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ABSTRACT
"Rocks" is a prototype kit of rock specimens, demonstration materials and activities for 5th and 6th grade classes to use over a two-week period. It is designed to allow students to discover that rocks were not always the same as they are today, that rocks contain clues to the changes they have undergone, what life on earth was like thousands of years ago, and forces that have been at work in nature. The box is divided into 5 phases; each phase designed to take about an hour of class time to complete. The teacher's guide section for each phase lists the rock specimens under consideration in that phase, outlines procedure for the activities, and points out the kinds of discoveries the children should be making. It also includes questions that the children should be able to discuss as a result of their experiments. Suggestions are offered for activities to follow up after the box has gone. Supplements include a bibliography, an inventory of the box, and a short descriptive note about the MATCH Box Project. (JY)

The Children's Museum

60 Burroughs St, Boston 30, Mass. 524-1550

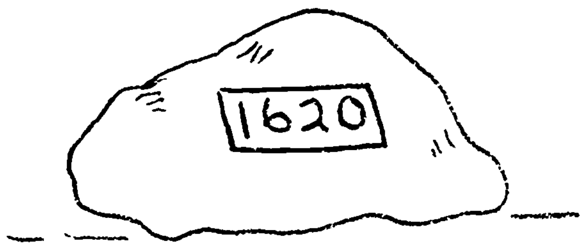
ROCKS

THE MATCH BOX PROJECT

Materials and Activities for Teachers and Children

The material in this publication was prepared under a contract with the United States Office of Education as authorized under Title VII, Part B, of the National Defense Education Act, 1958.

YOU CAN READ THE STORIES
THESE ROCKS TELL



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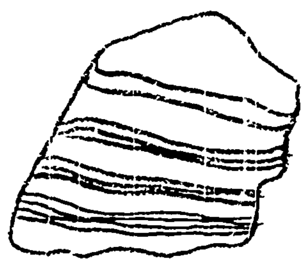
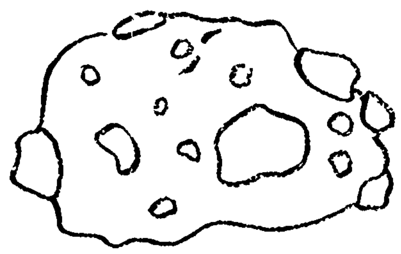




By
Genevieve R. Keating
Marion B. Carey
Ronald J. Kley

TEACHER'S GUIDE TO THE

ROCKS

MATCH Box

Grades 5-6

Prototype Edition

CONTENTS

ABOUT THIS BOX

WHAT IT IS

ROCKS is a prototype kit of rock specimens, demonstration materials, and activities for fifth and sixth grade classes to use over a 2-week period The aim of the Box is not to make geologists of the students. Rather, it should lead them to realize that the rocks they see were not always the same as they are today, and that the rocks themselves contain clues to the changes they have undergone, how they were formed, what life on earth was like thousands of years ago, and forces that have been at work in nature.

HOW IT WORKS

The Box is divided into five phases, color-coded to facilitate distribution of materials. The first three phases deal with sedimentary, igneous, and metamorphic rock. The fourth phase studies fossils. In the last phase, the class tries to decipher some unidentified specimens by applying the previous days' experience.

Each phase will take something over an hour of class time to complete. It is up to you whether you can complete the entire phase on one day, or whether you wish to spread it over two or even more days.

The activities will be more meaningful if they are done in the order given here, as the sedimentary rock phase begins with things the children can see with no previous rock experience, but the subsequent phases build on the earlier activities.

HOW TO PROCEED

For most activities, the class is divided into four groups, and each group works with identical sets of materials. You may wish to allow groups to proceed independently to the next activity, or you may want them all to change at the same time. In some cases, each group will have to take turns using a set of materials. For the two movies and the teacher-demonstrated classroom volcano, the entire class will watch together.

HOW TO PROCEED

Each activity is a demonstration of a geological process related to the rocks that are being studied. A series of questions is given at the end of each phase. Children should attempt to discuss these, using their experience as "evidence'.

The Teacher's Guide section for each phase lists the rock specimens under consideration in that phase, outlines procedure for the activities, and points out the kinds of discoveries the children should be making. It also includes questions that the children should be able to discuss as a result of their experiments. In addition to the instructions you as teacher will be giving to the children, the students are provided with cards of step-by-step instructions for using the materials in each activity packet. Each packet contains supplies for one experiment, and the cards are attached to the packet. Copies of these instructions are also included in the Teacher's Guide.

These are the rocks to be examined in the Sedimentary Rock phase:

CONGLOMERATE — A rough textured rock made up of smooth, fairly large pebbles

SANDSTONE — A finer textured rock that feels like sand; it is actually made up of sand grains and its color can vary depending on the color of the sand and other substances in it

LIMESTONE — A solid, heavy rock made up of whole shells of sea animals imbedded in a mass of smaller particles

COQUINA — A very rough, loosely cemented, light colored rock, made entirely of broken pieces of shell

SHALE — A fine textured, almost slippery rock, with smooth flat surfaces, made up of tiny flakes of clay or mud

SEDIMENTARY ROCK

The first phase of the Box deals with sedimentary rocks, and how they are formed. These rocks are the ones that are made up up of sediments -- small particles of matter, usually fragments of other rocks -- and compacted into rock, in most cases at the bottom of a quiet body of water. Five different types of sedimentary rock, each made up of a different kind of sediment, are included for the children to investigate. The rock specimens, and the materials for demonstrations or experiments, are all color-coded with blue markings.

After examining the rock specimens and trying the various activities, the children should be able to answer or discuss intelligently the problems posed at the end of this phase. Their opinions will be based on their observations and experiments, and they should be able to point out to classmates which experiment supports any statement they make.

These are the activities associated with sedimentary rock. They are designed to help children visualize what happens to these rocks in nature:

Synthesize Rocks

Children carefully examine a rock specimen to figure out what it's made of. From packages of different types of sediments, they then select those which make up the rock specimen, and mix the sediments in a paper cup. This is done for each of the five rocks, and should give the children a realization that the particles making up the specimen rocks were once unconsolidated.

Breaking Down Rocks

Children take turns breaking a piece of rock with a geologist's hammer, to make them realize that solid, hard rock can and does break. They should speculate on what natural forces would break down rock.

Children then file a notch or corner from one of the broken pieces of rock. This should give them an idea of the great amount of force, and especially time, that it takes to wear down rocks. The fine filings produced should make children realize this is how sand and soil are formed.

Some broken rock fragments are shaken together in a covered container to simulate the way rock gets worn into smooth pebbles in a river or on a beach. One fragment can be kept out, to compare it with those that have been tumbled and worn. Here also, fine particles, or sand, forms.

