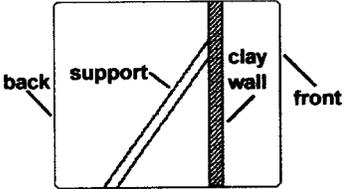
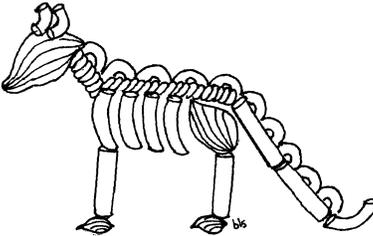
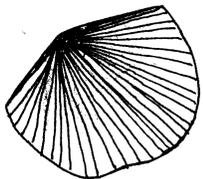
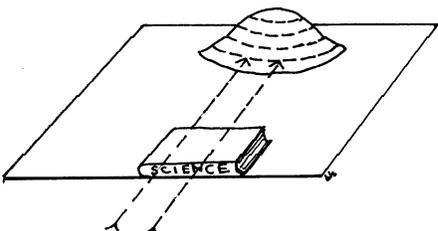
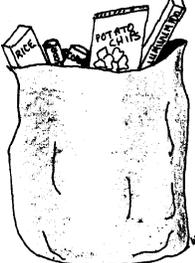
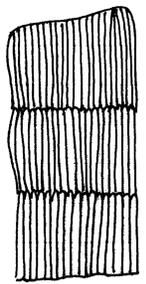
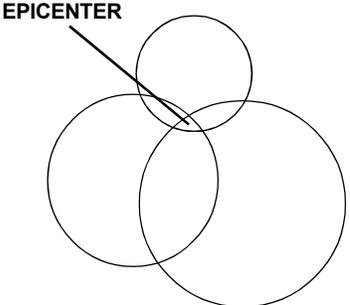
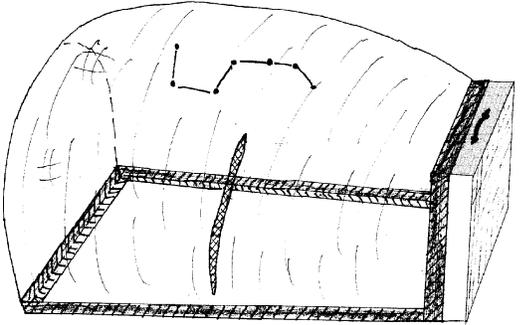




Adaptive Earth Science Activities



West Virginia Geological
and Economic Survey
Publication ED-13
1998





Foreword

In 1992 the National Science Foundation funded “Earth Science in West Virginia for the Twenty-First Century.” This program evolved into RockCamp, now funded by the West Virginia Geological and Economic Survey. RockCamp continually provides West Virginia K-12 teachers with experiential up-to-date earth science education. After graduating from an introductory session, participants are eligible to apply for advanced leadership sessions (RockCamp II) and field trip-based learning opportunities (RockCamp III, IV, etc.).

The word "adaptive" is not used lightly in the title. Some educators argue that the classroom implementation of new teaching ideas is not so much adoption as it is adaptation. RockCamp participants have volunteered to share some of their ideas with you. Your task is to imaginatively adapt their ideas for use in your unique classroom environment.

Tom Repine
RockCamp Director

A small committee of RockCamp graduates selected the activities in this book. Each reviewer was asked to select five activities from the 200 submissions. They then tested the five in their classrooms. **Adaptive Earth Science Activities** thanks them for their work, commitment, and energy.

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And the Winner Is...

by Elise Adkins

Logan Jr. High School

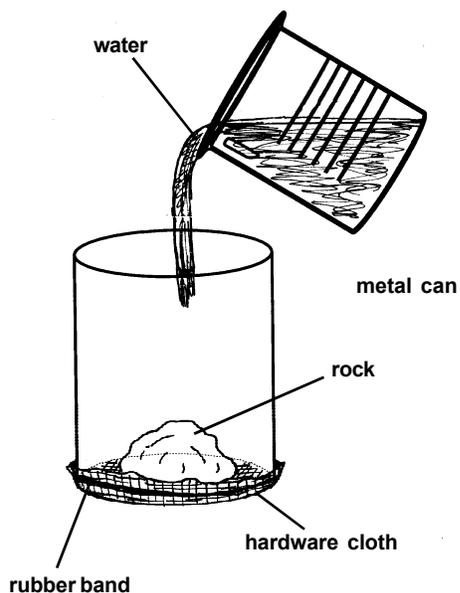
OBJECTIVE:

- To observe and compare the effects of running water on limestone and sandstone.

Materials and Equipment:

(For a group of two students)

- 2 small empty metal cans
- 2 pieces of hardware cloth
- 2 large rubber bands
- 1 vernier caliper
- Permanent marker or whiteout
- 3 collecting trays (dissecting trays, disposable aluminum pans, etc.)
- 1 piece each of sandstone and limestone (approximately same size)
- 1 half-gallon distilled water
- 1 graduated cylinder
- Notebook



TIME: 5 weeks at 5 minutes per class after the original set-up of 1 class period.

PROCEDURES:

1. Remove the bottom of the can. Cover the bottom of the can with hardware cloth and secure it to the outside of the can with a large rubber band. Repeat for the second can.
2. Trace the outline of each rock in the notebook. Measure the length, width, and thickness of the rock at various locations and record the data on the drawing. Mark the measured locations on the rock with a permanent marker or whiteout so future measurements can be repeated.
3. Place the piece of limestone in the can and label with the rock type. You can leave the rock in the can throughout the entire experiment.
4. Measure 30 ml of distilled water in a graduated cylinder. This water will drain into a collecting tray placed under the can.
5. Hold the can over the collecting tray and pour distilled water over the rock sample. Place collecting tray in a warm location to accelerate evaporation. Label the collecting tray limestone.
6. Repeat steps 2-5 for the sandstone sample.
7. As a control, pour 30 ml of distilled water in a collecting tray and place it with the others.
8. Repeat steps 4 and 5 a minimum of 15 times for each sample. Use only the first runoff for evaporation. Discard all runoff thereafter.
9. Remove each rock from the can.
10. Measure the marked locations; record data. Compare to the original.
11. Trace the outline of each rock; record measurements at marked locations. Compare data to the original.
12. Have students discuss the results and explore reasons for change.

ASSESSMENT:

- Students are to keep a record of procedures and measurements in a notebook. After all measurements are complete,

a chart should be compiled to ease interpretation of the information. Students are to write a brief summary of their conclusions. Possible questions to consider to help with the write-up are:

1. Have the dimensions of the rock samples changed?
2. If so, what could be responsible for these changes?
3. Did the dimensions of one rock change more than the other?
4. Is there a residue in the collecting tray(s)?
5. What do you think the residue is?
6. Where did it come from?
7. What would happen if water passed through the soil and layers of limestone underground for thousands of years?

Further Challenges:

- Compare the beginning and the ending mass of each rock sample. Calculate the percentage of mass loss in each sample. (Allow rocks to dry before taking the mass.)
- Use an equal mass of small limestone and sandstone pieces in each can. Pour 200 ml of distilled water through each sample and collect the runoff in a collecting tray. Allow water to evaporate. Compare the residue to that left when the same amount of distilled water is evaporated.



Latitude and Longitude

by Brenda Anderson

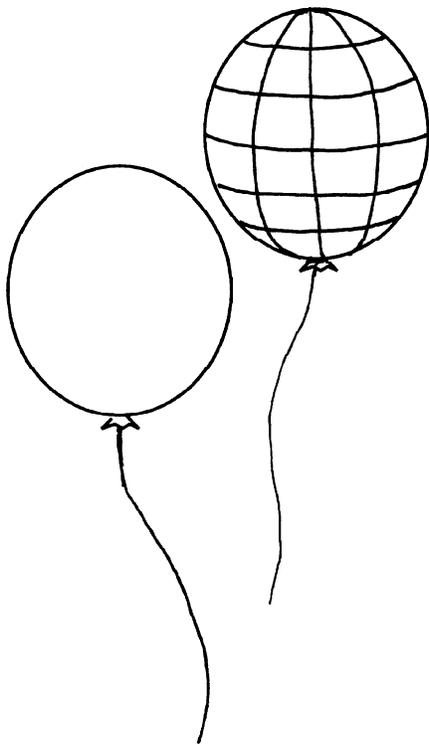
Oceana Middle School

OBJECTIVES:

- Create latitude and longitude lines on a balloon, determine measurements in degrees, and use the lines to locate places as well as learn to use time zones.
- Understand imaginary lines of longitude and latitude and understand how these lines help in locating places on a round surface.

Materials and Equipment:

- Large round balloons or balls (plain, no writing)
- Permanent markers
- Atlases
- Worksheet of places to identify



TIME: 2 to 3 class periods of 40 minutes each.

PROCEDURES:

1. Divide the class into groups of two. Pass out a balloon and two permanent markers of two different colors to each group. (Use permanent markers so lines will not wipe off immediately.)
2. Have students blow up the balloon and tie it off. Use the tied part as the North Pole and the other as the South Pole. Working with these two points, draw a ring around the center of the balloon for the Equator and mark with "0" and "Equator."
3. Draw a line halfway between the Equator and each pole. Have students identify this as the 45° north and south latitude lines. Draw another line between the pole and each 45° latitude line. Have students calculate this to be the 45°/2 or 22½° north and south latitude lines. What is the value of the latitude line between 45° and each pole? $[(90^\circ - 45^\circ)/2 = 22.5^\circ + 45^\circ = 67.5^\circ]$. Continue this until a sufficient number of lines are on the balloon. Make sure each latitude is labeled with "North" or "South" and value in degrees.
4. Draw a line from the North Pole to the South Pole. Mark this with "0" and the "Prime Meridian." Then mark a half circle on the other side of the balloon directly behind the Prime Meridian. Label this "180°" and the "International Date Line." Repeat the halving process and then create additional longitude lines. Mark off these longitude lines on the balloon using care to keep the lines as straight as possible. Do this on both sides of the Prime Meridian.
5. Students have now gridded their balloon just as a globe of the earth is gridded. They are now ready to work with these lines to place specific towns on the globe. Using an atlas, look up the longitude and latitude of well-known cities of the world and mark them on the balloon globe.

ASSESSMENT:

- Using a short verbal exchange, determine if the students have distinguished the difference between latitude and longitude lines.
- Deflate one of the balloons. Lay it out as flat as possible. Compare and contrast the appearance of the flat balloon grid with the spherical balloon grid.
- Have students describe the geometric shape made by longitude lines at the Equator and poles. Why does this occur? Can they explain why a map of a polar region might show a different-sized area than a map of the equatorial region?



Core Sampling

by Suzanne M. Anderson

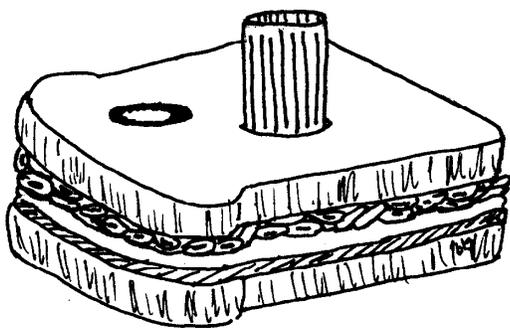
Worthington Elementary School

OBJECTIVES:

- *Infer from formulating a model that studying cores is one way to interpret Earth's history*
- *Model core sampling using a pasta noodle*
- *Model a sedimentary rock formation*

Materials and Equipment:

- Different breads (white, wheat, banana nut, etc.)
- Various spreads (peanut butter, jams, jellies, fresh fruit, etc.)
- Cereal (Rice Krispies, Cheerios, etc.)
- Plastic bags
- Plastic knives
- Paper towels
- Permanent markers (to mark bags)
- Manicotti or other large tube-shaped noodles
- Paper
- Colored pencils
- Straws (optional)
- Refrigerator



Sedimentary rocks are formed from loose particles that have been carried from one place to another and redeposited. These rocks generally are deposited in layers similar to the layers in a sandwich. Each layer can be identified by differences in color, texture, and composition. The oldest layer is the lowest (bottom) layer while the youngest layer is on the top. Over time the loose particles become compacted and cemented together to form layers of solid rock.

Evidence of change through time comes from the core samples that show layers of rock that make up Earth's crust.

TIME: Two class periods, 30-45 minutes long (including discussion).

PROCEDURES:

1. Have students bring in as many of the food items on the materials list as possible. You will need enough materials for pairs of students.
2. Construct the "sedimentary rock" sandwiches. Cereal within the layers can represent large particles or fossils.
3. Have students write their names on the plastic bags. Place the sandwiches inside the bags and store the sandwiches in a refrigerator until the next day. (The bread will harden a little and the layers will not slide around as much if the sandwiches are refrigerated.)
4. Next day, have students make core samples using the noodle as coring devices. Use the noodle to cut through the sandwich. The sandwich pushed up inside the hollow noodle is called a "core sample". To get the sandwich out of the noodle, break the noodle gently. (You could use straws to gently "plunge" the sandwich out of the noodle.)
5. On a sheet of paper have the students draw a picture of the "core sample." Color the different layers according to a predetermined legend (brown for peanut butter, red for jelly, etc.), and label them. Inform students that they have created a "strip log"--a useful tool made by geologists to model rock units.
6. Have students compare strip logs. Can they interpret the sequences of their classmates' sandwiches?

ASSESSMENT:

- Evaluation can be based on teacher observation of students' performance and cooperation, evaluating the drawings, and both written and oral questions. Student journals including all work, legends, and the interpretation of classmates "cores" are helpful.



Analogy of Relative Humidity

by Pamela Blackford

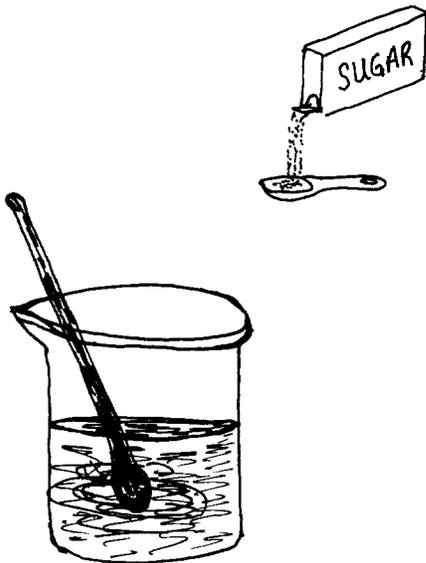
Martinsburg High School

OBJECTIVES:

- *Develop a graph with experimental data that will help students construct their own definition of the relationship between air temperature and the amount of water the atmosphere can hold.*

Materials and Equipment:

- 30 beakers
- Sugar
- Measuring spoons (10-15)
- Hotplates
- Graph paper



TIME: 25-45 minutes.

PROCEDURE:

1. Place students in small groups. Each group will need 3 beakers, a supply of sugar, and 2 spoons. (You can have the students bring water to a boil or you can have a large common container of boiling water available.)
2. Record observations in a journal.
 - a. 1st beaker:**
 - Heat water to boiling or get some boiling water from the common container. Measure and record temperature.
 - Add 1 teaspoon of sugar at a time to the water and stir. Does it all dissolve?
 - Continue to add sugar one teaspoon at a time until all the sugar no longer dissolves.
 - Record your observations.
 - b. 2nd beaker:**
 - Using water which is at room temperature, stir in one teaspoon of sugar at a time until all the sugar no longer dissolves. How many teaspoons of sugar did it hold?
 - c. 3rd beaker:**
 - Repeat steps above using ice-cold water. How much sugar did it hold? Measure and record temperature.
3. Students will use their data to make a graph showing the relationship between the amount of sugar dissolved and the temperature of the water.
4. After the graph is completed, provide students with a water temperature. Ask them to use their graph to estimate the amount of sugar that can be dissolved in it.
5. Verify the estimate through experimentation.
6. Plot the results on the graph. Ask student to suggest possibilities for any differences found between estimate and experimental result.
7. Repeat steps 4, 5, and 6 with another water temperature.
8. Ask the students to explain the relationship on their graph.
9. Have students look up the definition of relative humidity.
10. Ask students to relate their results to develop a simple definition of relative humidity.

ASSESSMENT:

Journals are reviewed according to the following scale.

- A. Journal very complete, neat, well written. Student's ideas are supported by observations.
- B. Journal complete, neat, needs some grammatical work. Most ideas are supported by observations.
- C. Journal lacking some information, not very orderly, needs major grammatical work. Very few ideas support by observation.
- D. Journal incomplete. Observations lacking. Very few ideas presented. None supported by observations.



How Much Lime is in Limestone?

by Mary Sue Burns

Pocahontas County High School

OBJECTIVES:

- Determine the percent composition of lime (calcium oxide) in a limestone sample.
- Determine the best economic use for a particular type of limestone.
- Recognize the integrated nature of chemistry and geology.

Materials and Equipment:

(Class of 30 working in pairs)

- 30 safety goggles
- 30 lab aprons
- 30 beakers (250 ml or others)
- 30 pieces of filter paper (15 of these for Step #9 must be high quality for very small particles)
- 15 funnels
- 15 graduated cylinders
- 15 stirring rods
- Centigram balances
- Limestone samples (use local samples that students bring in or teacher supplied. Samples should be crushed or chipped.)

