INTRODUCTION

An understanding of how our earth's surface evolved, how it has and will continue to change is important. By studying geologic history, students will understand the origin and structure of our earth. They will develop a deeper understanding of geology by investigating the structure of a specific region of the earth's surface. This lesson will help students increase their powers of observation and ability to predict and interpret geologic events. Students use topographic maps, discuss the value of all maps in our society, observe the effects of weathering and erosion on our earth's surface, and determine human impact on the geologic environment.

THE ACTIVITIES	TIME REQUIRED
Observe and Measure Information on a Topographic Quadrangle	45 minutes
Interpret Data About Local Rock Types	2 hours
Observe and Predict Forces of Weathering and Erosion	30 minutes
Communicate Feeling, Awareness, and Values	30 minutes

COMBINING THE ACTIVITIES

The activities in this unit are displayed singly. Depending upon the time available and the skill of the participants, you may choose to do only one activity or the entire series. For maximum learning, the activities should be experienced in the order listed in the unit, however, other suggestions are:

Suggestion
Title: Observe, Measure, and Interpret Data About Our Earth's Surface by Reading a Topographical Map
Activity: Study the significant features of a topographical map and learn how to read one.
Transition Statement: Discuss why a topographic map is useful to us.
Activity: Identify the highest and lowest elevation you can observe from where you are standing and locate the areas on your map.

Transition Statement: Let's compare your actual observations with the features on the map. Take a look specifically at what the land offers by examining rocks in the area.

Activity: Gather rock samples and prepare a dichotomous key representing them.

Transition Statement: By observing the characteristics of these rocks, we can learn about past events in this area.

CURRICULUM RELATIONSHIPS

Social studies and science are most likely to be strong components in the investigation. Math, language arts, and the creative arts can be worked in as the students report on what they found in their initial investigations. The fact that all curriculum areas come into use make these environmental investigations uniquely relevant and motivating. Students can clearly see the usefulness of the various subject matter.

Social Studies

1. Use topographical maps to compare the major topographical land features of your area with an area or a country being studied in social studies (land forms, vegetation, natural resources).
2. Study land ownership boundaries and compare the distribution of natural resources to type of land ownership.

Science

1. Correlate plant communities with features on a topographical map, taking into consideration landforms, climate, waterforms, etc.
2. Study the effect of weather on the natural environment. How does weather directly affect erosion?

Mathematics

1. Learn to use some of the units of measurement in weather calculation; for example, What is one inch of rain?
2. Estimate slope distance percent in relation to distances between contour lines.

Language Arts

1. Research and write an article on why change was made from metes and bounds to a systematic grid system of surveying in the United States.
2. Write a paper on how people in this area make a living based on the observations and inferences made from a map study.
3. Develop a chart of proverbs about weather in your area and how it affects the land.

Creative Arts

1. Construct an abstract pattern of a topographical map.
2. Construct a topographical map with a legend.

OBSERVE AND MEASURE INFORMATION ON A TOPOGRAPHIC MAP

CONCEPT Quantification, Order, Scale

PRINCIPLE Reading a topographic map helps people observe and interpret the environment more easily.

OBJECTIVE
- Students will be able to read a USGS topographic map and identify the various symbols. They will work in small groups to graph a profile of an area's topography.

PREPARATION Get topographic maps and make small copies from these maps of your study areas to distribute to students.

MATERIALS NEEDED
- Activity A: Read a Topographic Map and B: Graph a Topographic Profile
- Copied maps of the study area (if you plan to reuse yearly, laminate the maps)
- Guide to topographic symbols
- Marking pens, washable

PROCESSES USED
- Formulate models
- Observe
- Measure
- Communicate
- Use numbers
- Interpret data
- Define operationally

