Kansas 4-H Geology Leader Notebook

Chapter 3 — Minerals, Table of Contents

Crystal Shapes

Minerals — Geology Level II

What members will learn. . .

About the Project:

- What is a mineral?
- What shapes of minerals come in.
- How to identify a crystal.
- How the molecular structure determines a crystal's shape.

About Themselves:

- What's inside is what is important.

Materials Needed:

- Activity Sheet 16, *Crystal Models*
- Scissors
- Tape or glue (glue sticks are easy)
- Pencils
- Common minerals showing different shapes
- Square children's building blocks
- Magnifying glasses
- Member Handout 12, *Introduction to Minerals*
- Member Handout 13, *Crystal Recipes*; see specific recipe for additional materials
- Member Handout 14, *Crystal Shapes*

Time Needed: 30 Minutes

Activity

How many of you like crystals? They are pretty, aren't they? Today, we are going to start growing some crystals. We will also find out what some common shapes are and how to tell what kind of mineral a sample is by looking at the shape.

Now we are going to start a crystal-growing experiment. It will take a while to evaporate, so I will bring it back next time for you to see. Shapes form as the water evaporates and brings the molecules closer together.

A mineral always has the same basic shape. The shape may be messed up a little bit, with a portion missing, but the basic shape is always the same. How can that be? Well, it's because the way the mineral is made inside, its very smallest pieces always stay the same for one kind of mineral. Table salt, for example, is always made up of two chemicals, sodium and chloride,

Leader's Notes:

Use Member Handout 12, *Introduction to Minerals*, to introduce the mineral concept before beginning this lesson.

Use Member Handout 13, *Crystal Recipes*. The epsom salts in a plate is an easy and striking experiment. You might want to do it the night before, and bring it in, so they can see a finished product if it will be a while until you meet again.

Use building blocks to show how a larger cube is made of smaller ones. Take out one of the blocks to show a piece missing.

Hold up examples and pass around for members to handle. Also pass a magnifying glass, or have it available later.

Hand out Activity Sheet 16, *Crystal Models*

Younger members may want to skip the hexagonal model as it is the hardest.

Pass out Member Handout 13, *Crystal Shapes*.

Hold up examples that you have, and follow the same procedure of identifying the shape.

and it is always in the same amount to each other. If something else is in the formula, then it becomes a different mineral and might also have a different shape. Sometimes the crystal shapes are very small, and you need to use a magnifying glass to see them. Sometimes the shapes bump into each other as they are growing and combine in odd shapes. Sometimes the crystal gets broken after it is made, and it is hard to tell its original shape.

When there are easy-to-see shapes, it can help you tell which mineral a specimen is because the crystal shape is always the same for a mineral. If a piece of the mineral is square and clear, for example, you know it is not quartz because quartz forms pointed shapes with six sides. Several minerals might share one shape, however, so you can't use only crystal shape to identify a specimen. Color and hardness and other things are important also.

Now, here is an activity sheet to build models of some common kinds of crystals. Here are some of the models I have made up. First you will need to cut out all the shapes on the dark lines. Then, fold them on each light line. Check to see that the shape looks right. Then glue the tabs to the side of the shape near it. Hold them a little while for the glue to set. When we are all finished, we can talk about them.

Now that we are finished building the shapes, let's look at them and at this chart. What minerals come in this cubic shape? Here is a real salt crystal. Is it about the same shape? When you are done using the chart, put it in your notebook to save as a reference.

Dialogue for Critical Thinking

Share:

1. What did you see when observing the plate crystal?
2. Was it easier to see the shape on the model or the real crystal? Why?

Process:

3. What are some of the basic crystal shapes?
4. What are some minerals with cubic shapes? Hexagonal?
5. When a crystal "grows or forms," how is that different from a living thing that grows? (A living thing makes new material from sun energy and nutrients. It grows from the inside. A crystal makes no new material, it just results when the materials in the mixture clump together as the water evaporates, and it forms from the outside.)

Generalize

6. What did you learn about yourself through this activity?
7. Are your values, feelings, thoughts (things from within) more important than appearance, what you wear (things on the outside)? Why? Or why not?

