Activities in Historical Geology With IGO's

2001

Historical Geology
West Virginia Instructional Goals and Objectives

Historical geology is an integral portion of science instruction in the state of West Virginia as evidenced in the list of Instructional Goals and Objectives listed below. Every attempt was made to incorporate these WVIGOs into the activities which follow. These topic-specific WVIGOs, as well as others, are identified for each of the activities that appear in this document.

Fourth Grade

4.27 engage in active inquiries, investigations, and hands-on activities for a minimum of 50% of the instructional time to develop conceptual understanding and laboratory skills

4.62 [4,5] research evidence to discover the age of the earth – systems

4.63 [10] associate fossils with the periods in which they were formed – systems

4.66 [5] compare and explain the relative time differences to erode materials (e.g., a sand pile, mud pile, rock pile) – changes

Fifth Grade

5.27 [3,4,6,8,9,10,11] classify living and non- living things according to properties (e.g., structures and functions, mass, volume, density, solubility, conductivity, magnetism, weight, shape, color, freezing point, boiling point, evaporation, rocks and minerals) – systems

5.30 [3,4,6,7,8,9,10,11] recognize and explore methods for investigating physical changes (e.g., evaporating, condensing, boiling, freezing, melting, salinity, density, shape and size) – changes

5.32 [2,3,4,7,8,9,10] explain how the different characteristics of plants and animals help them to survive in different niches and environments (e.g., adaptations, natural selection, extinction) – systems

5.33 [4,7,8] identify the structures of living things and explain their functions (e.g., cells, tissues, organs, organ systems, whole organisms, communities, ecosystems) – systems

5.46 review fundamental earth science concepts including, relative age of the earth

5.48 [10] explore how fossils can be used to determine the age of rock layers – systems

5.50 identify and describe natural land forms, changes in these land forms and recognize that they may be used as a record of time – changes

5.51 compare and explain the different rates of weathering in certain materials (e.g., sand pile, mud pile, rock pile) – changes

5.55 [3,4,6,7,8,9,10,11] fabricate and illustrate models (e.g., solar system, structure of earth, erosion and weathering, forces which drive the rock cycle) – models

Sixth Grade

6.67 summarize the forces and results of plate tectonics – changes
6.69 develop an understanding in the change's of the rock record – changes
6.72 [4,9,10,11] construct and explain various models (e.g., solar eclipses, lunar eclipses, rock formation including sedimentary, igneous and metamorphic) – models

Seventh Grade

7.66 compare and contrast geologic time - changes
7.67 [4,10] construct and explain various models (e.g., motions of earth, sun and moon, ocean floor structures, coastal landforms and soil erosion) – models

Eighth Grade

8.64 summarize and explain the principle of plate tectonics – systems
8.73 construct and interpret rock layer models through stratigraphic interpretation (e.g., age, environment when deposited) – models

Ninth Grade

9.31 [3,4,5,7,8,10,11] design an environment which demonstrates the interdependence of plants and animals (e.g., energy and chemical cycles, adaptations of structures and behaviors) – models

9.33 construct and manipulate models which show variations in living things (e.g., excretory, digestive systems) – systems, models

9.35 [11] determine the number of neutrons, protons and electrons given atomic number and average atomic mass number and relate to the periodic table position – systems

9.36 associate proton number with type of element, electron distributon with reactivity, and number of neutrons with nuclear stability – systems

9.37 list the characteristics of radioactivity substances including alpha particles, beta particles and gamma rays – systems

9.38 define and describe the half life of a radioactive isotope – models

9.46 [11] experimentally determine the products of chemical reactions and write balanced chemical equations - changes, models

9.47 [6,7,11] conduct, write equations and classify five types of chemical reactions including synthesis, decomposition, single displacement, double displacement and combustion – changes, models

9.54 [7,8] differentiate among energy transformations (e.g., heat, light, sound, mechanical, chemical, nuclear) – changes

9.72 [4,6,10,11] analyze and describe a common rock sample (e.g., color, grain, and composition) – models

9.73 [4,6,10,11] employ tests to identify rocks and minerals (e.g., streak, color, hardness, and cleavage) – models

9.75 [10] examine geologic time emphasizing isotopic ages and biostratigraphy – changes

9.76 estimate the age of materials using existing radioisotopic data – systems

9.77 investigate formation and destruction of mountains (e.g., weathering, earthquakes, volcanoes, plate tectonics) – changes

9.85 explore the properties and motions of oceans – systems

9.88 research applications of space technology in everyday life (e.g., velcro, teflon, weather satellites) – systems

9.90 construct and explain models (e.g., solar systems, galaxies, constellations, stellar types, and stellar evolution) – models

9.91 identify contributors to the scientific body of knowledge including their diverse cultures

Tenth Grade

10.68 review fundamental earth science concepts including tests to identify rocks and minerals, topographic maps – systems

10.69 [3] investigate fossils (e.g., origins, use in establishing geological time, types of plants and animals included in fossil-fuel formation, compare fossils to present today organisms – systems

Environmental Earth Science (Grades 11-12)

ES.24 review foundational earth science concepts including rocks and minerals, properties of waves, constructing and interpreting weather maps, surface features found on maps, climatic relationships to biomes, use of data gathering instruments, temperature – phase change relationships

ES.38 identify and describe agents and processes of degradation (e.g., weathering by gravity, wind, water, and ice)

ES.40 understand the cause and effect relationships of degradational and tectonic forces with respect to the dynamic earth and its surface (e.g., volcanoes, earthquakes)

ES.42 list, identify, and sequence eras, epochs, and periods in relation to earth history and geologic development

ES.48 examine global change over time (e.g., climatic trends, fossil fuel depletion, global warming, ozone depletion)

ES.68 access, gather, store, retrieve, and organize data using hardware and software designed for these purposes

Contents

Stratigraphy

Sandstone - Ss (yellow)

Siltstone (orange)

Shale - Sh (green)

Clay (green or purple)

Limestone - Ls (blue)

Coal - C (black)

Concealed areas - (white)

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

WVIGO's

6.69 6.72
7.67
8.73
9.75 9.85 9.88 9.91
ES.24 ES.48

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.

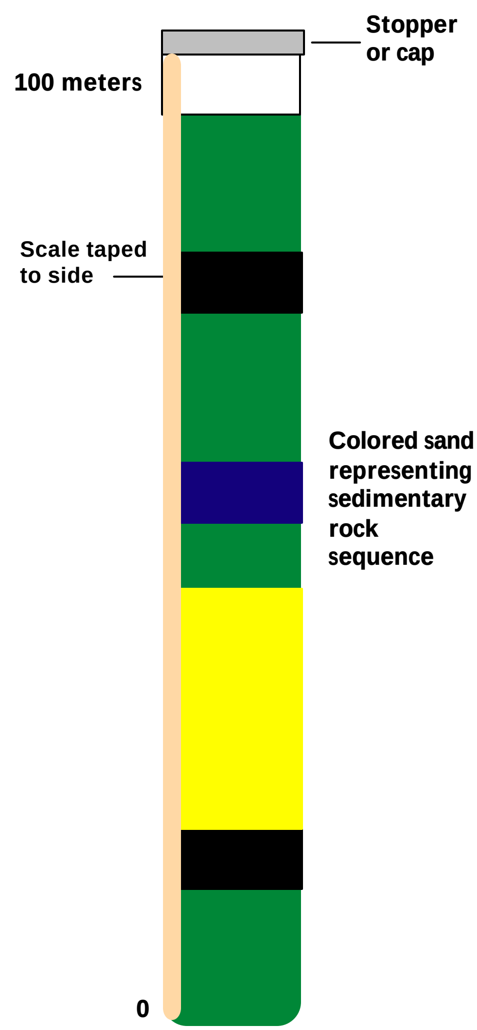
7. Each group will construct a geologic column to represent their assigned outcrop. Using the handouts as a guide, the students fill their tubes with the colored sand to complete their model. As each layer is poured, it must be compacted with a dowel rod. (If the layers of colored sand do not completely 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)

Core Sampling

by Suzanne M. Anderson
Worthington Elementary School

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 interprete the sequences of their classmates' sandwichs?

ASSESSMENT:

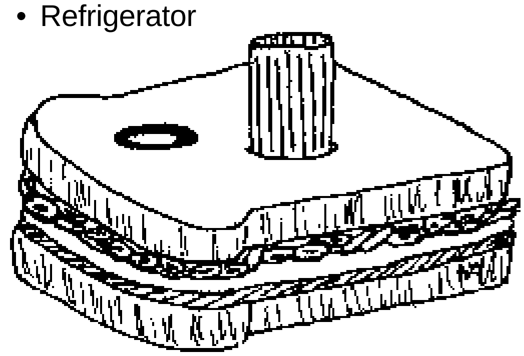
- Evaluation can be based on teacher observation of students' performance and cooperation, evaluating the drawings, and both written and oral questions. Student journals including all work, legends, and the interpretation of classmates "cores" are helpful.