TIME 45 minutes

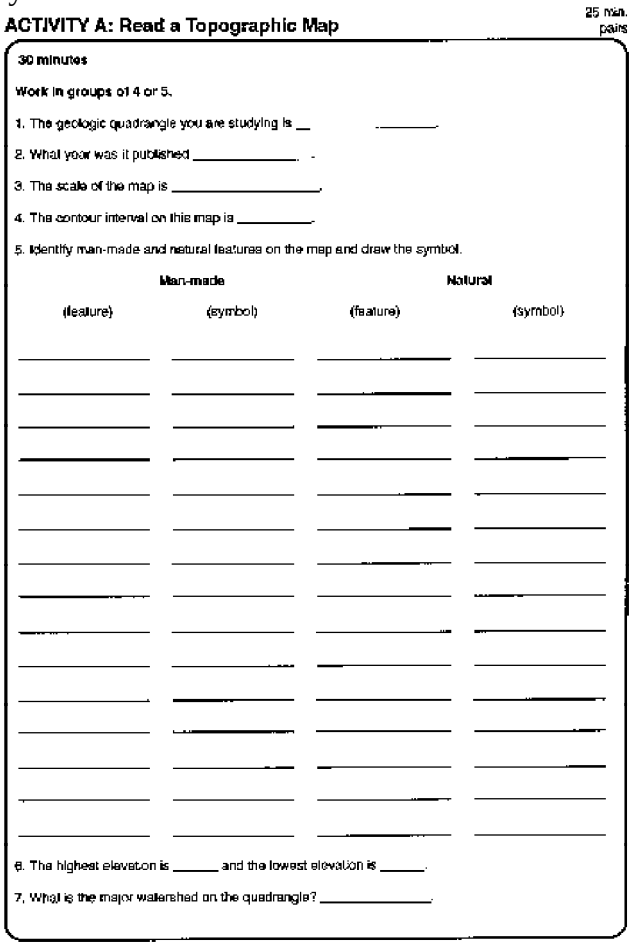
DOING THE ACTIVITY (indoors)

A. Set Stage

In this activity you will learn to read a topographic or contour map and to interpret the geologic environment. What are some things that you already know about topographic maps?

B. Procedure

1. Distribute maps and Activity A.



25 min.
pairs

ACTIVITY A: Read a Topographic Map

30 minutes

Work in groups of 4 or 5.

1. The geologic quadrangle you are studying is __ _____.

2. What year was it published _____.

3. The scale of the map is _____.

4. The contour interval on this map is _____.

5. Identify man-made and natural features on the map and draw the symbol.

Man-made		Natural	
(feature)	(symbol)	(feature)	(symbol)

6. The highest elevation is _____ and the lowest elevation is _____.

7. What is the major watershed on the quadrangle? _____.

Investigating Your Environment
Geologic History

2. Work in pairs.

C. Retrieve Data

Students fill out Activity A , and use them in a discussion.

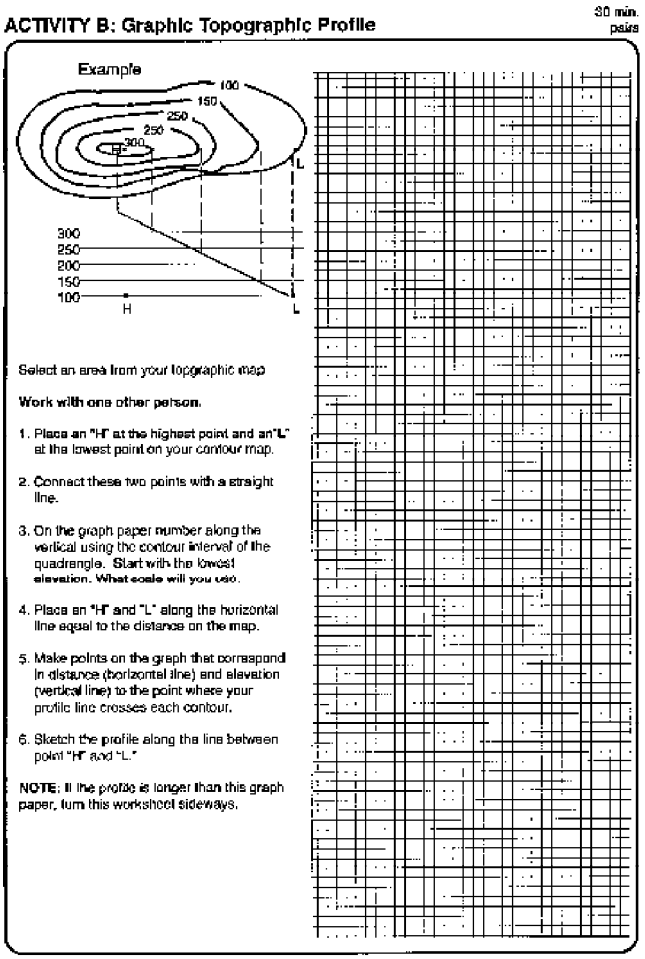
Discuss:

1. What did you find?
2. What is the most significant feature on the map? Why do you think so?
3. How did natural features affect the human development of this area?
4. Why is a topographic map useful?

NOTE: The concept of a watershed should be discussed or demonstrated.

D. Procedure

Now graph a profile of the area's topography. Students should work with a partner to complete the graph. Students use Activity Card B. Allow 30 minutes to complete the assignment. Have them select an area from their contour map.



E. Retrieve Data

Using completed Activity Sheet B, conduct a discussion.

1. What problems did you have, if any?
2. What patterns did you notice?
3. What questions do you have about this activity?
4. What scale did you use? Why?

CLOSURE Ask: What have we found out (so far) about topographic maps?

