.
2. Challenge the students to create a two-dimensional map of their three-dimensional underwater feature that would visually interpret it for other groups of students.
3. Help them think this through as a group. Draw a large circular shape on the board. Ask the students what they think the drawing represents. Guide the answers, if necessary, toward maps of landforms, such as a pond, an island, a race track circuit, and so on. Could it be the base of an underwater mountain? Draw a side view of an undulating mountain directly below and matching the horizontal margins of the circle. Tell the students the two drawings represent the

same thing, but from a different perspective. Ask the students again what they think the circular shape and the new side view of the circular shape represents. A mountain should be one of the obvious answers. How can we combine the two dimensions of the circle with the third dimension—height—in the second drawing on a flat map?

4. Hand out the Student Handouts and ask them to follow the instructions. When the equipment is ready, have the students check with you to make sure they set up correctly. Depending on your students' abilities you may have all setups complete and proceed as a class through drawing of the contour line. Some classes will take off and do this very well on their own. Having completed the first contour line, have the class add water to the first centimeter mark on the ruler, reminding them to take care when pouring the water into the funnel. Remind them about accuracy in measurement also. Once they draw the second contour line they may work at their own speed.

5. When the "maps" are completed, introduce the terms topographic and bathymetric maps and discuss contour lines to make sure the concept is clear.

6. Have the students remove the water from their models and display the models with the maps.

Pass around a model and challenge the students to pick the map that represents it from the maps displayed on the overhead projector.

7. During this oral assessment of understanding, show an overhead projection which is 180 degrees opposite in perspective to the view the students have of the respective feature. This not only tests the students understanding of topography with respect to the orientation but also reinforces the value of compass directions on maps.

8. Have students use the Ocean Exploration CD or web site to find and list the expeditions that explore each of the geologic features listed here: ridge/bank, submarine canyon, seamount or mid-ocean ridge/rift. Have them finds maps and/or illustrations of the features in this exercise, print them out, label them and put them up in the bulletin board. Also look for bathymetric maps that show the same features.

Student Handout

Read ALL of the instructions first!

Materials:

- Model in quart plastic container: follow the instructions on the Underwater Feature cards to build the clay model in a square plastic food storage box using modeling clay
- Measuring cup or liter beaker of water
- Plastic funnel
- Centimeter ruler
- Overhead projector acetate
- Waterproof felt tip marker
- Masking tape
- Scissors

Procedure:

Read these instructions carefully. They contain new terms you will need for the Student Analysis Worksheet.

1. Build and install your model underwater feature in your plastic container.

2. Place the centimeter ruler inside the container against a side wall near a corner. Make sure that the highest number mark is at the BOTTOM. Use the tape to attach the centimeter ruler to the container side, taking care not to make the measurement lines unreadable.

3. Cut the overhead acetate to a size that completely covers the container. On one corner of the acetate, cut away enough material so that the funnel spout can just fit through.

4. Tape the acetate to the top of the container. Attach the tape only at a few edges of the overhead and not completely across the container opening. You will need to remove the acetate later so use only enough tape to hold it firmly.

5. Insert the funnel into the opening and tape it so it is securely in place.

6. Check your setup for approval by your teacher.

Student Handout

7. Draw a line on the acetate that correlates with the place the feature meets the bottom of the container. If it meets the side, do NOT draw a line.

8. Take the beaker of water and carefully add water through the funnel until the water level rises to 1 centimeter or 0.5 centimeters on the ruler.

Note: If you have a feature with high relief like a tall seamount, use 1 cm intervals. If you have a flat feature like a bank, use 0.5 cm intervals.

9. View the model by placing your eyes directly above it, looking downward. Focus on the outline of where the model and the water meet. Using the felt tip pen, very carefully draw this outline on the acetate. Label it with the cm shown at that depth on the ruler. The line that you draw is called a "contour line." Do not draw a line where the water meets the sides of the container.

10. Add another 1.0 or 0.5 centimeters of water. Again, look directly downward at the feature. Focus on where the feature and water line meet. Draw this contour line in the same way you drew the first one, following the line where the water meets the feature. You now have two contour lines which represent a 1.0 or 0.5 centimeter change in depth. Label it from the ruler measurement.

11. Continue adding water at centimeter intervals and drawing the contour lines at each 1.0 or 0.5 rise until the model is completely covered with water. You have created a bathymetric map of the model.