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*

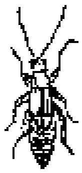
Materials and Equipment:

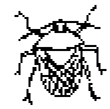
- Different breads (white, wheat, banana nut, etc.)
- Various spreads (peanut butter, jams, jellies, fresh fruit, etc.)
- Cereal (Rice Krispies, Cheerios, etc.)
- Plastic bags
- Plastic knives
- Paper towels
- Permanent markers (to mark bags)
- Manicotti or other large tube-shaped noodles
- Paper
- Colored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



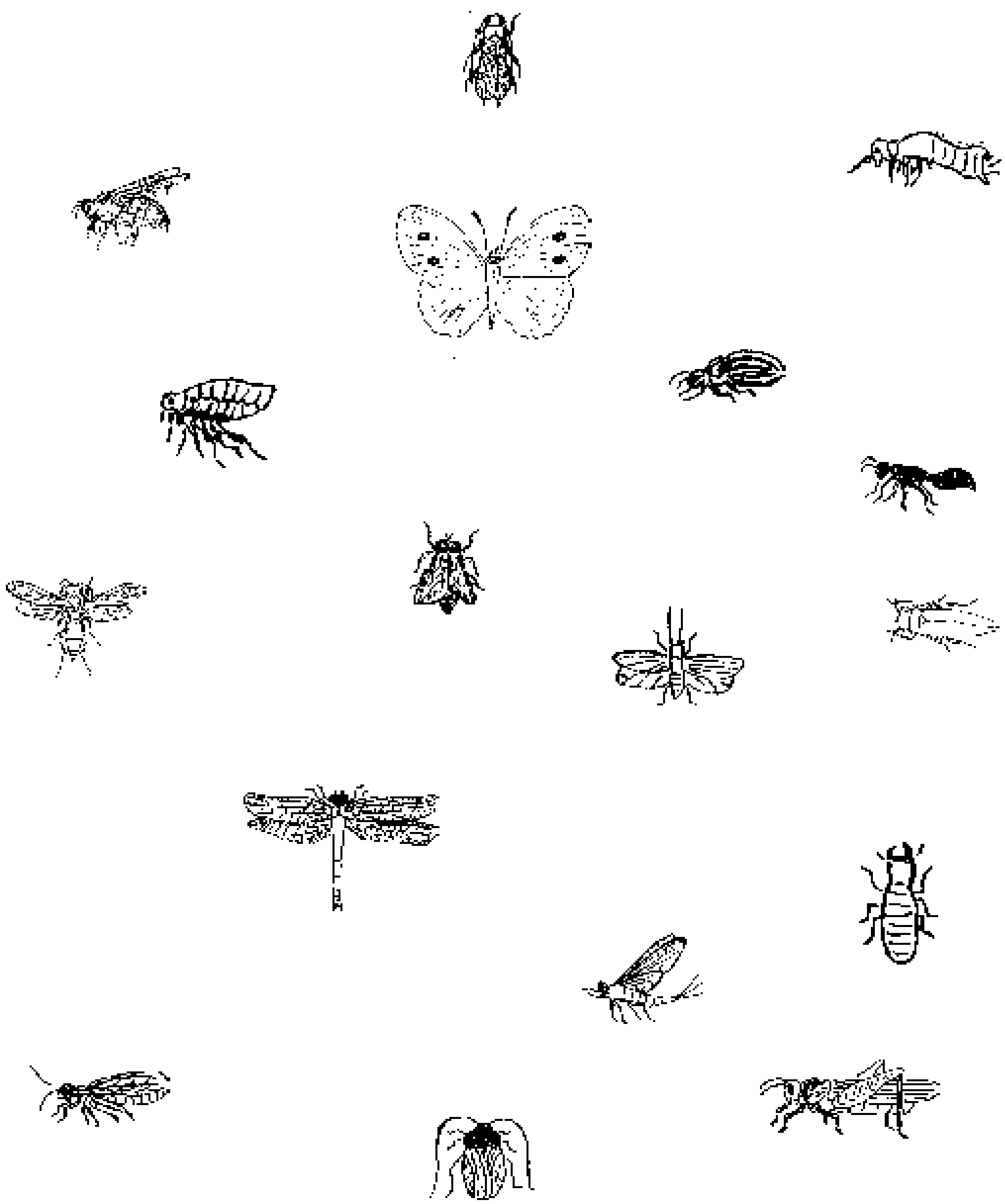
WVIGO's

4.27
5.55
6.69 6.72





Geologic Time



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

WVIGO's

5.46 5.48
7.66
9.75
ES.42

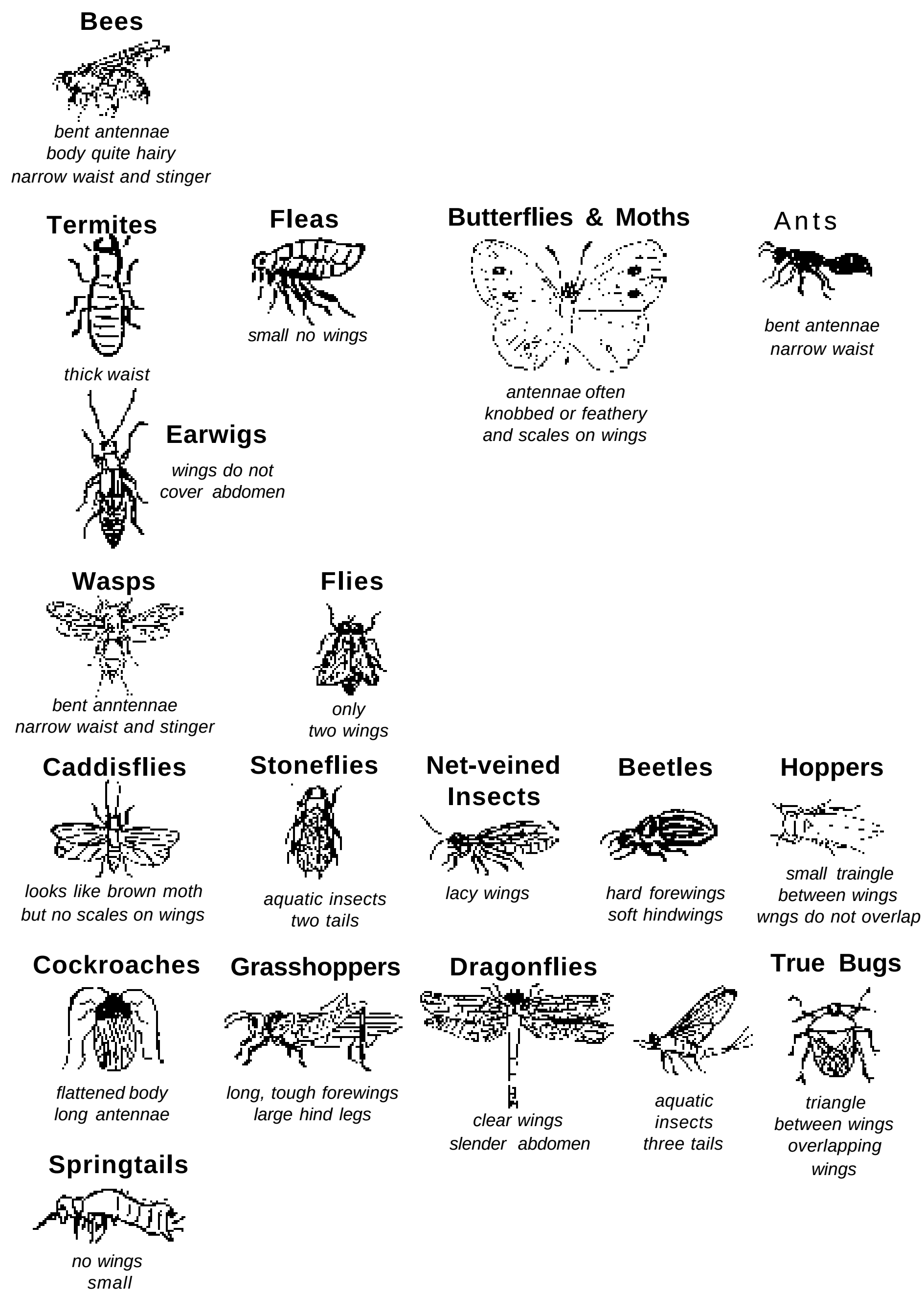
Further Challenge:

- 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
CENOZOIC	Tertiary 65 million years ago
MESOZOIC	Cretaceous 144 million years ago
MESOZOIC	Jurassic 208 million years ago
MESOZOIC	Triassic 245 million years ago
PALEOZOIC	Permian 286 million years ago
PALEOZOIC	Carboniferous 360 million years ago
PALEOZOIC	Devonian 408 million years ago



Exploring the Geologic Time Scale

by Deb Hemler
Fairmont State College

OBJECTIVES:

- *to better understand the design and significance of the Geologic Time Scale*
- *to practice reading information from tables and charts*
- *to practice integrating math and science by working with simple scales and measurement*

Materials and Equipment:

Per student:
- Ruler
- Exploration blackline master
- Geologic time scale (either blackline master provided or one from their text)
- Application blackline master.

WVIGO's

4.27 4.62
5.46
7.66
9.75
ES.42

EXPLORATION: (Creating an Individual Time line)

1. Hand out the "Exploration" (Figure 1) and have the students name 3 significant events in their lives and the year each occurred placing these in the first two columns of the table.
2. Students then calculate the number of years ago each occurred in column three.
3. On the back of the paper, students use rulers to draw a vertical line using the scale (1 cm = 1 year) to represent their life.
4. Students mark the bottom of the line "birth" and the top "present".
5. Using rulers and the same scale students mark each of the events they listed on their time lines.