Reagents:

(Amounts are approximate)

- 300 ml 6M hydrochloric acid
- 400 ml 0.5M ammonium oxalate
- 150 ml ammonium hydroxide
- 5 ml methyl orange indicator (pH meter or pH paper may be substituted)

Limestone (CaCO_3) is primarily made of calcium carbonate. Lime (CaO) is this carbonate minus carbon dioxide. Limestone is an important economic resource. Appropriate uses depend on the chemical composition of the sample, primarily the CaO content. For example a cement company in Martinsburg, WV uses the New Market limestone, which has a very high CaO content, mixed with the Chambersburg limestone which has a CaO content that varies from 38% to 52%. The final product will have a CaO content of 58% to 65%. Dolomitic limestone, which contains less CaO and more MgO , is not suitable for cement-making and is primarily used as aggregate (road bases, concrete, railroad ballast, etc.).

The procedure that follows is not intended to give a precise quantitative measurement of the CaO content. However, with care, student results should be adequate for comparison and for determination of appropriate economic uses. All metallic compounds will be dissolved in the hydrochloric acid. Any insoluble material, at this step, will consist primarily of silicas. Addition of the ammonium oxalate precipitates calcium as calcium oxalate. Most everything else stays dissolved. The mass of the calcium oxalate can be used to calculate the CaO content of the original sample.

This lab is not difficult for students who have prior experience working in the chemistry lab. It does require that students are familiar with basic techniques including measuring mass and volume, filtering, and use of reagents.

Many textbook chemistry labs are very abstract to students. The practical application, stressed in this lab, should add relevancy to previously learned skills and concepts. This activity would benefit both chemistry students and earth science students.

TIME: 40-60 minutes plus additional time to allow filter paper to dry.

PROCEDURES:

1. Put on safety goggles and lab aprons.
2. Find the mass of a sample of limestone. Use about 0.5 grams. Record the mass to the nearest 0.01 gram (or 0.001 gram, if possible).

3. Place the sample in a beaker. Add 20 ml of 6M hydrochloric acid. Wait until all bubbling stops.
4. Add a very small amount of additional hydrochloric acid. If bubbling occurs, wait until it stops and continue to add a small amount at a time until no more bubbling occurs.
5. Filter the solution into a clean beaker to remove any insoluble residue.
6. Slowly add 20 ml of 0.5M ammonium oxalate to the filtrate in the beaker.
7. Add about 2 drops of methyl orange indicator to the beaker.
8. While stirring, gradually add ammonium hydroxide to the beaker until the contents just turn yellow. Add an additional 5 ml of 0.5M ammonium oxalate.
9. Measure and record the mass of a clean piece of filter paper. (Use type that will filter out very small particles.)
10. Filter the contents of the beaker using the massed filter paper.
11. Allow the filter paper to dry thoroughly.
12. Measure and record the mass of the filter paper and precipitate.
13. Calculate the mass of the precipitate by subtracting the mass of the filter paper. (This is calcium oxalate monohydrate.)
14. Calculate the CaO content of your sample by multiplying the mass of the calcium oxalate by 38.39%.
15. Calculate the percent CaO in your original sample.
16. Write a statement describing an appropriate economic use for the type of limestone you tested. Compare the composition of your sample with those tested by classmates. Back up your statement with evidence gained in the chemical analysis.

SAFETY NOTE: Skin contact with these reagents should be avoided. Should it occur, rinse the affected area with large amounts of water. Also, this lab should be performed in a well-ventilated area. All safety procedures for a high school chemistry laboratory should be followed.

ASSESSMENT:

- Students results can be compared for consistency of results and to known ranges of CaO content. Student tests of New Market and Chambersburg limestones fell within known ranges.
- Students should be able to describe an economic use for limestone consistent with their results.

- Lab results can be checked for completeness.
- Follow-up activities can ask students to describe an example of the importance of chemistry in evaluating geologic resources.

Teaching Suggestions:

- Do this as a microscale lab using a wellplate and smaller quantities. Use the same mass for each sample and compare relative amounts of calcium by estimating the height of the precipitate in the wells.
- Maximum precipitation of calcium and minimum precipitation of everything else occurs at a pH between 3 and 4.5. A pH meter, pH paper, or other indicator could be used in place of the methyl orange.
- The heating of the solution, to 80-90 degrees celsius before proceeding to Step #6 will increase the size of the calcium oxalate crystals. They form very quickly from cold solutions and are small enough to go through ordinary filter paper. This requires more time and more safety precautions, but should increase the accuracy of results. **A fume hood is recommended during the heating and during the addition of ammonium hydroxide to the warmed solution.**

Further Challenges:

- Estimate the silica content of the sample by saving, drying, and weighing the insoluble residue from Step #5.
- Save the filtrate from Step #10 and analyze for magnesium content.
- Have students write chemical equations for the reactions that take place.
- Have students use solubility tables to explain the rationale behind the method of retrieving the calcium.

Parking Lot Gravel

by Mary Sue Burns

Pocahontas County High School



Gravel parking lots are an easily accessible but often overlooked geologic resource for teachers and students at most rural schools. The type of gravel found is usually indicative of an abundant nearby source. So, even though it is not *in situ*, it does give some clues about local rock types. In this way, comparisons can be made about different regions. This is also a good way to begin considerations of human impact on the land and the use of natural resources. In this activity, models are used to determine why gravel is used on parking lots.

TIME: 30 minutes for Pre-lab and Procedures; 30-60 minutes for Further Challenge.

PROCEDURES:

Pre-lab preparation: Cut the top off of two of the soda bottles close to the curve. Use a graduated cylinder or measuring cup to measure out a known quantity of water. Pour this into the soda bottle and mark this level with a marker. Do the same to the other soda bottle. Cut the bottom off of the other two bottles. Using the rubber bands, put netting over the mouths of the two bottles that still have tops. Invert these into the first two bottles. A small hole must be cut in each of the lower bottles in order to allow air to escape during the investigation.

The following may be done in groups or as a whole class experiment:

1. Place some gravel in the top section of one of the soda bottle columns.
2. Put soil in the other column to the same level.
3. Pour water into the top of the gravel column, timing how long it takes to reach the marked level; or time how long it takes for a certain quantity of water to drain through. Repeat for the soil column and any other materials. Record data and observations.
4. Students should provide a well-worded hypothesis to explain the observations and data.
5. The economic and environmental impact of simple crushed stone versus soil versus pavement should be explored.

OBJECTIVES:

- Increase awareness of human impact and use of a natural resource.
- Use models to observe differences in properties of materials.
- Determine why gravel is in parking lots.

Materials and Equipment:

- 4 plastic soda bottles (1 or 2 liter)
- Plastic or cloth netting (gauze or cheesecloth)
- 2 rubber bands
- Gravel
- Soil
- Sand, asphalt, clay, or other material (optional)
- Container for water
- Timer or watch
- Sample data table (sample included)

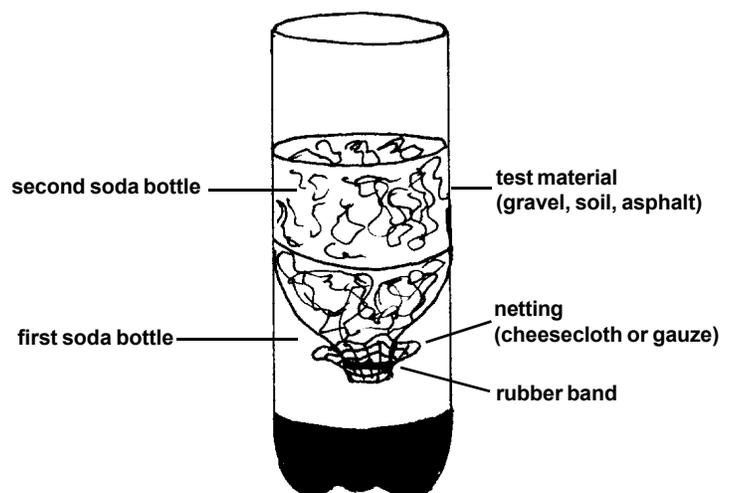
ASSESSMENT:

Tell students they are preparing a report for an environmental company evaluating parking lot construction. Students can prepare a short written description of their findings. In the course of their paper, they seamlessly incorporate answers to the following questions:

- What would happen to rain that landed on packed soil? Describe what a dirt parking lot would look like after a heavy rain.
- What would happen to rain that landed on a parking lot that was covered with a thick layer of gravel? What would this parking lot look like after a heavy rain?
- Many parking lots are paved. What would be the advantages of this? What would happen to rain that landed on a paved parking lot?
- Why do people put gravel on parking lots?

Teaching Suggestions:

- Use a key or field guide to identify the rock types in the samples.
- Use a geologic map showing exposed rock types and locate the collection sites for the samples. Is there any correlation between the exposed rock types and the gravel sample?
- Test the pH of water before and after it runs through the gravel sample.
- Observe gravel samples from other states. Compare these and hypothesize why they are different or similar.



Further Challenge:

- Is all parking lot gravel the same?

Further Challenge Questions:

- a. Describe the properties of the rocks in your gravel sample. Include any similarities and differences that you noticed.
- b. Did any of your observations give any clues about the type of place where this rock was formed or where this rock has been?
- c. Compare your sample to those of the other groups. Is there anything that is unique about your sample? Explain. Describe the similarities and differences among the various samples.

Materials:

- Various samples of gravel (these could include student- or teacher-collected samples. Samples could be collected as a class activity).
- Each group of students conducts an open-ended investigation to determine as much as possible about the properties of the gravel pieces in a given sample. Students should also look for weathering effects and fossils. Each group presents their findings and explanations of the rocks' geologic and economic history.



Groundwater Flowmeister

by Timothy A. Butcher

Williamstown High School

OBJECTIVES:

- *Learn how water flows through the ground and its effects on stream levels.*
- *Learn how contaminants seep into groundwater and affect water supplies.*

Materials and Equipment:

- Clear plastic or glass container (4" x 12")
- Fine sand
- Small gravel
- Fresh modeling clay
- Plastic cup
- 20 oz. plastic bottle
- Food coloring
- Spray pump (cleaned)
- Smoother (cardboard or plastic)
- Straw
- Gauze bandage
- 3' rubber hose
- Nail
- Knife/scissors
- Water
- 8" x 12" sheet white paper

Contrary to the belief of many, groundwater is not usually found in underground streams as we see in caverns, but is stored in layers of porous rock, flowing at about 4 cm/day.

Groundwater is often viewed as a limitless resource which will remain constant regardless of rainfall. Knowing water is stored in rock, the water must somehow move into this aquifer and replenish itself. Through rainstorms, the supply of groundwater is replenished or recharged at the high point in the watershed. Groundwater usually flows to lower elevations and fills streams, ponds, etc.

However, in time of drought the aquifer is not recharged, dropping the water table and causing the level of the stream/lake to fall. This drop in water level may result in residential wells going "dry" (the water level is too low for a pump to function).

The amount of rainfall is not the only item which affects the water table. People are currently using groundwater and over-drilling aquifers at such an alarming rate that we can cause water tables to dry. Some refer to this as "water mining." Home owners and industry, especially agriculture, are combining to place an enormous stress on the water table.

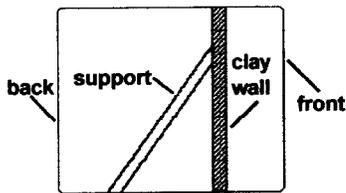
We live in a society of buried waste and storage tanks. These waste products and tanks often leak, very quietly, tons of toxic chemicals into our water table, contaminating a great area. The Environmental Protection Agency estimated that between 1950 and 1975, 5.5 billion metric tons of hazardous waste were spilled onto or buried in dumpsites throughout the United States. These have a great probability of eventually winding up in our groundwater supply.

TIME: Construction 1 hour; activities one to five 50-minute classes.

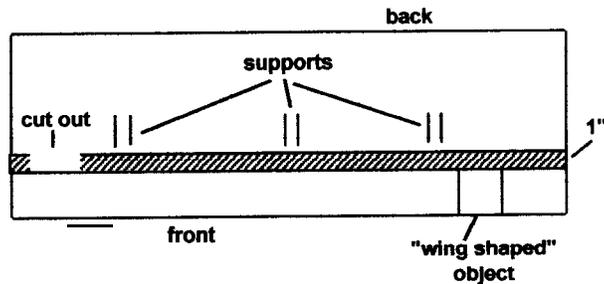
PROCEDURES:

Flowmeister Construction

1. Divide the clear container with a modeling clay wall, so you have approximately a 1" channel on the front side. The clay wall should be about 1/4" thick. To reinforce the wall, roll clay to make supports.

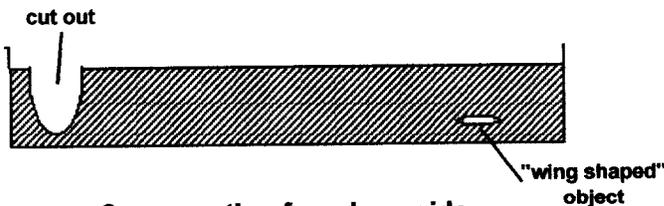


Cross section from narrow end.



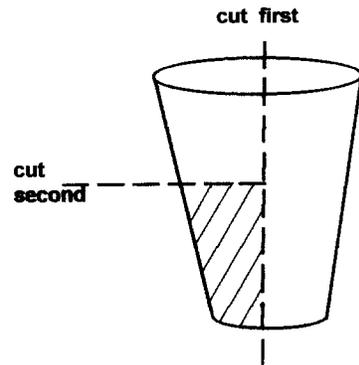
"Birds eye" view from long side.

2. Taper the edges of the clay against the container by running your finger down the border between the clay and container, making a firm bond between the two.
3. Cut out a small portion of the wall on the left side, so that only 3/4" of clay is left to the bottom.

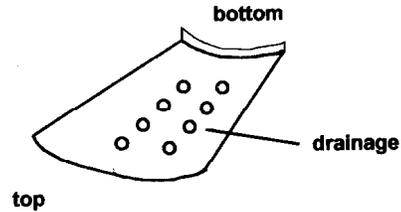


Cross section from long side.

4. Construct a clay object in the shape of a wing. Attach the clay object to the clay wall approximately 3/4" from the bottom. This represents an impermeable object.
5. Cut the cup in half so each side has a top and bottom portion. Then cut the top half off of one side.
6. Cut the bottom of this piece, leaving a 1/4" ledge.



- Using the nail or scissors, punch 5 holes in the side to allow for drainage.



- Place sand on the bottom, producing a small incline. Use a smoother to smooth this layer. A smoother can be a piece of cardboard or plastic.
- Place the plastic drainage piece against the clay wall lying flat on the sand. Turn a small portion of clay over the cup's lip. This will create a stream bed.
- Fill remaining channel with gravel.
- Poke a hole in the bottom of a 20 oz. bottle. Place a finger over the hole, fill with water, replace lid and sit upright on a paper towel.
- To remove water from the back, place one end of the rubber hose in reservoir and the other in a bucket. Start siphoning by using your mouth or a hand pump.

Using the Flowmeister

To Produce Stream Flow:

- Place the bottle on the right end of the container so the hole is exposed over the soil layers.
- As water flows, observe the spread of water across the aquifer into the stream bed.

To Demonstrate Drilling and Using a Well:

- Cut straw into 3" sections.
- Drill a well by pushing the straw into the soil layers.
- Place gauze in spray pump tube (keeps out sand).
- Insert spray pump into well and start pumping.

To Demonstrate Contamination:

1. Take eye dropper and place drops deep in the soil for deep contamination or take eye dropper and place drops on surface for surface contamination.
2. Watch it spread and notice the events which happen around the clay.
3. Use spray pump to pump water supply from soil. Observe how groundwater becomes contaminated.
4. Spray contaminate onto white paper.

Calculations:

1. Speed at which water contaminations flow.
 - Measure time and distance of water flow and use formula: $\text{speed} = \text{distance}/\text{time}$.
 2. Area which contaminate covers.
 - Measure the length, width, and height. This may have to be estimated.
- What are some problems a well may encounter?

Further Challenges:

- Turn bottle off to simulate no rain. Watch what happens to the water level.
- Open bottle lid so stream flows out bottom of bottle. This simulates a major thunderstorm (flood).
- Build barriers to stop contamination.

ASSESSMENT:

- Can students accurately describe the movement of groundwater through rock?
- Presented with definitions of the terms "porosity" and "permeability," students are able to complete a written assignment comparing and contrasting the porosity and permeability of various rock types relative to stream recharge and toxic waste disposal and clean-up.

**Assessment Questions to be Answered from
Recorded Student Observations:**

- How does water flow through the ground?
- What types of contaminants will seep into groundwater?
- Describe how a contaminant might affect a water supply for a city, in a housing development, or in a single-family home with well water.
- How does groundwater affect stream (pond) levels?
- As the dye flows, describe the path it follows.