Apply:

8. How do crystal shapes affect your life now and in the future? (*Consider value of special stone jewelry shapes.*)
9. How will you act differently in the future as a result of this activity

and discussion?

Going Further

1. Grow another recipe of crystals from the Member Handout ___, *Crystal Recipes*. How is it the same? How different?
2. Design some model of other crystal shapes and make them. Tell what minerals come in that shape.
3. Using the same directions, make several different samples using different chemicals. Salt, alum borax and Epsom salts all work well. Give everybody a bottle of one of the solutions and see if they can tell what it is by growing the crystals and comparing it to yours.
4. Buy a crystal kit and grow crystals from it. Compare them to the crystals from the household chemicals. Often they use less common chemicals that make larger or brightly colored crystals.
5. Look for examples of minerals in different or unusual shapes. Rock shops often sell them.
6. Look at crystals under a microscope. Observe crystals as they form by putting a little saturated solution on a slide. Warm slide carefully with a match (leader does this) as you watch. What happens?

References

Donitrovic, Anna; "Eggshell Geodes," *Rock Talk* Jan 94. (Reprinted in *The Glacial Drifter*.)

Hoehn, Robert G.; *Earth Science Curriculum Activities Kit*; 1991; The Center for Applied Research in Education, West Nyack, NY 10995

Stangl, Jean, *Crystals and Crystal Gardens You Can Grow*

VanCleave, Janice; *Earth Science for Every Kid*; John Wiley & Sons, Inc. NY

Written by: Pat Gilliland, Kansas 4-H Geology Curriculum Team

Reviewed by: Will Gilliland, Environmental Scientist, Division of Water Resources, Kansas Department of Agriculture.

James P. Adams, Associate Professor, 4-H Youth Development, Kansas State University

Crystal Shapes

Member Handout 12, Introduction to Minerals

Minerals — Geology Level II

What is a mineral?

"A mineral is a natural, inorganic substance with a characteristic chemical composition and definite physical properties."

1. A mineral is formed in nature. A ruby that formed in the earth is a mineral, but a ruby that was made by a person (synthetic) is not a mineral.

2. A mineral is made up of substances that were never alive (inorganic). Coal, natural gas and petroleum are not minerals, because they were formed from the remains of animals and plants.

3. A mineral has the same chemical make-up wherever it is found .The kind of matter present and the amount of each kind of matter are always the same for a given mineral no matter where it is found. Sand is not a mineral because samples from different places usually have different chemical make-ups.

4. The atoms of a mineral are arranged in a regular pattern and form solid units called crystals. For example: salt is a mineral having crystals shaped like tiny cubes. Sugar is another substance that has a crystal form, however, sugar is not a mineral since it is made from a plant.

Identifying Minerals:

1. Minerals are identified by their physical properties.

2.Each mineral has physical properties which make it different from all other minerals. (Which can be used for identification.)

3. The physical properties of minerals are:

Crystal Form: Many minerals form crystals which are helpful in their identification.

Color: Color may be the most obvious property of a mineral; however, some minerals have slight impurities which give a variety of colors. Example: quartz

Streak: Streak is the color of a mineral in its powdered form and is obtained by rubbing a mineral across a plate of unglazed porcelain. The streak of the same minerals usually shows the same color, even though the minerals themselves sometimes have a different color. Hematite may very in color, but it will always show a red-brown streak.

Luster: Luster refers to the way light is reflected from a mineral surface. There are two types of luster: metallic and non-metallic.

Hardness: Hardness is a mineral's resistance to being scratched. The harder mineral always scratches the softer mineral.

Cleavage: Minerals cleave if they break along smooth, flat planes.

Fracture: Fracture is breakage along an irregular surface.

Specific Gravity: Specific gravity refers to the ratio of the mineral's mass to the mass of an equal volume of water.

Taste, Smell, Magnetism: Some minerals have specific properties of their own which help to identify them. You can taste halite (salt), smell sulfur, tap jade for a bell-like ring, and pick up magnetite with a magnet.

Author: Rita O'Neal, Kansas 4-H Geology Curriculum Team

Reference: *Exploring the World Through Geology*, p.10, K-State Research and Extension, Manhattan, Kansas.