TRANSITION Now that we have learned to use a topographic map and draw a topographic profile, let's focus on the rocks that make up some of the landforms we

discovered on our maps.

INTERPRET DATA ABOUT LOCAL ROCK TYPES

CONCEPT Cause/Effect, Interaction, Order, Quantification, Invariance, Replication, Fundamental entities

PRINCIPLE The earth's crust is composed of many kinds of rocks, each consisting of one or more minerals.

OBJECTIVE

- Students will be able to:
  1) Describe the physical characteristics of rocks.
  2) Prepare a dichotomous key representing rock characteristics.
  3) Demonstrate an ability to test predictions about rock types.

PREPARATION Select a site where students can work in groups to collect rock samples. The site should offer a variety of rock types within a close range. The site should also have different elevations that are easily observable. (The facilitator should read the activities in this session in advance of selecting the site). Prepare rock samples with freshly broken surfaces for Activity E.

MATERIALS NEEDED

- Activity C: Interpret Data About Local Rock Types, D: Dichotomous Key of Rocks, E: Rock Characteristics & Rock Data Sheet
- Information sheet - print duplex
- Maps of the study area
- Guides to topographical symbols
- Marking pens
- Small hammers
- Hand lenses
- Dilute HCI

PROCESSES USED

- Observe
- Classify
- Communicate
- Infer
- Interpret data

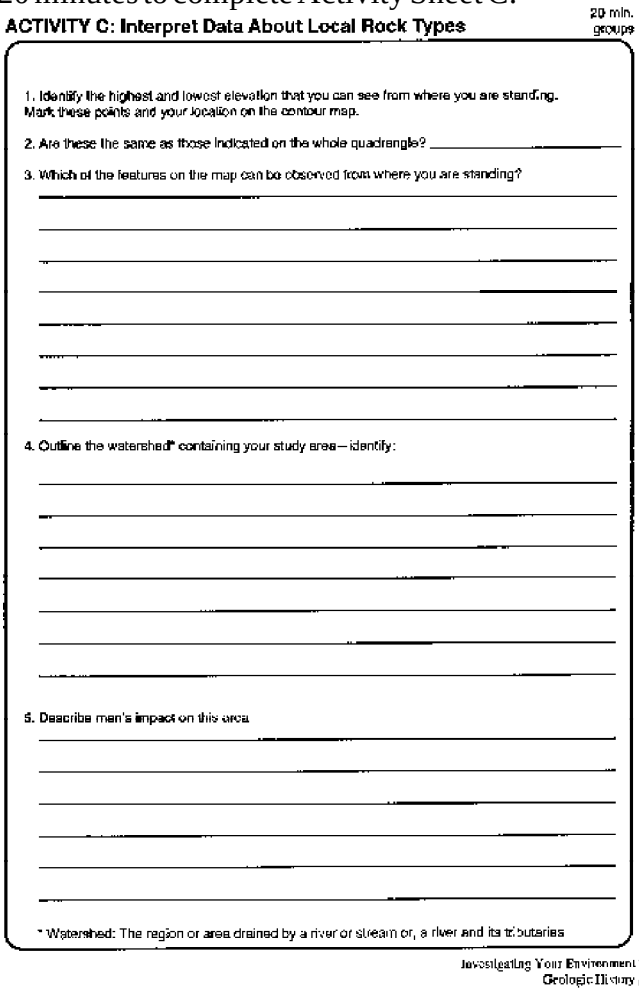
TIME 2 hours
DOING THE ACTIVITY (outdoors)

A. Set Stage

The earth's crust is made up of many kinds of rocks which consist of one or more minerals. In this activity we will investigate some of the rocks found here on this study site.

B. Procedure

1. Distribute maps and Activity Sheet C.
2. Work in pairs
3. Allow 20 minutes to complete Activity Sheet C.



ACTIVITY C: Interpret Data About Local Rock Types

20 min.
groups

1. Identify the highest and lowest elevation that you can see from where you are standing. Mark these points and your location on the contour map.

2. Are these the same as those indicated on the whole quadrangle? _____

3. Which of the features on the map can be observed from where you are standing?

4. Outline the watershed* containing your study area—identify:

5. Describe man's impact on this area

* Watershed: The region or area drained by a river or stream or, a river and its tributaries

Investigating Your Environment
Geologic History

C. Retrieve Data

Students use the completed Activity Sheet C to discuss their findings. Possible questions to use are:

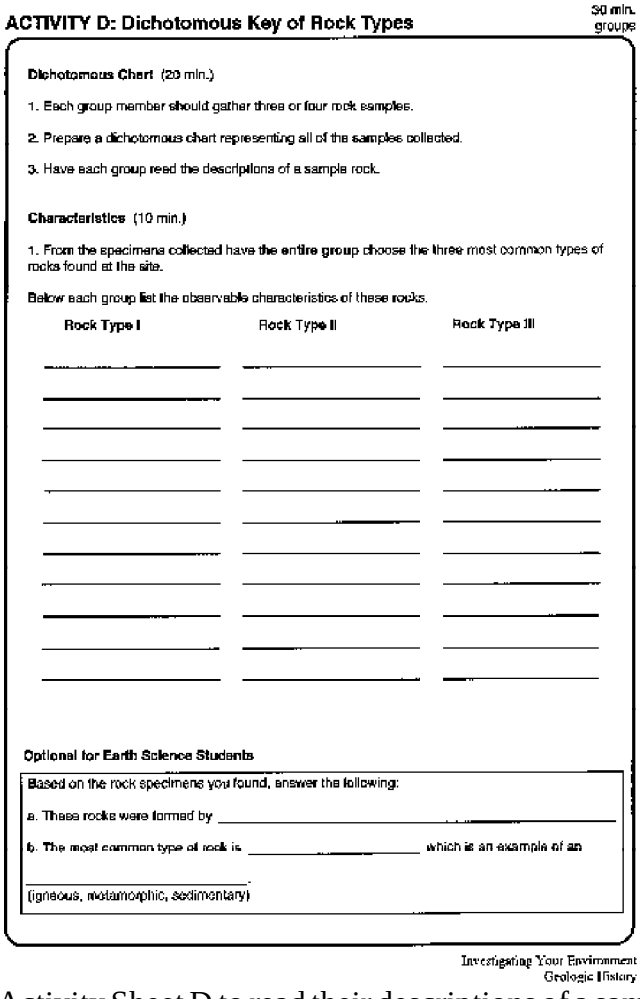
1. What features did you see from the study area?
2. What features are not shown on the topographical map?
3. What can we say about the topography of this area?

4. Discuss the relationship of human activity to the topography.

TRANSITION Now, look at the rocks found here. To help us see differences, we will be using a two-part classification system called a Dichotomous Key.

D. Procedure

1. Pass out Activity Sheet D.
2. Have each student gather 3 or 4 rock samples.
3. Students complete part 1 of Activity D and prepare a dichotomous key to all samples collected (20 minutes), work in small groups.
4. After 20 minutes, groups gather into large group and go on to part 2 of Activity Sheet D.



ACTIVITY D: Dichotomous Key of Rock Types 30 min. groups

Dichotomous Chart (20 min.)

1. Each group member should gather three or four rock samples.
2. Prepare a dichotomous chart representing all of the samples collected.
3. Have each group read the descriptions of a sample rock.

Characteristics (10 min.)

1. From the specimens collected have the entire group choose the three most common types of rocks found at the site.

Below each group list the observable characteristics of these rocks.

Rock Type I	Rock Type II	Rock Type III

Optional for Earth Science Students

Based on the rock specimens you found, answer the following:

a. These rocks were formed by _____

b. The most common type of rock is _____ which is an example of an _____ (igneous, metamorphic, sedimentary)

Investigating Your Environment Geologic History

E. Retrieve Data

Use completed Activity Sheet D to read their descriptions of a sample rock. Possible questions are:

1. What are the characteristics of a rock in this area?
2. What could the rocks tell us about this area's past events?
3. Under what conditions were these rocks formed?

TRANSITION Let's examine a freshly broken rock and see what we can find out about it.

F. Procedure

1. Provide students with rock samples that have freshly broken surfaces.
2. Distribute information sheets on rocks and Activity Sheet E.
3. Have students work in groups of 4 or 5 and allow 45 minutes to complete E.

ACTIVITY E: Rock Characteristics 45 min. groups

Use the information on the attached sheet to perform the tests and determine the characteristics of each specimen. Be sure that all tests are performed on a freshly broken surface.

Particle Size (texture)	Color	How does it break	Reaction to H20	Reaction to HCL	Rock
a.					
b.					
c.					

List any economic uses you think or know of f

1._____

2._____

3._____

ACTIVITY E: Rock Data Sheet

TEXTURE - PARTICLE SIZE	
Clay -	less than .002 mm
Silt -	.002 - .05 mm
Sand -	.05 - 2.0 mm
Gravel -	2.0 mm - 7.5 cm
Cobble -	7.5 cm - 25 cm
Stone -	larger than 25 cm

ROCK DESCRIPTION	
Igneous	These rocks are produced through the cooling of molten material. When the cooling process is slow, the rock contains fine-sized crystals of the individual minerals.
Sedimentary	These rocks are composed of small particles derived from previously existing rocks and deposited in layers upon surfaces of valleys and plains or upon floors of lakes and oceans.
Metamorphic	Alteration of previously formed rocks create these rock varieties from tremendous heat and pressure. Either igneous or sedimentary rocks can become metamorphic rocks.