Epicenters

by Jo Ann Byron

Shady Springs Junior High



TIME: Preparation and one 45-minute period.

PROCEDURES:

1. The mathematical solution for each situation is calculated as follows:

Arrival time of S-wave minus arrival time of P-wave times 60 seconds per minute times 2 miles per second (speed of S-wave) times 3 miles per second (speed of P-wave) equals the distance of epicenter from seismograph.

By doing some of the fixed calculations first, a short version of the previous equation would be:

Arrival time of S-wave minus arrival time of P-wave times 360 equals distance to epicenter from seismograph.

2. Here are some representative data for students to use for practice.

	P-waves	S-waves	Distance from epicenter	
Hawaii	12:00	12:09	<u>3240</u>	miles
Alaska	11:08	11:14	<u>2160</u>	miles
California	10:43	10:48	_____	miles
Cuba	10:00	10:10.41	_____	miles
Iceland	10:01	10:07.94	_____	miles
Italy	10:02	10:10.33	_____	miles

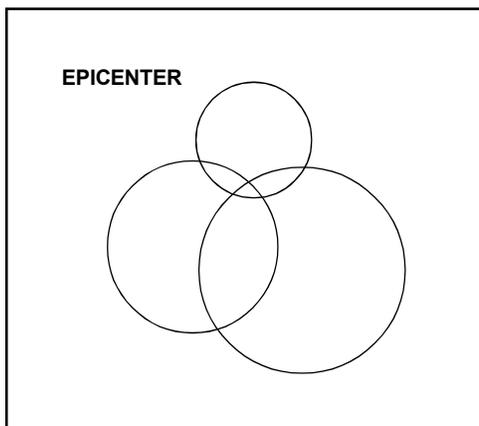
3. Use a world map with a scale. Have students draw circles, to scale, around each of the locations given in the chart. The radius of their circles should be equal to the calculated distance from the earthquake epicenter. The common point defined by an overlapping of circles reveals the geographic location of the epicenter.

OBJECTIVES:

- To calculate distance to epicenter from seismograph using arrival times of P-waves and S-waves.
- To find on a map the location of the epicenter of an earthquake.

Materials and Equipment:

- Compass
- World map
- Ruler, edge of paper, or string
- Calculator (optional)



ASSESSMENT:

- Students can accurately calculate the distances from the epicenter.
- Students correctly identify the location of the epicenter.

Further Challenge:

- A tsunami is a seismic sea wave that can be caused by an earthquake. They travel an average of 400 miles per hour. To determine how long it will take a tsunami to hit a given area, divide 400 into the distance from the epicenter to the “hit” area.

Star Gazing Inside

by Barbara A. Cline

Jefferson Elementary Center



Commercially available inflatable planetariums are expensive to buy or require reservations for borrowing far in advance. This homemade version is inexpensive, flexible, and fun to make. Older students can make the planetarium. Teachers will have to construct it for younger students.

TIME: Pre-class setup and 5 minutes per student groups of 3 for viewing.

PROCEDURES:

1. Take two plastic sheets and put one on top of the other.
2. Tape all four edges of the sheets together using duct tape.
3. Cut a hole half the size of a floor fan in one end of the plastic.
4. Tape the sheet to the floor fan.
5. Inflate planetarium by turning on the fan.
6. Cut a slit in the side of the inflated planetarium. This allows students to enter the planetarium to view the sky.
7. Make a sun and attach to the top of the fan.
8. Cut out the planets and arrange them in scale distance from the sun on top and outside of the planetarium.
9. Use star stickers to "draw" a model of a constellation onto the transparency or plastic wrap (Saran Wrap works best). Then tape the transparency constellation or plastic wrap constellation to the outside and top of the planetarium. Have the constellations match the night sky at the time you use the planetarium.
10. Darken the room, enter the planetarium, and use a flashlight to find the night space objects.

ASSESSMENT:

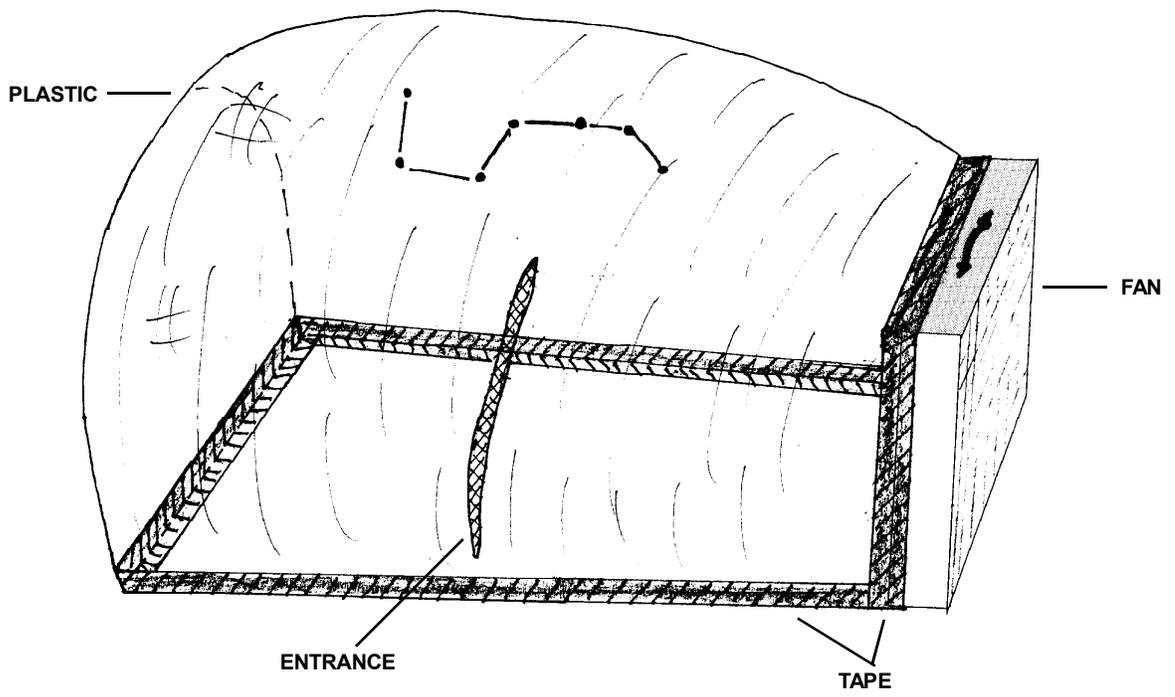
- Sketches of constellations should help student recognize them during a review process.

OBJECTIVES:

- To construct an inexpensive classroom planetarium.

Materials and Equipment:

- 2 plastic sheets 10' x 10'
- Duct tape
- Floor fan
- Extension cord
- Scissors
- Scale models of the planets
- Constellation patterns
- Star stickers
- Transparent tape
- Flashlight



Let's Talk Trash

by Melanie Files

Berkeley Springs High School



In areas where recycling is stressed, about 50% of the population recycles the allowed materials. What isn't recycled or reused is pitched in the trash.

TIME: One 60-minute class period.

PROCEDURE:

1. Empty the contents of the bag onto the table.
2. For each item indicate in your journal at least one way that you could:
 - a. *reduce* the use of the item.
 - b. *reuse* the item (*recycle* the item).
 - d. *pre-cycle* (choose not to use/buy the item) and tell why.
3. After you have completed the journal entries, compare and discuss the ways the items could be used and reused.
4. Construct something using *all* of the materials, including the bag they came in!

ASSESSMENT:

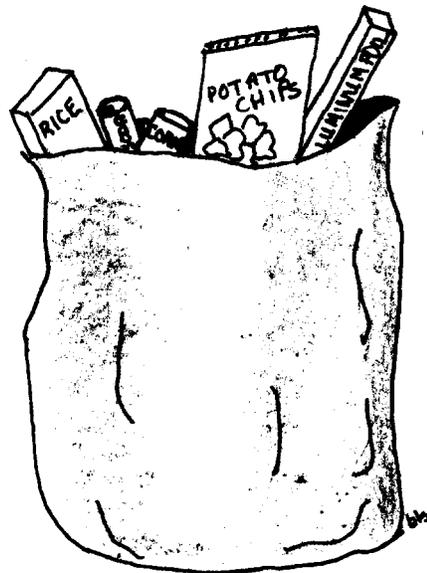
- Completeness of journal description and tables.
- Demonstrate student understanding of key terms by writing a short essay on recycling.

OBJECTIVE:

- *Inspecting a bag of trash.*
- *Deciding how to recycle or dispose of the contents.*

Materials and Equipment:

- One bag of trash (supplied by instructor)
- Scissors
- Glue
- String
- Staples/tape





Contour Line Activity

by Billie Diane Frame

Martinsburg North Middle School

OBJECTIVES:

- Develop the concept of representing the earth, or small portions of the earth, on paper.
- Explain scale as representations in miniature form.

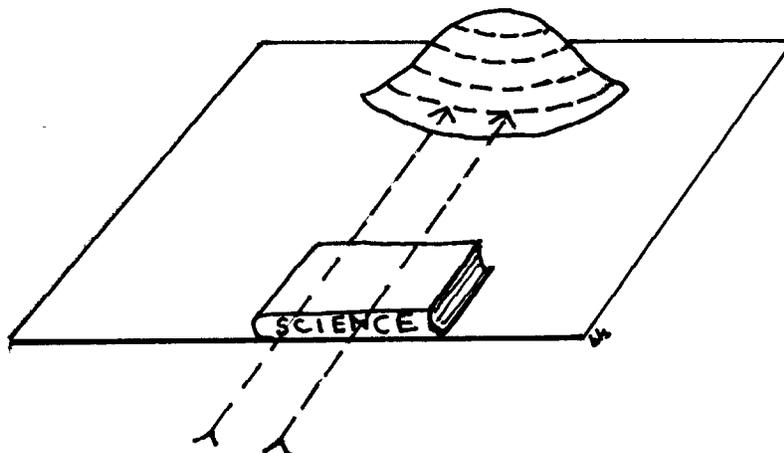
Materials and Equipment:

- Clay (various colors)
- Pencil
- Paper
- Thick book
- Thin book
- Piece of cardboard
- Colored pencils
- Toothpick

TIME: One 50-minute class period.

PROCEDURE:

1. On the piece of cardboard, form the clay into the shape of a mountain. Include hills and valleys, steep slopes and gradual slopes.
2. Lay a thick book on the table beside the “mountain.”
3. Have the student sight across the book to the mountain and put marks all the way around the mountain at the same level as the top of the book.
4. Draw a line around the mountain with a toothpick, connecting the marks made in step #3.
5. Have the student stand above their mountain and look directly down at the line just drawn. Ask these questions: Does the line form a circle? What shape does it form? What might the line represent?
6. Use a thinner book and draw a line further down the mountainside.
7. Stack two books and draw a line further up the mountainside.
8. Have the student stand over their mountain and look down at the contour lines. Ask the question: Are the lines the same distance apart all the way around the mountain? Where are they closer together? Where are they further apart?
9. Have the student draw two views of their mountain on paper. One will be a sketch of a profile of the mountain. Ask them to devise a way to show what the mountain looks like from an airplane. When finished tell the students they have drawn a *Contour Map*.



ASSESSMENT:

- Journal entries describe the activity and results. Entries must be concise, legible, accurate, and useful. A table of contents must be included and the pages numbered. A student definition of a contour line, what it represents, and some properties of contour line spacing should be included.
- Student must demonstrate an understanding of contour lines and contour maps by describing the landforms observed on an assigned map. These observations will be entered in the journal.
- Evaluation is also based on teacher observation, discussions with the student(s), and peer-group contract grading.

Teaching Suggestions:

- Modifications can easily be made depending on the grade level or the individual ability/interest of the students. Topographic maps and symbols can be introduced. Schedule a spokesperson from the state geological survey to present a program to the class. Contact a local surveyor and plan a local field trip to an on-sight surveying business.
- The teacher's objective is not to present a thorough treatment on map reading, but to develop the concept of representing the earth on paper that can lead into further discussion and maps activities.
- Review all directions orally. Display them in the room at the same time. This will alleviate questions that may occur during the activity. Designating stations within the room and letting the students work cooperatively in groups will provide optimum learning situations for all.

Further Challenges:

- As an extension activity, have the student exchange contour maps with a classmate. The student will look at the classmate's map only (not the clay model). They should each try to visualize and sketch what the other's mountain looks like just by looking at the map drawing. (Then they can look at the actual mountains and see if they were right.)
- At this point, each classmate can try to construct a new clay model using the contour map and the original materials

only. When models are complete, comparisons can be made for accuracy.

- More contour lines can be added by stacking various width books. Just remember to keep all lines from intersecting each other.
- Information obtained through constructing a model or exchanging maps with classmates can be charted or graphed. The entire class can assemble their hills and valleys to create a landscape. Locating some of the highs and lows on the earth will help the student visualize their planet.

Our Earth's Address

By James Giles

Craigsville Elementary School



TIME: 45 minutes.

PROCEDURES:

1. Arrange the class into groups of four.
2. Select one group to cut a piece of yarn that will reach across the room. Have them tape it across the center of the room from east to west. Tape the yarn about six feet from the floor. Label the yarn the "equator." Discuss aspects of the equator with the class.
3. Select another group to cut a piece of yarn (use a different color). Ask them to tape it across the center of the room perpendicular to the equator (north to south). Label this line the "prime meridian." Discuss the aspects of the prime meridian with the class.
4. Instruct the students to make longitude lines that will divide each row of students. Use the same color yarn used to make the prime meridian.
5. Instruct the students to make latitude lines that will divide the class into a grid system. Use the same color yarn used for the equator. When completed, each student will be inside their square.
6. After the class has built the latitude/longitude system, there are several concepts that can be taught using the grid pattern:
 - Latitude/Longitude;
 - Room location of each student;
 - World wind patterns;
 - Climate zones by latitude;
 - Your city/town address by latitude and longitude;
 - Continent hemisphere locations;
 - Different hemisphere locations;
 - Compass direction from the classroom;
 - Plate tectonics;
 - Topographic maps.

OBJECTIVES:

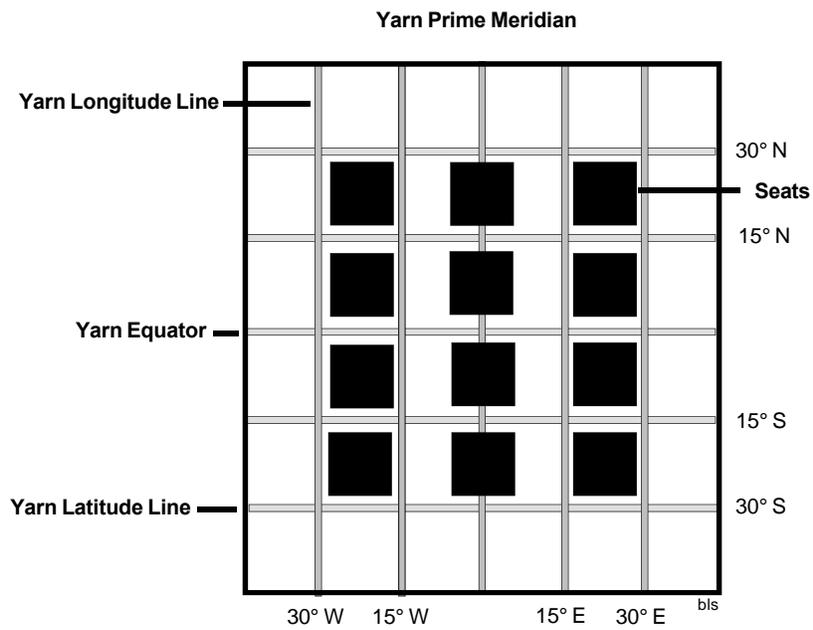
- *Increase the level of students' retention concerning latitude and longitude.*
- *Differentiate between lines of latitude and longitude.*
- *Describe how latitude and longitude are used to identify locations.*

Materials and Equipment:

- Yarn (2 skeins of different colors)
- Masking tape (1 roll)
- World map (flat)
- Scissors
- Globes

ASSESSMENT:

- When asked to move to a new square, the student will be able to identify their new location based on the constructed longitude and latitude lines.
- When asked to construct a paper map of the room, students will cite the lines as references to locate various objects.



Mudcracks: A Clue to the Earth's Past



by Donis Hannah
Robert L. Bland Middle School

TIME: Two to three 45 minute class periods.

PROCEDURES:

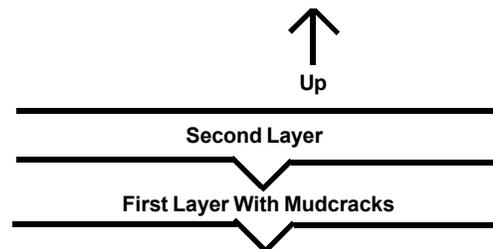
1. Predict what environments are needed to form mudcracks.
2. Students predict what will occur before activity is initiated (what will the dried mud look like?).
3. Collect or make mud and place 1/2 inch to 1 inch of mud on shallow aluminum pan.
4. Dry in oven at 250-300 degrees until dry or on electric stovetop at low setting until dry, or air and sun dry it. (Drying outside in the sun allows for potential evidence of animal trails, tracks, or burrowing.)
5. Add loose sediment (such as fine sand) to show how cracks fill in as layers form.
6. Add another layer of mud to dried layer. Allow this layer to dry.
7. When dry, slowly separate the two layers of mud.
8. Have students record observations made about the two layers when separated.
9. How can these observations be used to identify which way is up?
10. How would a geologist use fossil mudcracks to tell if a layer of rock was folded?

