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ABSTRACT

This instructional packet is one of 14 school environmental education programs developed for use in the classroom and at the Dahlem Environmental Education Center (DEEC) of the Jackson Community College (Michigan). Provided in the packet are pre-trip activities, field trip activities, and post-trip activities which focus on various geological concepts. Strategies for using these activities with fifth grade students are also provided. The pre-trip activities focus on: (1) igneous, metamorphic, and sedimentary rocks; (2) the rock cycle; and (3) weathering and erosion. These and other geological concepts are then reinforced during the indoor and outdoor activities conducted at the DEEC. Instructions and objectives for these activities are provided in a separate field trip guide. The post-trip activities include exploring geology at the school site and examining the effects of Mount St. Helens, and looking for geology in the news. (JN)

Reading the Rocks

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"Reading the Rocks" is one of fourteen school environmental education programs developed by the Dahlem Environmental Education Center of the Jackson Community College. Assistance for the project was provided by the Institute of Museum Services Special Projects Grant #G008103172, of the U.S. Department of Education.

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Reading the Rocks

A Fall Activity Packet for Fifth Grade

Where do rocks come from? How do we use them? What is soil and why do we need it? These are but a few of the questions that will be answered in "Reading the Rocks," a program designed for fifth grade students visiting the Dahlem Environmental Education Center.

This packet contains a wealth of pre-trip activity ideas and information that will enhance your students' field trip experience. Concepts such as the rock cycle and erosion will be expanded and illustrated at the Dahlem Center, along with a look at landforms and the stories in stones. You may decide to take side trips to a cemetery or a working gravel pit to extend your rock trip.

Also included are post-trip activity ideas to transfer this information to the school and home environments -- from identifying rocks in the kitchen to soil erosion on the playground. Other activities will involve your students in understanding current issues and the awesome effects of natural geological phenomena.

This exploration in earth science covers basic geology such as rock identification and soil formation. In addition, it introduces the more interesting aspects of this science: the constantly changing earth and its effects on our society. We hope these ideas will launch your class to a new awareness of their environment and the consequences of natural and human events, and encourage them to explore and learn on their own.

Contents

Goals and Objectives

Program Goal

Fifth graders will become more aware of our changing earth, our soil, and how geology relates to their everyday lives.

Program Objectives

Students will:

- -understand the formation of sedimentary, igneous, and metamorhpic rocks by making models or comparing samples.
- -learn how rocks change by explaining the rock cycle.
- -differentiate among rocks and minerals by sorting samples.
- -understand soil composition by comparing soil types.
- -become aware of the problem of erosion by doing a soil table experiment.
- -learn how the landscape was formed by observing different landforms.
- -realize their dependence upon rocks and minerals by discovering different ways they are used in the built environment.
- -understand how geological events affect humans by researching a natural phenomena and/or a geology-related problem.
- -become aware of the impact of our society upon the earth by understanding the interrelationships that exist between the two.

Pre-Trip Activities

The following activities will prepare your students for their field trip. The first is a "hands-on" activity that allows your junior geologists to create their own rocks. The last two explain how rocks and soils are formed.

1. Rock Groups

Introduce this unit to your students with a discussion about rocks and their formation. What are the characteristics of a rock? A rock does not need to be hard; in fact, baby powder is made from a very soft rock -- talc. A rock does not even have to be heavy -- pumice, the froth of lava, is as light as a ping pong ball!

A rock is a collection of minerals bonded together. A mineral is a single element or a pure substance. Gold, lead, quartz, and mica are a few minerals. Their chemical compositions and physical properties are stable. Since rocks are made of minerals, their properties vary with the mixture of ingredients. A rock can be compared to a chocolate chip cookie -- the flour, sugar, eggs, and chocolate are the minerals. Change the cooking time or the amount or variety of "minerals" and you get brownies or a cake instead!

Rocks are classified according to their formation. SEDIMENTARY rocks are formed under water by the continuous deposition of sediments eroded from the land surface. IGNEOUS rocks are made from cooled magma (molten mixtures of minerals deep within the earth) or lava (magma which seeps out at the surface). Heat and pressure can change sedimentary and igneous rocks into METAMORPHIC rocks.

SEDIMENTARY: *sedi* - to sit or settle
IGNEOUS: *ig(nis)* - fire
METAMORPHIC: *meta* - change; *morphos* - form

The "recipes" below enable your geologists to make their own sedimentary and igneous "rocks." If you can't scrounge enough materials for each student to make a rock of his/her own, try dividing the class into "rock groups." Each group can display and explain its "rock's" origin to the rest of the class.

Sedimentary Rocks

Sedimentary rocks are actually little chunks of rocks and minerals held together with a cementing agent. Fossils are often formed when aquatic plants and animals become trapped between layers of deposited sediments.

For each sedimentary rock, your students will need any size milk carton, sand, gravel, plaster of Paris, and water. Help them mix: 3 parts sand and gravel, 1 part plaster, and 1 part water. After stirring they should fill their carton 1/3 to 1/2 full with the mixture and set it aside for a day.

Continue this process several more days, varying the concentration of sand and gravel, until the carton is full. When the "rocks" are solid, ask the students to peel off the carton to let the remaining moisture evaporate.

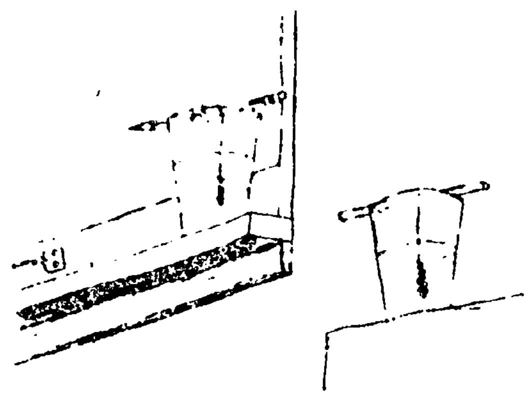
If layers are not evident in the rocks, break open some of them. What sediments are visible? (sand, gravel) What holds the sediment together? (Plaster of Paris is made from gypsum, a rock first mined near Paris, France.) From where does sediment come in real sedimentary rocks? (Sand, gravel, and silt are eroded from the land and deposited in the ocean.)

Igneous Rocks

When magma and lava cool, creating igneous rocks, crystals are formed within the rock. The mixture of minerals and the cooling time determine the type of crystals, and therefore the type of igneous rocks. Magma typically cools very slowly because the ground insulates the heat. These crystals grow into large chunks. Above ground, lava can cool quickly; these crystals may be too small to see with an unaided eye. Obsidian, volcanic glass, is an example of a quickly cooled igneous rock. The following experiments will give your students the opportunity to watch crystal formation.

•Each student will need a cup, a string, and a stick or pencil. You'll need salt, warm water, and a large container. Have several students make a saturated salt solution by dissolving as much salt as possible into the warm water. Then pour enough salt water into each student's cup to fill it half way.

They should tie the string to the stick and let the string dangle in the water. After a few days they should see crystals appearing somewhere, on the string, inside the cup, or maybe even on the stick!



Place some cups in a draft or sunny window where the water will evaporate quickly. These crystals should be more plentiful but smaller. Does changing the concentration of salt or temperature of the water change the crystal growth? Use a magnifying lens or microscope to examine the crystalline structure. What shape are the crystals?

•You can make a demonstration crystal garden by mixing equal parts (about 4-6 tablespoons) of salt, water, bluing, and ammonia, and pouring it over several pieces of charcoal in a shallow dish or pie pan. Watch your garden for several days. Where do you expect the crystals to grow?

You may want to involve your students in the proper disposal of your crystal garden when you are finished. Is it wise to dump chemicals down the sink if they eventually get into the water system?

Review with your class the contents of this chemical soup -- salt, water, and bluing are rather harmless ingredients, but ammonia is a very strong base. How can they determine the presence of a base, and neutralize it if necessary? (Use pH paper, and if basic, add an acid like lemon juice.)

If your crystal garden sat in the open for a week or more, the ammonia evaporated, leaving behind a neutral liquid. It can be dumped in a gravel driveway or flushed down a sink.

Metamorphic Rocks

Your students should know how to make a grilled cheese sandwich -- by heating and pressing a piece of cheese between two slices of bread. In similar manner, sedimentary and igneous rocks can be changed into metamorphic rocks. Likewise, a new metamorphic rock can be created from old metamorphic rock. The process takes place underground where there is pressure of other rocks, moving land masses and high temperatures.

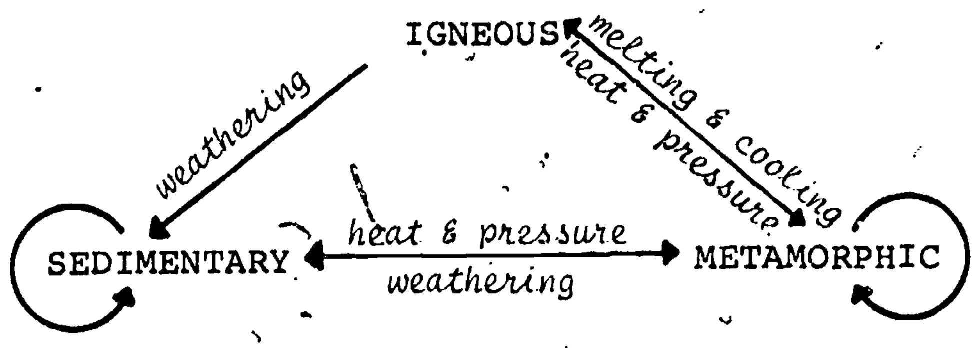
To illustrate this concept, students can examine samples of one or more of these rock pairs: limestone and marble, shale and slate, granite and gneiss. (Perhaps you can borrow samples from a physical science or earth science teacher, a college geology teacher, a teacher resource center, a monument company, or a lapidary.) The mineral composition of each pair is similar, yet the textures and patterns of the rocks are very different.

The shale and limestone are sedimentary rocks formed from mud and the shells of marine animals. Through heat and pressure these rocks can be changed into slate and marble. After examining the samples, ask your students which rock in each pair is harder? Do they differ much in appearance? Under the proper conditions, granite, an igneous rock, can be metamorphosed into gneiss. In which rock did the minerals melt and recrystallize into colored bands?

2. The Rock Cycle

Second by second, minute by minute, year after year, rocks change in ways that are hard to see. Forces such as heat, pressure, and weathering, build up and wear down rocks in a never-ending process known as the rock cycle.

Briefly discuss the rock cycle with your students as you draw it on the chalkboard. The cycle will be reinforced and explained in further detail during the field trip.



3. Weathering Rocks

From the moment a rock is exposed on the earth's surface, it begins to wear away. Weathering is both a physical and a chemical process.

Bring a large sedimentary rock to school. Sandstone, slate, limestone, or a conglomerate will do. Show it to your students, telling them that they are looking at some future soil! Then ask them to list ways that rocks are broken down into smaller pieces.

Here are some questions to get their wheels turning. Have your students ever seen a sidewalk cracked by a tree root? Ivy growing on a brick wall? A round pebble in a stream?

They will probably describe these examples of physical weathering:

- Temperature changes in the air cause rocks to expand, contract, and crack.

- Water seeps into the crack and freezes, widening it.

- Plant roots grow in the crack, widening it more.

- Raindrops or flowing water carry tiny particles that grind against rocks, wearing them down.

Prompt your students to think about chemical weathering processes, too. Unlike physical weathering which merely disintegrates rock into smaller pieces, chemical weathering transforms the composition of the material.

- Rain water can dissolve the minerals in rock. Carbonic acid, a weak weathering agent, is formed when rain mixes with the carbon dioxide in the atmosphere.

- Carbonic acid is also made by plants -- roots give off carbon dioxide which mixes with the water in moist soil and begins to change rock surfaces.

- Air pollutants cause chemical weathering. Some of our older city buildings are beginning to show the effects of acid rain and automobile emissions.

Challenge your students to change your rock to soil. They can try pounding and grinding, putting it in a stream, freezing and baking it in quick succession, and soaking it in vinegar, etc. (Caution the rock pounders to protect their eyes by wearing safety glasses or wrapping the rock in a cloth.) How long does it take to break the rock down?

To get an idea of how long nature takes to weather rocks, your students can visit a cemetery. Tombstones over a hundred years old may show signs of wear by wind and rain, especially if they are made of sandstone, slate, limestone, or marble. Why do you suppose that the majority of tombstones made today are granite? (Quartz, one of the minerals in granite is very hard.)

<u>Eroding Soil</u>

Soil is a living mixture of tiny rock particles, organic matter, water, and air. Organic matter is both living and decomposing plants and animals. A handful of soil may contain millions of organisms!

Scientists estimate that it takes 100 to 500 years to form one inch of topsoil from rocks and other organisms.

Each year, however, our topsoil is eroded at an incredible rate. On 1.3 billion acres of private crop, pasture, forest, and range land in the United States, an average of 5 tons of soil disappear from each acre. In many areas around the world the erosion rate is even higher. The difference between the soil created and the soil lost is a net loss of 7.5 to 10 tons per acre worldwide.

Erosion is simply the movement of soil from one location to another by wind, water, or slippage. The problem is that our nutrient-rich topsoil is the source of our food. Eroding winds and rain carry the soil to streams and rivers where it can clog waterways and increase the productivity of the aquatic system, causing floods and accelerated plant growth. In addition, farmers need to apply more fertilizer to achieve the same level of production from their poorer soil.