Student Handout
Underwater Feature Cards

Seamount
Volcanoes occur in the ocean too. If they build high enough above the ocean floor, they may form islands. The islands may weigh so much they eventually sink into the Earth's crust. Or they may not ever break the surface of the water. Either way, they may become seamounts—mountains under the ocean. Use your clay to make a volcano-shaped model mountain that is 6 cm high and not wide enough at the base to touch the sides of the plastic container.

Bank
Hard bottom features may rise above the continental shelf. Since many organisms need a hard surface to attach and grow, ridges or banks may be unusually rich areas. They may be large or small and may be quite irregular in shape. Use your clay to make a low mound that ranges from 0.5 to 2 cm high, covers about two thirds of the container bottom and has an irregular shape.

Submarine Canyon
Along the edges of the North American continent, the sea floor is shallow—forming an underwater plain that is very wide in some places and less so in others. Where rivers empty into the sea, canyons were cut into this plain when sea level was much lower during the Ice Ages. As sea level rose, the canyons became flooded. Use your clay to make a shallow sloping platform 4 cm high filling two sides of the container with the third side diagonal across the middle—the continental shelf. From the middle of the two sides, create a slope down to the bottom. Use a tool (dissecting needle or pencil) to cut a canyon that starts at the highest point in the corner between the two high sides and gradually gets deeper as it crosses the shelf. At the slope it should reach all the way to the bottom.

Mid-Oceanic Ridge/Rift
Make a flat bottom of clay about 1 cm deep from one color of clay. Make a thin rope about 1 cm in diameter of the same clay, rolling it in your hands. Lay a strip of the rope across the middle of the clay floor in the model ocean container. It should be about 1 cm higher than the floor. Use the second color of clay to make two flat sheets a little less than ½ the area of the container floor. Place one sheet down each side of the central "ridge" coming up to the middle but not touching so that the clay below shows through the middle. If the lower layer is red, you can think of it as glowing volcanic magma that flows up through the rift in the Earth's crust. In cross-section, there will be a small valley at the top of the ridge.

Student Handout
Underwater Feature Cards

Seamount
Volcanoes occur in the ocean too. If they build high enough above the ocean floor, they may form islands. The islands may weigh so much they eventually sink into the Earth's crust. Or they may not ever break the surface of the water. Either way, they may become seamounts—mountains under the ocean. Use your clay to make a volcano-shaped model mountain that is 6 cm high and not wide enough at the base to touch the sides of the plastic container.

Bank
Hard bottom features may rise above the continental shelf. Since many organisms need a hard surface to attach and grow, ridges or banks may be unusually rich areas. They may be large or small and may be quite irregular in shape. Use your clay to make a low mound that ranges from 0.5 to 2 cm high, covers about two thirds of the container bottom and has an irregular shape.

Submarine Canyon
Along the edges of the North American continent, the sea floor is shallow—forming an underwater plain that is very wide in some places and less so in others. Where rivers empty into the sea, canyons were cut into this plain when sea level was much lower during the Ice Ages. As sea level rose, the canyons became flooded. Use your clay to make a shallow sloping platform 4 cm high filling two sides of the container with the third side diagonal across the middle—the continental shelf. From the middle of the two sides, create a slope down to the bottom. Use a tool (dissecting needle or pencil) to cut a canyon that starts at the highest point in the corner between the two high sides and gradually gets deeper as it crosses the shelf. At the slope it should reach all the way to the bottom.

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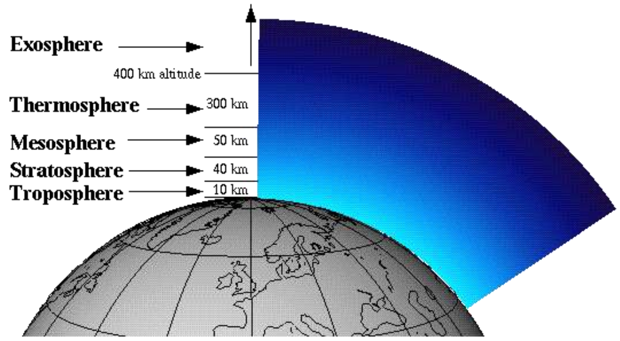
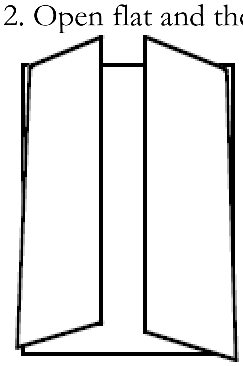
Layers of the Atmosphere Foldable