OBJECTIVE:

- Achieve an understanding of how sedimentary deposits, such as mudcracks, can form clues to the Earth's past.
- Determine how infilled mudcracks can be used to determine "which way is up?"

Materials and Equipment:

- Shallow aluminum pans (suitable for oven or stovetop heating) or styrofoam plates or trays
- Mud with a consistency of thick pudding



ASSESSMENT:

- Results of mudcrack study in a journal should include:
 - a. descriptions of the activity;
 - b. the predicted results;
 - c. the observations made;
 - d. conclusion based on what was learned about mudcracks and how they can be used to interpret the Earth's past.

Teaching Suggestion:

- If the opportunity allows, take the students outside where existing mudcracks have formed so they can make comparisons. The most exciting opportunity, if conditions allow, would be to air dry your mud, so the students can observe the trails of life forms in it.

Are All Limestones Created Equal?



by Deb Hemler
Preston High School

Sedimentary rocks include those which form as layers of sediment, become compacted and cemented, or fall out of solution. One example of sedimentary rocks is a group known as the carbonates. Carbonates, such as limestones, are considered nonclastic sedimentary rocks because they are not formed from the cementation of fragments of pre-existing rocks. Rather, they are primarily composed of the mineral calcite. Calcite is comprised of the compound calcium carbonate (CaCO_3) which is commonly found in solution in ocean water and is readily incorporated into the shells of sea organisms. A classic mineral characteristic of calcite is that it readily reacts with hydrochloric acid (HCl). This investigation uses this property to see whether all limestones have the same calcium carbonate composition.

TIME: Two 45-minute class periods.

PROCEDURES:

1. Wearing safety goggles, use a masonry hammer to powder medium-sized limestone specimens from each of the three locations. Using a mortar and pestle, work the powder to uniform size.
2. Mass 1-gram sample of crushed limestone from site A. Transfer to a clean 150-mL flask.
3. Pour 50 mL of dilute HCl over each sample. Let the solution react. Swirl the flask often to ensure all of the limestone has reacted to the acid. Continue this process until no visible or audible fizz is detected.
4. Mass a clean, dry piece of filter paper. Record.
5. Filter the solution in 150-mL beakers to obtain the undissolved residue. (Note: Suction filtration works best; however, if gravity filtration is only available then allow 15-20 minutes of the period for filtration.)
6. Repeat steps 2-5 for limestone samples from site B and C.
7. Using forceps, place filter paper on a watch glass and place in an oven or leave out to dry overnight.
8. Mass the insoluble residue and subtract the weight of the filter paper.

OBJECTIVE:

- Recognize the difference in composition of carbonate rocks.
- Relate this to depositional environment and economic importance.

Materials and Equipment:

(for class of 30)

- 15 samples from 3 different limestone formations
- 15 pairs of safety glasses
- 15 rock hammers
- Diluted hydrochloric acid (5-10%)
- 15 triple beam balances
- 15 graduated cylinders
- 15 funnels
- 15 pieces of filter paper
- 15 Bunsen burners
- 45 cotton swabs (Q-tips with paper stems)

SAFETY NOTE: When using hydrochloric acid, follow all lab safety measures.

Questions:

1. Calculate percentage of calcium carbonate in each sample. How does the amount of carbonate compare in each type of limestone? What could have caused this difference?
2. What metals, if any, were present in the carbonate samples?
3. Investigate the importance that purity (percentage of calcium carbonate) plays in the economic value of limestones.
4. What are your recommendations for the use of these limestones?

9. Compare the results obtained for the samples.
10. Using the data from other groups, calculate the average insoluble residue mass for each limestone sample.
11. Place the wet tip of a cotton swab into the insoluble residue of site A. Flame the swab and record any color change.
12. Repeat for site B and C.

Teaching Suggestions:

- West Virginia limestone samples from the Ordovician, Mississippian, and Devonian work well for this lab. If accessible, limestone from Florida could be substituted for one sample or used to add an additional treatment. Dolomite and siderite are other carbonates which may be used, however the word "limestone" in the lab title should then be changed to "carbonate" to reflect this modification.
- For younger students, the teacher should powder the limestone for students. The rock can be placed in a plastic bag to minimize airborne fragments. A masonry hammer or heavy rock hammer works best for this.
- This activity utilizes many laboratory techniques in one activity: using a mortar and pestle, massing powders, filtering and drying filtrates, and using flame tests. This lab is best staged near the middle to end of a semester when students have had prior experience with these varied techniques.
- The flame tests may be left out as these results are often inconclusive. Due to its magnesium content a dolomite may be used to produce a different flame color. Only cotton swabs with paper stems should be used.
- Older students can calculate the relative deviations of their data from class averages.

Whether it Weathers?

by Deb Hemler

Preston High School



Students generally comprehend that mechanical weathering of rocks leads to the formation of sediments. What is not realized is the amount of energy in an environment or the length of time required for processes to happen. The following activity is a lesson in mechanical weathering, a process involving the physical breakdown or disintegration of rock by erosional agents such as wind, water, and ice. These agents carry materials which wear down rocks through actions such as abrasion. The speed at which rocks weather depends on several variables. This semester-long activity investigates the process.

TIME: Two 50-minute periods to organize, and then one 50-minute period a month for a semester for data collection.

PROCEDURES:

1. Assign students into 12 groups, for each group mass one each of the limestone, shale, and sandstone samples and record. Soak samples for one week in water and record the new masses.
2. Cut the wire mesh with wire cutters into six 10 cm x 10 cm squares (see drawing on next page).
3. Wire four of the squares together to form a cube without wiring the top. Place the samples of limestone and sandstone into the wire cube and secure the last wire square to the top of the cube (see drawing on next page).
4. If a stream environment is available near the school, the project should be done there. If one is not within walking distance, have the groups place the samples in those environments near home.
5. Groups 1 and 2 will place their cages in the fast-moving water of the stream. Groups 3 and 4 will place their cage in slow-moving water. Groups 5 and 6 will place their cage in a pool (still water).
6. Groups 1 through 6 should stake their cages and secure them to the stakes using heavier wire. Flagging may be attached to the stakes for easy relocation and data collection.
 - a. Students will record the velocity of the stream at the various sites. Using a meter tape, measure 10 meters,

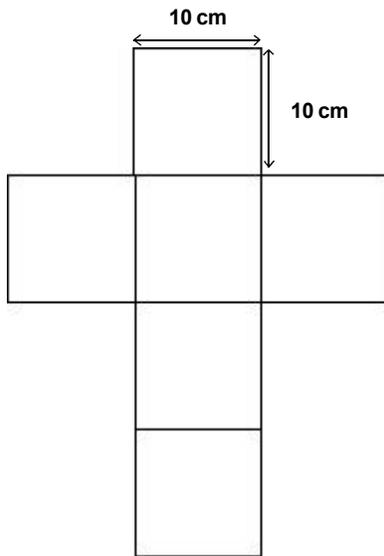
OBJECTIVE:

- Examine physical weathering of rocks.
- Investigate the efficiency of various erosional agents.

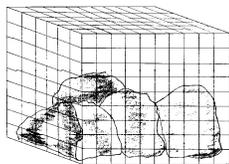
Materials and Equipment:

(for class of 30)

- 12 shale samples
- 12 sandstone samples
- 12 limestone samples
- 12 pieces of wire mesh (30 cm x 20 cm)
- 12 strips survey flags
- 12 wire cutters
- 12 metal stakes
- 1 roll wire
- Pliers
- 6 portable balances
- 6 metric tapes
- 6 stopwatches
- 6 oranges (or floating balls)
- Thermometer
- Mallet
- Wind gauge



Wire mesh design for cutting out cubes for construction



Wire mesh cube with rock samples

drop an orange, and record the time it takes for the orange to travel the 10 meters. The velocity can be determined by dividing distance by time.

- b. Once a month students should return to their sites and record the masses of their samples and stream velocities on their data sheets. Students should express lost mass in terms of percent mass lost.
7. Groups 7 and 8 will place their samples on the floor of a picnic shelter (preferably in a windy area). Groups 9 and 10 will place their samples out in the elements. Groups 11 and 12 will place their samples in a sheltered room with no temperature controls. Groups 7 through 12 will alternate recording daily temperatures, wind speed, and precipitation at the beginning of class. Temperatures should be averaged monthly and precipitation totalled.
8. At the end of the study, groups will assimilate their data and present their findings to the class in a “poster session.” All groups prepare graphs illustrating the relationship between loss of mass over time and variable(s) such as water velocity, amount of rainfall, or temperature. Their posters are displayed on the walls of the classroom.
9. Given a copy of the cumulative data, their final project is to write an individual paper on the class results. Their discussion should include the weathering rates of the three types of rocks and the overall effectiveness of each environment as an erosional agent (still, slow, and fast water, and precipitation and wind).

Questions To Be Addressed Might Be:

- Which rock sample initially absorbed the most water? Of what importance is this?
- Which sample weathered the most? Is this consistent with what you have learned about the local geology?
- Which erosional agent is the most effective? Explain the mechanism behind this type of erosion.

ASSESSMENT:

- Did students successfully use the available data to compare and contrast the samples?
- Does the data support their contention that the experiment was conducted over the course of the academic year/semester?
- Is the graphical representation of the data appropriate?

Teaching Suggestions:

- This project can be done as a year-long study to simulate actual data collection and research. It could be simplified for younger students. If the cages are constructed for the students in advance, little time is required for setup and these may be used the following year.
- While chicken wire is easier to cut, it is too pliable and only with some difficulty will form rigid cubes. Being a thin wire, it will degrade more rapidly than a stronger gauge.



Spelunking: Exploring Caves and Caverns

by Michele Lomano

Hedgesville Elementary School

OBJECTIVE:

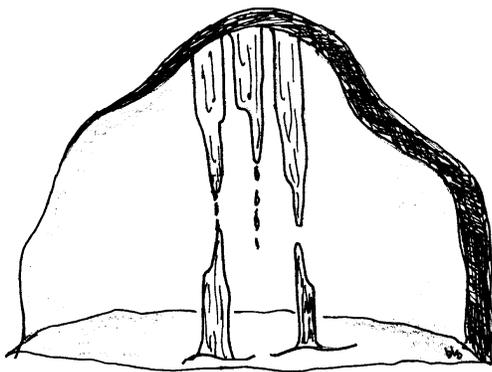
- Determine which rock type best forms caves.

Materials and Equipment:

(for each group of students)

- 6 Small beakers or baby food jars
- Diluted hydrochloric acid (5-10%)
- Triple-beam balance
- Grease pencil or masking tape
- 2 similar-sized pieces (hand specimen size) each of sandstone, shale, and limestone
- Paper towels

SAFETY NOTE: When using hydrochloric acid, follow all lab safety measures.



A cave or cavern is a natural opening in the ground that extends beyond the zone of light. Caves can occur in various rock types, but one rock type forms the most numerous caves—limestone. Limestone is composed of the mineral calcite (CaCO_3).

Most caves are formed by moving acidic water. Carbonic acid (H_2CO_3), produced when carbon dioxide (CO_2) combines with water, dissolves limestones. This acid begins to move slowly in small fractures in the limestone. This process may continue for thousands of years as the cracks become holes, and the holes become rooms, forming caves.

While this dissolving process continues, another process may occur—deposition.

Stalagmites, stalactites, columns, and flowstone are formed in the reverse way of that by which the cave itself forms. The formations occur when the mineral calcite, which dissolves from the rock as the cave is forming, is deposited. The dripping or seeping of the calcite-rich water determines the shape of the formation. When the water evaporates, the CO_2 leaves and only the calcite is deposited. Most formations are estimated to grow only one cubic inch per 120 years.

TIME: One 40-minute class period or one prior day setup and next day activity.

PROCEDURES:

1. Hypothesize which rock type best forms caves. Record hypothesis.
2. Label each beaker with the following:
 - A. Sandstone w/water
 - B. Shale w/water
 - C. Limestone w/water
 - D. Sandstone w/acid
 - E. Shale w/acid
 - F. Limestone w/acid

3. Using the triple-beam balance, measure the mass of each rock piece and record the data. Place each piece in the beaker labeled with its rock type.
4. Pour 50 ml (or enough to cover rock sample) of water in beakers A, B, and C. Pour 50 ml of diluted hydrochloric acid (or enough to cover rock sample) in beakers D, E, and F.
5. Let the beakers stand undisturbed for 20 minutes. Starting with the rock in beaker A, CAREFULLY and THOROUGHLY rinse the rock, being careful to avoid contact with the skin. Remove the rock, dry, then measure the mass of the rock. Record the results. Repeat this process for rocks B-F.

ASSESSMENT:

- Student data is clear and reasonable.
- Students properly relate the formation of a cave in limestone to chemical weathering.
- Students identify the solution weathering of limestone as chemical weathering.
- Students use observed results to successfully determine the effects of acid on various rock types and devise a way of positively identifying limestones in the field.

Questions:

1. In which beakers did change occur in the rock mass? In which beakers did no change occur?
2. Which rock type lost the most mass?
3. Why do you feel change occurred in some rock but not in others?
4. At the rate at which the rock in question 3 was dissolving, how long would it take to completely dissolve?
5. Compare and contrast the cave-forming abilities of the rock types you have tested.



Make Your Own Hertzsprung-Russell Diagram

by Mark Lynch

Lewis County High School

OBJECTIVE:

- *Create and use a Hertzsprung-Russell diagram.*

Materials and Equipment:

- Graph paper (1 per student)
- Colored pencils (1 set per group)
- Data tables (samples included)

References:

Astronomy: From the Earth to the Universe. Jay M. Pasachoff. Saunders College Publishing. 1991

Earth Science. Edward Tarbuck and Frederick K. Lutgens. Charles E. Merrill Publishing. 1985

By plotting the absolute magnitude against spectral class or surface temperature of stars, a useful pattern results. Most of the stars fall along a broad line running diagonally from hot and bright to cool and dim. Such graphs are very valuable to astronomy especially when studying life cycles of stars.

TIME: 50 minutes.

PROCEDURE:

1. Draw a spectrum across the bottom of the graph using colored pencils. This should look like a continuous spectrum (rainbow).
2. Plot the stars on the graph using the absolute magnitude versus the temperature. Use different colors that correspond to the colors you drew across the bottom of the graph.
3. Observe the heavy concentration of stars along the main sequence.
4. Label areas of the chart that correspond to the location of dwarfs, giants, supergiants, and white dwarfs.
5. Add some of the names of the stars you have heard of from the second list of stars.
6. Add the progression of stars from dust and gas at M 0 to a Black Dwarf at K +14. Draw a line to show how a star might move around in the H-R diagram during its life.

ASSESSMENT:

Assessment rubric

- A. Plots accurately represent data. Student is able to interpret plot by identifying location of main sequence stars on plot. Student can describe the relationship between magnitude and temperature.
- B. Most data is accurately plotted. Student can identify main sequence stars on plot. Student has some understanding of relationship between magnitude and temperature.
- C. Majority of data is plotted well. Student has trouble identifying main sequence stars on plot. Student cannot describe the relationship between magnitude and temperature.
- D. Plot is very inaccurate. Student has no understanding of the main sequence portion of the plot. Student will not try to explain relationship between magnitude and temperature.

Teaching Suggestions:

- Students should have been introduced to magnitudes of stars and the idea that stars evolve from one type or another. They also need to have a working idea of how color and temperature are related.
- You may want to use a larger piece of paper for the graphs, as they can get crowded if you add all the names.

Hertzsprung-Russell Diagram

Hotter Stars Cooler Stars

Absolute Magnitude

-5
-4
-3
-2
-1
0
+1
+2
+3
+4
+5
+6
+7
+8
+9
+10
+11
+12
+13
+14
+15
+16

Temperature (K)

O B A F G K M
30,000 25,000 7,000 5,000 3,000

violet red

**Data for
Hertzsprung-Russell
Diagram**

Absolute Magnitude	Temperature (K)
-5	27,000
-4.5	25,000
-4	5,000
-3	4,000
-2	20,000
-1	15,000
0	12,000
0	3,500
1	10,000
2	9,000
3	8,000
4	7,000
5	6,500
6	6,000
7	5,500
8	5,000
9	4,500
10	3,500
10	9,000
11	3,400
11	8,500
12	3,200
12	8,000
13	3,100
13	7,000
14	3,050
14	6,500
15	6,000
15	3,000

**Common Stars in the
Northern Latitudes**

Name	Absolute Magnitude	Spectral Class
Sun	4.79	G2
Betelgeuse	-5.6	M2
Sirius	1.4	A1
Arcturus	-0.2	K2
Vega	0.5	A0
Rigel	-7.1	B8
Altair	0.2	A7
Aldebaran	-0.3	K5
Antares	-4.7	M1
Spica	-3.5	B1
Pollux	0.2	K0
Deneb	-7.5	A2
Regulus	-0.6	B7
Castor	1.2	A0
Polaris	-4.6	F8

**Progression of a Typical Dwarf Star
Like the Sun**

	Spectral Class	Absolute Magnitude
1-Dust and Gas	M	0
2-Protostar	K	0
3-Sun	G	+5
4-Giant	K	-5
5-Variable	G	-5
	F	-3
	B	+2
6-Planetary Nebula	B	+2
7-White Dwarf	F	+10
8-Black Dwarf	K	+15

Fossil Origins

by Angela McKeen
Valley High School



The students are placed in groups of three, and each group receives a shoebox filled with various fossils. The students are to sort the fossils, give each fossil a geographic origin, and explain how they believe each fossil could have been formed.