Rock Talk

The following terms have been introduced in the pre-trip materials. Activity Sheet #1 will help your students review these terms.

EROSION -- the transport of topsoil by wind, water, or other natural means

FOSSIL -- the evidence of prehistoric life preserved in rock

IGNEOUS -- crystalized molten rock from magma or lava

LAVA -- molten rock at the earth's surface

MAGMA -- molten rock beneath the earth's surface

METAMORPHIC -- rock formed from pre-existing rock through high temperature and pressure without melting

MINERAL -- naturally occurring solid substance with consistent crystal structure

ORGANIC MATTER -- living organisms and the remains of dead organisms found in soils

ROCK -- natural collection of one or more minerals

ROCK CYCLE -- the natural cycle of weathering and deposition to form sedimentary rocks, burial and heating to form metamorphic rock, and melting and cooling to form igneous rock

SEDIMENTARY -- rock formed from accumulated sediments under water

SOIL -- mixture of minerals, water, air, and organic matter on the surface of the earth

WEATHERING -- the decomposition of rock into sediment by wind, water, and living things

In addition, the following words will be used during or after the field trip.

BEDROCK -- the relatively solid layer of rock found on the surface of the land or below the soil

CLAY -- a tiny grain of material in soil smaller than 0.0039 mm

ERRATIC -- a boulder deposited by glaciers

GEM -- a mineral valued for ornamental use

GLACIER -- a mass of ice formed by the recrystallization of snow that flows across the land

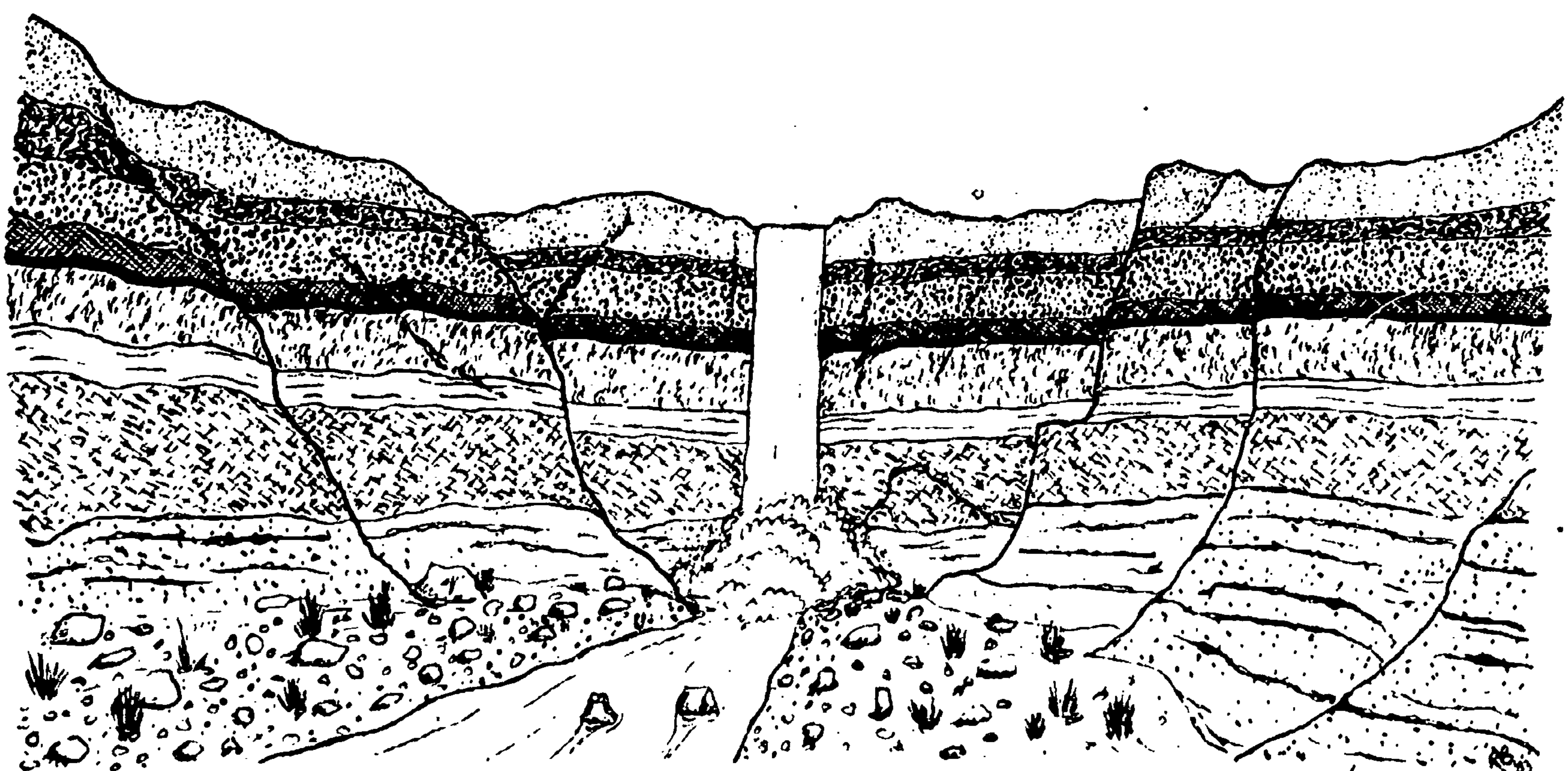
GROUND WATER -- subsurface water held above or within the bedrock

SAND -- sedimentary particles between 0.0625 and 2.0 mm

SILT -- sedimentary particles between 0.0039 and 0.0625 mm

VOLCANO -- a mountain created from successive eruptions of lava and ash from within the earth

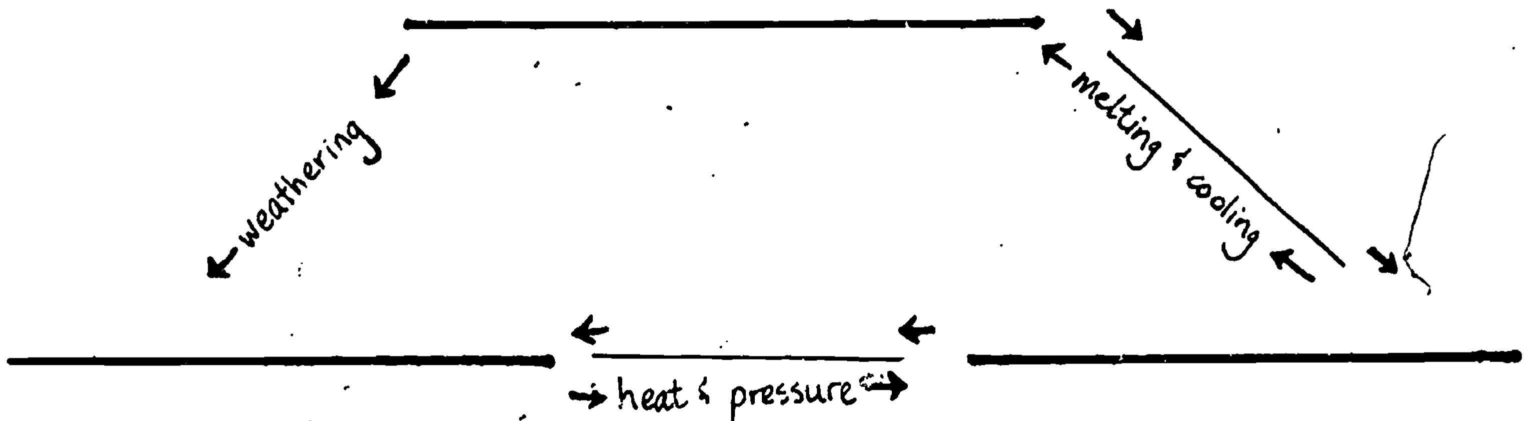
WATER TABLE -- the upper zone saturation of ground water

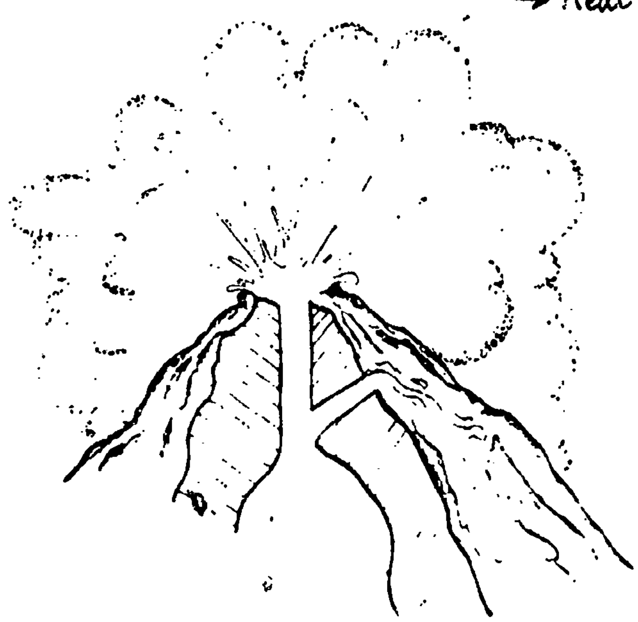


Name ______________________

Rock Talk

Complete this rock cycle by filling in the five blanks.





1. Molten rock under the ground is ______________________.
2. Molten rock outside the ground is ______________________.
3. Where would crystals be larger? ______________________.
4. Which type of rock is formed when the molten rock cools? ______________________.
5. Rocks are broken down into small pieces in a process known as ______________________.
6. Soil is formed from these small particles and dead plants and animals known as ______________________.
7. A neighboring town built an outdoor swimming pool. The work is finished, but around the pool, sloping down to the parking lot, is bare dirt. What will happen when it rains? ______________________ ______________________. What could the builders do about it? ______________________

Rock Talk

Activity Sheet 1

Dear Parent:

Our fifth grade class is busy studying rocks. So far we have learned about the three major types of rocks, how they are formed, and how they change. During our upcoming field trip to the Dahlem Environmental Education Center, we'll examine some rocks and minerals, learn about soil erosion, and hike to see some land formations. After the trip, we will examine the rocks and soils around school and study some issues that relate to geology.

You can help your "rock hound" learn more about geology by encouraging one of these home projects:

-Start a rock collection.

-Visit the rock and mineral display cases in Jackson Community College's McDivitt Hall, or the geology trail at the Waterloo Nature Center.

-Collect magazine and newspaper articles or watch T.V. specials on geological issues such as earthquakes, volcanoes, erosion, landslides, floodplains, groundwater contamination, or toxic waste disposal.

-Visit a sand dune, a landfill, or a gravel pit.

-Tour Jackson's downtown, observing granite buildings.

-Read a library book about rocks.

On the day of our field trip please listen to the weather report and encourage your child to dress for the weather. We will be outdoors for a few hours, so warm waterproof clothes and sturdy shoes are important.

Thank you,

Fifth Grade Teacher

Field Trip

Now that your students have been introduced to the concepts in the pre-trip materials, they are ready for their field trip to the Dahlem Environmental Education Center.

During a short indoor introduction, your students will review rock types, elaborate upon the rock cycle, and examine some rock and mineral samples. Outdoors, the class will compare soil types, weathering processes, landforms, and boulders along the trail. The stream and ground water will be observed for their role in weathering, erosion, land shaping, and hypothetical pollution problems. A demonstration with erosion boxes will allow students to predict where erosion will occur in other areas.

If it is possible to extend your visit, you can include a sidetrip to a local cemetery and/or gravel pit. The cemetery is a good place to observe weathering tombstones, and at the gravel pit students can appreciate the extent to which sand and gravel is mined and used in our region. The cemetery is within walking distance of the Center; the gravel pit is 10 miles south.

Gemstones, hand lenses, and rock and mineral guides are among the items available at the Center's gift shop. Arrangements for the cemetery, gravel pit, or gift shop must be made in advance.

Please encourage your students to listen to the weather prediction for the day of their field trip. They will be outside for a few hours, so stress the importance of dressing for the weather. Layered clothing and sturdy shoes are recommended.

Post-Trip Activities

The activities in this section pick up where your field trip left off. Through games, experiments, and research, your students will increase their backgound in basic geology. This background will enable your class to understand a variety of environmental issues.

1. Geology at School

School Site Rocks

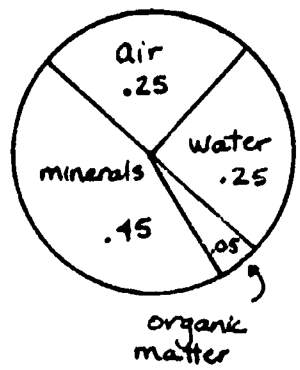
Rocks are all around -- in the lawn and on the parking lot. With special rocks of their own, students can participate in these sensory activities. Byrd Baylor's Everybody Needs a Rock suggests ten ground rules for finding special collectables.

Three fun classroom games will encourage your students to examine their favorite rocks and test their power of observation.

- With the class in a circle, have each student place his/her favorite rock in a central pile. Mix up the pile and challenge students to retrieve their own rocks.
- Redistribute the rocks to blindfolded students. Have them pass the rocks around the circle until they find their own.
- Challenge students to classify their rocks in as many different ways as possible -- according to shape, size, color, weight, texture, etc.