CONCEPT DEVELOPMENT: (Geologic Time Scales)

1. Provide students with a Geologic Time Scale (Figure 2).
2. Students in groups of 2 or 3 record observations about the geologic time scale. Observations might include but are not limited to:
   - oldest time at the bottom and youngest at the top
   - scale is divided into smaller blocks of time, eras are the largest divisions (eons might be on some time scales)
   - the age of the Earth
   - eras are divided into periods
   - periods are divided into epochs
   - the times represented in each of the eras or periods are not equal
   - the relative sizes of the blocks do not represent the amount of time of each era or period
   - abbreviations: mya (million years ago), bya (billion years ago), or bp (before present)
   - many eras end in "zoic"
3. Elicit at least one response from each group and record these on the board. Note: generally the fact that the time scale is not "to scale" in the representation of the size of

the blocks relative to the amount of time actually spent in this era is often overlooked by the students. Probe for this and other points they may miss.

4. Discuss each of these points as they are made by the students.
5. Ask the students "If the eras and periods of the geologic time scale are not equal time units, what criteria do scientists use to create the divisions?" Students might already know life forms, extinctions, and geologic events mark the beginning and ending of the various divisions.

CONCEPT APPLICATION: (Construction of a Personal Time Scale)

1. Students construct their personal time scales in the table (Figure 2) provided.
   a. Students are to give each of their "eras" a name which characterize it
   b. Students are to divide each era into two or more periods
   c. Students will give a description that characterizes their various periods
2. On the back of their time scales, ask students to write an essay comparing and contrasting their personal time lines to the geologic time scale.
   (Differences: shorter, names are different. Similarities: should provide many items from above list)

Personal Time Line:

1. Using a ruler, draw a vertical line to represent your life thus far using the scale: 1 cm = 1 year.
2. Mark the bottom end of the line "birth" and the top end "present."
3. Mark the events you listed in the table above on your time line using the same scale.

FIGURE 1. Exploration

Event	Year It Occurred	# of years before present
1		
2		
3		

FIGURE 2. Geologic Time Scale

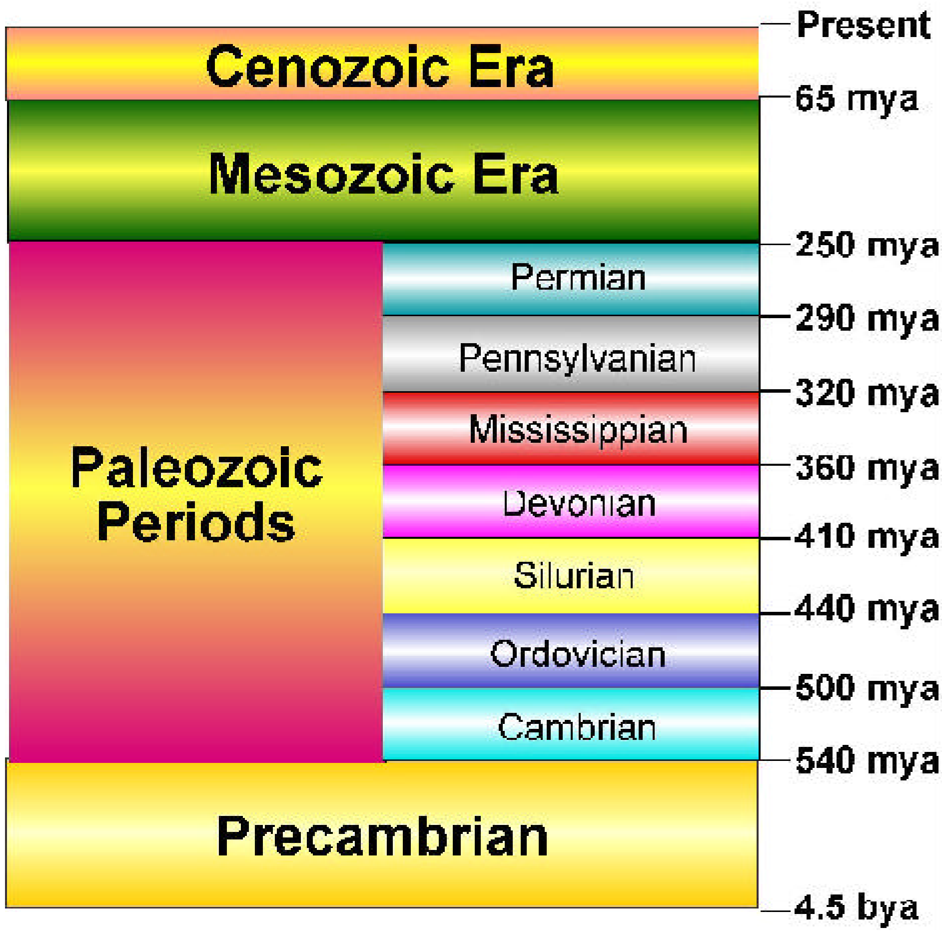


FIGURE 3. Application

Personal Time Scale

Era	Period	Description

A Constructivist Scale Model of Geologic Time

by Deb Hemler
Fairmont State College

EXPLORATION:

1. String a clothesline 4.6 meters in length somewhere in the room where students can reach it.
2. Divide Event Cards and paper clasps among student groups of 2 or 3.
3. Have student groups discuss where on the time line the events should be placed. Send two groups at a time to the clothesline. Using the paper clasps they are to place their cards where they think they occurred on the time line.
4. When all groups have finished discuss any prior knowledge used to place the events on the time line. Some students will know the dinosaurs occurred during the Mesozoic or that man is very recent. Some might place organisms from least complex to more complex (e.g. bacteria - man)

Concept Development:

1. Hand out the Geologic Time Events sheet and ask students to compare where they placed events to when they actually occurred.
2. Discuss surprises. Many students are surprised to see that grass evolved so late. This actually is not so surprising when you think of grass as a specialized flowering plant. It had to evolve the ability to grow from its base rather than its apex and withstand constant "cropping" or mowing by animals.
3. Discuss common misconceptions. Tyrannosaurus rex did not lunch on Stegosaurus...they lived about 60 million years apart! Mammals were around when the dinosaurs roamed the earth, they were just small and shrew-like.
4. Have students move their events to the proper order in which they occurred. (At this point they will only be in the correct order not the correct location.)
5. Read to students the Cinema Model of the Geologic Time Scale. Ask them to discuss any points they notice.

***OBJECTIVES*:**

- *to assess prior knowledge of information on Geologic Time*
- *to familiarize students with the eras of geologic time and some events associated with each*
- *to enable students to grasp the concept of a billion years and the relatively short period of time man has occupied the earth*
- *to practice integrating math and science by working with the concept of scale*

Materials and Equipment:
***Per class*:**

- 1 clothesline (5 meters long)
- 30 paper clasps (medium)
- 1 set of event cards (duplicated on card stock and cut apart)

***Per group*:**
- meterstick

Per Student:
- ruler
- Modeling Time blackline master
- calculators (optional).

WVIGO's

7.66 7.67
9.75
10.69
ES.42 ES.48

Geologic Time Event Cards

Organism Event Cards

- Bacteria
- Green Algae
- Jellyfish
- Trilobites
- Sharks
- Spiders
- Cockroaches
- Ferns
- Earthworms
- Pangea Forms
- First Mammal
- Stegosaurus
- Grass
- Archaeopteryx
- Lucy
- First Flowering Plant
- Tyrannosaurus
- Camel

Mountain Building Event Cards (used with upper grades)

- Taconic Orogeny
- Acadian Orogeny
- Modern Appalachians

Geologic Era Cards

- Precambrian begins
- Paleozoic begins
- Mesozoic begins
- Cenozoic begins

6. Ask the students how their placement of events on the time line relates to when events happened in the movie? (Most likely students will have events too close to the beginning of time on earth)

Concept Application:

1. Ask the students if they can get more accurate with their model of time? Discuss the concept of a scale model and how it was used in the movie model.
2. Discuss the scale for this model: If the clothesline is 4.6 meters long and the age of the earth is about 4.6 billion years, what is the scale for our model? (1 Billion years = 1 meter)
3. Review the SI units of measure (1 Meter= 100 cm = 1000 mm) if necessary.
4. Now ask students to determine the time equivalent for a centimeter and millimeter. Allow time for students to discuss the scale. Ask for student responses working out the scale measures with the class.

   How much time does a meter represent?
   1 meter = 1,000,000,000 or 1 billion years
   A centimeter?
   $$1 \text{ cm} = \frac{1{,}000{,}000{,}000 \text{ years}}{100} = 10{,}000{,}000 \text{ years}$$
   A millimeter?
   $$1 \text{ mm} = \frac{1{,}000{,}000{,}000 \text{ years}}{1{,}000} = 1{,}000{,}000 \text{ years}$$
   (or 1 million years)

5. Once the entire class understands how to convert time to distance on the clothesline. Have the students calculate the placement of each of the events in the Modeling Geologic Time table.
6. Using a meterstick, have student groups place their events in their proper locations.
7. Ask students to make some observations regarding the newest model of geologic time they have produced.

Modeling Geologic Time

Event	Years Ago	Scale Distance
"Lucy"	4 mya	
Camel	35 mya	
Grass	55 mya	
Cenozoic Era (begins)	65 mya	
Tyrannosaurus	65 mya	
First Flowering Plants	125 mya	
Archaeopteryx	140 mya	
Stegosaurus	160 mya	
First Mammal	240 mya	
Mesozoic Era (begins)	250 mya	
Pangea Forms	260 mya	
Earthworms	300 mya	
Allegheny Orogeny (begins)	320 mya	
Cockroaches	330 mya	
Ferns	370 mya	
Sharks	400 mya	
Acadian Orogeny (begins)	410 mya	
Spiders	450 mya	
Taconic Orogeny (begins)	460 mya	
First Vertebrate	515 mya	
Trilobites	520 mya	
Jellyfish	545 mya	
Paleozoic Era (begins)	545 mya	
Green Algae	1 bya	
Bacteria	3 bya	
Precambrian Era (begins)	4.6 bya	

Note: (mya= million years ago, bya= billion years ago) These dates are approximations and will vary depending on the source consulted. The dates used in this figure were obtained from: A Correlated History of Earth. 1994. Pan Terra, Inc.