	ROCK	TEXTURE	DESCRIPTION
IGNEOUS	Granite	Medium to coarse grained crystals.	Light colored - white or salmon-pink with dark speckles. A freshly broken surface has glassy specks which reflect light.
	Basalt	Extremely fine grained	Dark colored
	Obsidian	Glassy	Dark - generally black, green or brown. Exhibits conchoidal fracture (like chip off the bottom of a bottle).
SEDIMENTARY	Pumice	Porous, glassy	Light colored, very porous, many small cavities, floats.
	Conglomerates	Coarse	Consolidated gravel and/or sand particles. Light colored. (Resembles cement.)
	Sandstone	Fine	Consolidated sand, variety of colors (resembles mortar), porous.
	Shale	Very fine (microscopic)	Consolidated clay and silt. Any color. Breaks in flat planes
	Limestone	Very fine (microscopic)	Chiefly calcite, generally white or light colored. Fossils may be present. Dilute HCL will cause effervescence.
	Coal	Very fine	Dark, generally brown or black. Derived from plant decomposition. May contain fossils.
METAMORPHIC	Slate	Microscopic, fine grained, smooth	Variety of colors, splits readily into thin sheets. Formed from shale.
	Schist	Flaky, visible particles	Visible flaky minerals. Formed from slightly metamorphosized igneous or sedimentary rocks.
	Gneiss	Coarse grained	Contains both light and dark materials. Parallel streaks. Variety of origins.
	Quartzite	Fine to coarse	Usually light colored, not porous, formed from sandstone or conglomerate.
	Marble	Coarse grained	Many colors, exhibits veining, fossils and bedding destroyed metamorphism. Formed from limestone or dolomite. Dilute HCL will cause effervescence.

Investigating Your Environment
Geologic History

G. Retrieve Data

Students use completed Activity Sheet E to report the results of their tests. Possible questions are:

1. What are the results of your tests?
2. What difficulties did you encounter in determining the kind of rock you studied?
3. What does the information tell us about the area's past events?
4. What might make a rock economically valuable?
5. Based on the economic value of the rocks that we just discussed, what might be the economic value of the whole study area?
6. What are other uses of the rocks and of the area?
7. How could humans use the capability of this area?

CLOSURE Name two things you learned in this lesson. Share those with a partner. Then partners share with another pair, or ask:

What have we found out about rocks so far?

TRANSITION We have examined rocks and minerals at one point in time. However, chemical and physical forces of weathering are changing them. In the next lesson, we will look at the interaction of weather and the earth.

OBSERVE AND PREDICT FORCES OF WEATHERING AND EROSION

CONCEPT Cause/Effect, Interaction, Fundamental entities, Change, Cycles, Force, Order

PRINCIPLE Weather affects our lives every day. By observing certain phenomena, we can use signs of weathering to forecast changes in our environment.

OBJECTIVE

- Students will be able to 1) Understand the relationship between the forces of weathering and erosion, and 2) illustrate a geologic cycle.

PREPARATION Select a site that has a rock wall, a road cut, or a stream bank.

MATERIALS NEEDED

- Activity Sheet F: Influences of Weathering
- Pens or pencils

PROCESSES USED

- Observe
- Predict
- Infer
- Classify
- Communicate
- Question
- Define operationally
- Interpret data
- Formulate model

TIME 30 minutes

DOING THE ACTIVITY

A. Set Stage

Weather affects our lives every day. By observing certain phenomena, we can use signs of weathering to forecast changes in our environment.