The Soil Under Your Feet

From their field trip, your students should know that soil is made of minerals (sand, silt, clay, and gravel), organic matter (living and dead), water and air. The amount of each of these components varies from region to region, according to climate, bedrock, topography, and time. In fact, even in regions with the same soil type, the plants can change soil texture and productivity. In this activity students can compare the soils around their

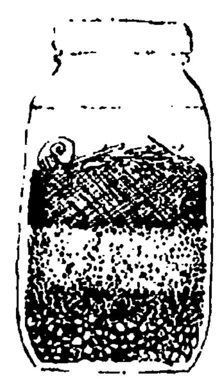


school and homes and locate potential erosion problems.

•Take your class outside to collect soil from a variety of locations. A ½ cup is plenty, and shouldn't be missed. Try collection sites like these: the pitcher's mound or the bottom of a slide, under a tree, the edge of a field, and a seldom-used spot. Encourage your students to look closely at the soil samples -- the color, the particle size, the moisture, and the living critters may be noticed.

•The shake test will separate the soil particles into definable layers and give your students another parameter with which to compare soil. Put each sample in a jar and add twice that much water. Cover the jars and shake them.

When the particles have settled out of the water, compare the depth of each layer in the jars. Which layer is always at the bottom and why? (The largest particles -- gravel or sand -- fall to the bottom because of their weight.) Which soil has the most or the least organic matter? (Organic matter should be the darkest layer, often near the top.) Where would the best garden grow? (The best garden would have the most organic matter, provided there is enough sunlight and moisture.) Where is the soil more likely to erode? (Open, exposed soil, especially on a slope, is most likely to erode. A lack of organic matter may indicate erosion has already occurred.)



For homework ask each student to collect a soil sample or two from their yard or neighborhood. Their soils can be compared to the school soils in the same manner.

For more soil activities, transparencies and ditto masters, see Conserving Soil by the Soil Conservation Service. This teachers guide is available from your local Soil Conservation District and may be in your school library.

2. Rocks at Home

By now your students should be quite aware of the presence of rocks in the natural environment. But what about the built environment? When you take a second look around, you'll find that rocks and minerals fill nearly every aspect of our lives.

Ask the students to look around the room listing the rocks and minerals in your school. Building materials, the blackboard, chalk, table legs, pencil graphite, and perhaps even buttons are a few examples of the rocks we live with.

Some may wish to explore the production process of glass or tile to determine their geological roots.

Encourage your students to think about rocks and minerals at home, too. Where should they start looking? Activity Sheet #2 can be used as homework, sending the students to each room in the house to look for rocks. The following list will guide your thinking!

Driveway
- limestone
- gravel
- asphalt

Bathroom
- talc
- pumice (some soaps)

Toolbox
- garnet (sandpaper)
- lime

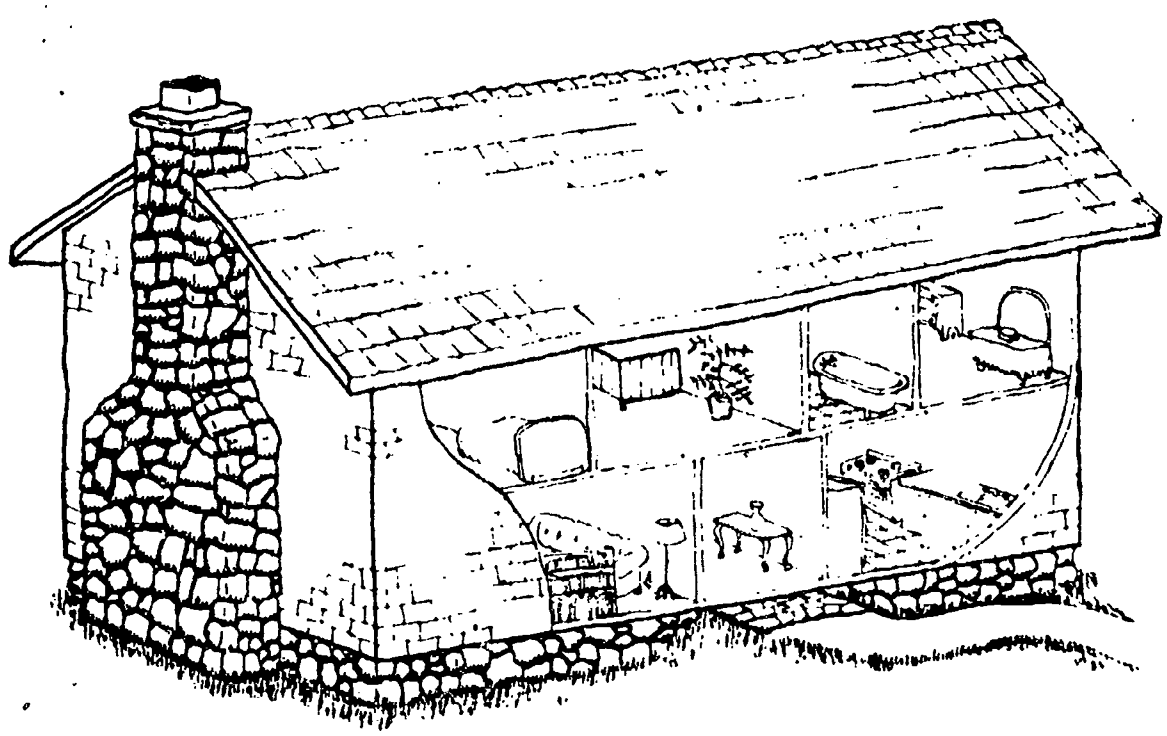
Laundry Room
- borax

Desk
- graphite (pencil)

Kitchen
- salt
- glass (quartz)
- pottery (clay & colored minerals)
- porcelain (fine white clay)

Jewelry Box
- diamond
- garnet
- turquoise
- silver
- gold

Walls
- plaster
- slate
- concrete - human-made conglomerate



You and Our Changing Earth

Fortunately for you and your students, geology is much more than a study of rocks and soil. Our earth is the foundation of life, both a literal support system and a source of life-sustaining materials. As our growing population crowds into cities and expands onto deserts and mountain slopes, resources in strategic locations on our planet are strained to their limit. This raises some geological issues that your students have the background to understand:

decreased soil fertility and erosion
irrigation and lowered water table
seasonal flooding
solid waste pollution and landfills
depleted mineral resources
energy conservation

In addition, people living in zones where the earth is rapidly changing are constantly challenged by earthquakes, volcanoes, and landslides.

It is important for your students to recognize that these issues are related to geology and that they may be of personal importance to them someday. These questions will take research, cooperative planning, and wise decision-making to solve.

The first activity will increase your students' awareness of a variety of current geological issues. The following set of activities will guide you through an investigation of one of the most interesting and dynamic geological events in North America -- the eruption of Mount St. Helens. While the latter may be very distant from your class, it is an excellent example of people responding to a dramatic change in the landscape. And, too, fifth graders and volcanoes seem to be made for each other!

Geology in the News

Because the earth concerns people in many different ways, rocks and soil are buried in the newspaper and TV broadcasts every day! It may take an observant geologist to find them, however. Help your students generate a list of geological issues that may appear in the news. Here are a few to get you started:

earthquakes	erosion	farming
flooding	fossil fuels	groundwater pollution
landfills	landslides	land use planning
mining	mineral rights	sand dunes
soil conservation	volcanoes	

For the next few days, ask your students to scour the news media for articles on these topics. Collect their finds and randomly distribute the clippings to small groups of students. Have them read the information and give a short news broadcast for the rest of the class.

Mount St. Helens

Early on the morning of May 18, 1980 a volcano near Portland, Oregon erupted. The force and heat of the explosive blasts flattened the forest in 180 square miles and showered the Northwest with ash -- up to four inches in some cities. When the major eruption was over, a cubic mile of mountainside had been relocated, lowering the elevation of the peak about 1300 feet.

The fact that Mount St. Helens erupted is not unusual; active volcanoes alter the landscape in many places around the world. The amazing aspect of the Mount St. Helens eruption is that it happened in our lifetime and in an accessible location. Scientists and other observers have a fascinating opportunity to explore plant succession on the ash, recolonization of lakes and streams within the blast zone, the effect of the inorganic ash on the surrounding forest, and the growing dome within the crater. The brochure in the back of this packet provides some information on Mount St. Helens as your students explore this eruption and other volcanoes around the world.

<u>A Volcano on Your Playground -- A Demonstration</u>

The actual event of an erupting volcano can be likened to opening a warm bottle of pop. Take two, unopened bottles of the same size and type of pop, refrigerate one and keep the other in a warm place. Do not use bottles with screw caps. When temperatures are quite different, take the bottles, a bottle opener, and your students outside for the volcanic demonstration.

First, give both bottles to one student to shake. They should be held together so they will be shaken the same amount. Ask the class to predict the results, and have a brave soul open both bottles. Note what happens to the pop and how much is left.

Here are some questions and answers to help you lead a class discussion:

What happened? (A mixture of gas and liquid erupted from the bottles.)

Which bottle lost the most and why? (The warm bottle, because the warmer molecules move faster, expand and release a greater amount of dissolved gas.)

Where was the gas in the closed bottle? (Dissolved in the liquid, under pressure.)

Why did the gas rush out? (The pressure was released when the bottle was opened, and the liquid carbon dioxide changed to a gas. Since the gas occupies more space, it left the bottle in a hurry, taking some liquid pop with it.)

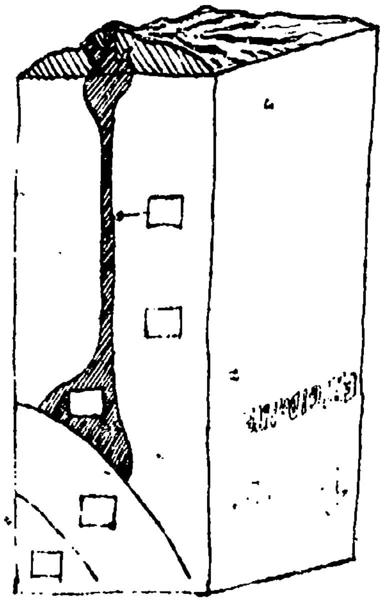
How are bottles of pop like a volcano? (The molten rock (magma) under a volcano contains dissolved gases. The heat of the earth and the cap of the volcano keep the magma under great pressure. When either the pressure builds to "blow off" the cap, or a crack develops in the mountain side, the pressure is released and the gases escape in an eruption, carrying molten rock with it. In the case of Mount St. Helens, an earthquake triggered a landslide, causing a crack in the mountain, and the volcano erupted.)*

*Modified from <u>Mount St. Helens Classroom Activities -- Elementary</u> and reprinted with permission of Educational Service District 112, Vancouver, Washington.

<u>A Volcano in Your Classroom -- A Model</u>

The geology of volcanoes will be graphically explained with this scale model of a cross section of a volcano, all the way down to the earth's mantle -- the molten core of magma. Your students can make the volcano, with your guidance. You will need a box at least 80 cm tall (refrigerator box would be fine) or wall space for a mural, paper, playdough, paints, opaque projector, and glue.

Enlarge the diagram on Activity Sheet 3 with your opaque projector to fill a piece of paper the size of your box or section of wall. Cut the paper at the zig zag line and spread the two sides apart so that sea level and the top of the Pacific plate are 60 cm apart. You can fill in the bottom of the box with mantle; the top surface should be sea level so the mountain of playdough can sit on top. then label the parts of the model as shown on Activity Sheet 3.*



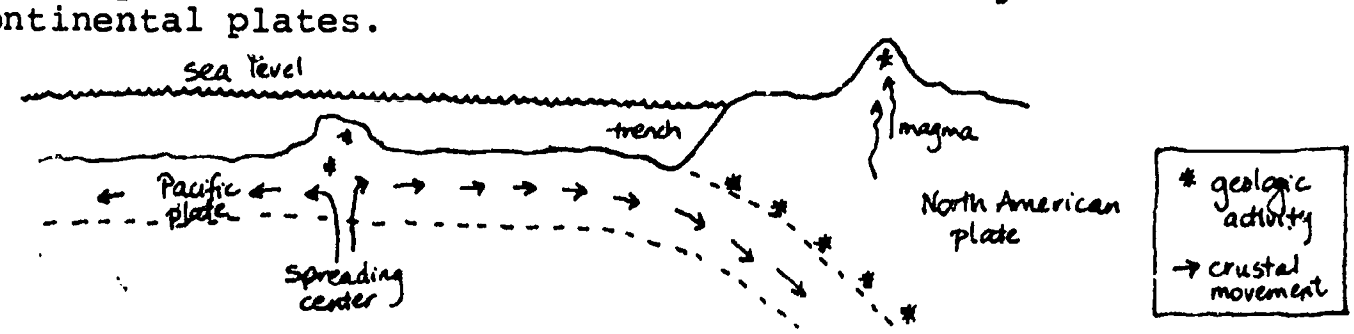
**Modified from Mount St. Helens Classroom Activities -- Elementary and reprinted with permission of Educational Service District 112, Vancouver, Washington.*

Understanding Your Model: What Makes Volcanoes

To understand the connection between the Pacific and North American plates, grab a globe or a world map and explain the theory of plate tectonics to your class. Geologists believe the continents were one land mass at one time in the history of the planet. Indeed, if you imagine each continent as a separate piece in a jigsaw puzzle, South America seems to fit next to Africa.