The Cinema Model of Geologic Time

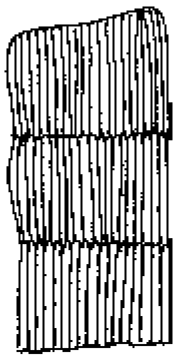
If the age of the earth were compressed into one year:

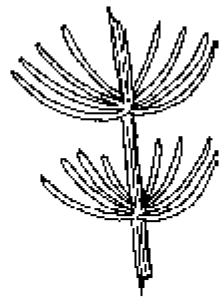
1 day	=	12,300,000 years
1 hour	=	513,000 years
1 minute	=	8,550 years
1 second	=	142 years

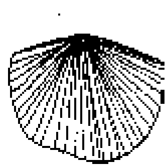
The movie would look something like this:

Years ago	**Event**	**# of days**	**movie date**
4.5 by	earth accreting from gas and dust	1	Jan 1
3.8 by	molten earth	60	Mar 1
3.5 by	First stromatolites (prokaryotes)	81	Mar 22
2.5 by	end of Archean Era	162	June 11
1.5 by	first eukaryotes	243	Sept 1
700 my	Ediacaran fauna	309	Nov 5
575 my	Paleozoic Era begins	319	Nov 15
480 my	primitive vertebrates	326	Nov 22
406 my	Devonian fishes	332	Nov 28
344 my	Appalachians forming	337	Dec 3
270 my	Appalachians finished	343	Dec 9
221 my	start of Dinosaurs	347	Dec 13
135 my	Dinosaurs rule supreme	354	Dec 20
65 my	Dinosaurs extinct/ Rocky Mtns begin	360	Dec 26
2 my	earliest man *Homo habilis*		Dec 31; 8PM
6000 yrs	recorded history begins		11:59:18
507 yrs	Columbus makes it to the "New World" European settlement of America in last 3 seconds of the movie		11:59:57

Fossils








Fossil Origins

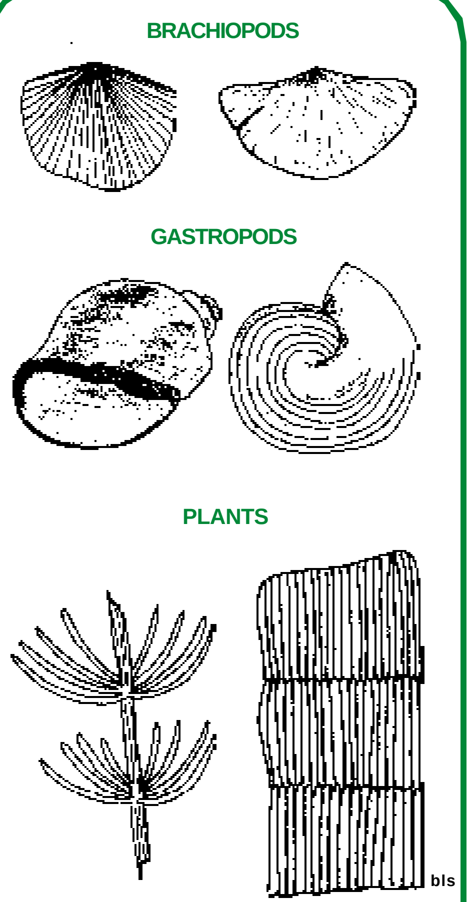
by Angela McKeen
Valley High School

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



Asterophyllites equisetiformis   Calamites sp.

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.

WVIGO's

4.63	
5.46	5.48
9.33	9.75
10.69	
ES.42	

Pasta Paleontology

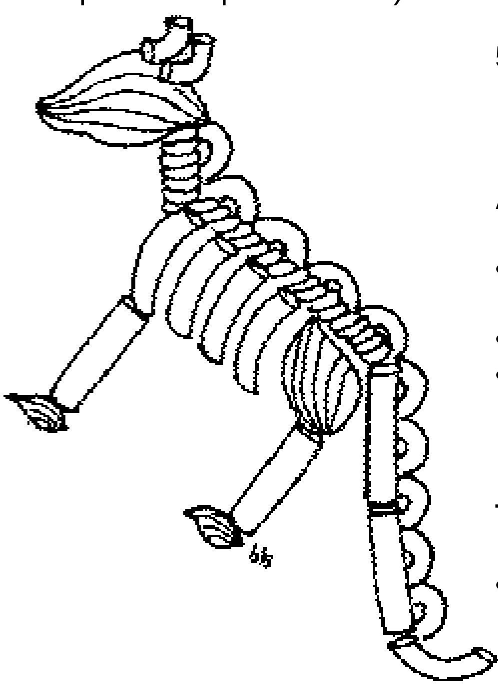
by Nancy Moore
Walton Middle School

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).



WVIGO's

4.27
5.32 5.33

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.

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.

OBJECTIVE:

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

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.

Materials and Equipment:

STATION A: ***Message in a Fossil***

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

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 scoopfuls of plaster with about 15 ml of water. Stir the mixture so it looks like pancake batter (thick, but easy to pour). Add water or plaster as necessary.

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

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?

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?

Materials and Equipment:

STATION C: *Mystery Fossils*
- Collection of unlabeled fossils
- Variety of resource materials (fossil handbooks, encyclopedias, posters)

WVIGO's

4.27 4.63
5.32 5.33 5.46 5.48

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?

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

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.

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

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.

Fossils and Ancient Environments

by Paula Waggy
Franklin High School

TIME:

10 minutes on first day
45 minutes on second day
45 minutes on third day
(note: best done on three consecutive days; can't be done in a 90 minute block because the plaster requires time to harden)

PROCEDURES:

- Divide the class into groups of four or five. Ask each group to quietly decide upon an environment to represent with fossils they will make.
- Students should determine what objects they will bring from the environment they have chosen. Objects should be small and within each group come from a common environment. The “fossil objects” can be man made or natural. Choices of environments and “fossils” should be kept secret within the group.
- Instruct students to bring their objects to class the next day. Each student should have one object.
- Pass out small balls of modeling clay to each group. Each student should press the object s/he has brought into a clay ball to make a mold.
- Mix plaster of paris and water in paper cups with plastic spoons.
- Pour the plaster into the molds and label with students’ names. Set aside until the following day.
- Ask each group to write a description of the environment they have chosen on an index card. The descriptions should include the average temperature, the amount of moisture, the amount of light, the general shapes of predominant objects and the elevation.
- Collect the descriptions and keep them for the next day.
- Remove the “fossil” casts from the clay molds and place each group’s “fossils” in a sandwich bag.
- Exchange the bags of “fossils” between the groups.
- Distribute a blank index card to each group. Ask groups to examine the “fossils” and try to identify them. Record the names of the “fossils” on the index cards.
- Using the “fossils” as clues, students will try to describe the environment from which the fossils originate. Use the same criteria as the day before.

OBJECTIVES:

- ***To make "fossils" using the cast and mold method.***
- ***To understand a paleontologist's use of fossil clues to recreate ancient environments.***

Materials:

- Modeling clay
- Plaster of paris
- Plastic sandwich bags
- Index cards
- Water
- Paper cups
- Plastic spoons
- Miscellaneous small objects

WVIGO's

6.69 6.72
9.31 9.75
10.69

Extension:

Read some excerpts from the book, The Dinosaur Heresies, New Theories Unlocking the Mystery of the Dinosaurs and Their Extinction by Robert T. Bakker. Chapter 5, " The Case of the Brontosaurus: Finding the Body" is a good discussion of the clues leading to the modern hypothesis about brontosaurus habitat.

Problems Facing Paleontologists for Discussion

- Soft bodied animals rarely become fossilized.
- Often only part of an organism is fossilized or only a fragment is found.
- The body parts of an animal may have been moved to a location near the body parts of a different animal.
- Plants decay quickly and may not fossilize.
- Fossils may be carried from one site to another by erosion or floods.

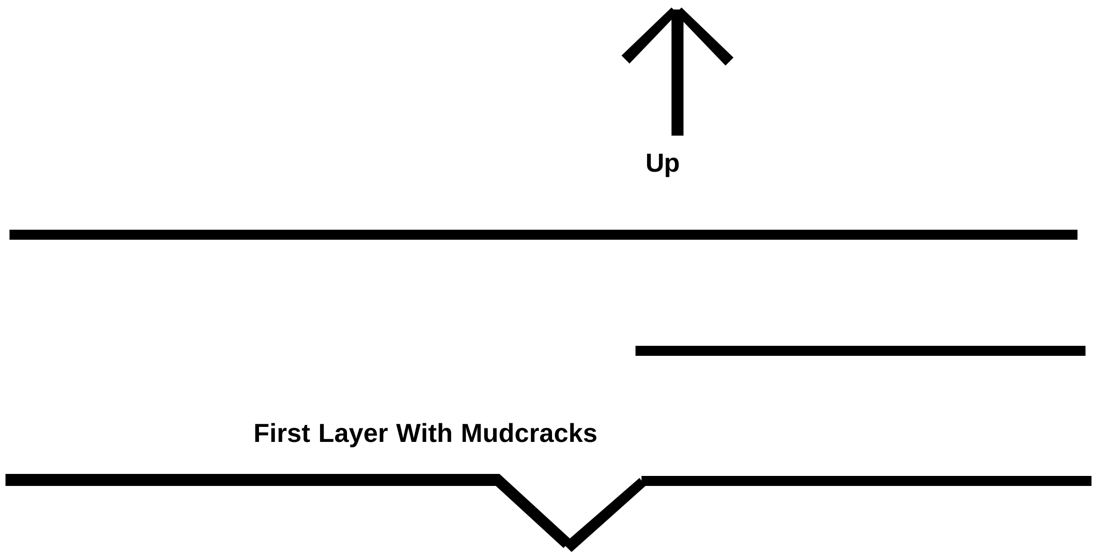
ASSESSMENT:

Distribute samples of real fossils (preferably from a local area) to students. Ask students to prepare written descriptions of the environment in which the organisms lived. Remind students to use the principle of uniformitarianism in determining the ancient environment. Emphasize the importance of supporting their ideas with information that is true about present day environments.