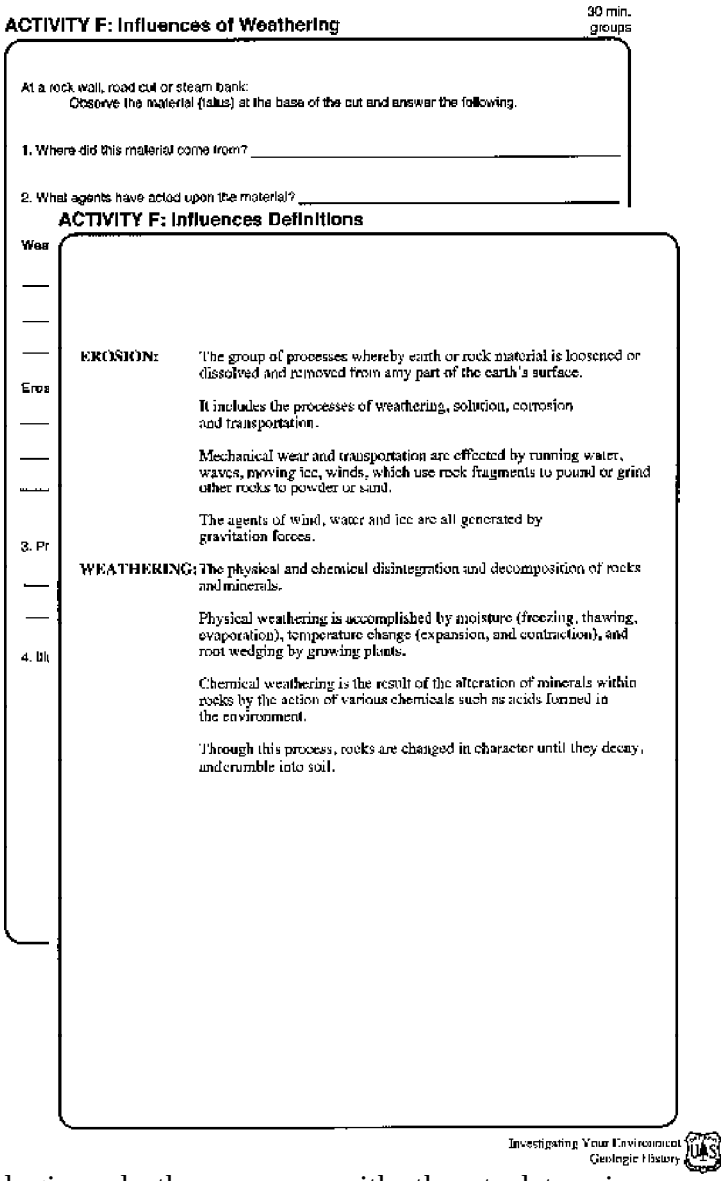
B. Procedure

1. Distribute Activity Sheet F and Influences definitions.
2. Work in groups of 2
3. Allow 30 minutes

C. Retrieve Data

Students complete Activity Sheet F and then use it to discuss their findings. Possible discussion questions are:

1. What are some of the relationships between the forces of weathering and erosion?
2. What were some phases (parts) of the geological cycle that you identified?
3. How might weathering be different on different rock types?
4. What are the benefits, if any, of weathering and erosion?



ACTIVITY F: Influences of Weathering

30 min.
groups

At a rock wall, road cut or steam bank:
Observe the material (talus) at the base of the cut and answer the following.

1. Where did this material come from? _____

2. What agents have acted upon the material? _____

ACTIVITY F: Influences Definitions

Wea

Eros

3. Pr

4. Ill

EROSION: The group of processes whereby earth or rock material is loosened or dissolved and removed from any part of the earth's surface.

It includes the processes of weathering, solution, corrosion and transportation.

Mechanical wear and transportation are effected by running water, waves, moving ice, winds, which use rock fragments to pound or grind other rocks to powder or sand.

The agents of wind, water and ice are all generated by gravitation forces.

WEATHERING: The physical and chemical disintegration and decomposition of rocks and minerals.

Physical weathering is accomplished by moisture (freezing, thawing, evaporation), temperature change (expansion, and contraction), and root wedging by growing plants.

Chemical weathering is the result of the alteration of minerals within rocks by the action of various chemicals such as acids formed in the environment.

Through this process, rocks are changed in character until they decay, and crumble into soil.

Investigating Your Environment
Geologic History

CLOSURE In pairs construct a geologic cycle, then compare with others to determine parts common to the cycle.

TRANSITION People need to think about the environment as more than a resource. This next activity helps us explore our feelings and the values of geology.

COMMUNICATING FEELING, AWARENESS, AND VALUES

CONCEPT Interaction, Perception, Cause/Effect, Change

PRINCIPLE People have a definite impact on our environment and its natural resources.

OBJECTIVE
- Students will be able to describe their feelings about human effects on our geologic environment.

PREPARATION Tell students to think carefully about what they have learned so far and decide how they feel about our responsibility in taking care of our natural environment.