TIME: Approximately 50 minutes.

PROCEDURES:

1. Separate fossils into groups that are similar in appearance.
2. Write a brief description of each group of fossils. What type of rock is the fossil in? What does the fossil look like? etc.
3. Try to come up with a present-day animal or “thing” that looks like your fossil. Does it look like a flower? Does it look like a shell? etc.
4. Where do you think this fossil came from? A swamp? A lake? An ocean?
5. Select one group of fossils and write a brief (at least one complete paragraph) “history” for these fossils. Where were they when they were alive? How long ago did they exist? What happened to them? Why did they fossilize?
6. Be prepared to share your ideas out loud with the class.

ASSESSMENT:

- Student achievement is assessed through cooperative participation in a small group (no more than 3 per group).
- Students’ ability to express their thoughts in an organized written description and ideas.
- Students’ sharing their ideas with the rest of the class.

Further Challenge:

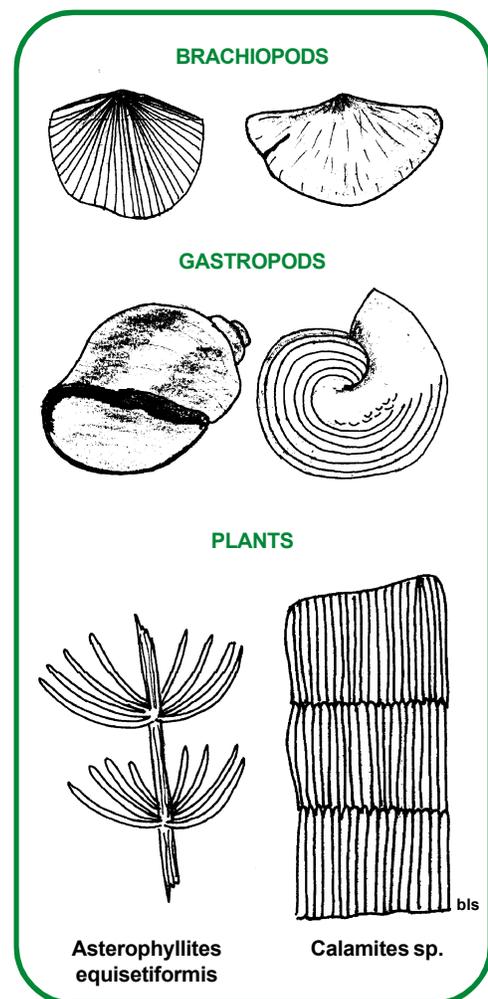
Use this activity as an introduction to the fact that West Virginia was periodically covered by a shallow sea. Relate this idea to plate tectonics and reasons for changes in sea level.

OBJECTIVES:

- *Categorize and hypothesize the origin of fossils.*
- *Explain the reasoning behind their ideas.*

Materials and Equipment:

- Marine fossils of West Virginia
- Plant fossils of West Virginia
- Sheet of poster board per group
- Lots of imagination





Weathering and Fossil Preservation

by Margaret Miller
Pratt Elementary

OBJECTIVE:

- Demonstrate how plants or animals become preserved as a fossil by blocking off exposure to water and air.

Materials and Equipment:

- Disposable cups
- 2 one-inch diameter balls of clay
- 3 sugar cubes
- 1 plastic spoon for each student
- Water for each cup



TIME: 20 minutes.

PROCEDURES:

1. Wrap a piece of clay around one of the sugar cubes so that one half of it is covered with the clay. Wrap clay entirely around the second sugar cube and seal it tightly.
2. Drop the sugar cube without any clay on it, the cube half wrapped, and the cube which is entirely wrapped in clay into the water.
3. Stir until the plain sugar cube is dissolved.
4. Remove the other cubes from the water and examine the remains.

ASSESSMENT:

- Student observations are recorded in a portfolio. Observations are legible, clear, and sensible.
- Inferences and comparisons should be supported directly by observations recorded in the portfolio.

Teaching Suggestions:

- Have students first predict what they think will happen.
- Have the students write the procedures. Once the cubes have been removed, have students write their observations about the conditions of the two remaining cubes.
- Have students make inferences and comparisons as to how fossils are preserved.
- Have students write their conclusions.
- If possible, take students on a fossil hunt field trip.

Compass Treasure Hunt

by Nancy Moore

Walton Middle School



Make a set of task cards (one card per group of students), each card with a starting point (a desk, a tree, etc.), followed by four directions which include the number of paces to be taken in a particular direction. The course should have the students ending up at some object (tree, desk, etc.).

TIME: Prior setup and one 40-minute period.

PROCEDURES:

1. Allow class to experiment with the compass. See if they can discover and share the techniques for basic compass orienteering. Make sure students know how to orient themselves in a particular direction using a compass. If the student wants to go east, he should hold the compass parallel to the ground. Without moving the compass, he must pivot until the red arrow (the north-seeking arrow) points to "N." Direct the student to locate a point that is due east. He now must walk toward that point the number of steps indicated.
2. Have class practice orienting themselves in a variety of directions. Have them stand with compass in hand. Say, "Find south." Check to see that all students are facing the correct way. Do the same with east, west, and north. Depending upon the age and experience of students, you can also try to have them locate NE, NW, SE, SW, NNE, ENE, etc.
3. Once students can orient themselves well, divide the class into groups of three or four. Give each group a task card. The students will follow directions and find their treasure.

ASSESSMENT:

- The students can be asked to stand and orient themselves in a particular direction. If you do this with individual students, the rest of the class can help you to evaluate by placing their compasses on the table with the north-seeking arrow pointing to "N" and checking to see that the individual student is facing the right way.

OBJECTIVES:

- Use a compass for orientation and to follow a course.

Materials and Equipment:

(for class of 30)

- Compasses (30 or 1 per group)
- Index cards with four directions on them (1 per group)
- Treasure bags (baggies with 1 treat per student)

Task Card

Starting at your desk take four paces east, two paces northwest, six paces west, and three paces south-east.

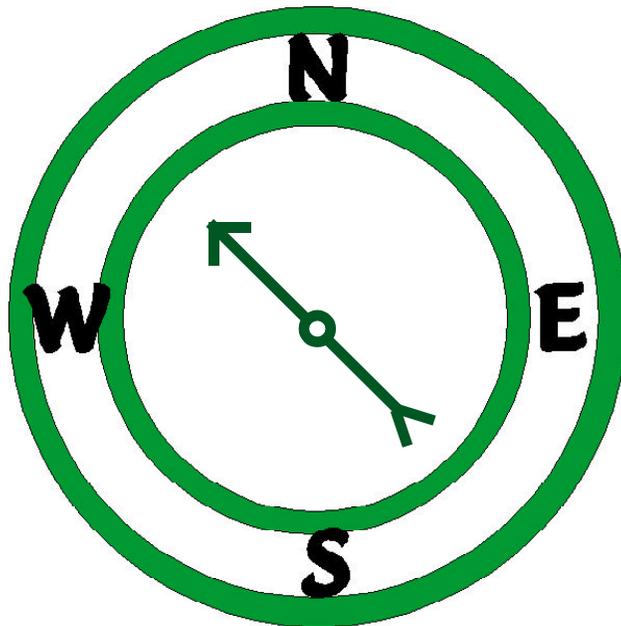
Describe your new location.

Teaching Suggestion:

- This activity can be done inside or outside.

Extension:

Have students determine the length of their pace. Measure a hallway or use a field. Have each student count the number of steps needed to cover a predetermined distance. Divide the distance by the number of paces to determine the length of one pace. How could this be used for calculating distance walked, or the length of a building, or the height of a tree (geometry lesson)?



Pasta Paleontology

by Nancy Moore
Walton Middle School



TIME: 40-minute period.

PROCEDURES:

1. Give each student or group of students a bag of pasta. Tell them to pretend that they are paleontologists. Their assignment is to take these bones and put them together to make a dinosaur skeleton.
2. Give students enough time to construct their dinosaur, then encourage them to travel around the classroom to examine the dinosaurs made by the other students.
3. Discuss differences and similarities in the dinosaurs. Plant-eating dinosaurs usually walked on all four legs. Meat-eaters usually walked on their two hind legs. Plant-eaters often had some sort of protective device (horns, plates, etc.). Have students identify the plant-eaters and the meat-eaters made by classmates.
4. Record characteristics used to identify each pasta dinosaur.
5. Discuss the importance of a paleontologist having knowledge of biology, anatomy, etc. Have students think about identifying unknown animals from strange bones.

ASSESSMENT:

- Students are actively involved in the construction of a "pasta dinosaur."
- Record why they picked certain pasta to be certain bones.
- Have students observe all constructions. Verbal discussion of similarities and differences should be supported by their written observations.

Teaching Suggestions:

- Tell students that their dinosaur will be lying on the table, not standing up. Relate this to problems encountered by paleontologists working with real dinosaur fossils.

Further Challenge:

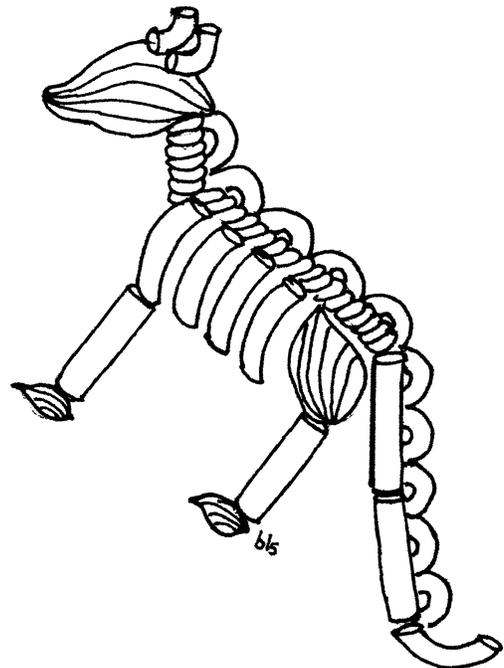
- Give students pictures of dinosaurs and have them identify them as plant-eaters or meat-eaters.

OBJECTIVES:

- Use different types of pasta to represent bones as they reconstruct a "dinosaur."
- See one of the problems of a paleontologist as they view the variety of "dinosaurs" that are constructed from the "bones."

Materials and Equipment:

- 1 baggie per student or group containing an equal assortment of pasta (elbows, spaghetti broken into smaller equal size pieces, small and large rigatoni, rotini, 1 shell pasta to represent head).





Rock Riddles

by Nancy Moore

Walton Middle School

OBJECTIVE:

- Use synonyms of words used in earth science lessons to write “Rock Riddles.”

Materials and Equipment:

- Paper and pencil for each student.
- Copies of dictionaries and thesauruses which can be shared by students.



“Hink Pinks” are riddles with one-syllable rhyming answers (fat cat, sweet treat). “Hinky pinkies” are riddles with two-syllable rhyming answers (paper scraper, handy candy). Rock Riddles are patterned after this.

TIME: 45 minutes.

PROCEDURES:

1. Have students come up with a list of earth science words. List these on a chalkboard. (Examples: rock, stone, plate, coal, slate, shale, etc.)
2. Have students come up with words that rhyme with the earth science words. The pair of words will usually be an adjective/noun combination. Watch out--they may be quite silly. (Examples: rock talk, stone loan, plate fate, coal bowl, late slate, pale shale, etc.)
3. The students must now write a question for which the rhyming pair would be the answer. They may NOT use either of the rhyming words in the question. This is where the thesaurus comes in handy. For example:
 - a. What do rocks get when they need money? (stone loan)
 - b. What happened to the earth’s crust? (plate fate)
 - c. Where did the black sedimentary rock play football? (coal bowl)
 - d. What metamorphic rock was running? (late slate)
 - e. What do you call a crumbly sedimentary rock that is light in color? (pale shale)
4. Once students have the knack of writing “Rock Riddles,” they can write them independently and share them with their classmates. This may be a fun way to start each class by sharing a new riddle.

ASSESSMENT:

- Students will be evaluated according to their ability to write “Rock Riddles.”

Deep Ocean Current Forces

by Sally Morgan

East Fairmont High School



TIME: One 50-minute class period.

PROCEDURES:

PART A: Density

Obtain the 4 different colored, different density solutions. It is up to you to determine the layering order of the solutions. Place one or two fingers' width of each solution, drop by drop, into the test tube (straw) without mixing them, so that the most dense solution will go to the bottom.

1. Choose a colored solution and place it into the test tube (straw). Make sure to record the order in which you place the solutions.
2. Choose another colored solution and slowly place it in the test tube (straw).
3. If mixing occurs, start a new trial. Make sure to begin with a different color. Reminder: Record all data.
4. Continue in this manner until you have determined the order of density.

Questions:

- In which order did you find the solutions layered (from bottom to top)?
- Why do you think this occurred?
- If these materials were added to the ocean, which order would they arrange themselves?

PART B: Salinity and Density

Salinity affects ocean currents. You will now need to obtain the 4 different colored, different saline solutions.

Repeat the procedures in Part A with the new solutions. This time you will be determining the order of salinity.

Questions:

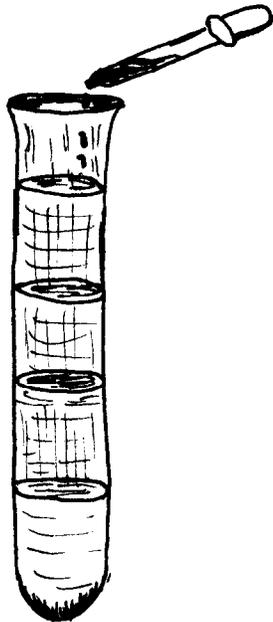
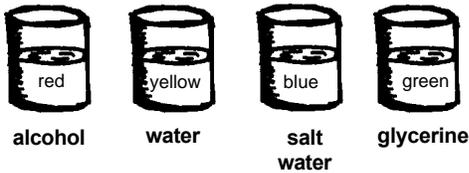
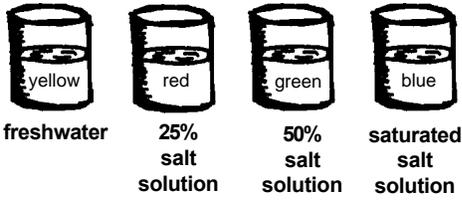
- In which order did you find the solutions layered (from bottom to top)?
- Why do you think this occurred?
- If these materials were added to the ocean, which order would they arrange themselves?

OBJECTIVES:

- Find out how different densities affect a solution.
- Find out how differences in salinity affect a solution.
- Find out how temperature affects a solution.

Materials and Equipment:

- 8-10 test tubes (straws can be substituted with clay or potato slices)
- 4 droppers
- 4 different density solutions of different colors (alcohol, water, salt water, and glycerine)
- 4 different saline solutions of different colors (freshwater, 25% salt solution, 50% salt solution, and saturated salt solution)
- Ice
- Candle or bunsen burner
- Beaker
- Food coloring



- Where in the ocean would the saltiest water be located?

PART C: Temperature and Density

Temperature affects ocean currents.

1. Heat your test tube from Part B. Observe any internal movement. Record your observations.
2. Obtain a beaker. Fill it half full of warm water.
3. Gently add a drop of yellow or red food coloring at the center. Observe the movement. Record your observation.
4. Add an ice cube to the beaker of colored water.
5. Add one or two drops of dark food coloring (blue or green) directly on the ice cube. Observe the movement. Record your observations.

Questions:

- What happened when you heated the salt water solution?
- Where in the ocean might this occur?
- What happened when the ice and food coloring were added to the water?
- Where in the ocean might this occur?

ASSESSMENT:

- From this investigation, discuss how the density affects ocean water.
- Students have recorded data.
- Recorded data supports statements and hypothesis.
- Students relate density, salinity, and temperature to each other.
- Students develop an understanding of what drives some ocean currents.

Fossils in Time

by Karen Parlett

Pleasants County Middle School



This unit consists of a set of activities that introduce students to fossils. It can easily be adapted to other grades with a few changes. The focus can also be changed. Students can be introduced to fossil formation, fossil types, index fossils, or mapping.