The early land mass split into plates, moving across the globe by "floating" on the earth's mantle. Each continent sits on one or more plates. The land under the oceans are plates of denser material. Because new land is forming under the oceans, the Pacific plate is growing.

Along the edge, the Pacific plate meets continental plates. Because the ocean plate is more dense, this material slides beneath the continental plate. If it goes deep enough, the rock is melted into the mantle. The friction between these moving plates causes earthquakes and volcanoes. The famous "Ring of Fire", named after the zone of activity around the Pacific Ocean from South America across Alaska to Japan and south, is actually the area of contact between the moving ocean and continental plates.



So, the friction of the moving North American and Pacific plates heats the rock in the earth, making magma. When the pressure is great enough, magma moves up through weak spots in the earth's crust. The weight of the magma slows its movement as it cools into a dense mass, until the heat, pressure, and movement within the earth cause the volcano to erupt.

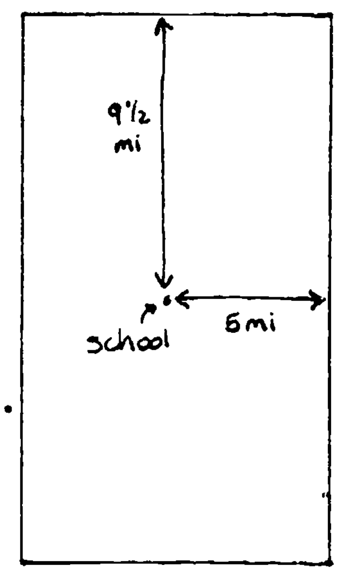
The Real Volcano

Using the Forest Service publication in the back of this packet, explain to your students the story of the 1980 eruption of Mount St. Helens. You may wish to display the pictures and collect newspaper and magazine articles for more information (see References).

Mapping the Blast Zone

The force of the energy that shot out of Mount St. Helens knocked over trees, killed plants and animals, and spread ash and rock over a great deal of land. Your students can determine the area of the blast zone by using Activity Sheets 4 and 5. If you can duplicate #5 onto a transparency, your students can use this as an overlay onto the Mount St. Helens map. If not, students can cut the blast zone out of the map, and trace its shape onto the grid.

Because ¼" equals one mile on the map, a ¼" block on the grid equals one square mile. Have your students count all the squares that are completely within the blast zone. Depending upon the placement of the grid, they should get about 146. Then ask them to count all the partial squares. Since there should be as many squares that are almost inside as almost outside, divide this number (about 84) by 2 to get the total whole squares. The entire blast zone should be about 188 square miles (146 + 42).



Since it's rather difficult to envision that much land, use your school as the middle and determine the boundaries of an 188 square mile block around you. That would be an area about 10 miles by 19 miles!

How many football fields would fit inside the blast zone? Since one square mile can hold 516 field, a quick multiplication results in

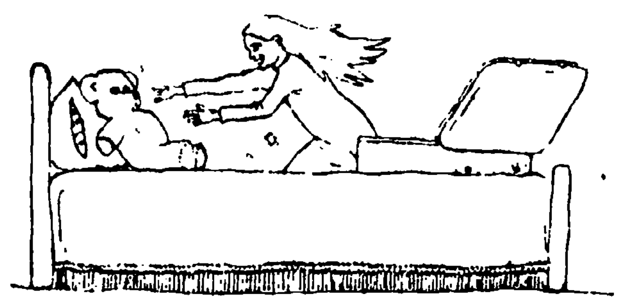
97,008 football fields inside the blast zone. Wow!*

Emergency!

Many people near Mount St. Helens had no time to prepare or escape from the massive eruption. Over 50 people died, probably from inhaling fumes and ash, the intense heat, or falling timber. But many others along the river valleys had time to grab a few possessions and run from the flow of mud and debris that tumbled down, driven by the melting glaciers. The following activities use the scenario of the Mount St. Helens mudflows to explore your students' values regarding their possessions.

•Working individually, ask your students to imagine they have just received an evacuation notice. A wall of mud is racing toward their home. They have 15 minutes to leave. They can only take one small suitcase. What would they pack and why?

•Divide the class in groups of 6 and assign each student one of these roles: grandparent, parent, college student, teenager, fifth grader, and pre-schooler. This time the whole family can take only one suitcase. What should go in it?



•One family on the river lost their $10,000 home and all their possessions but one. Ask your students what one thing they would like to find when the flood subsides.

•The above family found a dented, muddy teakettle. Do your students think they will throw it away?

As your class discusses their values and possessions, it may be helpful to classify items and/or prioritize them: survival tools, family mementoes, irreplaceable items, etc.*

*Modified from Mount St. Helens Classroom Activities -- Elementary and reprinted with permission of Educational Service District 112, Vancouver, Washington.

Three Years Later

Although a far cry from the moist, shady fir forest that surrounds it, the Mount St. Helens blast zone no longer fits earlier descriptions of "lifeless," "barren," or "moon-like."

Where the deep snows of 1980 protected small trees and plants during the eruptions, green bands of foliage line the valleys. Huckleberry roots also survived, and without towering trees to block the sunlight they now cover hillsides where the ash eroded quickly.

Animals, too, survived the blast, protected below the surface -- ants, beetles, and spiders merely crawled out of the ash, and fish, frogs and salamanders were still in the mud under the icy lakes. A wide variety of other animals have immigrated into the blast zone. Mountain bluebirds and juncoes are often seen among the ash-dusted snags, and along streams, elk tracks disclose their evening travels.

The recovery is occurring much faster than anyone expected, though it may take generations of plants and animals to rebuild the forest ecosystem around Mount St. Helens. This exciting drama is protected within the Mount St. Helens National Volcanic Monument, currently the most researched area in the world.

<u>Volcanoes and Values</u>

To review your study of volcanoes and the 1980 Mount St. Helens eruption, and to give your students an opportunity to share their ideas, lead a discussion using the following questions:

- If you have a chance to visit Mount St. Helens what would you like to see?
- If you owned land near Mount St. Helens would you return or sell the property?
- What should happen to the land within the blast zone?
- Should people live where the earth is rapidly changing, like flood plains, earthquake zones or landslide areas? Who should make this decision?

Congratulations! You put some rocks into your students' heads -- sedimentary, igneous, and metamorphic rocks, that is. You helped your rock hounds explore the geology in and around their homes and schools. Finally, you provided your students with an explosive experience in understanding volcanoes! For this, and helping your students expand their knowledge of issues related to geology, you and your "rock stars" deserve a pat on the back. Good job, Teach!

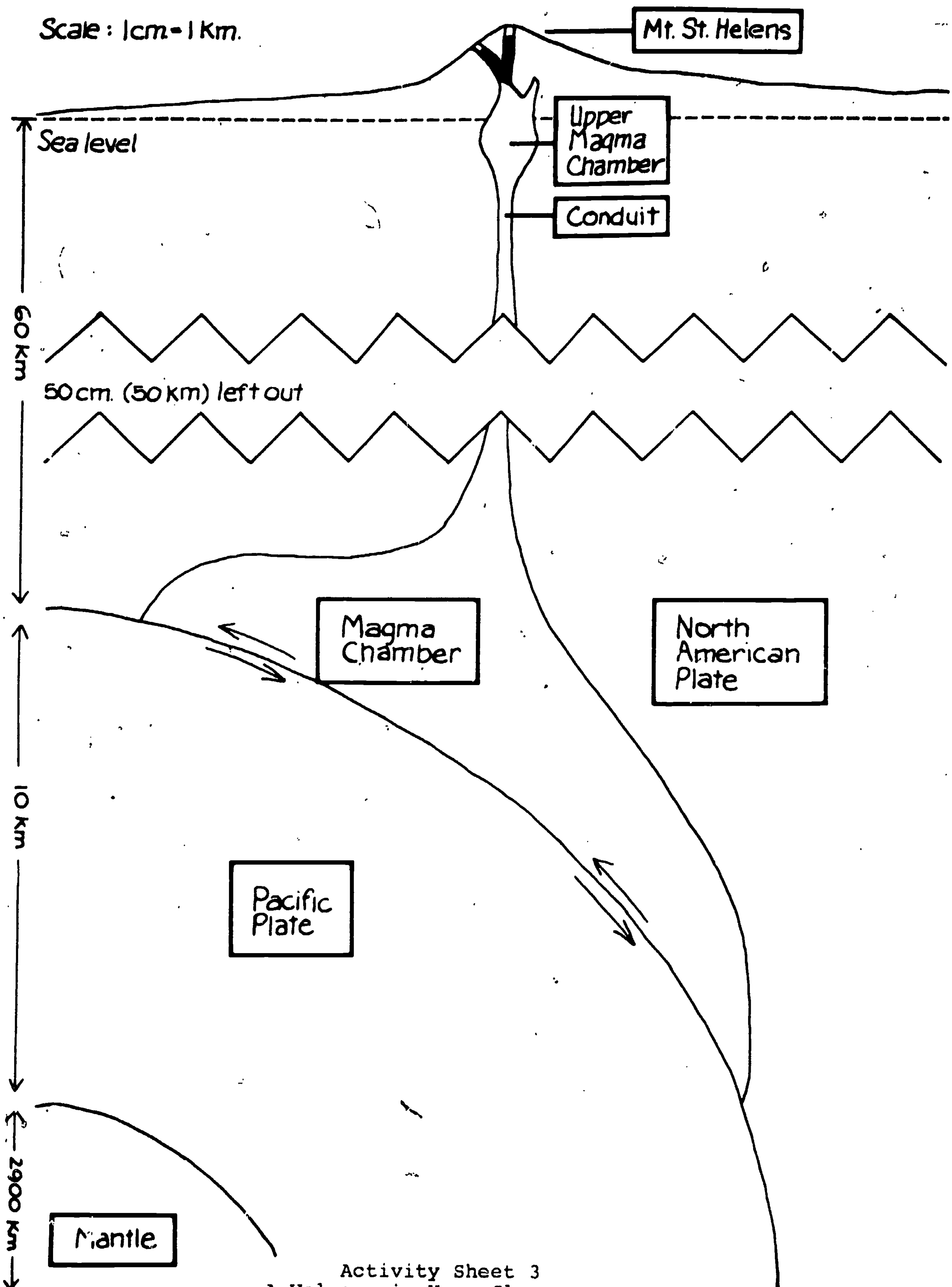
Name ______________

Rocks and minerals can be found almost everywhere, if you know where to look. Try to find at least one rock in each room of your house. Some rooms may be loaded! The rocks and minerals you now use may not look very much like the original version. Use your imagination!

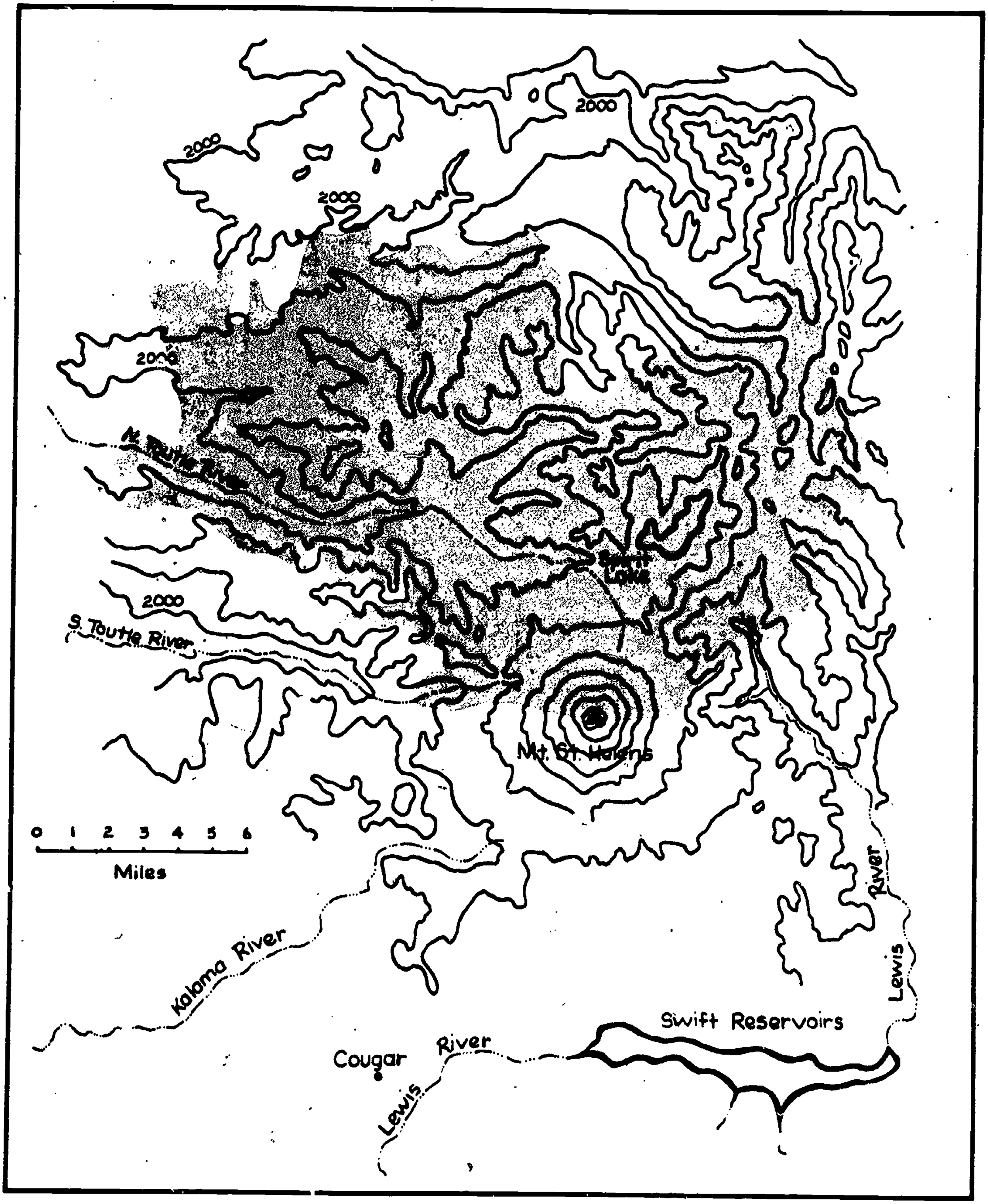
Location	Rock/Mineral
Driveway	
Kitchen	
Bathroom	
Jewelry Box	
Toolbox	
Walls	
House	
Laundry	
Desk	