Children drop a small piece of coquina into some vinegar, and watch the rock dissolve into shell fragments. In nature, many materials, including acids like vinegar, and even plain water, work to dissolve rock.

Sediment Tank

Children sprinkle sand, pebbles, shells, etc. into water to see how layers of rock form. The tank can be left to settle over night, and the solidified rock removed.

These are some questions the children should now be able to answer:

Why are sedimentary rocks sometimes called "second-hand rocks"?

If there are sedimentary rocks near your home, what does this tell you about conditions in the distant past?

How long do you suppose it would take for a river to cut a gorge ten feet deep? How could this happen fastest?

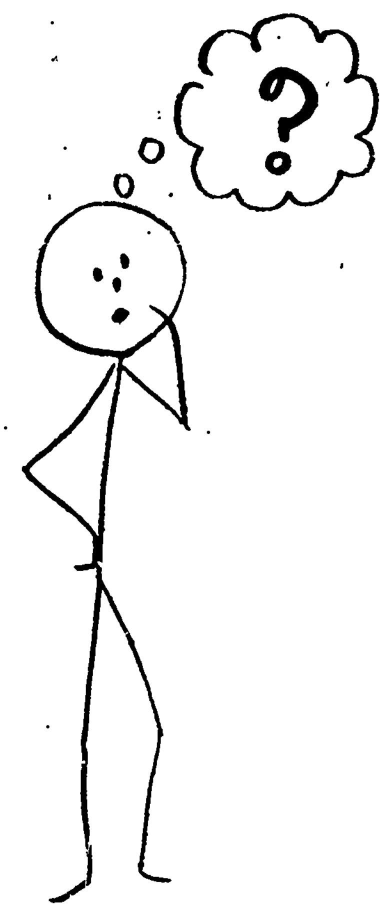
How did your favorite beach form? Is it changing? Could any rock be forming there now? What kind?

Was the rock you hammered and filed a sedimentary rock? Will it ever be a sedimentary rock?

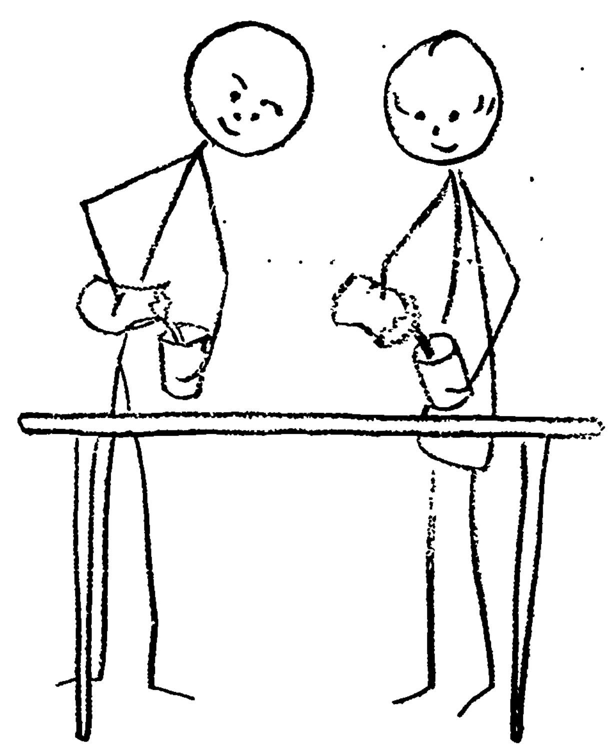
STUDENTS' INSTRUCTIONS

These appear on cards attached to the packet of materials for each activity in the Sedimentary Rock (Blue) phase, and are reproduced here for your information and convenience.

Synthesize Rocks

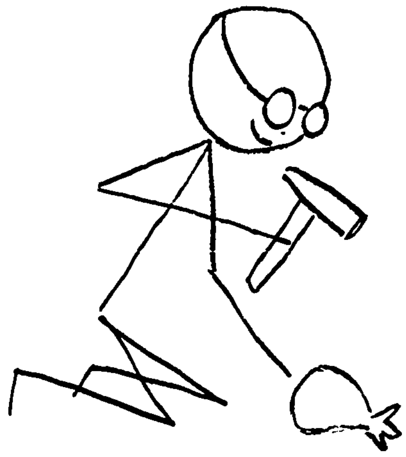


To synthesize (or put together artificially) mixtures of the ingredients in the specimen rocks, do this. Choose a rock. Find the plastic bag containing the material it's made of. Put some in a paper cup. If the rock is made of more than one type of material, make a mixture in the paper cup. Don't forget coloring. Use a separate cup for each of the five rocks. Keep the mixture, dry, to be used later. You'll soon find out how sand becomes sandstone, etc.



STUDENTS' INSTRUCTIONS

Breaking Down Rocks

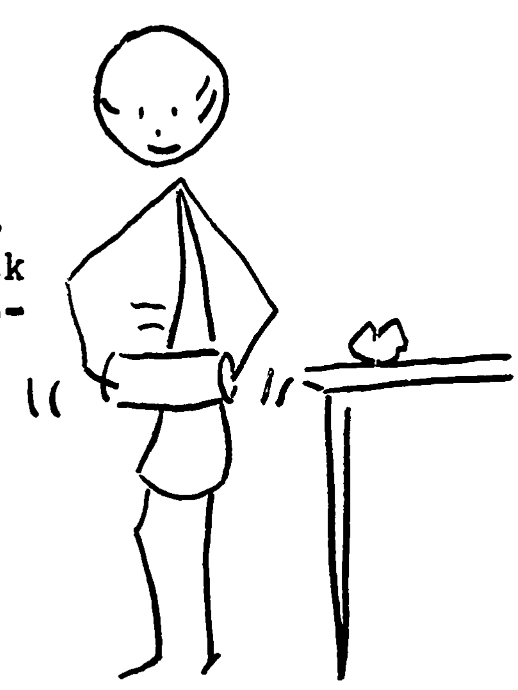


Some of the rock specimens you're working with are made up of small particles of older rocks. But rock seems so solid and permanemt. What kind of force could break it into particles?

- Take the small specimen bag out of the covered plastic cup. In the bag is a piece of granite (not a sedimentary rock). Leave the rock in its bag and hold it against a concrete surface. Put on the goggles and hit the rock with short strokes of the hammer. Break it into about six pieces.
- Next, take the largest piece and see if you can make a notch in it with the file. Or try filing off a corner. File over a piece of paper or cloth so you can catch and save whatever is filed off the rock. See how big a pile you can make in five minutes.

  What about the smooth pebbles the conglomerate was made up of? How did they get worn down?