Crystal Shapes

Member Handout 13, Crystal Recipes

Minerals — Geology Level II

General Instructions:

Most of these recipes use a saturated or super saturated solution of a chemical. This can be made by stirring the chemical into water until no more dissolves. One to 4 tablespoons of material usually dissolve in one cup of water. You can usually feel the undissolved material in the bottom with your spoon. To make a supersaturated solution, heat the water before you try to dissolve the chemical. It will hold more dissolved material than unheated.

Different common household chemicals can be used and usually substituted and compared with each other. They are: Table salt, Epson salts(available in drugstores) and Alum (a canning ingredient). Sugar also makes crystals, but is not a mineral. Laundry bluing or food coloring may be added for color. Avoid disturbing the crystals as they grow.

Materials Needed:

- Spoons, measuring cups, bowls, water, household chemicals
- Additional materials as stated in each recipe

Plate crystals

Cut a circle of dark construction paper to fit the bottom of a disposable pie or pot pie pan or an old lid. Pour a thin layer of the saturated solution in the pan, about 1/8 inch or less. Allow it to stand undisturbed for about one day. This easy experiment produces clearly visable crystals. Epsoms salts are especially effective.

Suspended Crystals

Pour a little of the solution in a shallow container and allow it to evaporate. Take the best crystal and suspend it with string so it hangs into a glass or other container (a "seed" crystal). Fill the container with supersaturated solution and suspend the crystal in it. Allow it to set for a day or two, or longer, until it grows bigger. This produces bigger, more impressive single crystals, but can go wrong if the solution is not saturated. A variation is to skip growing a seed crystal and just suspend the string.

Crystal Gardens

There are many variations of this. Basically, you place some porous materials like brick, cinder, charcoal briquette, flower pot shards, lava, sponge, etc. in a pan. A shallow disposable plastic container works well. Then you pour on a solution of a chemical, usually salt and ammonia (1 or 2 tablespoons hasten evaporation). You may also add some bluing (a laundry aide) or food color for color. Three tablespoons each water, salt, and bluing, and 1 tablespoon ammonia works well. You may sprinkle a little salt on for seed. Let it stand for a few days. Add more solution to the bottom of the container after a few days if you want it to continue to grow.