Rocks At Home

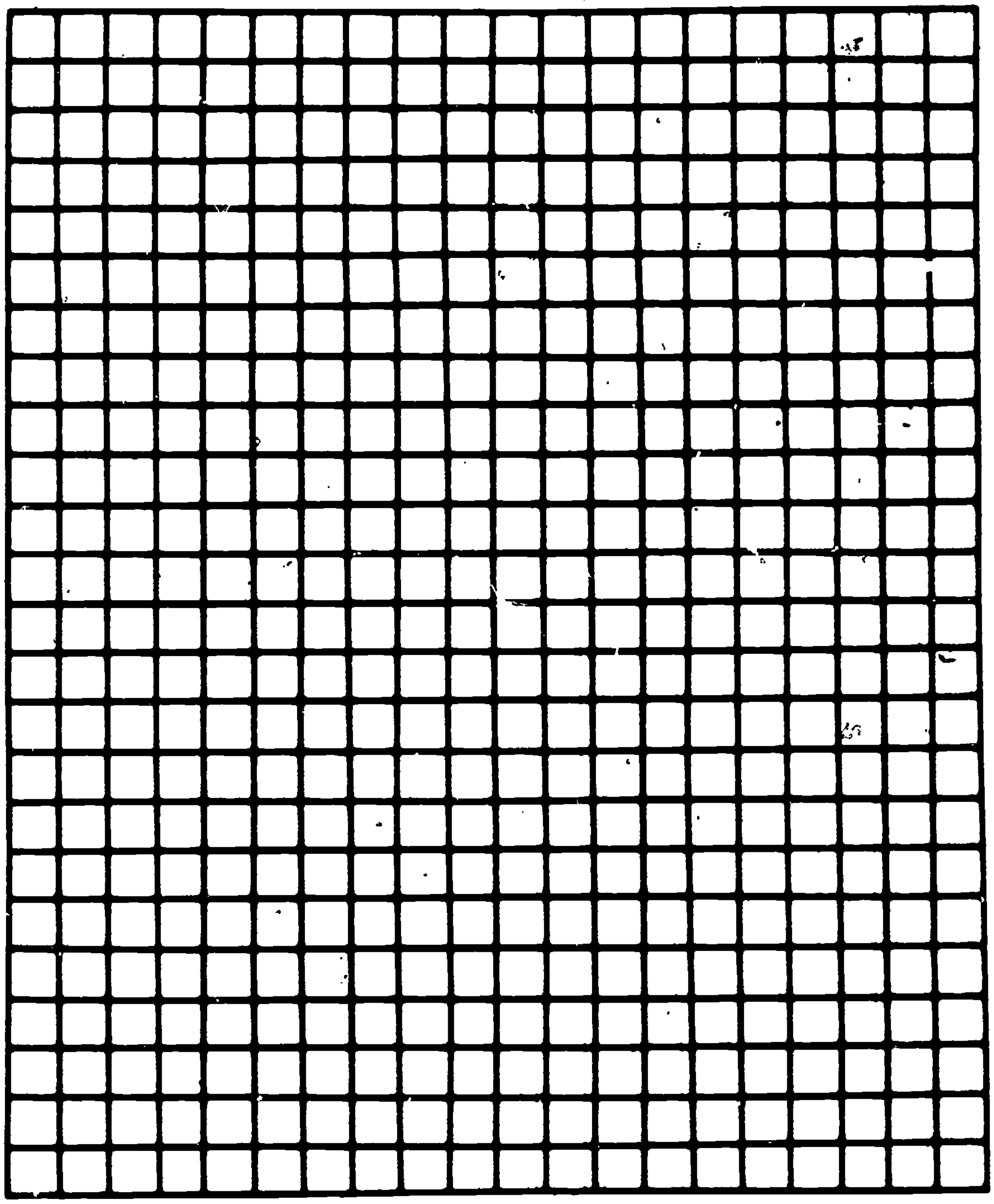
Activity Sheet 2



Activity Sheet 3
A Volcano in Your Classroom



Activity Sheet 4
Mapping the Blast Zone



GRID 1/4" - 1 MILE
1 SQUARE - 1 SQUARE MILE

Activity Sheet 5
Mapping the Blast Zone

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At REMC...

The Jackson County Intermediate School District's Regional Educational Media Center has the following:

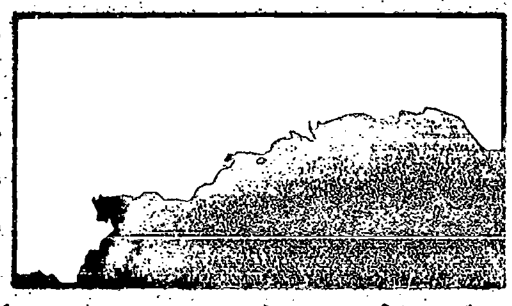
Motion Pictures:

"Crystal Gazing"	MP 549
"Erosion and Weather"	MP 2571
"Eternal Change"	MP 348
"Face of the Earth"	MP 903
"The Origin of Rocks and Mountains"	MP 1182
"The Problem with Water is People"	MP 1949
"Recycling Our Resources"	MP 1331
"Rocks and Minerals - How We Identify Them"	MP 1357
"Rocks for Beginners"	MP 1975
"Rocks That Reveal the Past"	MP 1976
"Strip Mine Trip"	MP 1491
"Succession -- From Sand Dune to Forest"	MP 472
"A Town That Washes its Water"	MP 1589
"Volcanoes -- Exploring the Restless Earth"	MP 1655

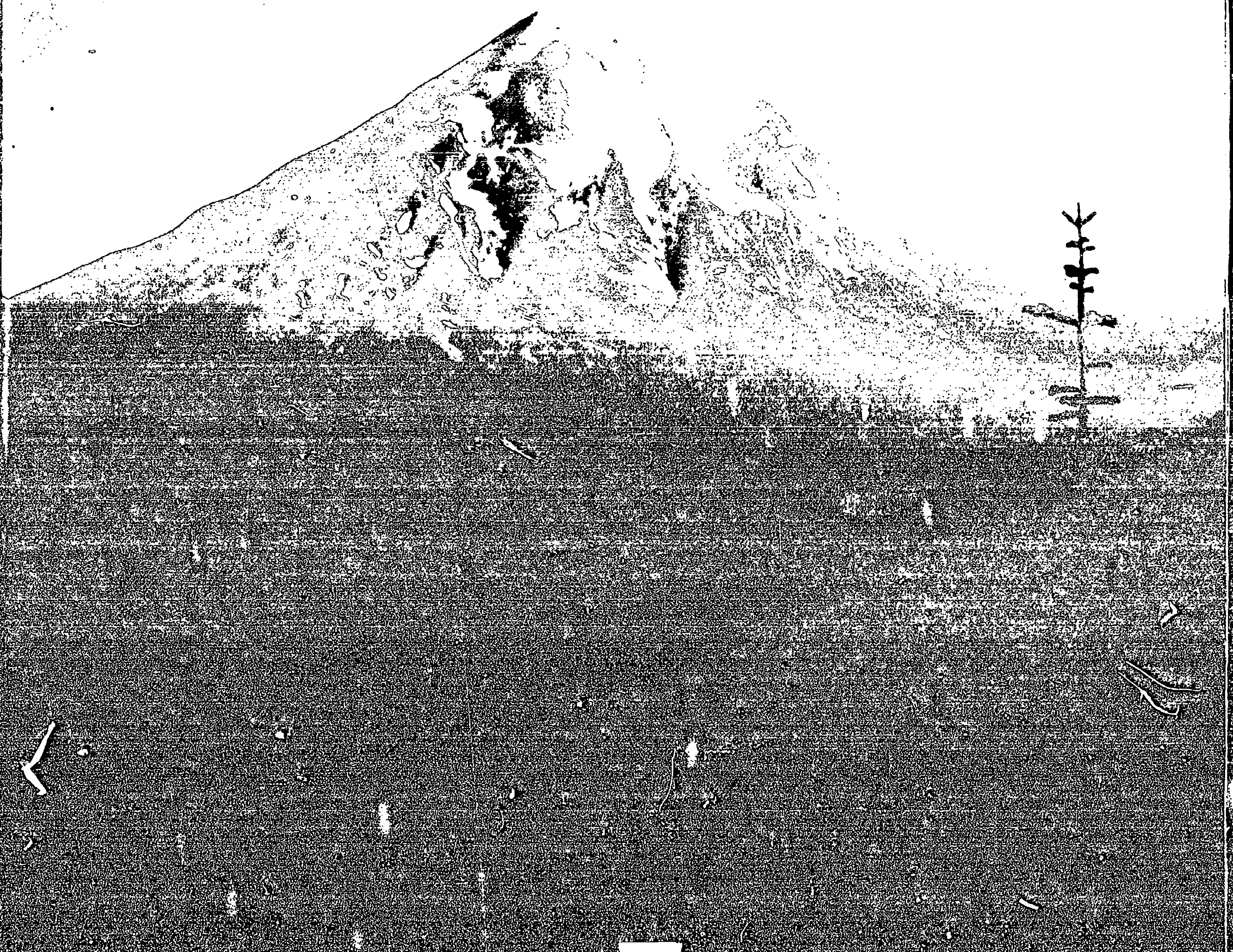
Filmstrips, Kits, Models, or Video Cassettes:

	Science Shelf	
"All About Rivers"	6	KT 642.4
"Earth and Wonders"	6	KT 0141
"Exploring Earth Science"	6	KT 642.1
"Geology Demonstration Kit"	16	SE 0581.1
"Glaciers and the Ice Age"	16	KT 0494
"Investigating Rocks"	13	KT 0505
"Landform Study Program"	16	4SE 0762
"Rocks and Minerals of Michigan"	8	KT 0542
"Violent Earth"		VC 59

A beautiful [illegible] by lush forests. A tall, symmetrical, snow-capped peak dominating the skyline. A mountain [illegible] with the beauty of geologic youth. These are the memories of Mount St. Helens . . . landmarks of the Pacific Northwest forever changed by one of the most cataclysmic events witnessed on the North American Continent. An explosive volcanic eruption.

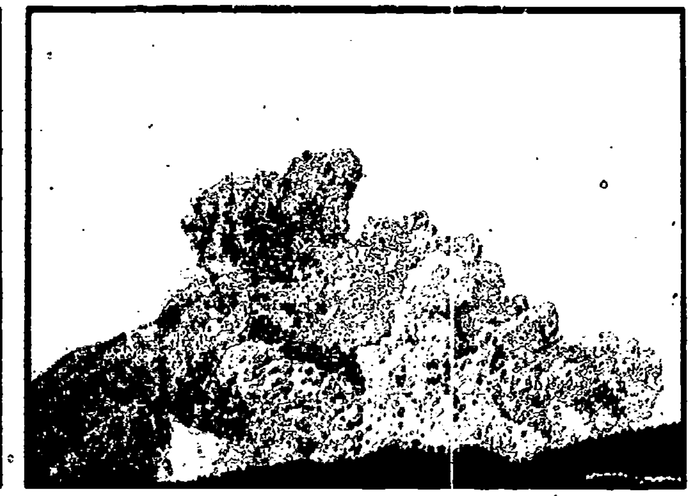


The Sleeping Mountain Awakes. Scientists had predicted a reawakening of volcanic activity on Mount St. Helens. The geologic history of the mountain, including recorded accounts of activity in the early-to-mid 1800's, told them the mountain was only sleeping, not extinct. On March 20th, 1980, an earthquake measured at 4.1 on the Richter Scale announced to the world Mount St. Helens was stirring. Earthquakes continued with increasing frequency until by March 27, it was difficult to distinguish between individual earthquakes due to the constant shaking of the ground.