- Put all but one of the fragments of granite, made when you cracked the rock, into the plastic cup and put the cover on. Now SHAKE as hard and as long as you want. What would cause this process in nature?
- When you open the cup, compare one of the shaken fragments with the one you kept out and didn't shake. Can you see any difference? If not, shake some more.
- Take a close look to see if there's anything in the cup now besides the granite fragments. What is it?



Sometimes water, and the chemicals in it, work to erode rock by dissolving it. This is easiest to see with a rock like coquina. You will need the packaged specimen of coquina, a paper cup and some vinegar from the bottle your teacher has. The cup should be about 1/2 full of vinegar. Drop the coquina in the vinegar and watch.

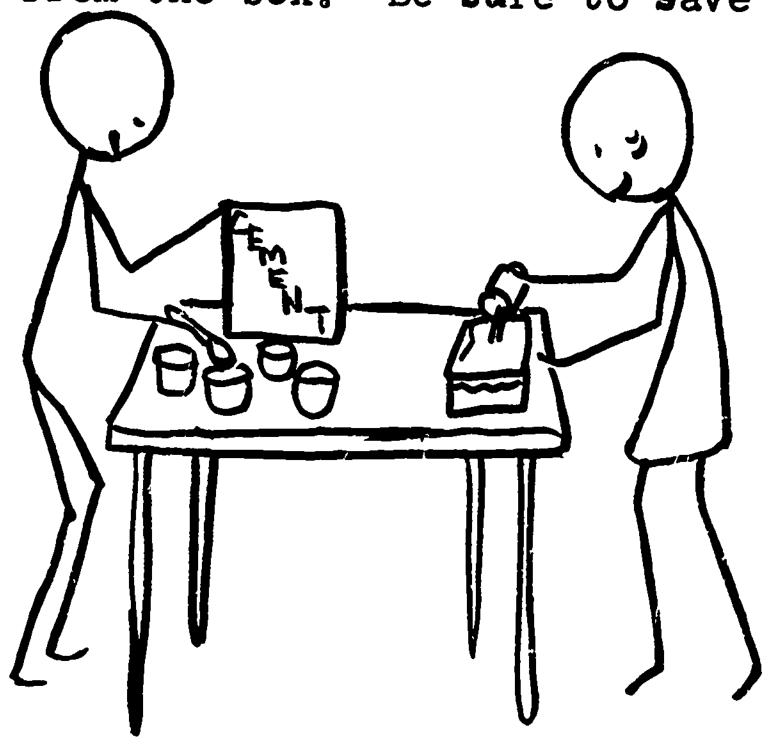
Sediment Tank

STUDENTS' INSTRUCTIONS

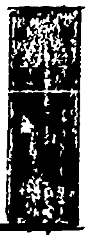
You know that sedimentary rocks are made of various kinds of small particles and you have an idea where the particles came from. But how were they formed into solid rock? What makes the difference between the ingredients you mixed in the paper cups in the first activity and the actual rocks you've been examining?

This experiment isn't exactly the way it happens in nature, but it should give you a pretty good idea of the process.

- You'll need the clear plastic box, the mixtures from the activity on synthesizing rock, the small plastic bags of cement and plaster of Paris, and PATIENCE. Do not remove the plastic liner from the box.
- Mix some dry cement or plaster of Paris -- about a spoonful -- with each cup of your mixture.
- Fill the box about 1/4 full of water.
- Sprinkle one of your rock mixtures over the water and watch it sink. Wait until every bit has disappeared from the surface and sunk to the bottom.
- Now add another layer. Wait again before continuing. Keep this up, letting each layer settle until all the mixtures are used. The order of layers is important.
- Let the box stand overnight (IN NATURE IT TAKES A FEW THOUSAND YEARS) and then pour off any remaining water. You can then carefully remove the "rock" from the box. Be sure to save it.



These are the rocks to be examined in the Igneous phase of the Box:



PUMICE

A gray, lightweight rock formed while steam, gases, and bits of magma-cooled-to-ash were thrown from a volcano. It's full of air bubbles left when the gases escaped.

LAVA

A dark, bubbly looking rock formed when hot magma was flowing over the ground. Often it cools in such a way that you can see the direction in which it was flowing.

OBSIDIAN

A black, glassy rock formed on the skin of a rapidly cooling lava flow. The magma in this case cooled too quickly for any crystals to form.

BASALT

A dark, fine grained rock that formed by cooling quite rapidly, usually on or very near the earth's surface. Often it forms directly under the obsidian "skin".

GRANITE

A coarse grained rock containing crystals of different-colored materials, usually black, white, and transparent. It is formed as magma cools very slowly -- deep under the surface of the earth.

IGNEOUS ROCK

The second (red) phase of the Box is about igneous rocks -- those formed directly from molten magma or melted rock. The magma was melted by heat and pressure far below the surface of the earth, and forms hard rock as it cools on or nearer the surface. The children will work with five types of igneous rock, all of which can be formed from the same magma. The differences in texture, as the activities should show, depend on the speed of cooling, and the speed of cooling depends on the place where cooling happens.

These are the activities that help children visualize the processes that form Igneous Rocks:

Frozen Rocks

The class watches a 16mm sound film that shows rock actually in the process of forming. This is igneous rock cooling and hardening from molten magma which has forced its way to the surface of the earth.

Crystal Former

Children experiment with a device that forms solid crystals from a melted substance, in order to compare this with the crystals found in some igneous rocks. They try cooling the crystal former slowly and quickly to see that the faster magma cools, the smaller the crystals are.

Magma Map

Children take turns looking at a transparent cross-section diagram showing where various igneous rocks are formed, and that different textures of rock form from the same magma, depending on the temperature in the place where it cools.

Classroom Volcano

A small pile of chemical is burned, building up a "mountain" of ash, the same way ash from a volcanic eruption builds a mountain of falling pumice. (THIS DEMONSTRATION MUST BE DONE BY THE TEACHER. SEE INSTRUCTION CARD.)

Some questions the children should be able to discuss after completing the Igneous Rock phase of the Box:

How does a volcano build a mountain?

Why does pumice float:

Do all igneous rocks come from volcanos?

How can different kinds of rock be formed from the same magma?

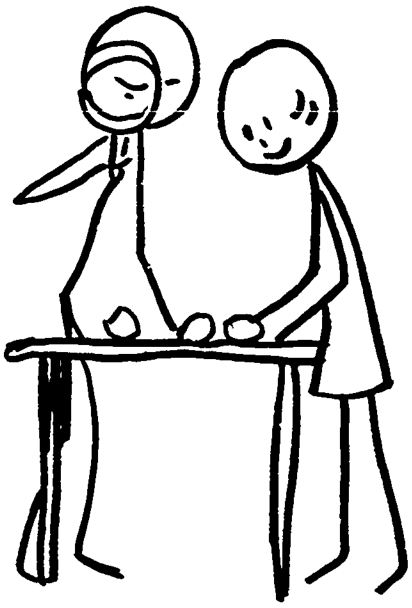
Could you ever see freshly-made rock?