Eggshell Geodes

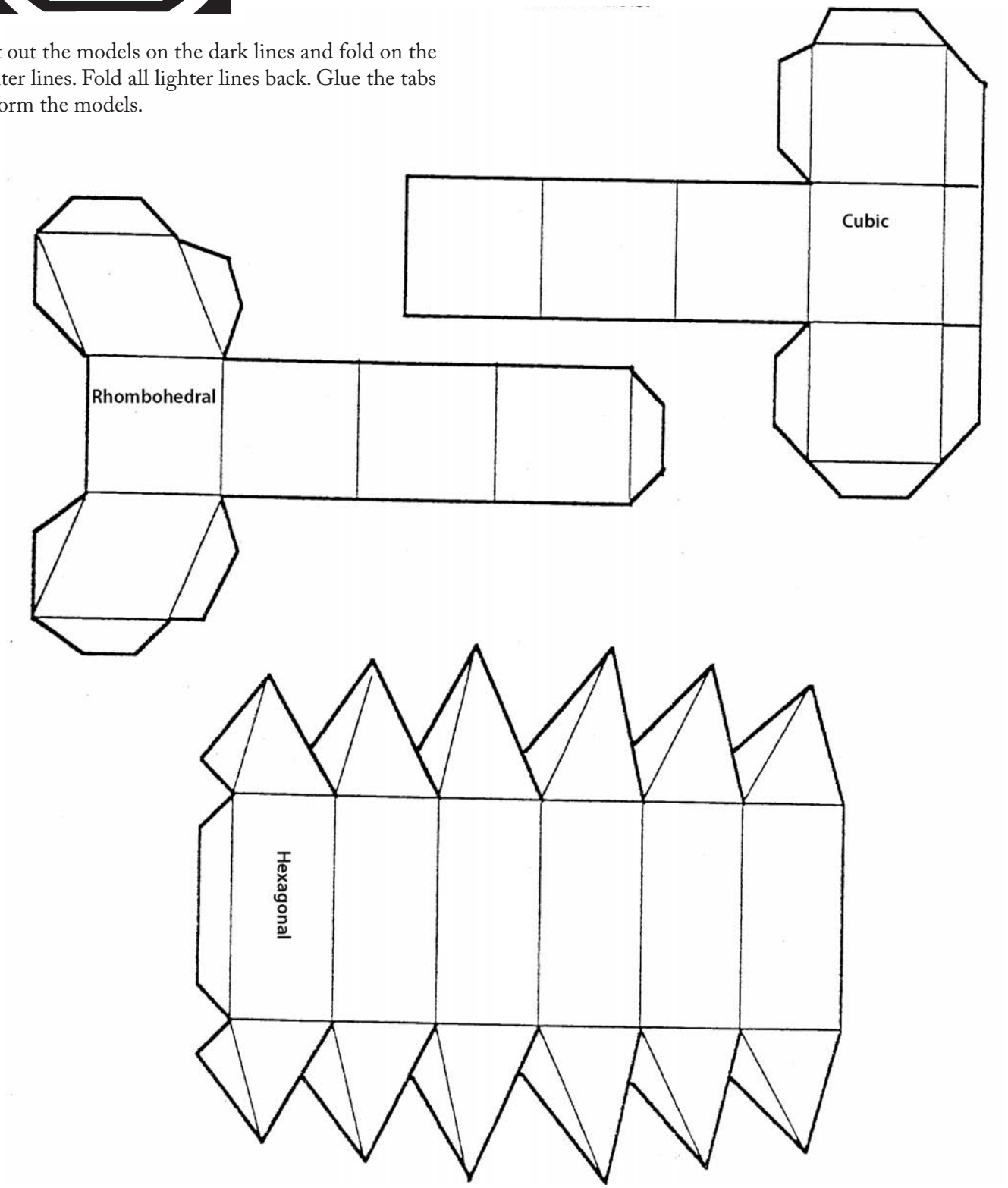
Remove the membrane from half an eggshell. Place the eggshell in the egg carton and pour saturated salt solution in it. Add a drop of food color, if desired. Let set until evaporated. Add more solution as it evaporates if you want more crystals.

Crystal Shapes

Activity Sheet 16, Crystal Models

Minerals — Geology Level II

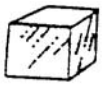
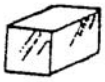
Cut out the models on the dark lines and fold on the lighter lines. Fold all lighter lines back. Glue the tabs to form the models.



Crystal Shapes

Member Handout 14
Crystal Shapes

Minerals — Geology Level II

Type	Surfaces	Shapes of Surfaces		Examples
Cubic	6		all are square	alum, pyrite, garnet, gold, sodium chloride (salt), silver, diamond
Hexagonal	8		two are hexagons; six are rectangles (angles of rectangles are right angles)	ice, ruby, sapphire, quartz, emerald, apatite
Monoclinic	6		four are rectangles; two are parallelograms; 16 angles are right angles; eight angles are not right angles	sugar, gypsum, borax
Orthorhombic	6		all are rectangles; three pairs of rectangles, each pair a different size; corner angles are right angles	topaz, Epsom salt, rhombic sulfur
Rhombohedral	6		all are rhombuses; no right angles	calcite
Tetragonal	6		four are rectangles; two are squares (corner angles are right angles)	white tin, zircon
Triclinic	6		all are parallelograms (no right angles at corners)	boric acid, copper sulfate

Cleavage and Fracture

Minerals — Geology Level II

What members will learn …

About the Project:

- How to identify a mineral by how it breaks.
- Some minerals have both cleavage and fracture.
- Minerals that show cleavage break along flat surfaces or planes.
- Minerals that show fracture break along irregular planes.

About Themselves:

- They can observe and learn from the various tests they make on mineral specimens.
- They need to protect their eyes with safety glasses when breaking minerals and rocks.
- Experimenting can be fun.

Materials:

- Safety glasses for each child
- Mineral samples with cleavage like halite or calcite
- Covering to protect the table surface (newspapers)
- Some type of rock hammer, such as one made by welding a piece of pipe to a railroad spike.
- Member Handout 15, *Types of Mineral Cleavage*

Activity Time Needed: 20 minutes

Activity

Does the mineral have a broken surface? The way in which a mineral breaks is described as either cleavage or fracture. Minerals cleave if they break along smooth flat planes. Different minerals have their own characteristic cleavage that can be used to identify them.