TIME: Each station lasts one 45-minute class period. Last 10 minutes are devoted to cleanup and completing record sheet.

PROCEDURES:

Students use a set of learning stations at which they work in cooperative groups. Students rotate through jobs as the groups rotate through the stations. The stations are labeled for descriptive purposes only. They are designed to be completed in any order.

DAY 1—STATION A: *Message in a Fossil*

This program simulates a fossil dig and shows the students tools and techniques used in uncovering fossils.

1. As the students uncover fossils, they match them to fossils in a “museum” and build an appropriate diorama for their own museum.
2. Record the information in logbook and on time scale chart.

Questions:

- Name two tools a paleontologist uses when looking for fossils.
- Name two fossils your group found.
- From what era and/or period did those fossils come?

DAY 2—STATION B: *Fossil Casting*

Each student makes a plaster cast of a fossil of their choice.

1. Soften the piece of clay. Make it large enough to fit the bottom of the cardboard tube. Do not attach it to the tube yet.
2. Rub dishwashing liquid on the fossil. This keeps the clay from sticking to the fossil. Press the fossil firmly into the clay and then lift it out of the clay. You now have a *mold*.
3. Put your name on the cardboard tube. Place the tube on the clay, centering your mold. Seal the tube with the clay so it won't leak.
4. Mix two scoopsfuls of plaster with about 15 ml of water.

OBJECTIVE:

- *Use a variety of skills to explore and develop an understanding of fossil formation, types, age, environments, and identification.*

Materials and Equipment:

STATION A: *Message in a Fossil*

- Computer
- "Message in a Fossil" software by Edunetics. Students work through 1 lesson.

Materials and Equipment:

STATION B: *Fossil Casting*

- Plaster of paris
- Plastic cups
- Stirring sticks
- Water
- Dishwashing liquid
- Graduated cylinders
- Clay
- Cardboard rings
- Labeled collection of fossils
- Fossil handbook

Stir the mixture so it looks like pancake batter (thick, but easy to pour). Add water or plaster as necessary.

5. Pour the plaster mixture into the cardboard tube. Place it on a tray to dry overnight. This will be your cast.
6. Read about the fossil you are reproducing and choose one of the following activities to complete:
 - a. Draw a picture of the animal in the environment it may have inhabited.
 - b. Write a short story telling about how this animal may have lived.
 - c. Write two or three paragraphs describing a present-day animal that is similar to the fossil you cast.

Questions:

- What fossil did you choose?
- From what era and/or period did the fossil come?
- What does “index fossil” mean?
- Would your fossil be a good index fossil? Why or why not?

Materials and Equipment:

STATION C: Mystery Fossils

- Collection of unlabeled fossils
- Variety of resource materials (fossil handbooks, encyclopedias, posters)

DAY 3—STATION C: Mystery Fossils

1. Students use the resource materials to identify at least five fossils found at the station.
2. Students draw a picture of the fossil and name it.
3. Tell the time range (era, period) and environment or habitat in which it lived.

Questions:

- How many fossils did you identify?
- Which resource helped you find the most information?
- Which fossil was the earliest one you identified? In which era and/or period did it exist?

DAY 4—STATION D: Fossil Dig

1. Students work together as a group to sift and search a box of sand to find fossils.
2. Students draw what they find, identify it and keep one sample. Extra fossils are returned to the box for the next group.

Questions:

- Name three kinds of fossils your group found.
- In what type of environment did these plants or animals live?
- How did you decide what the environment was like?

DAY 5—STATION E: Puzzle Time

1. Students glue puzzle pieces to newsprint to make a time scale poster.
2. Check completed puzzles to make sure they are correct.
2. Students color puzzle or complete a word puzzle based on geologic terms.

Questions:

- During which era did fossil signs of bacteria and algae first appear?
- During which period did fish fossils first appear?
- Name the era and the periods when dinosaurs flourished.

ASSESSMENT:

- Assessment is based on the student's work at each station, the completion of the logbook questions, and the geologic time chart. Most stations also have written work that the student must complete either individually or as part of a group.

Materials and Equipment:

STATION D: Fossil Dig

- Container large enough for group of four students to work in
- Fossiliferous soil (obtained locally or from a reliable source)
- Sand
- Soil
- Rocks for filler
- Identification sheet
- Handbooks
- Hand lenses

Materials and Equipment:

STATION E: Puzzle Time

- Envelope containing pieces for 1 geologic time scale puzzle
- Glue
- Newsprint or construction paper for mounting puzzle
- Colored pencils for coloring completed puzzles



Name that Rock

by Karen Parlett

Pleasants County Middle School

Objectives:

- Reinforce observation, classification skills, and organizational skills.
- Remember characteristics of the three main classes of rocks.
- Learn to recognize and identify some locally common rocks and begin their own rock collection.

Materials and Equipment:

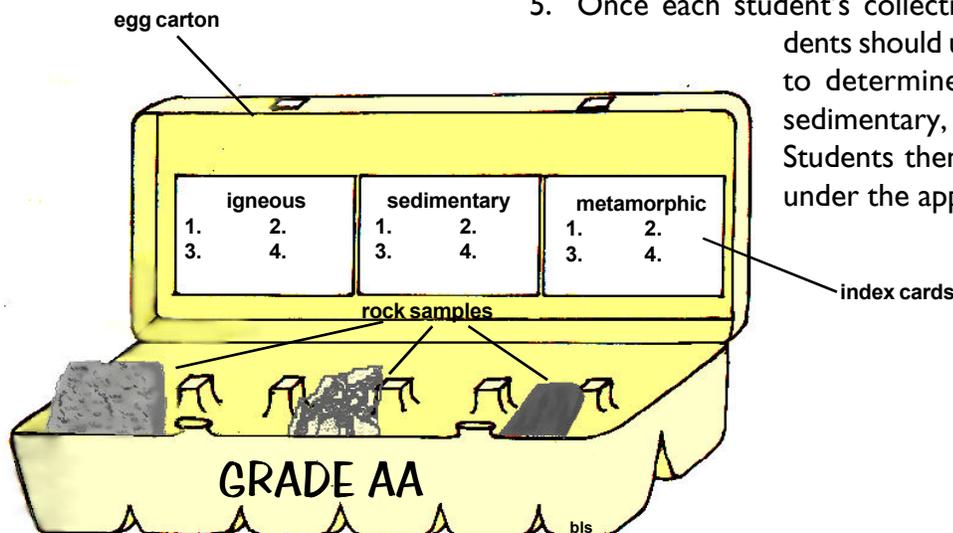
- Container of mixed gravel including limestone aggregate
- Cups with water for rinsing rocks
- Acid for testing limestone
- Egg cartons for collection
- Pens for marking rocks
- Hand lenses
- Rock identification books (optional)
- Index cards

Safety Note: When using hydrochloric acid, follow all lab safety measures.

TIME: One or two 45-minute class periods.

PROCEDURES:

1. Students work in groups of 4 or 5. Each group will need a small container of mixed gravel, a cup of water, and paper towels. Instruct the students to rinse off their rocks and group them. Give as many or as few limitations as needed. Give a time limit (such as 5 to 8 minutes) and tell the students that each group will need to explain how they grouped the samples. After each group has explained the classification system used, spend a few minutes discussing the use of classification in science in general. Introduce or review the three major classes of rocks and give them some general characteristics to look for.
2. Ask the student to develop a classification chart based on the system developed in Step 1. Check each group's work and make suggestions where necessary. When students find rocks that may be limestone, they should test the rocks with acid. **(Teacher may need to do this step for students depending on grade level.)**
3. Each student should prepare a half egg carton for the collection. On an index card, each student should write limestone, sandstone, granite, gneiss, and whatever other rocks you have available. The index card should be attached to the inside cover of the egg carton.
4. Each student should then number their rock samples to correspond to the labels on the index card.
5. Once each student's collection has been checked, students should use rock identification books to determine which of their rocks are sedimentary, igneous, and metamorphic. Students then list their rocks on a chart under the appropriate heading.



ASSESSMENT:

Assessment rubric

- A. Classification system complete. Numerous aspects of rock description mentioned such as size, shape, color, surface appearance (luster), hardness (resistance to scratching), reaction to acid, grain size, composition, rock type (sedimentary, igneous, or metamorphic), etc. All samples described.
- B. Classification system consistently lacks one or two major descriptors. All but one sample fully described.
- C. Classification system lacks many major descriptors. More than one sample not described.
- D. Classification system inadequate. Many samples not described.



Mighty Metamorphic Power Rocks

by Karen Parlett

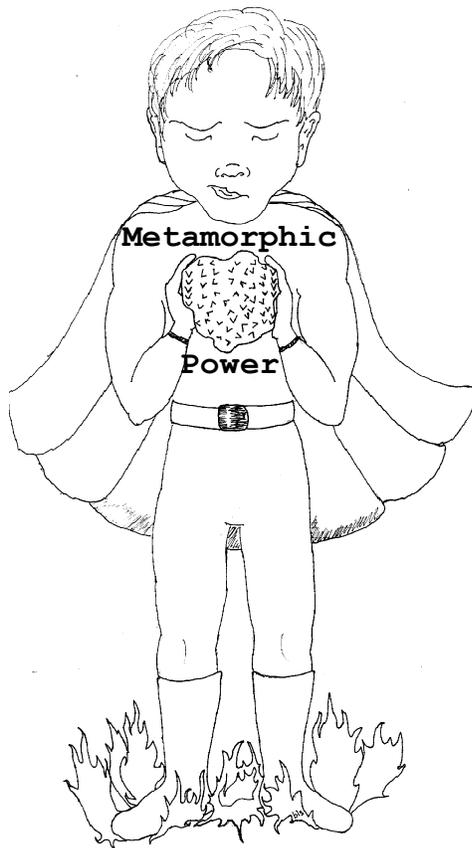
Pleasants County Middle School

OBJECTIVE:

- Students will describe various ways rocks can form, and recognize that rocks change over time.
- Students will write a short story, skit, or comic strip about how the rocks became the Mighty Metamorphic Power Rocks.

Materials and Equipment:

- Various resource books
- Brief description of rocks
- Biographical information of rock "personalities"



TIME: Two to three 40-minute classes.

PROCEDURES:

Mighty Metamorphic Power Rocks

Biographical Sketch:

We are normal igneous and sedimentary rocks.

Gary Granite: Used to be a hothead magma man, but is cool now.

Larry Limestone: Smooth, gray, strong, but kind of fizzy (or is that dizzy).

Beverly Bituminous Dark, energetic, "lights up the room" type girl.

Sammy Sandstone: Gritty, often tough, but tends to crack under pressure.

Sharon Shale: Smooth, but kind of crumbly.

1. Heat and pressure changed us into the Mighty Metamorphic Power Rocks. What are our Mighty Metamorphic Power names?
2. Use these descriptions, or some of your own, to make up a story, skit, or comic strip about these rocks who become the "Mighty Metamorphic Power Rocks." You may want to add more characters. Just remember to use real rocks and some real possibilities in your story. Use rock books and encyclopedias to help you. Add illustrations if you wish.
3. Students will present this to the class when finished.

Teaching Suggestion:

- Limestone can become marble, bituminous can become anthracite, sandstone can become quartzite, shale can become slate or schist, and granite might become gneiss.

ASSESSMENT:

- The finished product, story, skit, or comic strip is assessed as to accuracy and creativity. Students can explain how change relates the three kinds of rocks.

Musical Rocks

by Kathleen Prusa

Philippi Elementary School



TIME: Approximately 40 minutes.

PROCEDURES:

1. Lecture/Discussion: Using the book, observe and discuss the differences between rocks and minerals, and then rock types (igneous, sedimentary, and metamorphic).
2. Activity: Bring out rock samples from each type (for example: igneous--granite, diorite, basalt; sedimentary--sandstone, shale, limestone, conglomerate; metamorphic--gneiss, marble, or slate).
3. Have students describe the rocks. Color, texture, size, mass (heft), roundness, angularity, etc. may be important contributors to their instruments.
4. Have the students decide which work better at being shaken, struck, or scraped.
5. Create instruments from the rocks. Use other materials (toilet paper rolls, rubber mallets, paper, tape, etc.) to enhance sounds or to strike the rocks. For example, sandstone pieces can be scraped together, marble can be hit with rubber mallet, small pieces can be made into shakers with toilet paper rolls and tape.
6. Have a rock concert!
7. Observe reasons for the different sounds.
8. Make suggestions about the composition and nature of each specimen.

ASSESSMENT:

- Observe how the instruments work.
- Have students make suggestions for the noise each instrument makes.
- Grades are based on participation, creativity, and completeness of ideas about the nature of each specimen(s).
- Students reveal some understanding of the differences in rocks.

OBJECTIVE:

- *Provide young students with an innovative way of seeing the differences in physical properties of rocks.*

Materials and Equipment:

(for each group)

- Textbook
- Rock samples
- Toilet paper rolls
- Tissues
- Tape
- Paper
- Rubber mallets





Modeling Geologic Columns with Sand Art

by Debra Rockey
Wellsburg Middle School

OBJECTIVES:

- *Construct geologic column models of regional sedimentary rocks.*
- *Construct a scale model of rock layers.*
- *Compare the models with geologic time.*
- *Determine the relative age of each rock.*
- *Explain the relationship between rocks and the environments in which they formed.*
- *Relate minable coals to the local economy.*

Materials and Equipment:

(for each group)

- 1 clear plastic tube or plastic container
- 1 stopper (to seal tubes)
- Clear glue
- Masking tape
- White sand (200 grams)
- Non-toxic powdered Tempera paint (black, blue, yellow, orange, red, and green)
- Mixing bucket
- 4-6 containers for colored sand
- Small paper cup (for filling tubes)
- Dowel rod (for compressing sand)
- Set of colored pencils
- Symbol key for sedimentary rocks
- Cross section of local rock outcrop

Geologists use rock descriptions to construct a vertical model (geologic column) of a site. By comparing the columns for different sites, it may be possible to trace (correlate) key beds from site to site. The accuracy of geologic maps and estimates of mineral reserves is dependent upon the accuracy of correlations.

Correlations may be made by modeling outcrops and surface exposures. Correlation of sub-surface strata may be made by modeling drilling data.

Geologists use certain colors to distinguish sedimentary rock types in stratigraphic models. Sandstones are indicated by yellow, black is used for coal, blue is for limestone, and green is used for shale. Red is a modifier used to denote special features of the rock such as reddish shales. Important features of the rock layer such as fossils or concretions should also be noted.

TIME: Three 45-minute class periods.

PROCEDURES:

1. Prepare the plastic tube. One end should be permanently sealed. If necessary, prepare the end of the tube by using a permanent glue to seal the end.
2. Mix the non-toxic powdered Tempera paint with the sand and water as needed. You may use buckets or large plastic containers to mix the sand.
3. Divide the students into small groups of 2 or 3.
4. Each group is given a handout of geologic formations. The students will use colored pencils to shade the geologic columns and local cross sections to correspond with the various rock strata. The students will color the rock layers in the following manner: limestone (Ls)--blue; shale (Sh)--green; coal (C)--black; sandstone (Ss)--yellow; clay--green; and concealed areas--white or undyed sand.
5. Determine any appropriate scale for the model. Divide the total height of the rock layers in the cross section by the length of the tube. (Caution: Leave space at the top to seal the tube.)

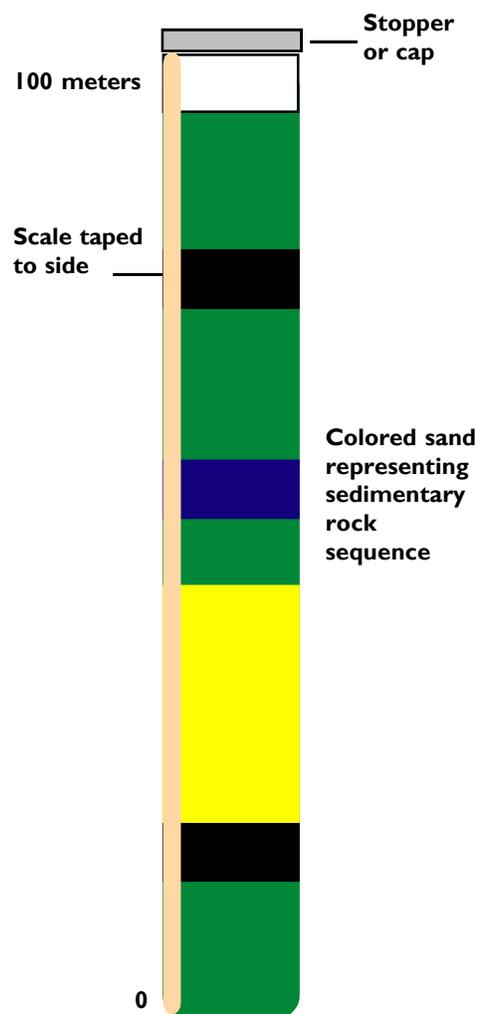
6. The students must place a strip of masking tape on the side of the plastic tube, placed from the sealed end of the tube to the opening at the top. The tape will be used to note measurements, presence of fossils, or special features of the rock strata.
7. Each group will construct a geologic column to represent their assigned outcrop. Using the handouts as a guide, the students fill their tubes with the colored sand to complete their model. As each layer is poured, it must be compacted with a dowel rod. (If the layers of colored sand do not completely fill the tube, the remaining area should be filled with undyed sand.)
8. Each completed tube is capped with a stopper. Attach labels to indicate the outcrop represented in the model.