Was there ever a volcano in your neighborhood?

How can there be granite mountain peaks?

Why did we call igneous rocks "frozen rocks"?

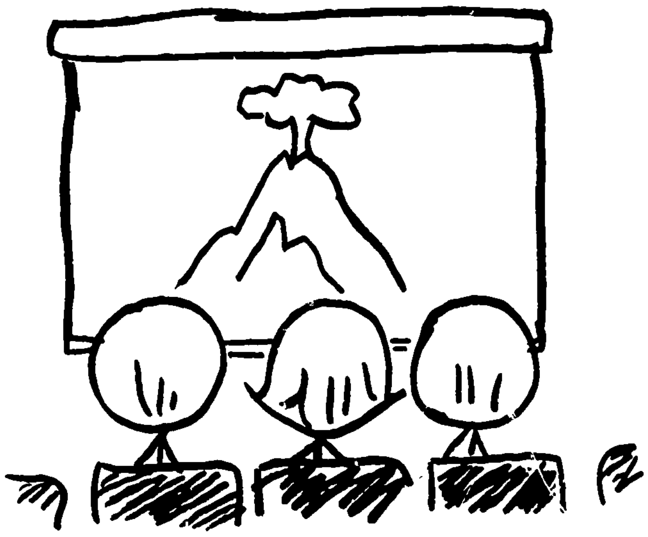
Frozen Rocks



There are five rocks in the specimen bag. Take them out and examine them. In what ways are they different from the sedimentary rocks that you worked with? Do you think these rocks could be sedimentary, or did they form in another way? You will be seeing a film that shows some rock forming. Watch to see if you see rock like any of these specimens. Watch also for clues to why these rocks are different.

These are the rocks you have:
Pumice - A gray, lightweight rock. Do you think it's light enough to float?
Lava - A bubbly-looking rock; can be reddish, brown or dark gray.
Obsidian - A black, glassy rock
Basalt - A dark, fine grained rock
Granite - A coarse grained, grayish speckled rock.

STUDENTS' INSTRUCTIONS

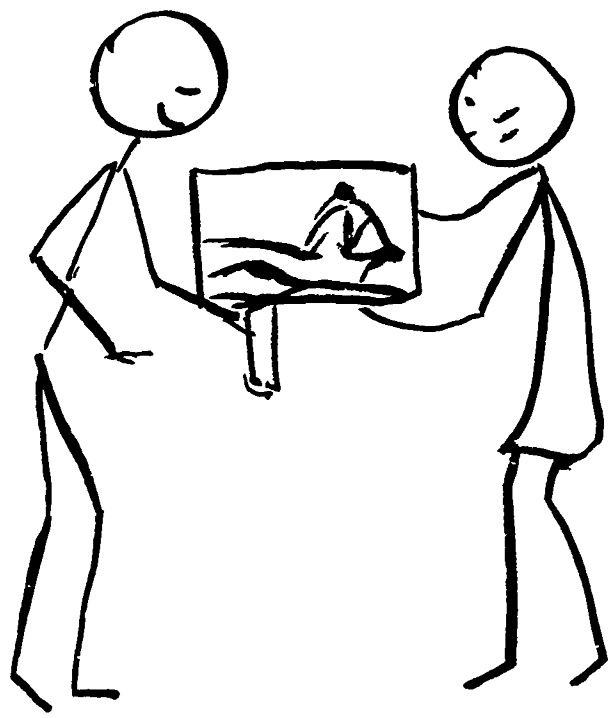


STUDENTS' INSTRUCTIONS

Crystal Former

Look at the crystal forming slide. Does it look at all like granite or basalt? If you hold your crystal former against the small light bulb and melt the substance inside it, you are forming something like liquid rock. Do not allow the whole slide to darken -- just a spot about as big as a nickel. Now watch the slide closely as it cools and hardens or "freezes". This will take a few minutes. Can you see the crystals grow? What happens when you cool it in cold water? In ice? Look at your basalt and granite samples again. Can you read the clues that tell how they were formed? Can you tell why you can't find any crystals in obsidian? (Once the chemical melts it will take two or three minutes for crystallization to begin again.)

Magma Map



You saw how temperature affects the size of crystals in the rock that is formed. But did you figure out why some liquid rock cools faster than others? The Magma Map is a drawing of a cross-section or slice through the earth, from the surface to deep down where the molten magma stays. You can push up the "magma" to see how it fills the cracks in the earth, and can even erupt on the surface as a volcano. Look for the spots where each type of igneous rock forms. Do they all form in the same place? How does the place where granite forms differ from the place where obsidian forms?