Types of cleavage:

Cubic: Halite or salt, cleaves in three directions, each at right angles to the others. Therefore, halite breaks up into cubes or rectangular blocks.

Rhombohedral: Calcite also cleaves in three directions, but the surfaces are not at right angles. Therefore, calcite breaks up into blocks that lean on one side.

Leader's Notes:

Show examples of each.

Provide Member Handout 15, *Types of Mineral Cleavage*.

Basal: Basal cleavage is parallel to the base of the crystal. Mica cleaves in only one direction and fractures in all others. Therefore, a block of mica splits into thick sheets. Each sheet, however, fractures when bent or twisted.

Cleavage should not be confused with crystal forms. When a mineral exhibits cleavage, it will break into pieces that have the same configuration as the original sample. By contrast, quartz crystals do not have cleavage, and if broken, would shatter into shapes that do not resemble each other or the original crystal.

Minerals that do not exhibit cleavage are said to fracture when broken. Those that break into smooth curved surfaces resembling broken glass have a conchodial fracture. This conchodial fracture made it possible for Indians to chip arrowheads. Other minerals with fracture break into splinter or fibers, but most break irregularly.

Give each child newspapers to cover the table, safety glasses for eye protection, hammer, and mineral sample.

Instruct the members to tap the specimen firmly with enough force to break the specimen, but not to smash it. Discuss the type of cleavage of the specimen. Demonstrate or experiment with the other two types of cleavage not illustrated by the experiment.

Dialogue for Critical Thinking:

Share:

1. What mineral did you find hardest to break along lines?

Process:

2. What is the difference between cleavage and fracture? (Cleavage breaks in straight lines, and fracture breaks are round, irregular or splintered.)
3. What are three types of cleavage? Give examples of each.

Generalize:

4. Why is it important to wear safety glasses when breaking the minerals?
5. How does experimenting help you learn?

Apply:

6. Which of the cleavage types do you have in your collection?
7. What minerals can you identify using cleavage? Fracture? Crystal Form? (Cleavage: mica cleaving in layers. Fracture: glass, obsidian and chert breaking with conchoidal fracture. Crystal form: Quartz, characteristic of pointed crystals.)

Going Further:

1. Investigate other forms of cleavage such as a diamond, etc
2. Explain why the conchoidal fracture was important to the Indians and tell what minerals they used to make artifacts.
3. List types of fracture and give examples of each.
4. Make a collection of different types (examples) of cleavage or fracture.