Introduction:
The atmosphere is divided into five layers. It is thickest near the surface and thins out with height until it eventually merges with space. Here's a brief description of each of the layers:
1) The troposphere is the first layer above the surface and contains half of the Earth's atmosphere. Weather occurs in this layer.
2) Many jet aircrafts fly in the stratosphere because it is very stable. Also, the ozone layer absorbs harmful rays from the Sun.
3) Meteors or rock fragments burn up in the mesosphere.
4) The thermosphere is a layer with auroras. It is also where the space shuttle orbits.
5) The atmosphere merges into space in the extremely thin exosphere. This is the upper limit of our atmosphere. *(From: http://www.windows2universe.org/earth/Atmosphere/layers.html)*

Instructions:
1. Fold a piece of light blue paper in half hamburger bun-style.
2. Open flat and then fold each side toward the center fold - shutter-style.



3, Color the long dark lines that represent temperatures changes: from the bottom -- blue, red, blue, red, representing decreasing, increasing, decreasing, increasing temperatures.
4. Carefully cut out the diagram of the atmosphere. Fold in half lengthwise and cut apart. Paste each half onto the front shutters of the light blue paper. Paste toward the bottom so you have room for a title at the top.
5. Cut the two parts of the title out and paste on the top of the shutters.
6. Cut out the boxes that contain the characteristics of each of the eight layers of the atmosphere. Paste inside the foldable under the correct layer. Be sure to put the main layers on the inside left and the minor layers on the inside right.
7. Cut flaps for each of the layers on the front shutters.
8. Carefully cut out the small sketches **ONE AT A TIME**. Read the words that tell you where to paste the sketch and paste to the front of the foldable on the diagram of the atmosphere.
Do NOT cut out the words that tell you where to paste each sketch!
9. Fill in the Name Tag and paste on the back.

Questions:

1. List the four main layers.

2. List the four minor layers.

3. Which two minor layers of parts of a main layer?

4. Which layer is the most important to you and why?

5. What two layers protect you?

6. Which layer acts like a giant magnet? What does it attract?

7. What does the air in the troposphere do as it heats up from the sun?

8. What cloud indicates the top of the troposphere?

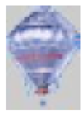
9. What runs along the top of the troposphere?

10. What attaches itself to this jet stream and, in a sense, tells you where the stratosphere begins?

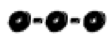
Blackbird SR-70
26 km

Boeing 747
12 km

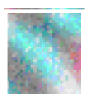
Balloon
5-7 km



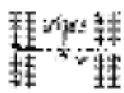
Ozone molecules
20-30 km



Aurora Borealis
100-250 km



Intl. Space Station
300 km



Flock of Geese
6-7 km

Weather
near the surface

Cirrus Clouds
16 km

Cumulonimbus
up to 16 km

Radio Waves
96-112 km

Meteors
48-80 km

Unmanned Spacecraft
3000 km

<u>TROPOSPHERE</u>

Temperature: DECREASES, 6.5 °C per km to about -60 °C

Characteristics:

1. Most weather occurs here where we live
2. Convection Currents

<u>STRATOSPHERE</u>

Temperature: INCREASES, to about -20 °C

Characteristics:

1. Contains most of atmosphere's ozone
2. Where jets and manned balloons have gone

<u>MESOSPHERE</u>

Temperature: DECREASES, -100 °C at top

Characteristics:

1. Protects Earth from meteors
2. Coldest region of atmosphere

<u>THERMOSPHERE</u>

Temperature: INCREASES, 2,000 °C at top

Characteristics:

1. Temps get up to 2000 °C
2. Air molecules are 1 km apart!

<u>OZONOSPHERE</u>

Characteristics:

1. Ozone is made of 3 oxygen atoms
2. Protects the surface from Sun's UV rays
3. Humans are causing Ozone depletion

<u>IONOSPHERE</u>

Characteristics:

1. Lower part of Thermosphere
2. Radio waves bounce back to Earth's surface

<u>EXOSPHERE</u>

Characteristics:

1. Upper part of Thermosphere
2. Artificial Satellites orbit here

<u>MAGNETOSPHERE</u>

Characteristics:

1. Earth's Magnetic Field
2. Causes Aurora Borealis (Northern Lights)

Layers of the Atmosphere

Name______________
Class______________
Date______________