ASSESSMENT:

- The students must correctly label each rock layer in the model.
- The students must propose at least one environment of deposition indicated by their model.
- The students must indicate the scale used to create their model.

Teaching Suggestions:

- There are some factors which make correlation difficult. The deposition of a sedimentary rock layer may not be continuous over an extended area. In some areas, erosion may have removed all or part of the rock layer.
- Plastic tubes should be 30 cm long and have an internal diameter of 2.2 cm. Each tube holds 180 grams of sand (slightly more than 1/2 cup of sand)
- The dyed sand can be reused. Rinse the sand with water and strain it through cheesecloth. Allow the sand to dry and then re-dye the sand.
- Conduct a field trip to compare the models with the outcrop sites.
- In some cases, siltstone may be distinguished from sandstone by using orange colored sand. The fire clays which lie under some coals may be indicated by using purple sand.



- Have samples of the rock types available for students to observe.
- Have the students compare the model geologic columns with slides or photographs of the actual outcrops.
- Red sand may be used as a modifier to distinguish certain rock types such as “red bed” shales.
- Place emphasis on recording the proper sequence of rock layers in the models.

**Abbreviations, Color Codes,
and Symbols
for Sedimentary Rocks**

	
Sandstone - Ss (yellow)	Siltstone (orange)
	
Shale - Sh (green)	Clay (green or purple)
	
Limestone - Ls (blue)	Coal - C (black)
	
Concealed areas - (white)	

Doughy Topos

by Christine Sacco

Warwood Middle School



TIME: 60 minutes.

PROCEDURES:

1. Have each group make 4 different sizes of pancakes out of different colored dough.
2. Trace the 4 pancakes on a sheet of white paper.
3. Have the students stack the four different size pancakes on top of each other, largest on the bottom. Have one edge of the dough line up.
4. Discuss elevation. Discuss the way water will flow. Discuss slope (steepness, gentle erosion from water over a period of years).
5. Pour water over the dough so students can see the path of water.
6. Have students use a plastic knife and cut out a pie wedge.
7. Discuss stream flow (V's).
8. Take the traced shapes and cut them out.
9. Glue shapes on top of each other, largest on the bottom. Have one edge of the shapes line up (same as the dough).
10. Label contour lines starting with 0 m.
11. Place a folded piece of paper on the contour map and mark the contours.
12. Take the marked paper and construct a profile on grid paper provided.
13. After profile is made, make a cross section of the dough model and compare files.

ASSESSMENT:

- Student profile is realistic.
- Student can find stream carved "V's" on a topographic map and use them to explain the direction of water flow.
- Given a clay model showing dipping layers of rock, the students can extrapolate their findings to explain why some "V's" point downstream.

Objectives:

- *Understand the basic concept of elevation.*
- *Understand that streams may form upstream V's.*
- *Construct a contour map.*
- *Construct a topographic profile.*
- *Compare and construct a flat contour map to a 3-D model.*

Materials and Equipment:

(for each group)

- 4 different colors of dough
- Paper and pencil
- Plastic knife
- Glue
- Scissors

Topo Dough

1 cup flour
1/2 cup salt
1 cup water
3 tablespoons oil
2 teaspoons cream of tartar
Food coloring

Mix together and cook over medium to low heat. Knead 1-2 minutes.



Black-Box Ocean Floor Landforms

by Ron Sacco

Moundsville Junior High

OBJECTIVES:

- Measure the depth of various points simulating sonar mapping of the ocean floor.
- Construct profiles from recorded data.
- Identify examples of ocean landforms.

Materials and Equipment:

(per student)

- 1 shoebox with lid (or similar box)
- 1 calibrated chopstick or dowel rod for a probing device
- Ruler
- Nail to punch holes in box lid
- Scissors
- Masking tape
- School glue
- Supply of cardboard
- Writing utensil

TIME: Allow 3 class periods.

PROCEDURE:

1. Draw a grid on the top of the box lid. (I have the students follow these instructions since the boxes vary in size.)
 - a. Place box so its length is running left to right in front of them.
 - b. Measure and mark the middle on both ends and connect the marks creating a middle line.
 - c. Draw two more lines parallel to the middle line and equally dividing the distance above the middle line.
 - d. Draw two more lines parallel to the middle line and equally dividing the distance below the middle line.
 - e. Starting at the left end measure across the top and bottom marking every inch (or 2 or 3 cm).
 - f. Connect the top and bottom marks to complete the grid.
 - g. Label the five rows of holes A, B, C, D, and E. Label the column of holes 1, 2, 3, etc.
2. Calibrate the probing device (example: cm)
3. Create various landforms by taping cardboard inside the box.

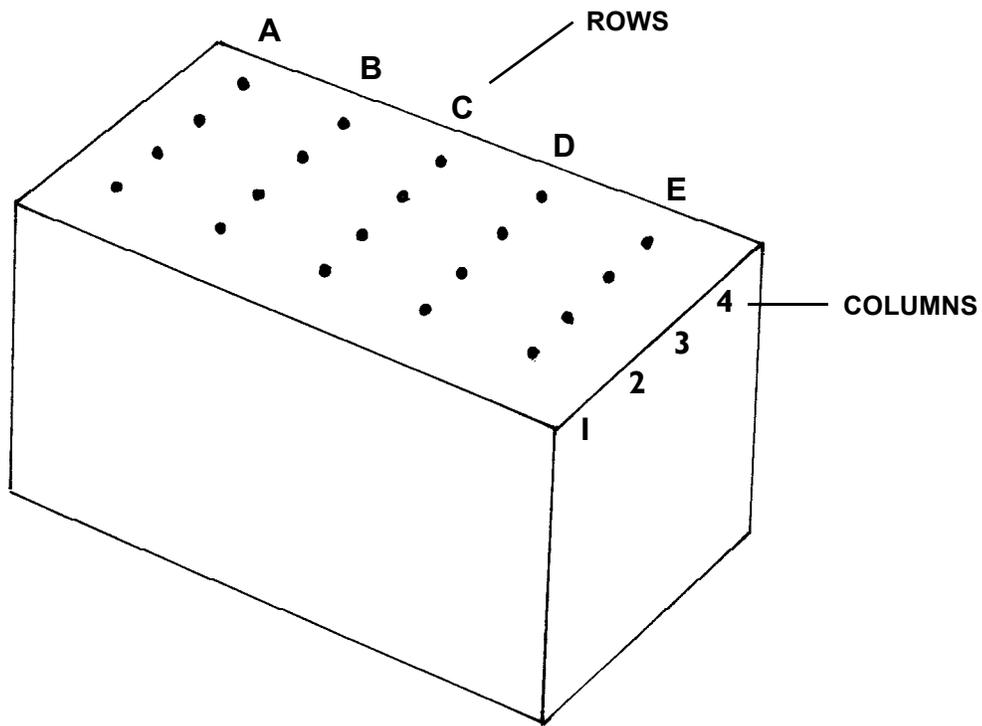
Examples of landforms:

continental shelf	mid-ocean ridge
continental slope	seamount
abyssal plain	island
ocean trench	guyot

4. Tape the lid on the box.
5. Students exchange boxes with another group (a box with contents they have not seen).
6. Students use the probing device to determine the depth below sea level for each grid intersection and record data on the data table (activity sheet).
7. Graph data from each line to make several profiles.
8. Label predictions of landform names on profiles.
9. Don't open box. Discuss uncertainty of explanation and inference.
10. Open box and compare profiles with content.

ASSESSMENT:

- Participation and performance.
- Ability to record data.
- Ability to use data to make and support predictions.





Constellation Box Activity

by Jennifer L. Smith
Mountainview Elementary

OBJECTIVES:

- Compare and contrast the winter and summer constellations.
- Use observations and additional resources to answer questions about constellations.

Materials and Equipment:

- 2 constellation boxes, one winter sky and one summer sky (see separate directions)
- Data sheet to record observations
- Question sheet to be completed at end of activity

Optional:

- Audio tape of “space” music
- Cassette tape player with headphones

Materials and Equipment for Constructing Constellation Box:

- 2 large cardboard boxes (equal in size)
- Paintbrush
- Hammer
- Pencil, pen, or marker
- Nails of various diameters
- Heavy, black cloth
- Black tempera paint
- Clear, wide packing tape

TIME: Prior preparation and one 45-minute class period.

PROCEDURES:

Construction Directions for Constellation Box:

You will need two boxes for this activity. One box should represent a winter sky and one should represent a summer sky. (If you prefer, boxes could represent fall and spring skies.)

1. Turn one box so that the open end faces up.
2. Use packing tape to tape down any flaps that are on the inside of the box.
3. Paint the inside of the box black. Allow to dry.
4. Turn the box over so that the bottom is facing up.
5. Draw dots in the form of constellations on the bottom of the box. Using an enlarged star chart from a book will help. (If you are using a star chart from a book, don't forget to reverse the pattern so it will be correct from the inside.)
6. Use the hammer and nails to punch out the dots through the bottom of the box. The holes should vary in size to match the relative brightness of the stars.
7. Turn the box over and cut a "doghouse door" opening in one side of the box that is large enough for a child's midsection to fit through.
8. Attach black cloth over the opening so that no light can enter the box. It should be long enough so that it will drape over a child's midsection and out onto the floor.
9. When both boxes are completed, place them in a sunny or well-lit area of the classroom.

Activity Directions:

1. The student will lie down with his/her head and upper part of the torso inside one of the constellation boxes to observe the sky and record observations. Be sure to set a time limit for observing *before* the student enters the box. Optional: While lying in the box, student can listen to the cassette tape of “space” music through the headphones.

2. The student will lie down in the second constellation box to observe the sky. He/she will make and record observations.
3. After the student has had an opportunity to observe both constellation boxes, he/she will use their observations plus other additional resources to compare and contrast the visible stars and complete the question sheet.
4. Assign each student a constellation to research. Have them tell the names of the stars in that constellation, how the constellation was named, etc.

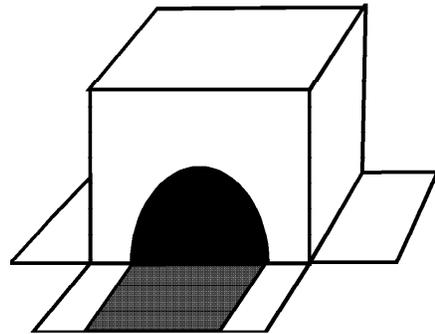
ASSESSMENT:

The evaluation of this activity can include, but is not limited to, the following techniques:

- Teacher observations of the activity.
- Student self-evaluation.
- Completeness of student observations and statements.
- Checking answers to the questions.

Further Challenge:

- Invite your students and their parents to bring a blanket and join you at the school on a Friday evening. Play the “space” music cassette to get everyone in the mood to stargaze. You may also want to bring along snacks to share with your fellow stargazers.
- Invite a guest speaker to your classroom to talk about the stars, planets, the space program, or any other appropriate topic.
- Have students write and illustrate a book about stargazing or other appropriate topics.
- Have each student make their own constellation box, following the instructions provided with this lesson.
- Have students graph brightness, size, color, etc. of the stars in various constellations.





Oooh, What A Relief It Is...

by Tanya Smith

Sacred Heart of Mary School

OBJECTIVES:

- Understand use of cross-sectional profiles and contour lines to represent elevation.
- Create a landform model demonstrating an understanding of major landforms.
- Apply concepts through constructing a "contour map" of landform models.

Materials and Equipment:

- Flashlight
- Relief map/physical map of the U.S.
- Pottery clay (non-firing/2 pounds per group)
- Tools (popsicle sticks, toothpicks, etc.)
- Metric ruler
- Graduated cylinder
- Clear containers with clear lids
- Overhead transparency
- Transparency markers
- Tape
- Water
- Blue food coloring
- Beaker
- White unlined paper
- Newspapers, paper towels (for spills)
- Collapsible drinking cup
- 7.5-minute topographic map of surrounding area

TIME: Adapted over 3 or 4 days. Limit group size to 5 students.

PROCEDURES:

1. Introduce the topic of elevation with a relief map. Discuss and review the four basic landforms. Involve the group in making a cross-sectional profile of the United States.
2. From the relief map, introduce the use of contour lines. Go over rules for using contour lines. Develop through discussion and examples.

Rules for Using Contour Lines:

- a. Contour lines never cross.
- b. In areas of high relief (steep areas), contour lines are closer together.
- c. In areas of low relief (flat areas), contour lines are farther apart.
- d. Contour lines "V" upstream.
- e. Hachure marks show a depression in elevation.

3. Break class into small groups for "Constructing the Landform Models." Each group will use the following materials:
 - a. Approximately 2 pounds of clay
 - b. Popsicle sticks, toothpicks (used as "tools")
 - c. Clear container with clear lidEach group is responsible for constructing a landform model with the materials provided.
4. Let models dry overnight.
5. Assign each student to draw a cross-sectional profile of their model and write a short paragraph describing the features of their environment.
6. Review concepts covered so far. Use a collapsible drinking cup to reinforce the use of contour lines. Distribute materials to groups and lead class through the procedures for "Constructing Contours." Each group will use the following materials:
 - a. Previously constructed landform models.
 - b. Metric ruler
 - c. Overhead transparency

- d. Transparency marker
 - e. Tape
 - f. Water
 - g. Food coloring
 - h. Beaker
 - i. Graduated cylinder
7. Students will work to create contour maps by following these procedures:
- a. Use tape to secure an overhead transparency to the container's lid.
 - b. Measure a predetermined amount (e.g. 100 ml) of colored water into a graduated cylinder and pour the liquid over the landform model.
 - c. Place lid over the model and use marker to carefully trace the water line.
 - d. Repeat steps 2 and 3, adding a consistent amount of colored water and tracing the water line until the landform has been mapped by means of contour lines.
 - e. Drain water off of landform models and dispose.
 - f. Have a class discussion and demonstration of concepts and evaluation.

ASSESSMENT:

- Have students present their completed projects to the class illustrating their understanding of:
 - a. How elevation is shown on topographic maps.
 - b. How contour maps relate to cross-sectional profiles and contour intervals.
 - c. How the distance between contour intervals indicates the steepness of the slope of the landform, and basic landform features.
- Have students exchange contour maps and draw cross-sectional profiles from this information, identify features, and then match with appropriate models.

Further Challenges:

- Provide groups of students with 7.5-minute topographic maps of the local area and have them identify various landform features.

- Practice cross-sectional drawings from maps.
- Have a “Topographic Treasure Hunt” and have students locate specific information on topographic maps.
- Have students construct original topographic maps with scale and legend.

Behind Jurassic Park

by Paula Waggy

Franklin High School



The possibility of recreating dinosaurs from DNA in insect saliva stirs the imagination. This improbable scenario can be used to start students considering what other organisms shared the Jurassic scene with ancient behemoths. They may be startled to realize that most of the insects alive during T- rex's reign would be familiar to them, as all but six common modern orders of insects had already evolved.

TIME: 50 minutes.

PROCEDURE:

1. With students working in pairs, pass out the cardboard or styrofoam strips with insects pinned to them but in the wrong time periods. As an alternative, students can use their own insect collections and receive empty strips.
2. Line each strip up with the marked sections matching the geologic time periods on the Geologic History of Insects sheet. Use the sketches on the sheet to help determine where to put each insect. Insect field guides can be used to check questionable specimens.

ASSESSMENT:

- Ask students to keep the strips lined up beside the Geologic History of Insects charts. Check for accuracy after they have rearranged the insects into the correct time periods during which they evolved. For most insects, a typical member of an insect order has been represented on the chart. Consider that all the other insects in that order evolved during the same time period. For instance, a yellow jacket would be placed beside the Triassic period where bees, wasps, and ants are listed. The exception is order *Orthoptera*. Most evolved during the Triassic period (i.e. crickets, mantids, katydids, etc.). However, the cockroach was 115 million years ahead of the rest of the order and evolved during the Carboniferous period.

OBJECTIVE:

- *Match modern insects to the time period in which they evolved as an attention-getting introduction to geologic time.*

Materials and Equipment:

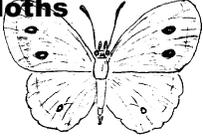
- 8-10 pinned insect specimens
- Cardboard or styrofoam strips divided into sections which match the time periods on the Geologic History of Insects sheet
- Geologic History of Insects sheet

Further Challenge:

- Pick a geologic time period and research it to find out what type of plants lived then, what large and small land creatures inhabited the earth, and if any other flying creatures besides insects had appeared. Draw the environment on a poster or mural including as much detail and as many species as possible. This activity can take as long as five 50-minute class periods. Working in pairs on a posterboard is an effective way of accomplishing this. By the end of the activity after students have shared their research and art work, they have a good working knowledge of the geologic time periods.