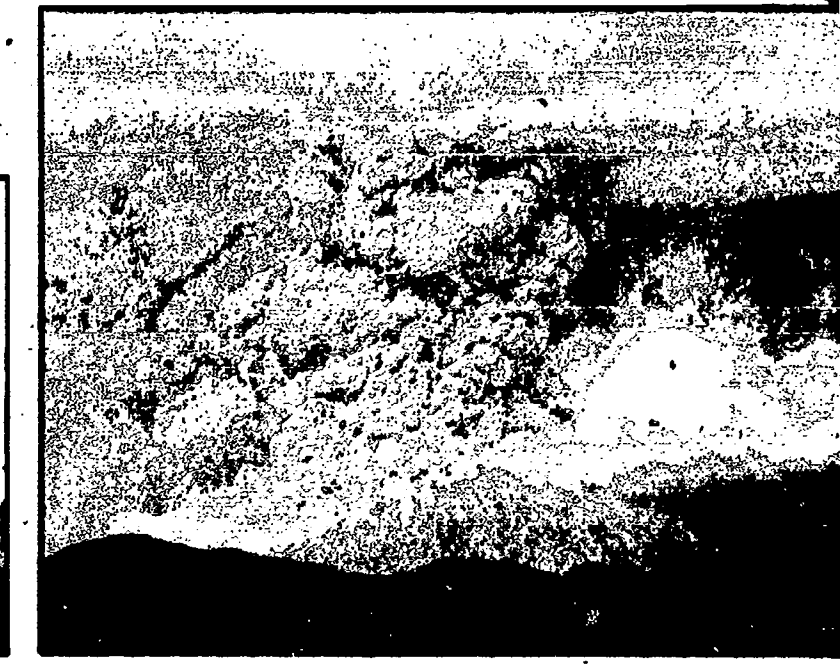
Early April, 1980... erupting steam adds to mystique of still-beautiful Mount St. Helens.

May 18, 1980, 8:32 a.m.... Apocalyptic Sunday...



... north side of Mount St. Helens explodes...

... unleashing an awesome destructive force...



... still filling a funereal sky hours later with towering ash plume.

When an eruption just after noon on March 27 blasted a crater in glacial ice near the summit, Mount St. Helens' 123-year sleep was over. Additional eruptions throughout the evening of the 27th enlarged the initial crater and threw pulverized rock and steam into the night sky. By mid-morning March 28, a second crater had formed near the first. During the next few days, explosions enlarged both craters until they joined and continued growing as one crater.

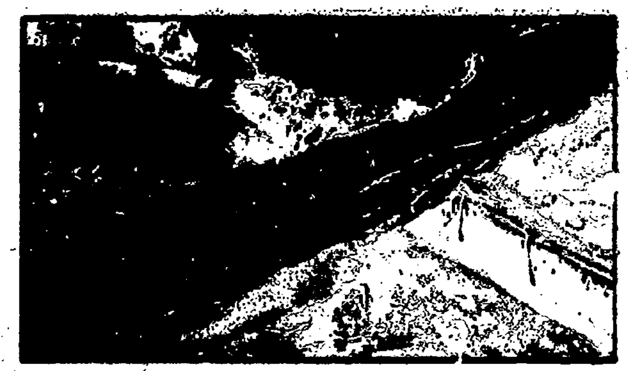
On April 3, a new type of seismic activity, harmonic tremor, was recorded. Harmonic tremors are a continuous vibration of the earth caused by the movement of molten rock or "magma" beneath the volcano. A section of the north side of the mountain began to swell by as much as 4 to 5 feet a day from forces within the mountain. Minor earthquakes, eruptions of steam and ash, and other activity alternated with quiet periods.

Practically without warning, Mount St. Helens erupted early Sunday morning, May 18th. The eruption began with a gigantic explosion which hurled approximately one cubic mile of pulverized rock and ash almost 14 miles into the atmosphere. The force of the blast flattened trees and other vegetation in a fan-shaped area 8 miles long and 15 miles wide to the north of the mountain. Trees were uprooted, or snapped off at ground level, stripped of their limbs and laid flat like millions of dominoes spreading out from the crater. With the blast, came fast-moving flows of superheated steam, ash, and gases incinerating vegetation in its path and starting forest fires on the mountain's flanks. Mud flows created by melted glacial ice and snow coursed down the mountain's sides to the north, flooding into the Toutle and Cowlitz River drainages. The flows gouged and filled the land into new forms as it moved.

Steam from the heated waters of what was once Spirit Lake rose as huge plumes in the air. As of mid July, 28 deaths were immediately attributed to the hot gases and ash with 36 persons still missing.

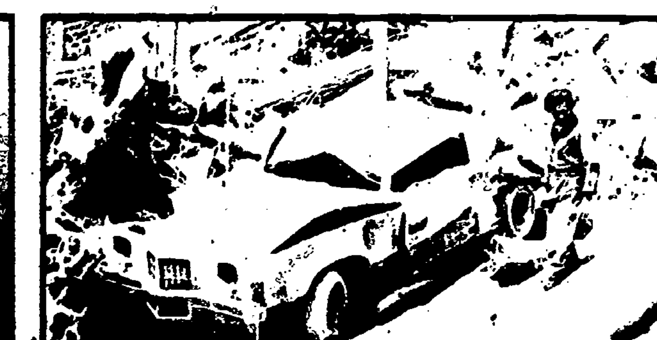
Blown to the east by prevailing winds, ash from the eruption began a course across the United States. Cities in its immediate path, like Yakima, Washington, some 80 miles away were heavily blanketed by the ash. For hours after the eruption, ash blanked out the sun over cities in Washington turning broad daylight to darkness. Within 4 days, ash from the eruption had reached the East Coast. The largest ash cloud reached over 63,000 feet and was traced around the world.

Huge trees six feet or more in diameter lay toppled and jackstrawed over thousands of acres.

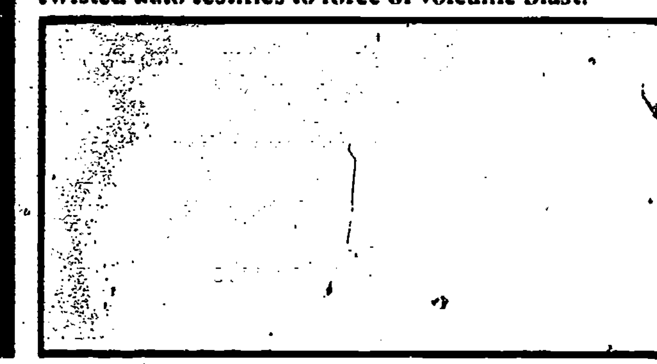


Relentless torrents of mud, water and debris knocked out many bridges.

Clouds part to reveal shocking spectacle of debris-filled Spirit Lake, a barren shoreline, and moon-like north slope of Mount St. Helens, its gigantic and steaming crater extending beneath overcast skies.

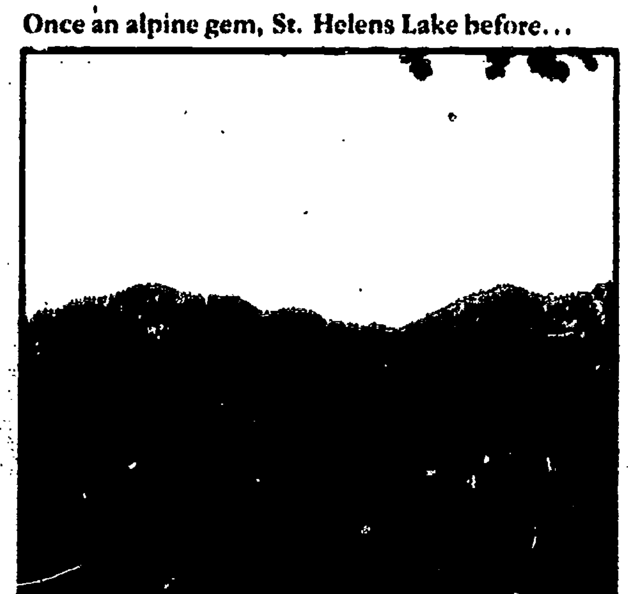


Several miles from crater, a seared, battered and twisted auto testifies to force of volcanic blast.

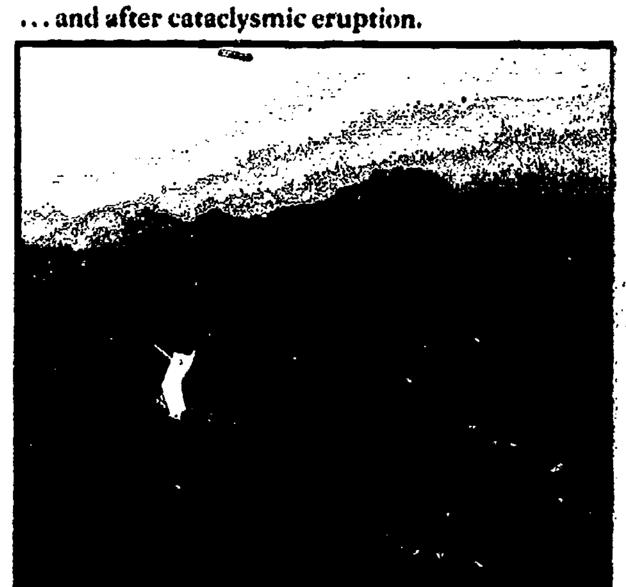


Lava dome rising in smouldering crater may hold secret to volcano's future.

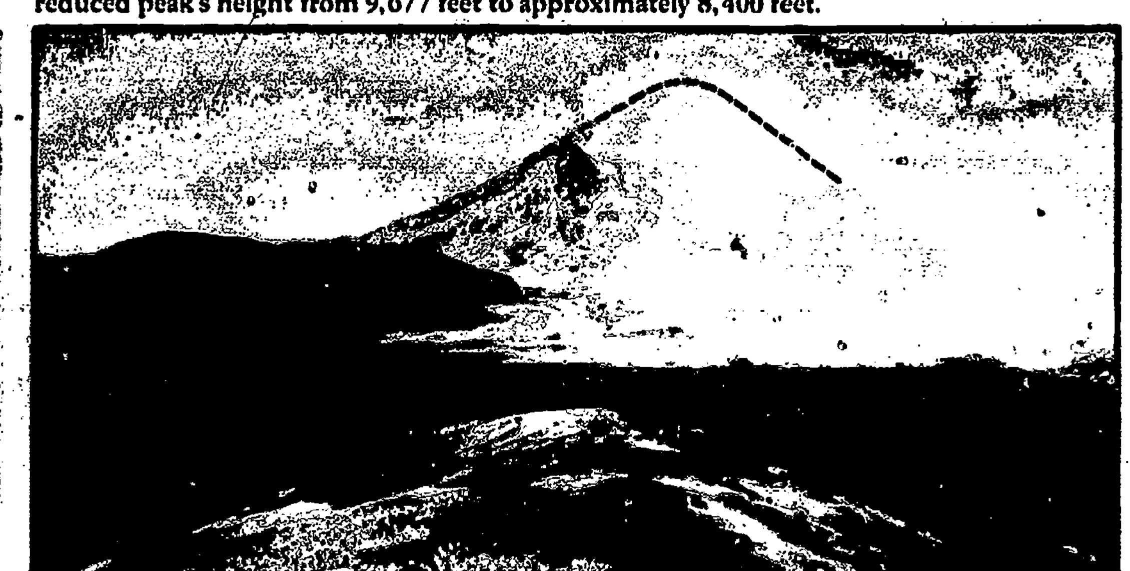
Once an alpine gem, St. Helens Lake before...

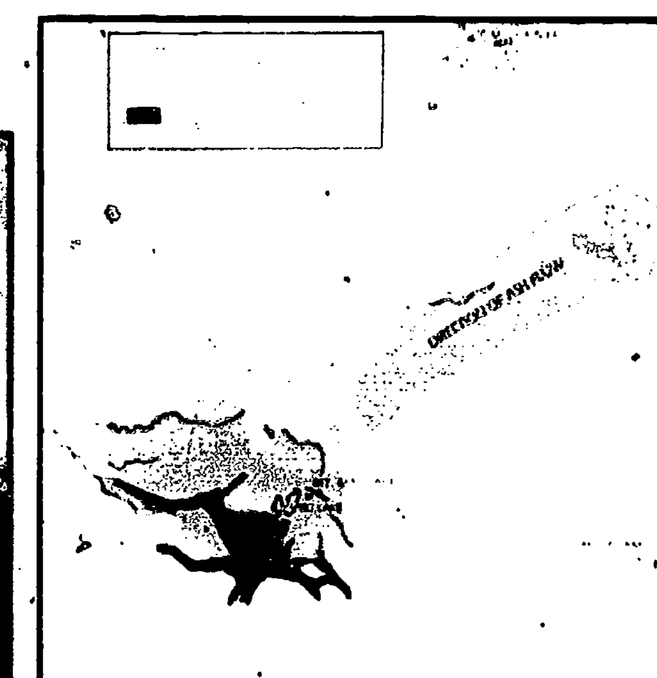


... and after cataclysmic eruption.



Dotted line indicates former profile of Mount St. Helens, as viewed from north. Eruption reduced peak's height from 9,677 feet to approximately 8,400 feet.





Mount St. Helens stands on, and partially conceals, the eroded remains of an earlier volcano active between 2,500 and 40,000 years ago. The mountain we see today has been formed over the last 2,500 years. Most of the upper part of the cone was built only 350-400 years ago.

Mount St. Helens is known as a "strato" volcano. It is composed of lava flows and fragmented material of pumice and other debris. A cross-section would reveal alternating layers of lava, ash, and rock debris.

Caves known as lava tubes are found within some lava flows. These are formed when a crust develops on the surface of a fresh stream of lava. When the lava flow subsides, the molten material drains away, leaving a hollow tube or cave. Ape Cave and many other smaller caves in the lava south of Mount St. Helens were formed this way.