MATERIALS NEEDED
- Activity Sheet G: Communicate Feelings
- Pen or pencil

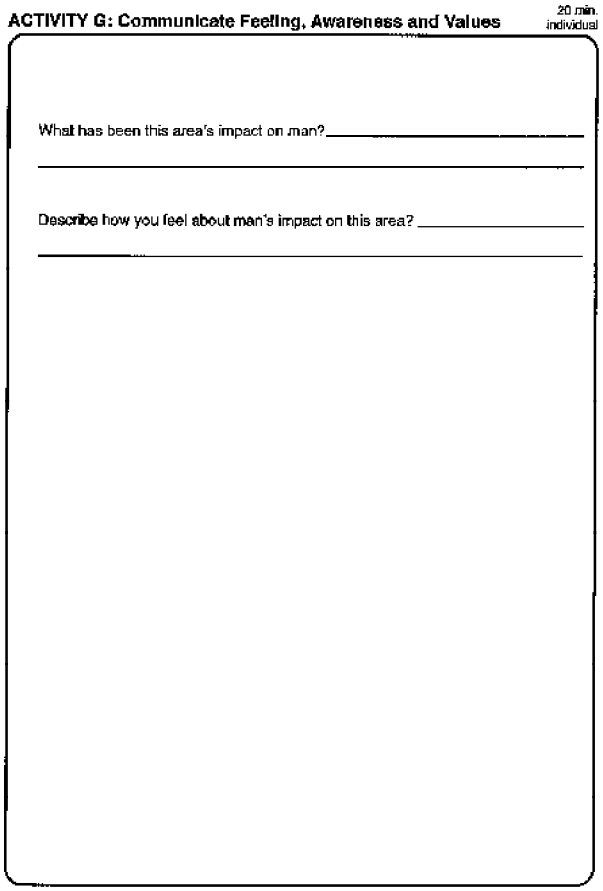
PROCESSES USED
- Communicate
- Observe
- Infer
- Question

TIME 30 minutes

DOING THE ACTIVITY (indoors, outdoors)

A. Set Stage

People impact their environment and its natural resources as well as an area's geologic features. In this session, you will have the opportunity to spend some time thinking about geology. Even though the two questions are specific to this site, you may communicate general feelings too. Feel free to write, draw, or do both to answer the questions. You have 20 minutes. Please remain silent and work by yourself.



B. Retrieve Data

When students reassemble, ask for volunteers to share responses to each question. Discussion begins from sharing. Additional discussion questions:

1. What impact has this area had on people?
2. How might these change in the future?
3. What impacts have people had on this area?
4. How might these change in the future?
5. What are some of your feelings about the human impact you observe?

CLOSURE Does what we do in an environment impact our feelings about the area? Do our feelings about an area, impact what environmental impacts we will make on that area?

ACTIVITY A: Read a Topographic Map

25 min.
pairs

30 minutes

Work in groups of 4 or 5.

1. The geologic quadrangle you are studying is _____.

2. What year was it published _____.

3. The scale of the map is _____.

4. The contour interval on this map is _____.

5. Identify man-made and natural features on the map and draw the symbol.

Man-made		**Natural**	
(feature)	(symbol)	(feature)	(symbol)

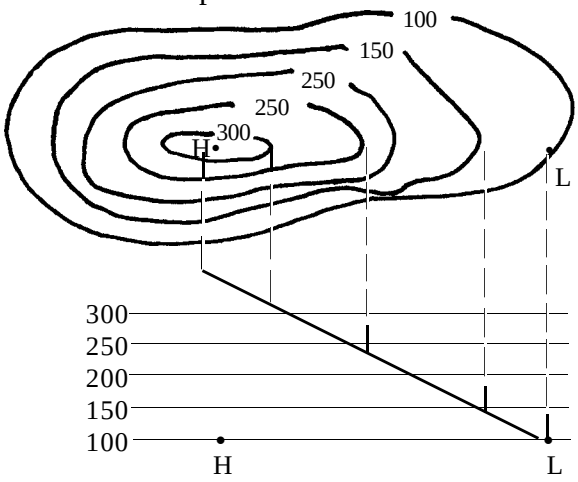
6. The highest elevation is _____ and the lowest elevation is _____.

7. What is the major watershed on the quadrangle? _____.

ACTIVITY B: Graphic Topographic Profile

30 min.
pairs

Example



Select an area from your topographic map

Work with one other person.

1. Place an "H" at the highest point and an"L" at the lowest point on your contour map.

2. Connect these two points with a straight line.

3. On the graph paper number along the vertical using the contour interval of the quadrangle. Start with the lowest elevation. What scale will you use.

4. Place an "H" and "L" along the horizontal line equal to the distance on the map.

5. Make points on the graph that correspond in distance (horizontal line) and elevation (vertical line) to the point where your profile line crosses each contour.

6. Sketch the profile along the line between point "H" and "L."

NOTE: If the profile is longer than this graph paper, turn this worksheet sideways.

ACTIVITY C: Interpret Data About Local Rock Types

20 min.
groups

1. Identify the highest and lowest elevation that you can see from where you are standing. Mark these points and your location on the contour map.

2. Are these the same as those indicated on the whole quadrangle? _____

3. Which of the features on the map can be observed from where you are standing?

4. Outline the watershed* containing your study area—identify:

5. Describe human's impact on this area:

* Watershed: The region or area drained by a river or stream or, a river and its tributaries

ACTIVITY D: Dichotomous Key of Rock Types

30 min.
groups

Dichotomous Chart (20 min.)