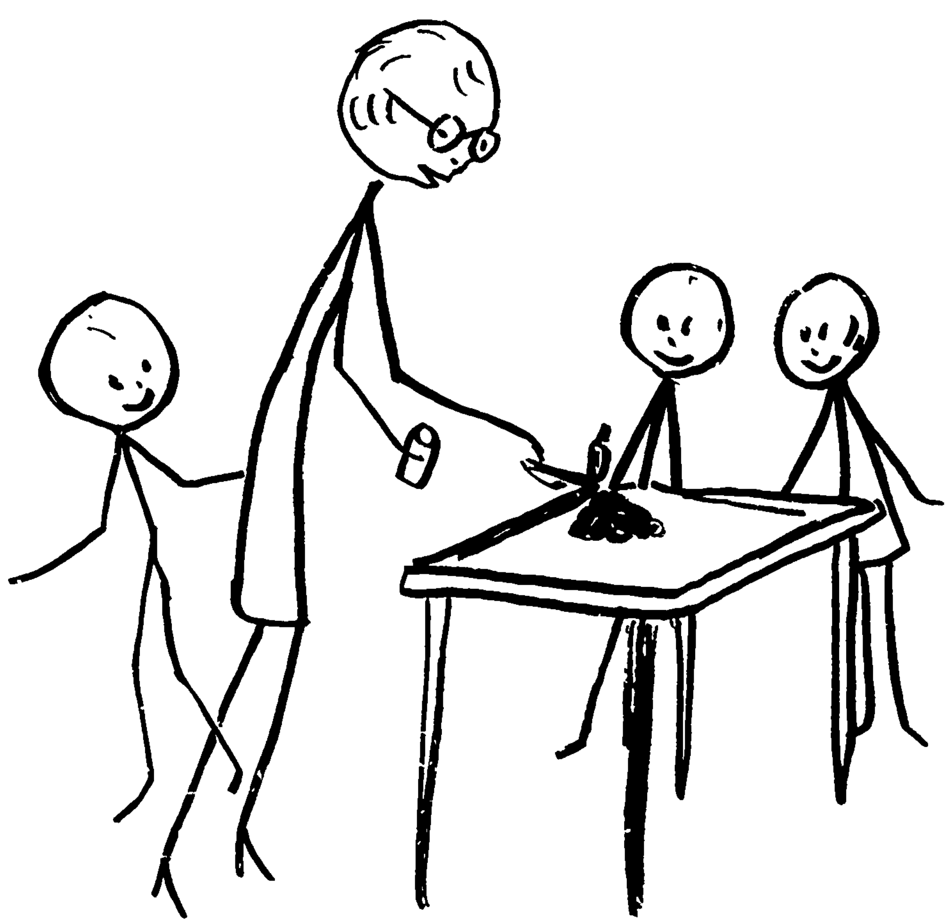
TEACHER'S DEMONSTRATION INSTRUCTIONS

Classroom Volcano

(THIS DEMONSTRATION MUST BE DONE BY THE TEACHER. The chemical, ammonium dichromate will not explode and will not flare up, but precautions should be taken to avoid mishaps. It should be used in a well ventilated room, and the children should NOT handle either the chemical itself or the dust it produces. In the case of contact, immediately flush skin or eyes with plenty of water.)

Spread newspapers on the floor or table to catch the "fallout". Pour the contents of the can onto the metal sheet. Strike a match and light the center of the pile. It smoulders slowly. You may need a second match.

Once the volcano has begun to give off sparks, remove the match and stand back to observe a volcanic mountain in formation. There will be considerable ash formed as the chemical burns. Some of this will fall beyond the metal sheet. The ash is very light and easily disturbed, but you should try to avoid scattering it before all the children have had a chance to see the "mountain", which may even have a crater in the middle.



These are the rocks to be studied in the Metamorphic phase of the Box:

QUARTZITE

A hard but sandy-textured rock formed when the cementing materials in sandstone are replaced by solutions that harden more, under heat and pressure.

GNEISS

A coarse-textured, black and white irregularly striped rock. It is made up of the same materials as granite, and is formed by the heating and squeezing of granite.

SLATE

A dark smooth rock with shiny specks in it. It always breaks into flat pieces. It is formed from shale by great heat and pressure.

FOLDED SHALE

A form of shale which has been squeezed enough to alter its shape, but not enough to metamorphose it into slate by having its particles pressed very tightly together.

METAMORPHIC ROCK

This phase of the Box deals with rocks that have been changed or "metamorphosed" from either igneous or sedimentary rock, by heat and pressure, to the point where the original form is no longer recognizable. This phase also deals with some of the forces that metamorphose rock, or that change it to a lesser degree.

These are the activities to help the children visualize how rocks change and metamorphose:

Birth and Death of Mountains

Class watches a 16mm color film on "Birth and Death of Mountains" to see forces that change rocks by building mountains and by wearing them down. The building forces are folding, faulting, forming domes over expanding underground magma, and piling up volcanic material on the surface. The wearing down forces are ice, wind, and water. Broken-off parts of the rock itself sometimes help wear down rock.

Rocks Before and After

Children match and compare the metamorphic rock specimens with some rocks already studied, to see if they can find which ones are related. Gneiss metamorphosed from granite; quartzite from sandstone, and slate (and folded shale) from shale.

Rocks Before and After

Children press and squeeze sets of clay pellets to simulate heat and pressure changing rocks to a metamorphic form. Different shaped pellets are analogous to different rocks. The round pellets, when pressed together just enough to stick well, are like sandstone. When they are squeezed almost beyond recognition, they are like quartzite -- with a smoother texture, and more solidly compact. The diamond shaped pellets, when pressed so they interlock, are like the crystals in granite. More pressure squeezes the crystals themselves out of shape, as in gneiss. The strips are like the mud or clay flakes in shale, which are pressed tightly together to form slate.

Folding

Groups take turns squeezing a foam rubber model to visualize shale or layered rock being folded by pressure within the earth.

Earthquake

Children bend and break simulated layered rock which they made as one of the sedimentary phase activities. They see which ways the ground can move when there is a fault or crack in the surface.

These are some questions children should be able to discuss after completing these activities:

Can you figure out which of all your rock sepcimens is the oldest?

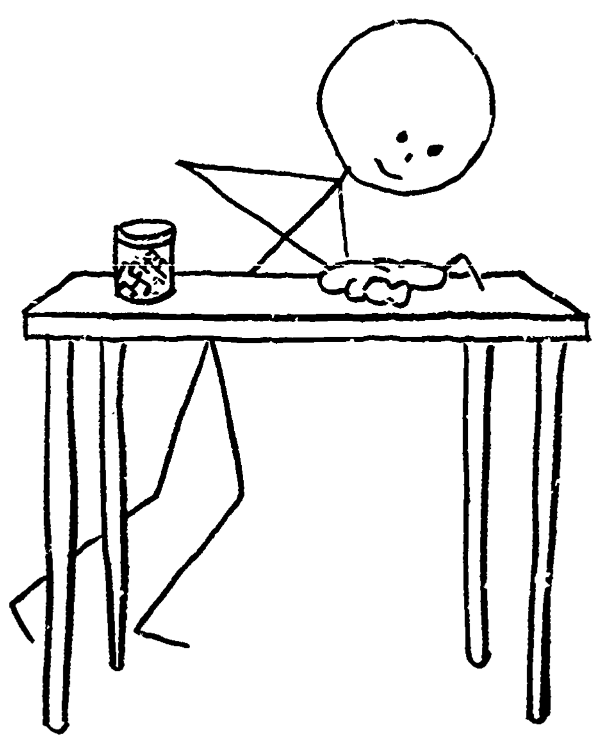
Why wouldn't you want to live near a fault in the earth?

What type of mountain would be the hardest to climb?

Can you think of other ways geologists might classify rocks -- besides the way they formed (igneous, sedimentary, or metamorphic)? How might a non-geologist classify rocks?

STUDENTS' INSTRUCTIONS

Rocks Before and After



Examine the 3 rocks from your purple rock bag. Have you seen any of these rocks before?
Now get your granite (Red), sandstone and shale (Blue) specimens and compare the 6 rocks. There are three pairs here that go together.
Sandstone and quartzite;
Shale and slate;
Granite and gneiss.

In what ways are they the same? Different?

Keep your granite and gneiss specimens out for reference.

Remove the diamond shaped pellets from the plastic bag and watch the pellets as you SLOWLY press them together. Continue until you can see the different colors only as streaks in a mass.