Geologic History of Insects

(Insects are listed beside the period during which they first developed.)

CENOZOIC	Quaternary 2 million years ago					
	Tertiary 65 million years ago	<p>Bees  bent antennae body quite hairy narrow waist and stinger</p>				
MESOZOIC	Cretaceous 144 million years ago	<p>Termites  thick waist</p>	<p>Fleas  small no wings</p>	<p>Butterflies & Moths  antennae often knobbed or feathery and scales on wings</p>	<p>Ants  bent antennae narrow waist</p>	
	Jurassic 208 million years ago	<p>Earwigs  wings do not cover abdomen</p>				
	Triassic 245 million years ago	<p>Wasps  bent antennae narrow waist and stinger</p>	<p>Flies  only two wings</p>			
	Permian 286 million years ago	<p>Caddisflies  looks like brown moth but no scales on wings</p>	<p>Stoneflies  aquatic insects two tails</p>	<p>Net-veined Insects  lacy wings</p>	<p>Beetles  hard forewings soft hindwings</p>	<p>Hoppers  small triangle between wings wings do not overlap</p>
PALEOZOIC	Carboniferous 360 million years ago	<p>Cockroaches  flattened body long antennae</p>	<p>Grasshoppers  long, tough forewings large hind legs</p>	<p>Dragonflies  clear wings slender abdomen</p>	<p>Mayflies  aquatic insects 3 tails</p>	<p>True Bugs  triangle between wings overlapping wings</p>
	Devonian 408 million years ago	<p>Spring-tails  no wings small</p>				



Contour Mapping Earthquake Intensities

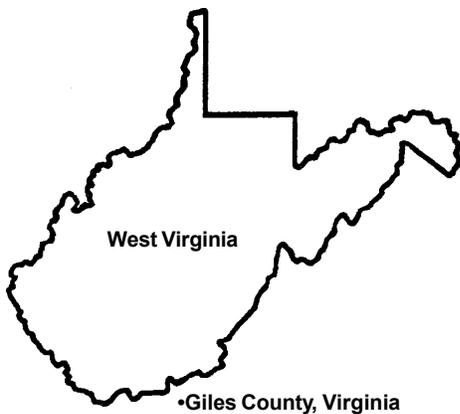
by Paula Waggy and Deb Hemler

OBJECTIVE:

- Investigate a historical earthquake using the Mercalli Intensity Scale.
- Plot the intensities of the quake to create a contour map.

Materials and Equipment:

- West Virginia road map
- West Virginia county outline map
- West Virginia newspaper accounts of the Giles County, Virginia, earthquake of 1897
- Colored pencils or magic markers
- Mercalli Scale of earthquake intensities



Students often associate earthquakes with California and the San Andreas fault. They do not realize that sizable earthquakes, although not frequent, can occur in other parts of the United States, particularly their own state of West Virginia. The following activity makes the topic of earthquakes more relevant to students living on the east coast.

TIME: 90 to 135 minutes.

PROCEDURE:

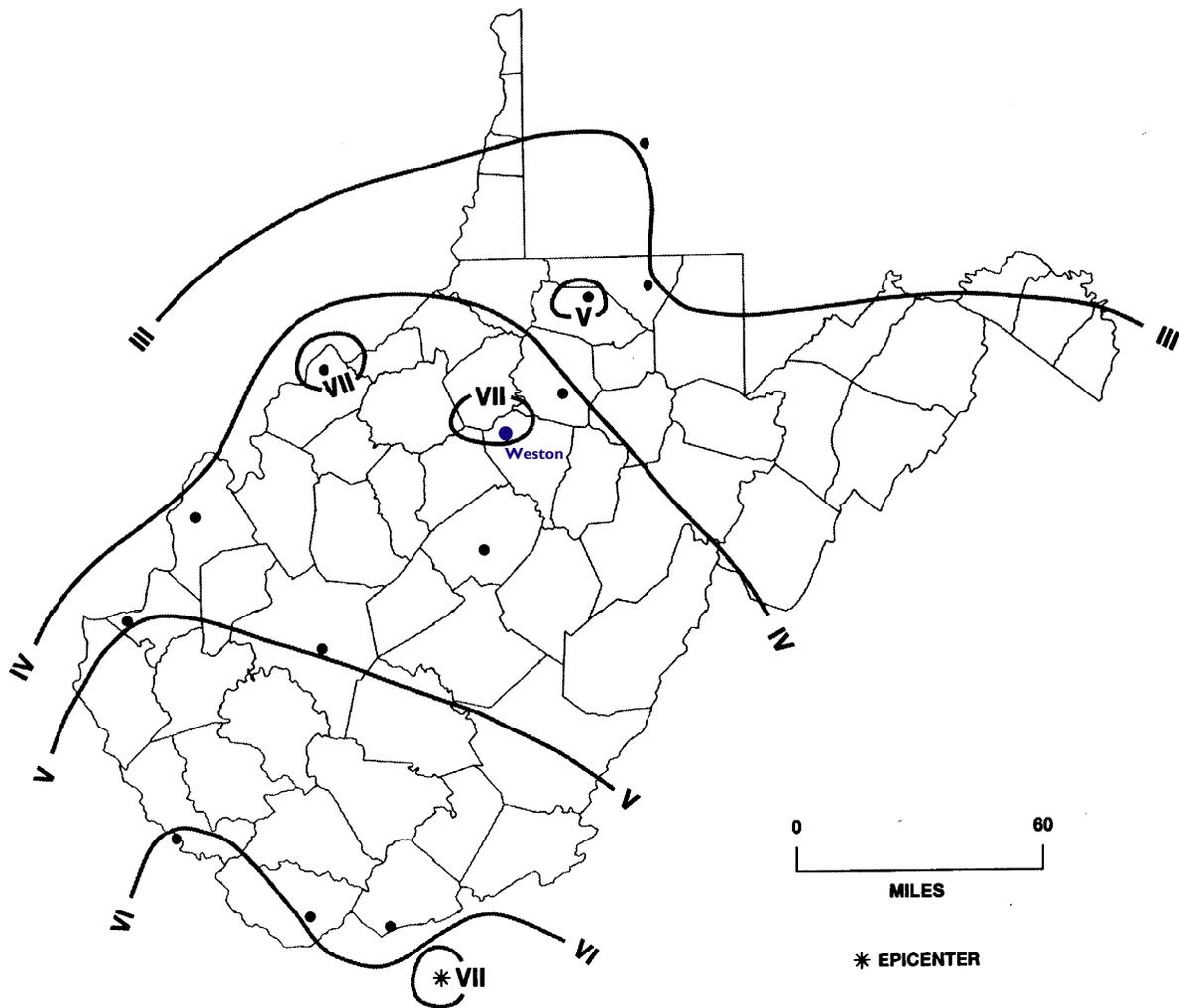
1. Introduce students to the Mercalli Scale of earthquake intensities. Students use one of the Giles County, Virginia, earthquake newspaper articles to determine the Mercalli intensity number to assign to that area of the state. Students should then assign Mercalli intensities for all the cities listed on the map. They can use a West Virginia road map to find the locations of the additional cities not listed on the county map.
2. Instruct the students to write these intensities at the appropriate locations on the West Virginia state map. When all intensities are recorded, students should draw contour lines delineating areas of similar intensities. They can color the map using reds, oranges, and yellows for the highest intensities and greens, blues, and violets for the lowest intensities.
3. Students then try to explain any patterns that they see in the contour map.

Questions:

- Ask students why the contour lines are not in neat concentric circles around the epicenter. Relate this to the general geology and geography of West Virginia. (Reference materials may be required for this.)
- Consider the higher and more rugged mountains in the eastern part of West Virginia as compared to the mountains of lower elevation in the western part of the state.
- Discuss the fact that every student's map has slightly different contours. The Mercalli Scale does not match precisely the newspaper accounts, therefore different values may be assigned to the same location by different students. How does the Richter Scale avoid these discrepancies?

ASSESSMENT:

- Identification of Mercalli intensities is appropriate.
- Contour map appropriately reflects available data and obeys rules of contouring.
- Interpretation of contour patterns is appropriate.
- Hypothesis for contour variations is appropriate.



Modified Mercalli Intensity Scale of 1931 (Abridged)

- I. Not felt except by a very few under especially favorable circumstances.
- II. Felt only by a few persons at rest, especially on upper floors of buildings.
- III. Felt quite noticeable indoors, especially on upper floors, but many people do not recognize it as an earthquake. Vibration like passing truck.
- IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building.
- V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
- VI. Felt by all; many frightened and run outdoors. Some furniture moved; a few instances of damaged chimneys. Damage slight.
- VII. Everybody runs outdoors. Damage negligible in buildings of good construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures.
- VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings; great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls.
- IX. Damage considerable in specially structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Ground cracked conspicuously. Underground pipes broken.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed; ground badly cracked. Considerable landslides from river banks and steep slopes.
- XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground.
- XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

Giles County Earthquake of 1897

In May of 1897, the second strongest earthquake ever to strike the southeastern quarter of the United States occurred near the town of Pearisburg, Virginia. It was a powerful quake and demonstrated its strength by damaging buildings in Virginia, West Virginia, Tennessee, and North Carolina.

It was felt over an area of 280,000 square miles from Georgia in the south, to Pennsylvania in the north, and from the Atlantic coast west as far as Indiana.

Today, an earthquake of this size would be detected by numerous seismographs throughout the world and digital information would pour into earthquake research centers via satellite networks. However, in 1897 there were no satellite networks or even seismographs to record this event.

This earthquake was largely forgotten, and within a few decades, most people living in the area were not even aware that such a strong earthquake had ever occurred in their region. However, in the 1960s, the construction of nuclear power plants created a demand for information about the strongest earthquake that could reasonably be expected in all parts of the country. These maximum expected events were to become "design earthquakes," i.e. earthquakes that nuclear power plants are built to withstand.

When the Giles County earthquake of 1897 was named as the design earthquake for the Blue Ridge physiographic province, scientists wanted to learn as much as they could about it. With no seismograph records, the easiest way was to obtain newspaper accounts of its effects. The following is an example of the 37 newspaper accounts students are provided with:

1897 NEWSPAPER REPORT FROM WESTON, WV

Weston, WV: An earthquake shock was felt here about two o'clock this afternoon. Several ladies were badly scared, and one fainted. A wall in the store room of the American Tea Company, which building is owned by A.A. Lewis, was split from top to bottom, leaving a crack fully one eighth of an inch wide. Several people were shaken from their chairs, and numerous articles upon walls and stands were tumbled to the floor. (Wheeling Register, Wheeling, WV)

Strike and Dip

by Donald J. Wagner
Franklin High School



TIME: 30 minutes.

PROCEDURES:

1. Stick a 1-foot piece of masking tape to a flat table top. Align the tape as directed by the teacher.
2. Line up the edge of the short wooden board with the masking tape, and prop the board on a textbook. Align the mark on the board with the edge of the book. This board represents a tilted rock layer.
3. Obtain a piece of wire and insert it in the center hole of a plastic protractor.
4. To measure dip angle, place the wire and protractor on the tilted board, with the wire parallel to the masking tape and the 90° mark on the protractor *straight down*. An index card, one edge on the table, the upright edge aligned with the 90° mark and the wire, will assure this. The angle of the dip is read where the upper edge of the board intersects the protractor. Record this dip value.
5. The direction of the strike is perpendicular to the dip, in line with the masking tape. Measure the direction with a compass. Record the strike direction.
6. Repeat steps 2-5 with other boards, props or masking tape directions as instructed by the teacher.

ASSESSMENT:

- This exercise is designed to clarify the concepts of strike and dip, and possibly practice before a field trip. Informal observational evaluation may be sufficient. If a grade is desired, simply check the student records of dip angle and strike direction against your predetermined correct answers. More advanced students should be more accurate.

Teaching suggestions:

- “Grade level” depends on ability. Students should be able to read a compass and a protractor.
- Assemble the “rock units” beforehand if you want two or more angles to measure. Wooden wedges are available at hardware or building supply stores.
- To allow the teacher to check the accuracy of the mea-

OBJECTIVES:

- Clarify the concepts of strike and dip.
- Measure strike and dip of a simulated rock outcrop.

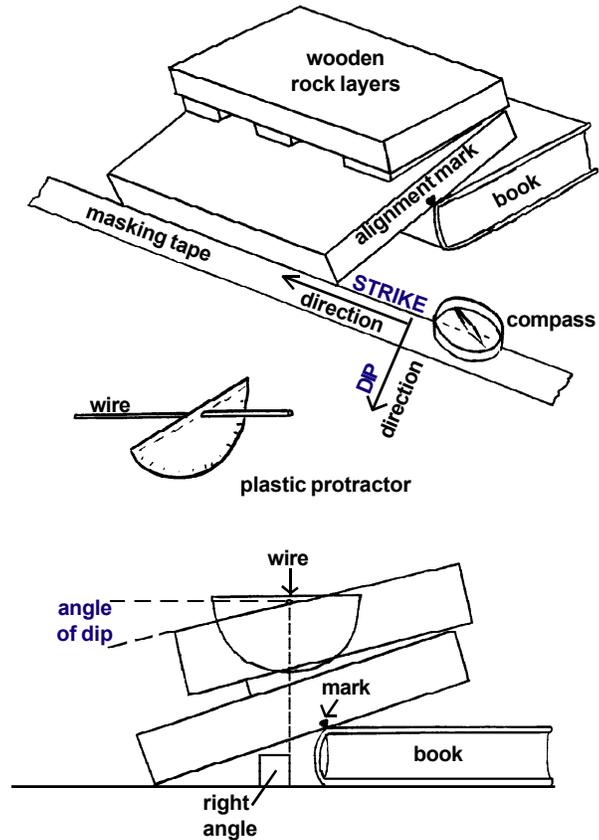
Materials and Equipment:

(class of 30 working in teams of 3)

- 10-20 wooden boards
- 20-40 wooden wedges (optional)
- 10 magnetic compasses
- 10 plastic protractors
- 10 wires
- 10+ masking tape
- 10 index cards

surements, have the students orient the masking tape in a specific direction (same for all, different?), use a specific book as a prop (their science text!) and align the book with marks you have put on the boards (see figure).

- The protractor *must* be held so that the 0-180° line is parallel to the table and the 90° line is perpendicular (see figure).



Solar System Travel Company



by Karen Williams
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In this activity I explain to my students that they are now employees of the SST Co. As such they will have to travel to their assigned solar body to study it so they can create an informative yet interesting travel brochure and TV commercial that will entice earthlings into vacationing there.

TIME: Seven to eight 50-minute classes.

PROCEDURES:

1. Assign students to groups of 3 or 4. Have each group draw the name of their planet/moon from a hat. To cover 8 planets, our moon, the sun, and some of the larger moons of other planets, they will share the presentations with each class through the videotaped commercials and brochures.
2. Their exploratory trip will actually involve 2 days of library research. During this time they may NOT use encyclopedias. They should discover basic information and interesting facts about their planet/moon that would be important to the tourists. Some of these include but are not limited to:
 - a. Size
 - b. Distance from Earth
 - c. Day/night length
 - d. Length of year
 - e. Average temperature (day/night)
 - f. Atmospheric composition and characteristics
 - g. Surface composition, characteristics, and geology
 - h. Number of moons and if they make good side trips (briefly describe)
 - i. Any information that makes the body unique or special
3. The next 2 days are spent planning their commercial and creating their brochure. The teacher can provide material to help create these. NASA will provide information if it is requested. Web sites contain many pictures and much information.
4. For the brochure, fold a large piece of construction paper into thirds to make a booklet. Samples of travel brochures

OBJECTIVE:

- Learn about the bodies that make up our solar system.
- Gain skills in using the tools of the library.
- Understand how to make a concise, informative, and interesting presentation.

Materials and Equipment:

- Video camera/VCR/videotape
- Construction paper
- Glue
- Markers
- Crayons
- Colored pencils
- Scissors
- Pictures, brochures, etc., from NASA
- Local travel brochures
- Optional: computer for Internet searches

from the local tourism bureau are helpful to have on hand.

5. Criteria for the commercial are as follows:
 - a. All students must participate;
 - b. It must be creative--have them think about what commercials hold their interest;
 - c. Must last between one and two minutes;
 - d. Must have visual aids;
 - e. Must communicate relevant information.
6. On day 5, return to library to videotape the commercials. While one group is taping, the others are "checking out" the brochures as a study method and taking notes. The commercial is 1-2 minutes in length and all group members must participate in some way.
7. Show to all classes as a lesson on the solar system. They should take notes. Show each commercial twice and have the group answer questions if they are in that class; if not, the teacher may answer their questions.
8. The students rate each commercial on a scale of 1-5 for entertainment value. This will be used as part of the grade for this project.

ASSESSMENT:

Brochure:

Creativity	Is it "eye-catching"? Is it attractive? Is the material presented in an interesting way?
Content	Is it accurate? Does it contain an adequate amount? Is it well organized?

Commercial:

Creativity	Student evaluation. Does it hold your interest? Is it a unique idea? Is it well presented?
Content	Same as brochure.