1. Each group member should gather three or four rock samples.

2. Prepare a dichotomous chart representing all of the samples collected.

3. Have each group read the descriptions of a sample rock.

Characteristics (10 min.)

1. From the specimens collected have the **entire group** choose the three most common types of rocks found at the site.

Below each group list the observable characteristics of these rocks.

Rock Type I	Rock Type II	Rock Type III

Optional for Earth Science Students

Based on the rock specimens you found, answer the following:

a. These rocks were formed by _____

b. The most common type of rock is _____ which is an example of an _____.

(igneous, metamorphic, sedimentary)

ACTIVITY E: Rock Characteristics

45 min.
groups

Use the information on the attached sheet to perform the tests and determine the characteristics of each specimen. Be sure that all tests are performed on a freshly broken surface.

	Particle Size (texture)	Color	How does it break	Reaction to H20	Reaction to HCL	Rock
a.						
b.						
c.						

List any economic uses you think or know of for each rock.

1._____.

2._____.

3._____.

ACTIVITY E: Rock Data Sheet

TEXTURE - PARTICLE SIZE
Clay - less than .002 mm
Silt - .002 - .05 mm
Sand - .05 - 2.0 mm
Gravel - 2.0 mm - 7.5 cm
Cobble - 7.5 cm - 25 cm
Stone - larger than 25 cm

ROCK DESCRIPTION	
Igneous	These rocks are produced through the cooling of molten material. When the cooling process is slow, the rock contains fair-sized crystals of the individual minerals.
Sedimentary	These rocks are composed of small particles derived from previously existing rocks and deposited in layers upon surfaces of valleys and plains or upon floors of lakes and oceans.
Metamorphic	Alteration of previously formed rocks create these rock varieties from tremendous heat and pressure. Either igneous or sedimentary rocks can become metamorphic rocks.

	ROCK	TEXTURE	DESCRIPTION
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	Basalt	Extremely fine grained	Dark colored
	Obsidian	Glassy	Dark - generally black, green or brown. Exhibits donchoidal fracture (like chip off the bottom of a bottle).
SEDIMENTARY	Pumice	Porous, glassy	Light colored, very porous, many small cavities, floats.
	Conglomerates	Coarse	Consolidated gravel and/or sand particles. Light colored. (Resembles cement.)
	Sandstone	Fine	Consolidated sand, variety of colors (resembles mortar), porous.
	Shale	Very fine (microscopic)	Consolidated clay and silt. Any color. Breaks in flat planes
	Limestone	Very fine (microscopic)	Chiefly calcite, generally white or light colored. Fossils may be present. Dilute HCL will cause effervescence.
	Coal	Very fine	Dark, generally brown or black. Derived from plant decomposition. May contain fossils.
METAMORPHIC	Slate	Microscopic, fine grained, smooth	Variety of colors, splits readily into thin sheets. Formed from shale.
	Schist	Flaky, visible particles	Visible flaky minerals. Formed from slightly metamorphosized Igneous or sedimentary rocks.
	Gneiss	Coarse grained	Contains both light and dark materials. Parallel streaks. Variety of origins.
	Quartzite	Fine to coarse	Usually light colored, not porous, formed from sandstone or conglomerate.
	Marble	Coarse grained	Many colors, exhibits veining, fossils and bedding destroyed metamorphism. Formed from lime-stone or dolomite. Dilute HCL will cause effervescence.

ACTIVITY F: Influences of Weathering

30 min.
groups

At a rock wall, road cut or steam bank:
Observe the material (talus) at the base of the cut and answer the following.

1. Where did this material come from? _____

2. What agents have acted upon the material? _____

Weathering Agent	**Result of the Action**

Erosion Action (types)	**Result of Action**

3. Predict what will happen to this material in the future. _____

4. Illustrate the geologic cycle exhibited by this material.

ACTIVITY G: Communicate Feeling, Awareness and Values

20 min.
individual

What has been this area's impact on humans? _____

_____

Describe how you feel about humans' impact on this area? _____

_____

ACTIVITY F: Influences Definitions

EROSION: The group of processes whereby earth or rock material is loosened or dissolved and removed from amy part of the earth's surface.

It includes the processes of weathering, solution, corrosion and transportation.

Mechanical wear and transportation are affected by running water, waves, moving ice, winds, which use rock fragments to pound or grind other rocks to powder or sand.

The agents of wind, water and ice are all generated by gravitation forces.

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Physical weathering is accomplished by moisture (freezing, thawing, evaporation), temperature change (expansion, and contraction), and root wedging by growing plants.

Chemical weathering is the result of the alteration of minerals within rocks by the action of various chemicals such as acids formed in the environment.

Through this process, rocks are changed in character until they decay, and crumble into soil.