Compare the quartzite specimen with sandstone.

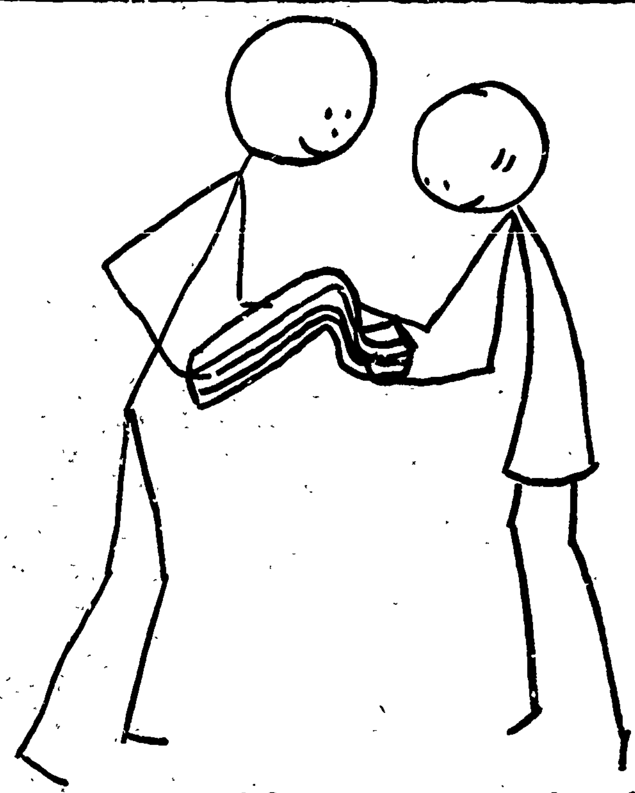
Take the round pellets from the package and press them together as you did before.

Finally, compare slate with shale. Press the packaged clay strips and watch as they flatten.

This shows how heat and pressure within the earth may change or metamorphose one rock into another with different characteristics. The experiment uses the heat and pressure from your hands to change clay pellets to a different form.

STUDENTS' INSTRUCTIONS

Folding

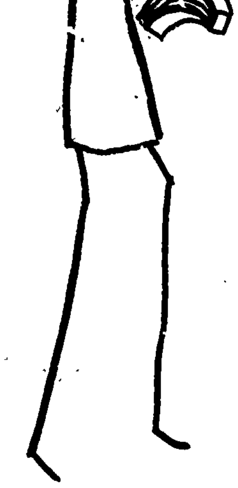


(Each group will have to take turns with these materials.)

The small plastic case holds a specimen of shale with a very wavy surface.

- Look at the specimen, feel it and try to figure out how it got that way. Maybe you can remember something from the film that will help explain it. Which of your metamorphic pairs does this specimen belong with?
- Take the foam rubber model and see if you can make it look like the shale specimen. What did you do to it? Imaging that happening in nature?
- Look at the photographs which show folding on a large scale. These are beds of sedimentary rock (how can you tell?) which have been folded like the shale specimen or the foam model. See if you can find a clue in the picture that tells how large the rock formation is.

Earthquake



Here you will use the layered rock which you made in the sediment tank activity. Think of it as a mile-long section of the earth's surface. Slowly bend the rock in your hands, until it faults and breaks in two. Now that the sides of the fault are separated, see how many ways the ground can move -- up and down, apart, sidways in different directions, etc Where, in your model, would heat and pressure be produced that could change sedimentary rocks to metamorphic?

These are the specimens to be examined in this phase:

DINOSAUR FOOTPRINT

This specimen is actually a reproduction made by Yale University of a slab of shale containing an impression of the foot of a small dinosaur, formed when the animal walked on soft mud.

FERN FOSSIL

This piece of rock actually has in it a "cast" (or impression left when the living organism decayed) of a fern leaf, formed when the leaf was buried in mud that eventually hardened. By the time the rock was cracked open to reveal the cast, the leaf itself had decayed.

GASTROPOD

This snail-shaped rock, a mold, was formed in this way : A snail was buried in mud or clay. The mud hardened and the snail decayed, leaving a snail-shaped space. Water containing chemicals oozed into the space. Eventually, the chemical solution hardened into rock -- and the rock was shaped like a snail.

PETRIFIED WOOD

A piece of a tree, whose living matter was gradually replaced by liquids containing minerals which hardened into rock. Only one area of this specimen has been polished, the rest is the way it was found.

FOSSILS

This phase of the Box deals with fossils -- the remains of plants and animals that lived on the earth in ancient times. Geologists use fossils as clues to the past in several ways, but here we will concentrate on what fossils are, and the three major ways they form in rock: impression, molds or casts, petrifaction.

These are the activities that simulate ways fossils form:

Making Fossil Footprints

The children walk a plastic dinosaur across a wet plaster surface, leaving footprints that will be preserved as the plaster hardens. This shows how the impression type of fossil formed in wet mud that dried and hardened into rock.

Molds and Casts

Children make imprints in plasticene, and fill in the spaces with more plaster, to see how this type of fossil formed after the decay of the animal.

Petrifaction

Groups of children take turns examining a transparent diagram showing how the contents of each cell are replaced by rock-forming solutions, resulting in a plant, shell, or bone that has actually turned to stone.

Some of the questions the children should be able to discuss at the end of the Fossil phase:

In what kind of rock should you look for fossils?

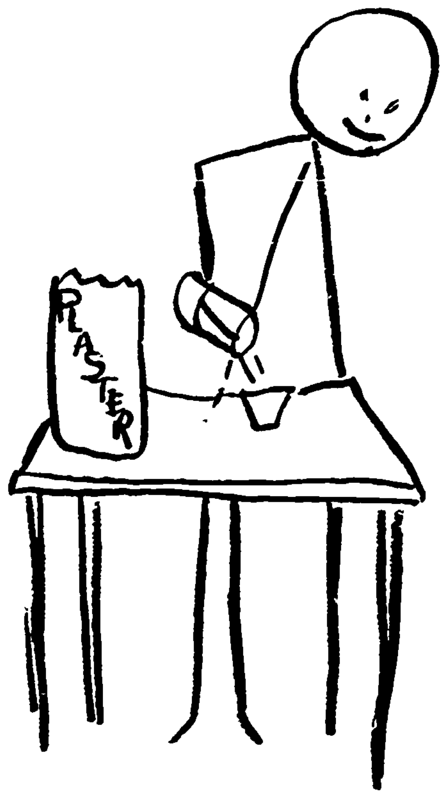
What kinds of animals are most likely to be preserved as fossils?

What conditions of climate and land change are needed to preserve fossils?