Teaching Suggestions:

When introducing and explaining this activity give students examples of "fossil objects" and environments that would be appropriate. For instance students could decide to make fossils from a sewing area. They could bring a thimble, a spool of thread, a button, a tracing wheel and a needle threader. Perhaps students decide to depict a natural environment such as a forest. They could bring in a twig, an acorn, a hemlock cone, a small bone or tooth, and a beetle. Other "environments" that work well for this activity are kitchen drawers, carpenter benches, jewelry boxes, tool boxes, office desk drawers, or fishing tackle boxes.

Sedimentary Features



Mudcracks: A Clue to the Earth's Past

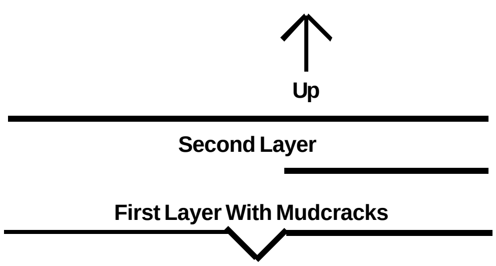
by Donis Hannah
Robert L. Bland Middle School

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



WVIGO's

5.50
10.68
ES.40

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?

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 interprete 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 power to uniform size.
2. Mass l-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.*

WVIGO's

9.46 9.47 9.72 9.73 9.77
10.68
ES.42

Questions:

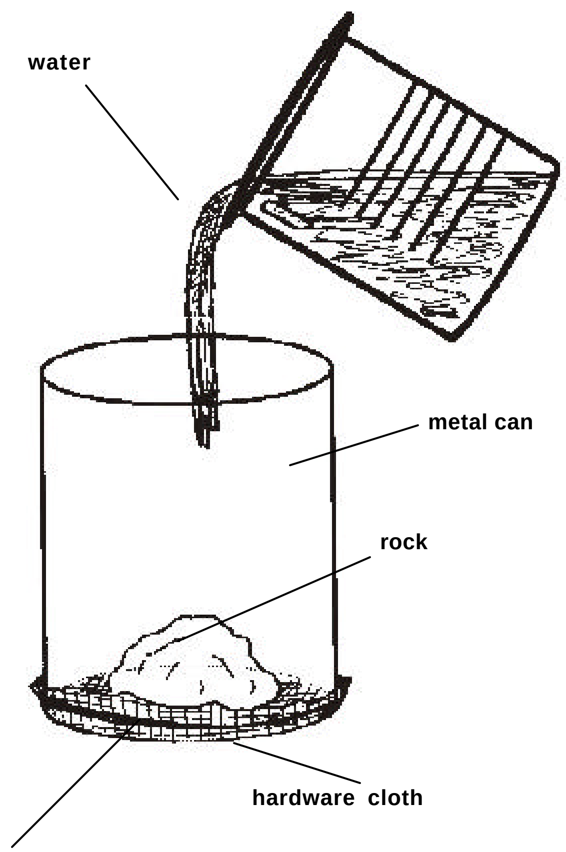
1. Calculate percentage of calcium carbonate in each sample. How does the amount of carbonate compare in each type of limestone? What could have caused this difference?
2. What metals, if any, were present in the carbonate samples?
3. Investigate the importance that purity (percentage of calcium carbonate) 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 insoluable 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 addtional 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.

Erosion



Whether it Weathers?

by Deb Hemler
Preston High School

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

WVIGO's

9.77
10.68
ES.38

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.

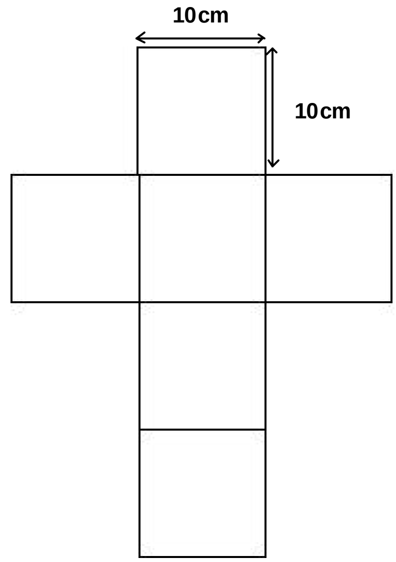
TIME: Two 50-minute periods to organize, and then one 50-minute period a month for a semester for data collection.

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, 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.

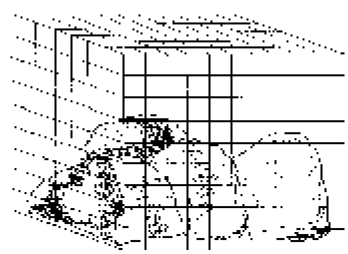
7. Groups 7 and 8 will place their samples on the floor of a picnic shelter (preferably in a windy area). Groups 9 and 10 will place their samples out in the elements. Groups 11 and 12 will place their samples in a sheltered room with no temperature controls. Groups 7 through 12 will alternate recording 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).



Wire mesh design for cutting out cubes for construction

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.


Wire mesh cube with rock samples

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.

And the Winner Is...

by Elise Adkins
Logan Jr. High School

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.

WVIGO's

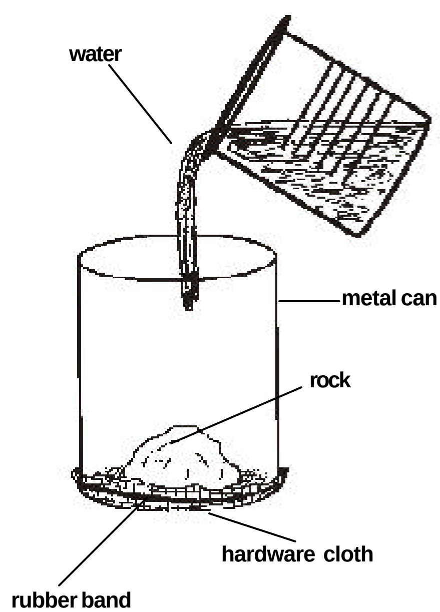
4.66
5.27 5.30 5.51
9.77
10.68
ES.38

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



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.

Weathering and Fossil Preservation

by Margaret Miller
Pratt Elementary

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.

WVIGO's

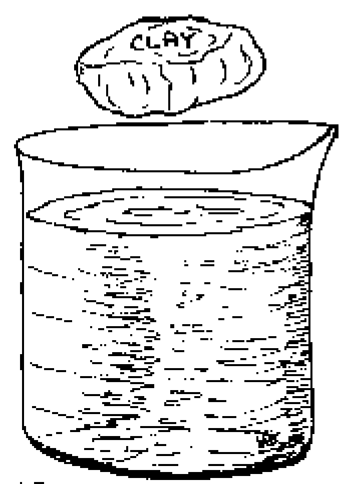
4.27
9.77

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



Ridge Top vs Valley Rocks "The Battle of the Toughest"

by Paula Waggy, Pendleton County High School
Deborah Ennis, Wheeling Park High School

OBJECTIVE:

- *to demonstrate the different weathering characteristics of ridge top and valley rocks*
- *to analyze why valleys form where they do and where ridge tops remain.*

Materials and Equipment:

- rock samples – one from a ridge top; two from valleys
- sock
- hammer
- small plastic peanut butter jars
- graduated cylinder
- balance
- cheesecloth

SAFETY NOTE: *Stress safety when instructing students on their rock sample collections. Discuss road hazards and incompetent slopes. Also caution students on watching where they put their hands, being aware of snakes, bees, poison ivy, etc. Caution should be taken when hammering rock samples. Safety goggles should always be worn.*

WVIGO's

5.30 5.51
9.77
10.68
ES.38

Rocks on ridge tops are different from those in valleys. This activity will enable students to understand why valleys and ridges form as they do.

PROCEDURES:

1. Prior to activity:
   a) have students collect and bring in rock samples
   b) teacher should place individual samples into a sock and pound with hammer to break into small pieces.
2. After reading procedure, construct a data table
3. Set aside a small portion of each sample for later comparison.
4. Mass 100g of each sample and put into the appropriately labeled jar. Observe the shape and sizes of each sample and record.
5. Pour 100mL of water into each jar.
6. Put lid on tight and shake for 5 minutes.
7. Pour water through a cheesecloth, mass each sample, and record.
8. Place 100mL of water and remaining sample back into each jar. Repeat shaking, pouring, and massing for a total of three times.
9. Construct a graph with mass on the y-axis and time on the x-axis using a different color for each sample. Be sure to make a key.