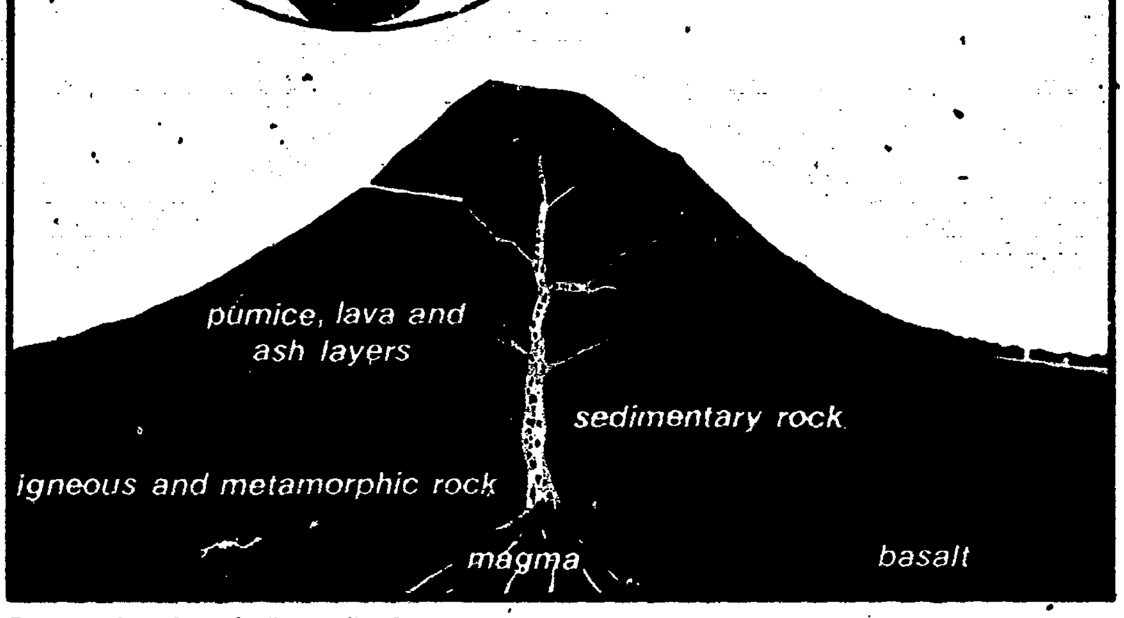
Geologists know Mount St. Helens has had periods of volcanic activity alternating with periods of relative calm. Around 1800, a dormant period of about 150 years was broken by a voluminous pumice eruption. Mount St. Helens was then intermittently active until perhaps as late as 1857. Newspapers of that period carried eye witness accounts of these eruptions, which were especially frequent in the 1830s and 1840s. Whether or not the 1980 activity will continue for as long a period of time is not known.

Earthquakes have been a regular feature of Mount St. Helens' volcanic activity. The first quake signaling renewed volcanic activity occurred on March 20, 1980. During the next 8 weeks, nearly 3,000 quakes were recorded with a magnitude of 3.0 or greater on the Richter Scale. Of these, over 371 were greater than 4.0 magnitude, with the largest one measuring 5.1.

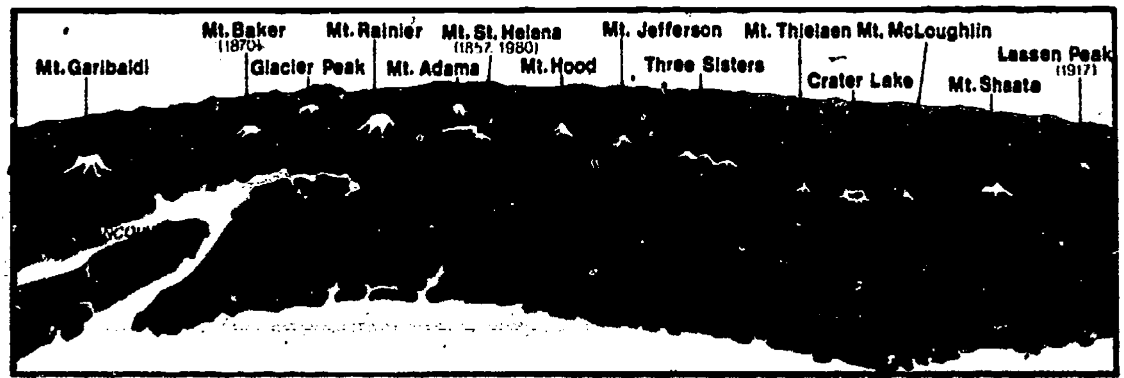
On the Richter Scale, earthquakes are measured on a scale of 0 to 9.0. The magnitude number relates to the total energy released by an earthquake at its source. An earthquake of magnitude 4.5 or more is capable of causing some very local damage; one of 6.0 or more can be very destructive.

Here is a sample reading of Mount St. Helens' earthquake activity recorded on a seismograph. The magnitude of the quake is measured by how long it lasts on the horizontal line, not by how much the line moves vertically.

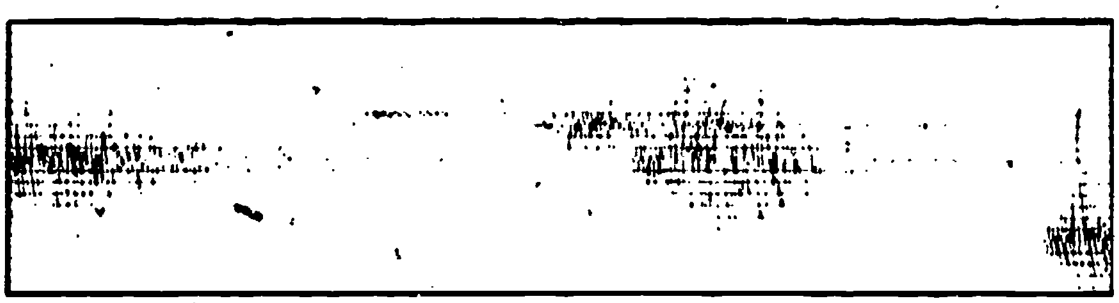
Mount St. Helens is part of a circle of known active volcanoes surrounding the Pacific Ocean. This circle of volcanic activity is known as the "Ring of Fire."

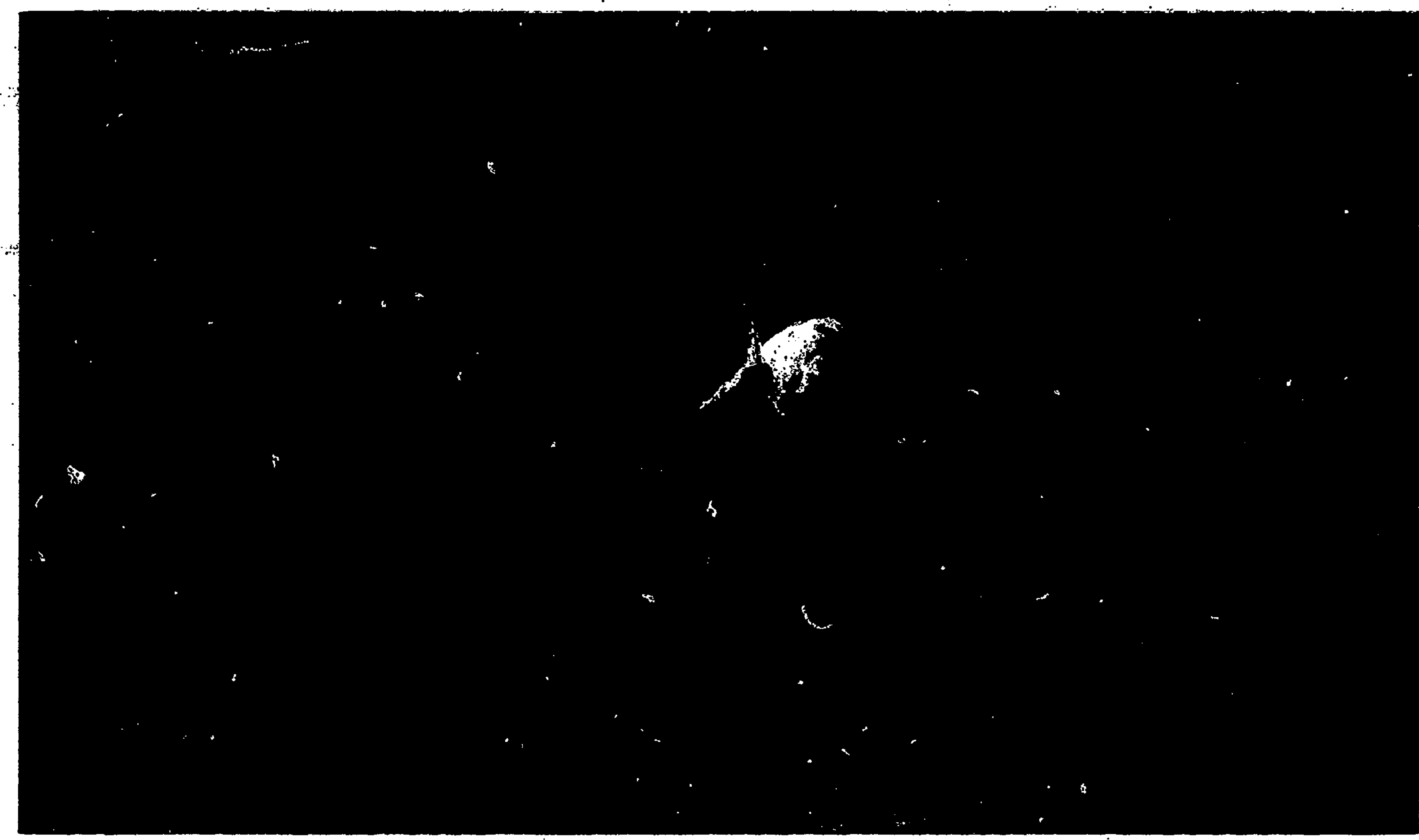


Cross section view of a "strato" volcano.



Major volcanoes of the Cascade Mountain Range.





Canadian artist Paul Kane witnessed Mount St. Helens volcanism in 1847, and later produced this painting of fiery night eruption watched from the west by awed Indians. Original painting hangs in Royal Ontario Museum, Toronto, Canada. Reproduced by Museum permissi

Northwest Indians told early explorers about the fiery Mount St. Helens. In fact, an Indian name for the mountain, Louwala-Clough, means "smoking mountain."

According to one legend, the mountain was once a beautiful maiden, "Loowit." When two sons of the Great Spirit "Sahale" fell in love with her, she could not choose between them. The two braves, Wy'East and Klickitat, fought over her, burning villages and forests in the process. Sahale was furious. He smote the three lovers and erected a mighty mountain peak where each fell. Because Loowit was beautiful, her mountain (St. Helens) was a beautiful, symmetrical cone of dazzling white. Wy'East (Mt. Hood) lifts his head in pride, but Klickitat (Mt. Adams) wept to see the beautiful maiden wrapped in snow, so he bends his head as he gazes on St. Helens.

Mount St. Helens received its present title from Captain George Vancouver, a British explorer, in 1792. Captain Vancouver named the mountain "in honor of his Britannic Majesty's Ambassador at the Court of Madrid," in October of that year as he viewed it from his ship at the mouth of the Columbia River. Baron St. Helens served as the British Ambassador to Spain from 1790 to 1794.

Volcanic activity can change drastically within a few minutes. Potential hazards include ash fallout, rapidly moving flows of mud (melted snow and ice mixed with ash), and "pyroclastic flows" made up of hot gases and lightweight volcanic particles such as pumice. These pyroclastic flows may skim along the mountain's surface like an avalanche. If caught in a heavy ash fall, make a face mask of cloth to filter the ash – it will be most effective if dampened. Many of the May 18 fatalities resulted from suffocation because fine ash filled the lungs.

Please keep informed of possible danger. Pay strict attention to all regulations. Be prepared to leave the area quickly if you notice threatening volcanic activity or if you receive word from the Forest Service or other government authority.

The Mount St. Helens Geological Area is part of the Gifford Pinchot National Forest, USDA, Forest Service. As one of 15 special Geological Areas in the National Forest System, it is being managed for public enjoyment and scientific study. Through visitor centers near Toledo and Ridgefield, Washington, the Forest Service offers information and interpretive programs to help you understand the special features of Mount St. Helens.

The goal of the Gifford Pinchot National Forest is to provide you an enjoyable and safe visit. Your cooperation will make this goal possible.

Further information may be obtained from:
Gifford Pinchot National Forest
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Vancouver, Washington 98660
(206) 696-7500

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READING THE ROCKS

Formal Objectives

Students will:

- understand the formation of sedimentary, igneous, and metamorphic rocks by making models and comparing samples.
- learn how rocks change by explaining the rock cycle.
- differentiate among rocks and minerals by sorting samples.
- understand soil composition by comparing soil types.
- understand the process of weathering by observing rocks and tombstones.
- learn how the landscape was formed by observing different landforms.
- become aware of the problem of erosion by doing a soil table experiment.

Informal Objectives

Students will:

- understand the earth is always changing.
- sort out and identify a bag full of 10 different rocks.
- on the trail, observe examples of weathering, soil formation, erosion, glaciation, and identify various boulders.
- visit the gravel pit to observe rocks and the operation.
- enjoy the outdoors.