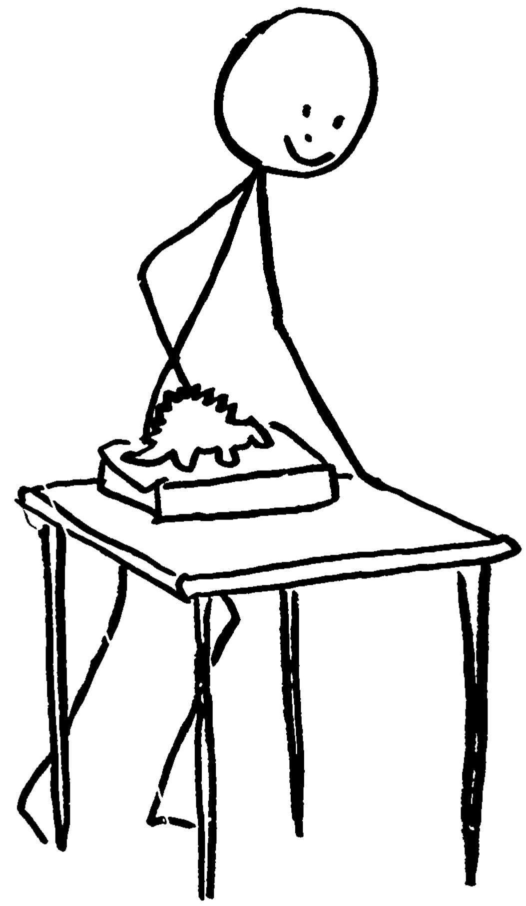
Can you tell what color a dinosaur was?

STUDENTS' INSTRUCTIONS

Making Fossil Footprints

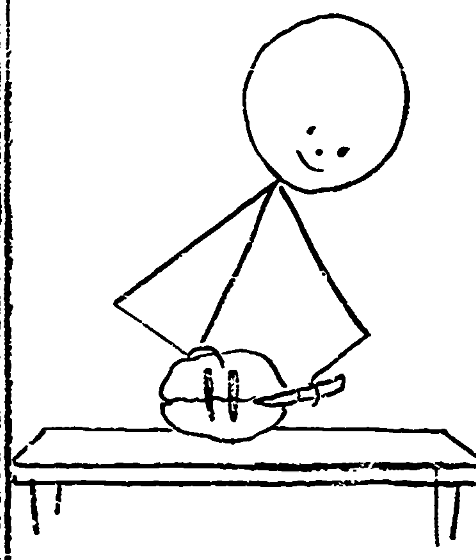


Mix plaster of Paris and a little water in a paper cup. (You can add some coloring material if there is any left from the Sediment Tank supply.) When the mixture is like stiff mud, pour it into the clear plastic tray. Now you can "walk" the plastic dinosaur across the plaster, leaving a trail of footprints. Let the plaster harden, as the mud did, and the footprints will be preserved.



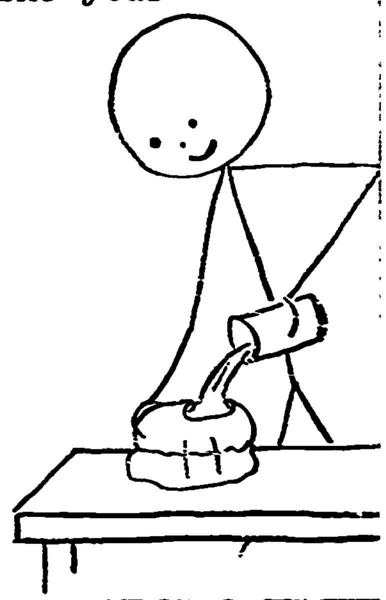
Casts and Molds

STUDENTS' INSTRUCTIONS

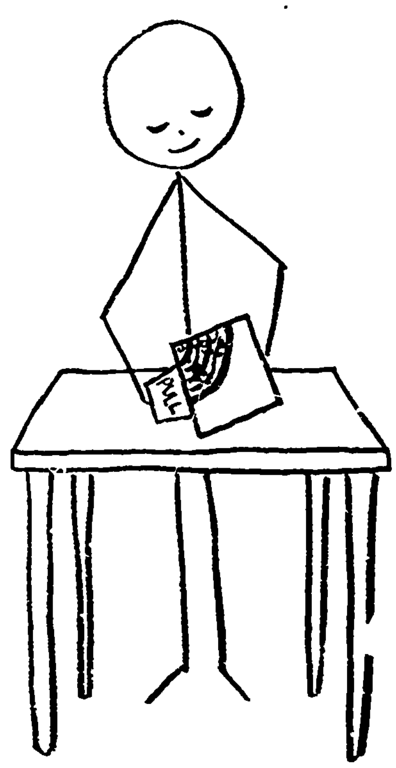


Make two balls of plasticene. Flatten one to a thickness of 1/2 inch and press the shell into it. Cover the shell with the second plasticene ball and press the plasticene down lightly all around the shell. With the knife, make a mark on the plasticene so you can line up the two sections after they have been separated. Make a 1/4 inch hole in the top, deep enough to reach the shell. Now with the knife, cut along the line where the two pieces are joined, and carefully remove the shell. In nature, the shell would decay after the mud hardened around it, leaving a rock mold like your plasticene one.

To make a cast, put the two plasticene halves together. Line up the marks you made in the clay and make sure the hole is on top. Make a thick but pourable mixture of plaster and water in the paper cup and pour it into the hole until it overflows. Let the plaster dry for about fifteen minutes. When dry, car.fully pry the two layers of plasticene apart with the knife and remove the plaster. You have made a cast of the shell, the way minerals hardening in the rock mold would make a fossil cast.



Petrifaction



The petrifaction diagram shows a cross section of a tree which has fallen to the bottom of a pond or marsh. Each cell of the log is filled with living material (green). As you pull the tab at the bottom of the diagram, the green substance in each cell is replaced by orange material -- to show how the living matter in each cell is replaced by minerals that were dissolved in the water. When the minerals harden, the wood is petrified, or turned to stone.

In the final phase of the Box, children are given rocks they have not seen before. They are not given experiments or clues, but are asked to use the knowledge they have gained in other phases of the Box to explain these unfamiliar rocks.

There are five mystery specimens. You can give one to each group of children, saving the geode for the attention of the whole class. You can have each group give a report on its rock, or have the individuals write up their own reports. In any case, the children's deductions can then be compared with a geologist's explanation of each rock.

The children might try to reconstruct the story of each specimen's past : look for clues as to how it was formed, what it's made up of, in what kind of place it was formed, how it was changed since its formation, and so on.