ASSESSMENT:

1. Students demonstrate an understanding of ridge rocks being tough and less resistant to erosion as to valley rocks being weak and more resistant to erosion.
2. Graphs accurately represent data and student is able to interpret graph by explaining the different weathering characteristics of ridge and valley rocks to each line plotted.

Teaching Suggestion:

- In order for this activity to give desire results, the teacher should examine samples prior to the lab making sure that the more resistant rocks are used for ridge samples and less resistant rocks are used for valleys. Suggested rocks for this activity include:

  Ridge rocks = very tough sandstone and limestone
  examples: sandstone = Tuscarora and Pottsville
  limestone = Helderberg
  Valley rocks = weak limestone and shale

Questions:

1. What observations can you make in the sizes and shapes of each sample?
   Explain your answer.
2. Which rock sample lost the most mass? Explain your answer.
3. What type of rock form ridges? Explain why.
4. What type of rock form valleys? Explain why.

Dating Rocks

A Radioactive Decay Model (Popcorn Lab)

by Mary Sue Burns
Pocahontas County High School

Radioactive dating is a useful method for determining the age of some rock material. Radioactive isotopes, atoms with unstable nuclei, include carbon-14, uranium-238, and others. As time passes, the nuclei give off particles and energy, thus, transmuting into different elements. For example, uranium undergoes a series of changes to become lead. By measuring the relative amounts of uranium and lead in a rock, geologists can determine how long it has been since the rock formed. A "half-life" is the time it takes for half of the original element to decay. Each time a half-life goes by, half the amount present at the beginning of that half-life has decayed. In this lab, popcorn kernels represent atoms. When a kernel points toward a designated direction, it will have "decayed".

OBJECTIVE:

- *To examine a model of the nuclear decay process found in radioactive nuclei and its use in geologic dating.*

Materials and Equipment:
- A shoebox with lid
- Unpopped popcorn
- Marker
- Graph paper

TIME:

PROCEDURE:

1. On the inside of the shoebox, draw two arrows with the marker. Place one arrow on one of the short sides of the box and one on one of the long sides of the box.
2. Count 128 kernels of popcorn out and place them in the shoebox.
3. Place the lid on the box and shake it three times.
4. Open the box and remove all of the kernels that are pointing towards the short end of the box with the arrow on it.
5. Count the number of kernels removed and subtract that number from the original amount in the box and record the number of kernels left in the box.

Safety Note:

1. *Wear protective goggles throughout the laboratory activity.*
2. *Use care in handling the popcorn.*

Trial Number	Kernels Remaining
0	128
1	
2	
3	

WVIGO's

9.35 9.36 9.37 9.38
9.54 9.75 9.76

6. Repeat this process of shaking, removing, counting, subtracting and recording until every kernel is removed from the box. Each shaking of the box will model the passing of a period of time.
7. Do not cheat: if no kernels are pointing in the correct direction, record the same amount of kernels as the trial before and continue the process until ALL the kernels are removed.
8. The data table should contain the number of the trial and the amount of kernels left in the box. It should begin with trial 0 and 128 kernels.
9. After all of the kernels have been removed, return them all to the box.
10. Repeat the experiment. This time, remove all the kernels that point at either of the arrows on both the short and long side of the box. This will represent the decay of a different isotope.

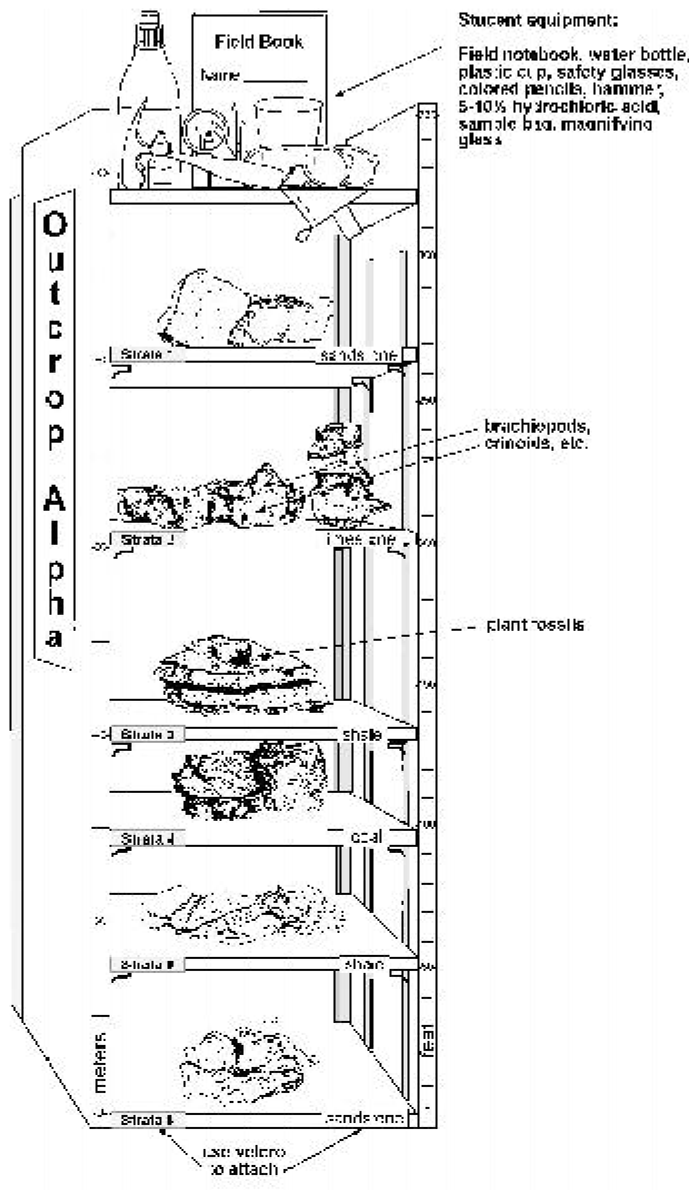
DATA ANALYSIS:

1. Graph the data from each experiment on the same piece of graph paper.
2. Place the trials on the horizontal axis. (Remember the shakes will model the passing of a unit of time.)
3. Place the number of kernels remaining on the vertical axis.
4. Remember that the 0 trial, 128 kernels remaining point must be placed on the graph.
5. Place all the points for the first experiment on the graph and connect them with a best-fit curve.
6. Place the data for the second experiment on the same graph and draw the curve.

CONCEPT DEVELOPMENT:

1. Using your graph, determine the half-life for each isotope modeled.
2. How did the half-life value change when the second experiment was performed?
3. How many trials (shakes) had passed when there were about 32 (1/4) of the kernels left?
4. How many half-lives have gone by if 7/8 of the uranium is now lead, leaving only ¼ of the original uranium.
5. Will all of the uranium in a rock eventually turn to lead? Explain your thinking.
6. How is the use of radioactive dating different from other geologic dating methods such as the use of index fossils?

Depositional Environments



*modified from Repine and Hemler of November 1999, *The Science Teacher*, p. 30.

Drawing from the Past and Building on that Knowledge

by Chris Cumashot, Pocahontas County
Angela McKeen, Wetzel County

PROCEDURE:

Exploration

Place students in groups of three. Give each group a different sedimentary rock sample, set of markers, safety glasses, acid bottle containing 10% HCl, one dropper, nail, magnifying lens, and a large sheet of freezer paper. (Rock samples should be readily identifiable.) Tell the students that they are to use the resources at their table and in the room to identify the sample and write the name of that rock at the top of the freezer paper. Ask them the following questions:

1. Does your sample react with the acid? (Only limestone will react with acid.)
2. What if you made a small amount of powder from your sample, will it then react?
3. Scratch off some of your rock and feel the sediments. Does it feel gritty? Does it resemble sand grains? Is it difficult to get any particles from your sample? Examine the particle size more closely with the hand lens.

Once the students have correctly determined the name of the rock sample, ask them to write one sentence about the material that they believe could have formed this rock. (Examples: Sand formed this sandstone. Decayed plants formed this coal.) It is not important that their first idea about what could have formed this rock sample be correct, only that they put some thought or imagination into it.

Concept Development:

Using one rock as an example, the teacher should identify the rock correctly, name the material that formed the rock, and then ask the students where such material could naturally occur today.

Example: "This rock is thinly bedded. It breaks easily. It does not react with the acid. When I scratch particles from the rock, the particles are very small and gritty. If I add some water to the particles, I form a kind of mud. This is a shale. Shale was formed from ancient muds. Where could we find areas of mud today?" Students often name places like mud slides, areas around swamps, the ground after a rain or flood. There are great examples.

OBJECTIVES:

- *By using sketches and constructing models of depositional environments, the students will bridge the gap between concrete knowledge and the more abstract concepts of historical geology*

Materials and Equipment:

- Classroom set of safety goggles
- 1 rock hammer
- 10% HC1
- 10 droppers
- 10 nails
- 10 magnifying lenses
- Labeled jars of various sediments including sands, silts, clays, and assortment of seashells
- Grain ID booklet
- Samples of sandstone, limestone, shale, and coal, or any other rock indicative of your area
- Large pieces of freezer paper
- Classroom set of colored pencils, markers, and/or crayons
- Classroom set of clear disposable storage containers
- Various reference books or approved web sites to assist students in identifying rock samples and their origin

WVIGO's

5.46
6.69
9.72 9.73 9.75
10.68

Ask the students to now brainstorm about their own samples. They should be able to come up with a few places for each sample. The students are to then label and sketch these environments on their large sheets of freezer paper. A brief explanation should accompany each sketch to insure that the students and the teacher both understand the meaning of the sketch.