Indoors

Welcome the group. Introduce yourself and the Dahlem Center. Preview with the students what they will be doing on the field trip and review and extend these concepts:

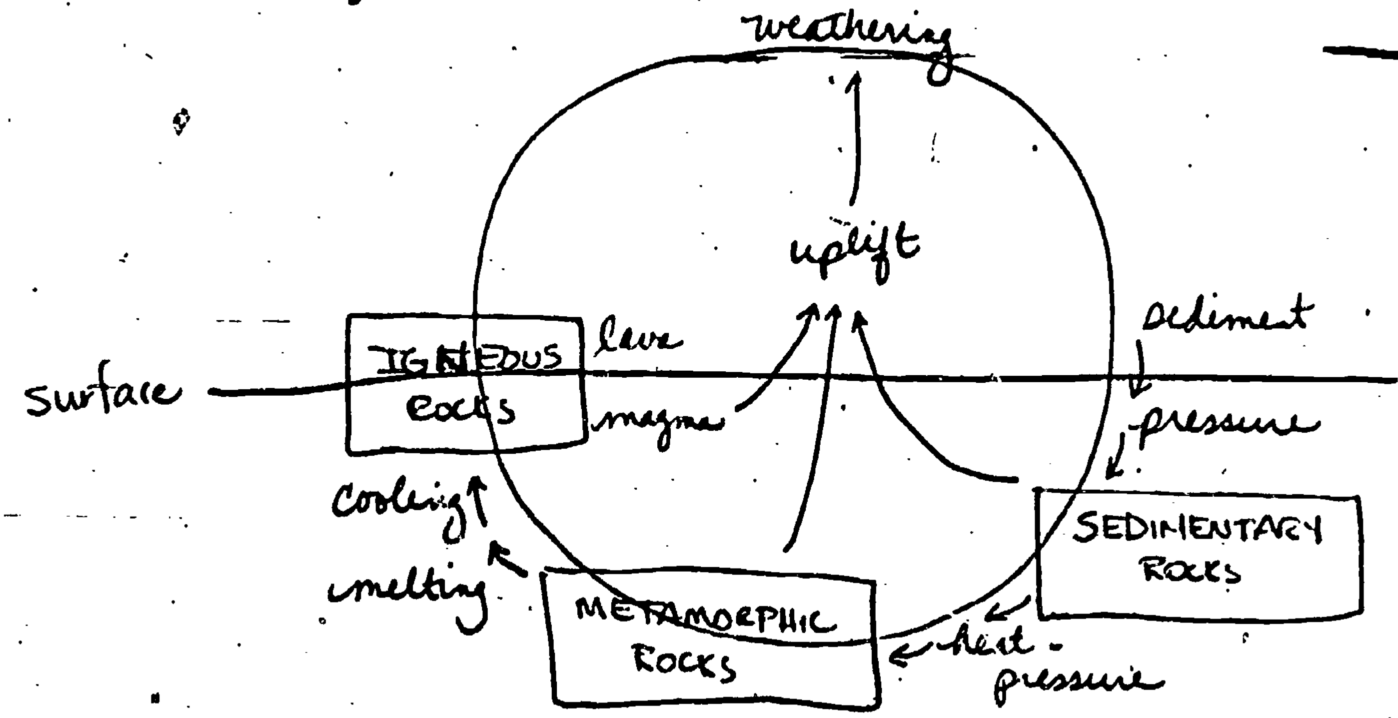
1- Rocks are made of minerals. Show examples of each.

2- Rocks are grouped into 3 classes. Explain how to identify sedimentary, igneous, and metamorphic rocks.

Divide the class into 10 groups. Give each a bag of rocks and ask them to sort the contents into 2 piles -- rocks and minerals. As you give them the proper division, review the three rock classes.

Then ask them to match each mineral to a rock in which it can be found. Prop up the rock/mineral key and go over the answers.

3- The earth is constantly changing, including rocks. Explain the rock cycle as you draw it on the board. Start with rocks weathering into sediment.



Crustal movement around the globe allows for rocks above and below the surface to change places.

Show them the map of the Atlantic Ocean floor to point out land formation and perhaps some plate tectonics theory, if you are up to it. Hint about the exciting section of the post-trip activity packet on the eruption of Mt. St. Helens, too.

Outside

At many places along the trail, you can discuss weathering:

rocks with cracks
lichens and moss on rocks
physical weathering processes
stream, rain, ice, etc.

By adding organic material (rotting and living plants and animals) to the bits and pieces of rock (sand and minerals), you get soil. Compare a variety of soil types, and discuss the benefits of fertile farmland, etc. Point out examples of erosion (displaces soil carried by wind or water) and the problems of "runaway" soil around the world.

> "The world's soil is eroding ar a rate of 2.27 million tons per year. If we were trying to accomplish this massive transport of soil, every man, woman, and child in the world would have to load 1,375 pounds of

soil each year, deliver it to the nearest body of water, and dump it in... In the U.S. soil erodes at an average rate of 9-12 tons per acre per year."

Cousteau Almanac, page 394

Use the following list of boulders along our trails to quiz the kids on rock classification.

Remind the group of glacial activity and explain the formation of wetlands, rolling hills, and the Great Lakes.

Use the stream and the hole in the ground to introduce the concept of a water table and discuss the hazards of chemical pollutants in the ground water supply. How would they feel if they couldn't drink the water in their homes?

At The Pavilion

Use the three soil boxes to do the soil erosion experiment. Have students pour an equivalent amount of water at the top of the boxes and compare the water that runs off at the bottom. Where is the greatest and the least amount of erosion and why? Through which box did the water flow faster? This illustrates one of the most fundamental principles of soil conservation: a grass or mulch cover protects soil from pounding rain and running water, holding it in place even on a slope.

"On one plot where corn had been growing every year for 6 years the annual soil loss was 89 tons per acre. On a plot in bluegrass sod, however, the annual soil loss was only .2 tons per acre."

Teaching Soil and Water Conservation, p 13.

Trips

If you have time to hike to the cemetary at the South Jackson Community Church, take along a weak hydrocloric acid solution, and compare the weathering rates of granite, sandstone, and limestone tombstones. Why would these rocks weather differently? The acid makes limestone fizz.

If the class is going on to the gravel pit, it will take 15-20 minutes to drive to Bundy Hill. A gravel guide's fact sheet should be forthcoming!

DAHLEM'S BOULDERS

1 At the end of the Arboretum boardwalk, on the right, in the shrubs in a light-colored igneous rock. It is composed mainly of feldspar minerals and the black hornblende minerals. It crystallized deep underground from a large volume of magma, molten rock. It was then uplifted, eroded from the Canadian landscape, and moved here by glacial ice.

2 In another few feet there are two rocks by the path and in the creek. The light-colored rock is probably igneous, similar to the first rock. The second, the darker, appears to be sedimentary--sandstone or siltstone. It has a nice coating of iron oxide which has been weathered from within the rock.

Lichen and moss are living on the rock. Lichen actually "eat" the rock by excreting carbonic acid, forming soil. Moss lives in that soil. Plants grow in soild that has lodged inside the cracks in the rock. As plant roots and stems grow, they continue to break the rock into smaller pieces: sediment.

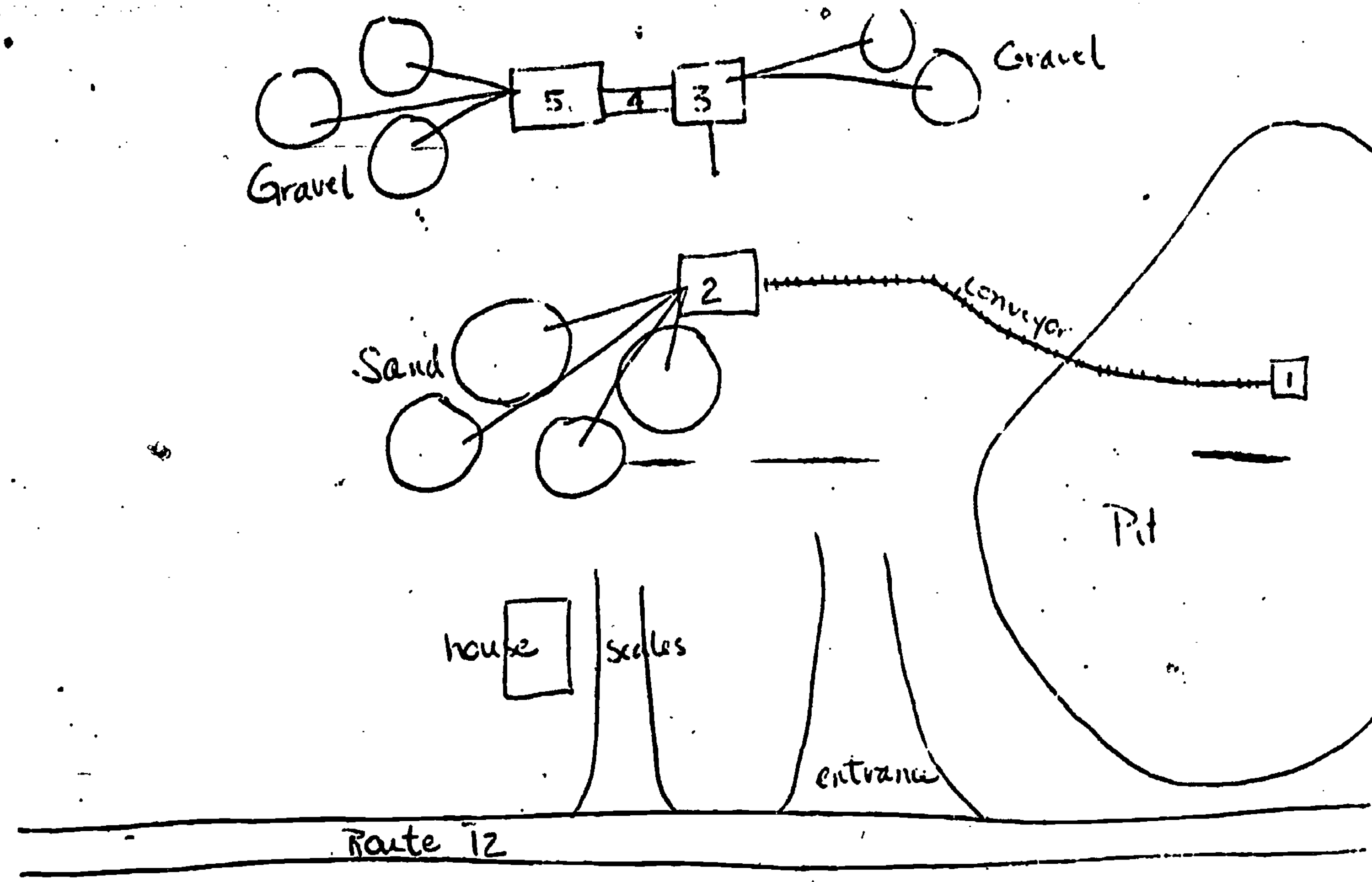
3 The creek has a sandy bottom. Water moves sand through the creek, downstream and eventually into Vandercook Lake.

4 Near the old anthill is an igneous rock.

5 Where the path enters the woods are two rocks. The left, pinkish, is granite, an igneous rock. The right, grey-blue, is metamorphic, quartzite. It has no visible minerals.

6 At any boardwalk, you can mention that the Jackson landscape is rather young -- deposited during the last glaciation, only 20,000 years ago. Because of its youth, rivers have not developed sufficiently to drain the land. Therefore, rain falls ont he hills around the ponds, soaks into the ground, and accumulates is depressions -- ponds or wetlands.

7 The very large grey-green boulder on the far side of the field where the path heads over to the pine woods is an igneous rock called gabbro. The white specks and white lines are mineral crystals, probably feldpar. The polished red areas on the side of the rock are iron oxide minereals which formed by weathering along a fault in the rock. The fault moved, hardening and polishing the oxides. Subsequently, the rock was removed from Canada and left here.



Michigan Aggregates Bundy Hill

1. Trucks haul a nearly pure mixture of sand and gravel from the working area in the pit to the beginning of the conveyor belt. The trucks dump their load by opening the bottom of the truck. Each carries about 40 tons. Rocks larger than 8" are crushed.

2. The first contraption separates the sand from the gravel with 2000 gallons of water per minute at a rate of 500 tons an hour. The sand is flushed into 4 piles according to size and the water is pumped to a holding pond and recycled. The gravel drops to the ground where it is fed to an underground conveyor which carries it up to the second separator.

3. Here the gravel is processed at 250 tons per hour where it is crushed, sorted by size--4 , and sorted by density--5 .

4. A rotating cone in a tank crushes the rock larger than 4" in diameter into smaller pieces, down to 3/8".

5. Carborundum is added to water to raise the specific gravity of the water from 1 to 2.5 so that most sedimentary rocks will float and the more dense igneous and metamorphic rocks will sink. The denser rocks can be used for concrete roads -- light rocks cause the roads to crack faster. The carborundum is salvaged for reuse before the water is pumped off.

- Sand is used for masonry, asphalt, and cement.
- Gravel is used for landscaping, concrete, drainfields, and asphalt.
- The hill originally was 1364 feet high - the highest point in Michigan. That was 200 feet and 31 years ago.
- There is 100 feet of gravel still below the surface.
- They close in cold weather because the belts freez up.
- Two wells are 245 feet deep.
- The sand and gravel was left here by a lobe of the Wisconsin glacier, which advanced 2 - 3 miles south of Bundy Hill.