MYSTERY ROCKS

These are the mystery specimens, with the geologist's explanation of each one:

A

This is a sample of sand grains, consisting of tiny pieces of rocks that were worn off mountains or cliffs, carried by wind, water, or possibly a glacier, and deposited on what is now a sandy beach. The particles in this sand are mostly quartz. There are also bits of feldspar, mica, magnetite, hornblende, and other materials, which can tell a geologist what kind of rock the particles came from -- and perhaps how far they were transported. You may want to read the story "Grains of Sand", which is on a card with the yellow phase materials.

B

This sedimentary rock is a sandstone from South Dakota. The layers are clearly defined, of different colors and thicknesses. This rock must have been formed from deposits of sand in a shallow sea or lake. The many colors are different materials picked up at different times by the stream that carried it into the sea. The sea in which this rock was formed eventually dried up, exposing the sandstone.

C

This smooth round rock is a granite cobble, and it was found on the edge of the ocean. By examining it with a magnifier, you can see the crystals, large ones, which were formed slowly, deep under ground. Eventually the covering rock wore away and the granite was exposed. Perhaps it was once on a mountain peak, worn and cracked by weather until it tumbled down the mountain side and was washed into a river. Here it was bounced against other rocks, growing smaller and smoother. The cobble may have traveled thousands of miles before it was picked up on the shore and put in the Rock Box.

D

This rock, which has fossils in it, is similar to the limestone that was examined in the Blue Phase. However, its texture and hardness are different. Perhaps you recall the quartzite that had been metamorphosed from sandstone. A similar process, infiltration by dissolved minerals that then hardened under heat and pressure, has changed this rock from ordinary limestone to "silicified limestone".

E

To read the story of this rough, sandy-textured rock, you'll have to see the inside of it. The teacher or a careful child can hold the rock firmly in the palm of one hand, and hit it, with a short stroke, with a hammer. Or this can be done against a concrete surface. The outside of the rock is limestone, but thi inside is made up of large quartz crystals. Their size means they formed very slowly. In this case, they could not have hardened from hot magma (that would have metamorphosed the limestone), but they solidified from materials that filtered into a natural cavity in the limestone. This formation is called a geode.

AFTER THE BOX HAS GONE

Encourage children to raise and discuss questions which may not have been answered in the course of their Rock Box studies. Where such mutual interchange of ideas does not yield a satisfactory answer, students might be encouraged to consult outside information sources (e.g. library books, museum exhibits, and earth science instructor in a local secondary school, or the department of geology at a nearby college or university.

Enlist student aid in setting up and maintaining a "Rocks Corner" where specimens may be brought in for display and/or identification, and where students may post newspaper items, photographs, or other items of geological interest.

Encourage children to devise and try out their own geological experiments, both at home and in the classroom.

Offer a prize for the best rock collection in the class-- judged on the bases of variety and quality of specimens; neatness, accuracy, and clarity of labeling and general organization; and self-collectedness of specimens.

Maintain a list of places in the local area that are of particular geological interest. (The location of such points of interest can probably be supplied by any of the outside information sources listed in #1 above.) Students who visit any of these areas on their own might be asked to report their observations to the class. Perhaps a class field trip to one or more of these localities might be arranged.

Plan a field trip in the neighborhood to locate evidences of rock weathering.

Encourage children to do some research on their own on such topics as earthquakes, volcanoes, glaciers, geological time, uses of rock.

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ESPECIALLY FOR CHILDREN

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Museum Staff Members who developed the Box:

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Mr. David Pradell, Driscoll School, Brookline

Other Museum Staff members who worked on the Box:

Patricia Cleary
Edward Grusheski
Judy Ulreich
Jeffrey Cole
Duncan Smith
Julie Snow
Jenefer Merrill

INVENTORY

The following items should be returned with the Box:

hammer
goggles
40 magnifiers
empty plastic bottle
two films--- "Hawaian Volcanoes"
"The Birth and Death of Mountains"

4 Blue Rock Bags containing conglomerate, sandstone, limestone, coquina, shale
4 sets of Blue Students' Instructions
4 plastic cups with lids
file
4 rectangular plastic boxes

4 Red Rock Bags containing lava, obsidian, pumice, basalt, granite
4 sets of Red Students' instructions
crystal former
magma map
empty classroom volcano can
metal sheet
light bulb

4 Purple Rock Bags containing gneiss, slate, quartzite
4 sets of Purple Students' Instructions
4 small plastic cylinders
folded rock specimen
dinosaur footprint cast
foam model

2 folding photographs
4 fern fossils
4 petrified wood specimens
4 gastropods
4 plastic dinosaurs
4 small plastic trays
4 Green Students' Instructions
Dinosaur footprint photograph
petrification diagram

1 Yellow Rock Bag containing 5 mystery rocks
1 copy "Grains of Sand"

Teacher's Guide

ABOUT THE MATCH BOX PROJECT

In June, 1964, under a contract with the United States Office of Education, we started the MATCH Box Project at the Children's Museum. The term "MATCH" stands for Materials and Activities for Teachers and CHildren. A MATCH Box contains materials, equipment, supplies and activities that work together to foster the teaching/learning of specific subjects at the elementary school level. The Boxes contain a high proportion of real objects and require little or no auxiliary equipment or supplies from the school. In every Box there is a Teacher's Guide which serves to organize and activate the three-way encounter between the materials, the teacher and the children.

MATCH Boxes are designed for the relatively intensive treatment of a subject over two weeks, and can be circulated among teachers through material resource centers, libraries, museums, AV departments.

As the Boxes are being developed, materials and activities are tried out in the schools. Prototypes are then assembled, evaluated in local classrooms, and revised prior to distribution.

The first five MATCH Boxes, completed in September, 1965, were: GROUPING BIRDS (Grades K-2); THE CITY (1-3); THE ALGONQUINS (3,4); SEEDS (3,4); and A HOUSE OF ANCIENT GREECE (5,6).

The Box described in this guide is one of a second "generation" of Boxes completed in September, 1966: HOUSES (Grades 1-3); ANIMAL CAMOUFLAGE (2,3); NETSILIK ESKIMOS (3,4); MUSICAL SOUNDS AND SHAPES (3,4); ROCKS (5,6); JAPANESE FAMILY 1966 (5,6); and MEDIEVAL PEOPLE (5,6).

A third generation of Boxes will be finished in September, 1967.

Though the Boxes are our most tangible product, we use them and the developmental process itself as a method for studying the role that real materials play in teaching and learning, and as a way of seeking principles by which media may be combined to create effective educational systems.

This Box and this guide are prototypes and will be revised. We welcome your comments and criticisms. Please write to the MATCH Box Project, The Children's Museum, 60 Burroughs Street, Boston, Massachusetts 02130.

Fred H. Kresse
Project Director