Teach/reteach if needed:

At this point, the students should have a basic understanding of how sedimentary rocks are formed. If the students need a review of the process, a mini-lesson is appropriate before they go on in this lesson.

Application:

The students should now be ready to tackle more difficult concepts. Join the small groups of three into groups of six. Pose the following problem to the groups: "Place your two rock samples at opposite ends of the freezer paper. You know the possible depositional environments of your own sample. The group that joined you knows the possibilities of their sample. Your groups must now sketch a plausible landscape that would explain how your two samples were found near one another. A one paragraph explanation must accompany each sketch to explain how the group decided on the landscape and why it is reasonable."

Examples: A sandstone is placed near a limestone. The sandstone represents the beach environment, while the limestone represents a shallow ocean environment. The groups would simply sketch the beach beside the ocean.

A coal is placed near a shale. The coal represents a plant dominated swamp or bog. The shale represents a place where water has receded. The sketch would consist of a swamp surrounded by a muddy area where both coal and shales could have formed.

At this point a little more practice may be needed, but most students will be nearing the point where they can connect the depositional environments on their own. One helpful tip is to keep the depositional environment sketches posted at the front of the room until it is time for a more formal evaluation.

3D Application:

Allow students to work with partners. Give the team a rock sample that neither had in their groups. The students are to identify the sample correctly and construct the depositional environment for the sample in the clear plastic containers. The students must try to use sediments of the appropriate grain size. For example, if the student has a fine-grained sandstone, the team should not use large-grained sands in their construction. The object is to construct an environment that could closely represent one of the samples. If the students have limestones, they may use sands or silts as the base of their construction, layer crushed shells above this, whole shells on top of that layer, then cover the area with salt water. If the limestone contains whole fossils, then the students should "make" animals that represent the type of sea life that is found in the sample.

EVALUATION:

Many times, students and teachers alike do not take the evaluation of drawings and models as seriously as they do a pencil-paper test. In this unit it is imperative that the grading of the sketches and models be given as much weight as a written test. The beginning sketches are like quizzes, but the final constructions and sketches are the means by which the teacher can examine the student's understanding of depositional environments in historical geology.

The most objective way to grade sketches and models is with a rubric. A sample rubric has been provided.

SCORING RUBRIC

0 points	1 points	2 points	3 points
SAFETY			
Student does not comply with the safety procedures.	Student must be told many times to follow safety procedures.	Student must be reminded twice about safety procedures.	Student follows all safety procedures and/or needs only one reminder.
PROCEDURE			
Student does not participate in lab.	Student does only one part of the three assigned parts.	Student attempts all parts, but some information is not correct or is missing.	Student completes all parts of lab, and the information is correct or on the right track.
SKETCHES/MODELS			
Student does not complete a model or a sketch.	Student does complete both parts, but there are at least three errors on each.	Student completes both parts, but there are at least two errors on each.	Student completes both parts, and there is only one error or less on each.
EXPLANATION OF MODELS/SKETCHES			
No written explanation is given with the model or sketch.	Written explanation accompanies only one part of the lab, or four or more errors are present if writing accompanies both parts.	Written explanation accompanies both parts; two to three errors are present in each part.	Written explanation accompanies both parts; one or fewer mistakes are present in each part.

Tell Me A Story...

by Tom Repine
West Virginia Geological and Economic Survey

This is a good way to introduce basic geologic concepts of superposition (the oldest layer of rock is on the bottom), stratigraphy, rock types, depositional environments, fossil assemblages, contacts between rock layers, etc. An incredible number of questions, ideas, interpretations, models, etc. can be generated from this simple line drawing. The most important requirements for this activity are a vivid imagination, the fortitude to defend your ideas, and the willingness to accept a more plausible explanation than yours when the time is right.

Objectives:

- *Recognize that a sequence of sedimentary rock relate to different environments of deposition of sediment.*
- *Develop techniques and ideas which realistically explain a sequence of sedimentary rocks*

Time : Variable depending on the depth of discussion. Normally 15 - 20 minutes.

Materials and Equipment:

- "Tell Me a Story" sheet for each student

Background information: The page is covered with common symbols used to designate rock types. The dashed lines represent shale (a sedimentary rock formed from deposits of mud and clay). The brick pattern represents limestone (a sedimentary rock formed from deposits of marine animal shells or chemical precipitation directly from the sea water). The dots represent sand grains. The various dot sizes indicate a variation between small and large sand grains. The thick black line represents a coal seam (coal normally forms from decaying plants growing in swampy, wet areas). The "smiley-face" symbols indicate the presence of sea shells. Finally, the black lines hanging down from the coal seam are tree and plant roots.

Procedures:

1. One way to begin this activity is with the following narration: "This is a cartoon of an outcrop of 300-million year old rocks found in WV. The little "smiley faces" are fossils (brachiopods in this case), the dots are sand grains of various sizes, the brick pattern is limestone, a partial brick pattern indicates the rock is only partly limestone, the thick horizontal solid black line is coal, and the little vertical squiggles sticking out below the coal are plant roots. (Does this help you figure out which way is up?) Dashed lines of different

WVIGO's

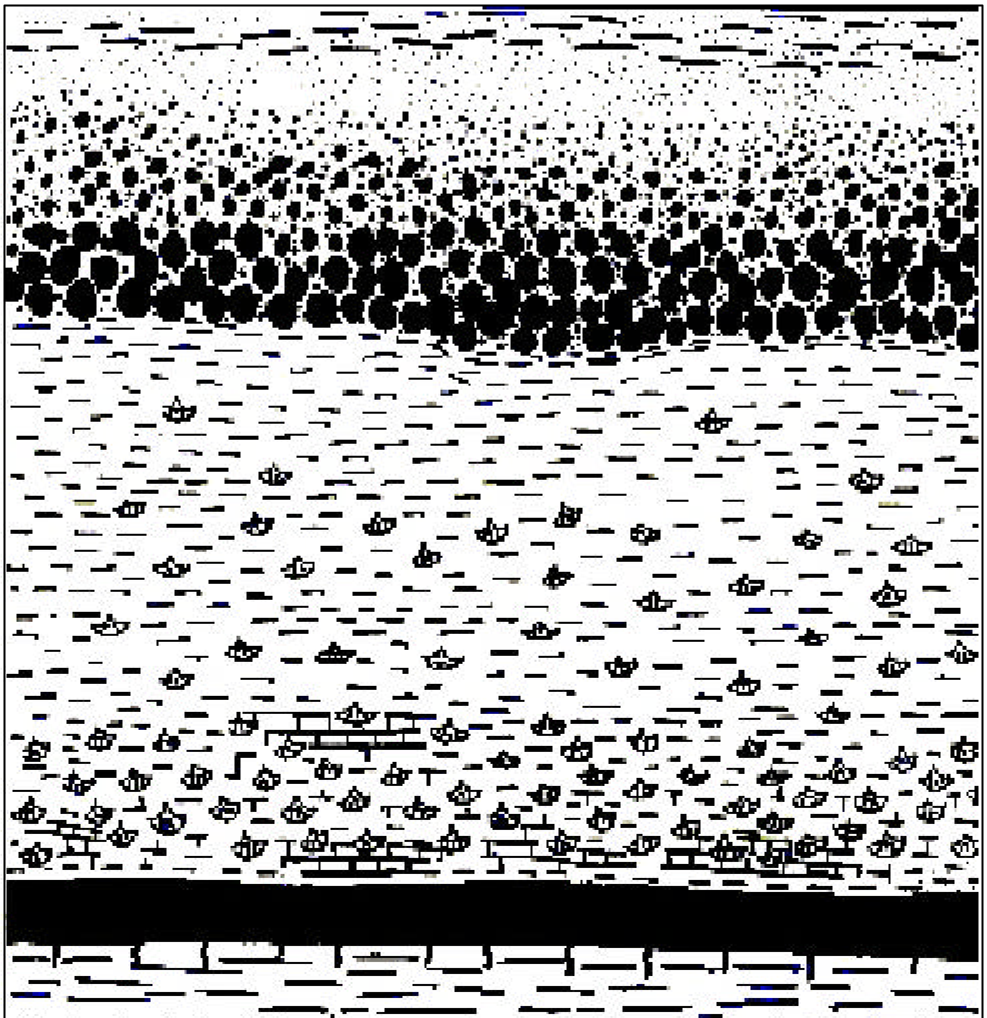
5.46 5.48
6.69
8.73
9.75
ES.48

sizes represent lack of artistic talent—they should all be the same length! Don't forget to note the differences in the way the various rocks touch each other (contacts). Some are well defined, others are less well defined, while some are actually not even perfectly horizontal. The number of fossils is not the same everywhere. The size of the sand particles shows a fairly consistent change vertically. Not all of the rock layers are continuous. To a geologist, these little clues provide insight into what happened long ago.

2. After this brief introduction ask students to develop explanations for how the rock sequence might have developed. It is important to continually remind the students that they need to think of the rocks as sediments. This can be done by asking "How would the sediment that formed the sandstone get there?"
3. Students will develop many different ways to explain how the sequence formed. There are no completely right or wrong answers. This exercise is a matter of interpretation and defending that interpretation based on available evidence. In the end, you will discover that some answers are more plausible than others. Just like scientists, the students will eliminate improbable or far-fetched ideas because they can not withstand the rigor of scrutiny.
4. After developing a suitable explanation prompt the students to see if they really understand the story. Questions such as "Which way is up?"; "Which rock layer is the oldest?"; "What was happening at this one spot 300 million years ago?"; and "Is there evidence of change over time?" can be used to probe their understanding of sedimentary rock formation.

Assessment:

Examination of student constructed narratives explaining their interpretations for how the rock sequence formed should contain rock names and relate these rock names to environment in which sediments might be deposited.



No Scale Intended

Tell Me A Story...
Of This Cartoon of a Sequence of
Sedimentary Rocks in West Virginia!

Outcrops in the Classroom

by Tom Repine, West Virginia Geological and Economic Survey and Deb Hemler, Fairmont State College

Objectives:

- *Relate sedimentary rocks to depositional environments*
- *Compose a credible story explaining the formation of a vertical sequence of sedimentary rocks in one location.*
- *Compose a credible story using environments of deposition to explain lateral changes in rock type*

Material and Equipment:

- One outcrop simulator for each group of three students.
- Sketches/pictures of various environments such as lakes, streams, shorelines, etc.
- Field notebook
- water bottle
- plastic cup
- safety glasses
- 5-10% hydrochloric acid
- sample bag
- magnifying glass
- various rock samples.

WVIGO's

5.46 5.48

Introduction

By casually dismissing the vertical stacking of sedimentary rocks we, as teachers, violate the very principles (such as superposition) we are trying to get our students to visualize. We have found that the simulation introduced in this activity provides a way to correctly view and, as a result, intuitively grasp concepts. Outcrops in the Classroom provides students with the observational, record keeping, and interpretative experiences of a field geologist. Pedagogically, the activity revolves around student resolution of questions, such as "How do you know that? or "How can you draw that conclusion based on what you see?" Our goal is to ensure a collective exclusion of ideas until students realize that one or two interpretations more plausibly respond to all of the data. At the end of this process, we make it quite clear that different interpretations, based on well thought out ideas which honor the data, must be valid.

Time : minimum of one 45-minute class period. Add a second period for discussion of ideas.

Procedures:

1. Read the following introduction: "These rocks are 300 million years old. They are sedimentary rocks. They formed when sediments were transported to a new area by wind, water, or ice. Sediments vary in size. Faster moving water can move bigger grains of sediment than relatively slower moving water. So, cobbles and boulders are often interpreted as evidence of fast moving water. Very small sediments, like clay and mud, fall out only when the water is not moving at all. So, as the water slows down, the different grains sizes fall out in different places—often right beside each other. A geologist refers to this as deposition. The location where it happens is called the environment of deposition. This could be a sand bar, a sea-shore, a lake, a swamp, etc. At some point in geologic time, these individual grains become

cemented together. This is called lithification. We then have a sedimentary rock."

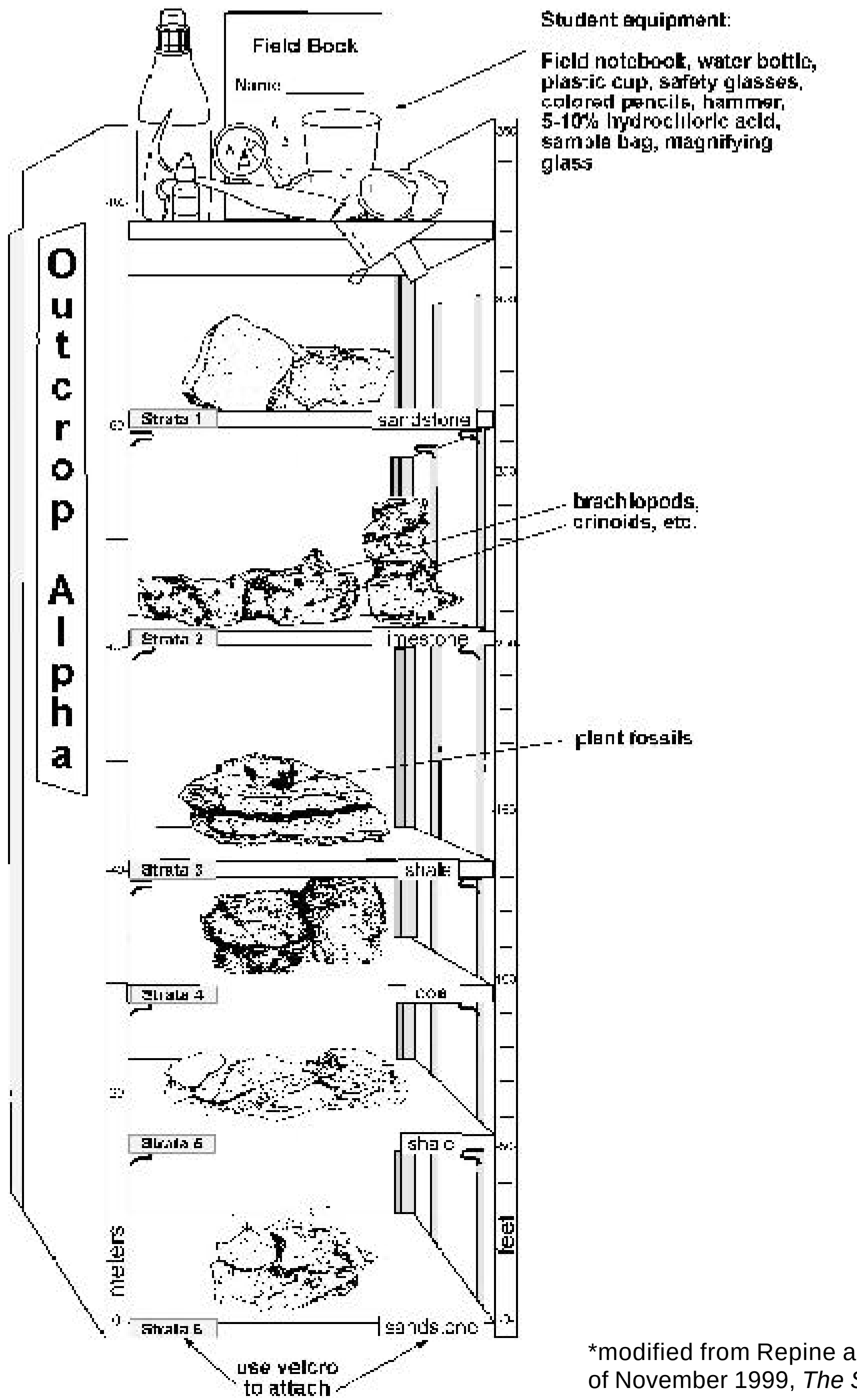
2. Some of the common sedimentary rocks are in the outcrop simulator. Each different rock type represents a different depositional environment. Each group must observe and record data. All data should be recorded in a field notebook. Once this is done, develop a story which, supported by the data, explains the origin of the sequence of rocks in your outcrop. Although each group must collectively develop an interpretation, each student is responsible for recording observations and ideas. Sketches showing important observation which support interpretation are helpful and suggested.
3. As they work on the simulators, encourage students to envision the sequence of sedimentary rocks as lithified accumulations of transported sediments. Asking "How did the sediments that formed your rocks get there?" seems to help them focus on the dynamics of sediment transport and deposition. Forming a clear mental image of what these depositional environments look like is important. Facilitate this process by providing each group with a set of sketches such as beaches, lakes, sand bars, swamps, etc.
4. Each group now composes an explanation which, in their own words and based on their data, provides a realistic story explaining how their vertical assemblage of sediments accumulated. This includes plausible explanations for changing from one environment to another. Without effort, and in their own words, we have let them introduce themselves to the concepts of uniformitarianism, lithification, superposition, etc. We may not have used the terms but they do understand the principles. All members of each group assume active roles in presenting their group's interpretation to the entire class. The presence of plant and/or animal fossils are used to postulate ancient land or water environments in which the organisms thrived. Past geologic and present geographic conditions start to become connected. They no longer see rocks as just rocks but

as indicators of dynamic systems in the geologic past. A coal bed begins to be seen as a swamp, a sandstone may be imagined to be an old beach, dune, sandbar, or delta. Shale becomes mud from a flood and a limestone with seashells means an ocean was there.

5. After each group has finished an interpretation, they tape their sequenced sketches to the board. As each new outcrop is added to the board it becomes apparent that environments change not only vertically but horizontally. Data from all of the simulators is cooperatively shared to allow class discussion of variations in stories from outcrop to outcrop. Students must now develop a comprehensive story to explain the observed lateral changes in depositional environments. Classroom discussion of these interpretations often reveal fatal flaws in the students reasoning. Thus, they quickly realize that while there can be multiple “right” answer, all of the evidence tends to adequately support only one or two interpretations.
6. Looking at the sketches in vertical columns allows them to interpret changes over geologic time. Looking at the sketches along lateral rows allows them to begin thinking of what an ancient landscape may have looked like. They are recreating the geographic landscape of 300 million years ago.

Assessment:

Embedded assessment is provided by the students placing the names of the rock and a sketch of various environment beside each rock. If the student’s association of a sketch with a rock is not “reasonable” leading questions can be used to redirect the group’s work. Within a learning cycle context, we normally use Outcrops in the Classroom as an exploratory activity. Thus, we normally choose not to assess the students progress. Rather, we treat it as a opportunity to learn how to work with data and deal with problems. However, we do occasionally use the activity for concept development, concept application, or performance assessment. Based on the grade level involved, scoring is accomplished by employing a rubric emphasizing rock description, interpretation of environments, and development of vertical and lateral geologic changes.



*modified from Repine and Hemler of November 1999, *The Science Teacher*, p. 30.