Author: Rita O'Neal, Kansas 4-H Geology Curriculum Team

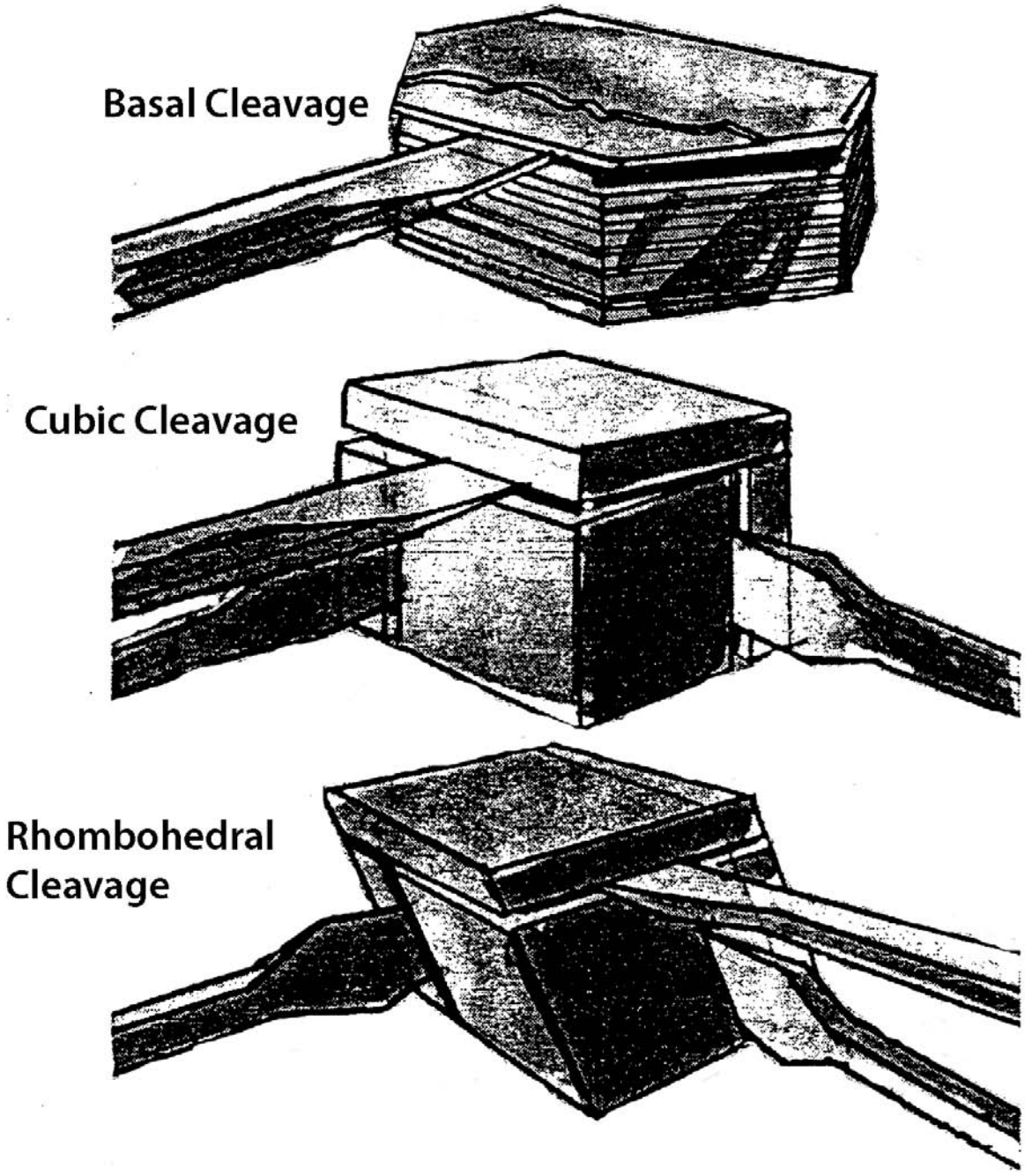
Reviewed by: Will Gilliland, Environmental Scientist, Division of Water Resources, Kansas Department of Agriculture.

James P. Adams, Associate Professor, 4-H Youth Development, Kansas State University

Cleavage and Fracture

Member Handout 15
Types of Mineral Cleavage

Minerals — Geology Level II



How Hard is Hard?

Minerals — Geology Level II

What members will learn …

About the Project:

- How hardness can be used to identify minerals.
- How to use the hardness scale.

About Themselves:

- Preferred way of learning.
- Mnemonic devices help them remember lists.

Materials:

- Small samples of Calcite, Quartz and Gypsum (Selenite) for each member (Do not tell them what they are.)
- Plastic zip-lock bag to hold the three specimens
- Copies of *Kansas Rocks and Minerals* or other mineral I.D. guide
- Hardness Test Kit (optional)

Activity Time Needed: 30 minutes

Activity:

Not all minerals are the same hardness. A mineral that can scratch another is the harder of the two. There is a hardness scale called the Mohs Scale.

This hardness scale was named after Frederich Mohs, a German mineralogist, who lived from 1733-1839. He recognized the fact that some minerals are harder than others and devised the hardness scale we now use. All minerals have a hardness number and can be placed on this scale according to their hardness. This scale lists 10 common minerals and gives each mineral a number from one to 10, with number one being the softest and 10 being the hardest.

Leader's Notes:

The MOHS Scale should be explained to members. This presentation could be given by the leader or be presented as a project talk by one of the members.

Ask the members to create a mnemonic saying to help remember the hardness scale such as: "The Girls Can Flirt And Other Questionable Things Can Do."

The MOHS Scale includes the following:

1. Talc (softest)
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Orthoclase (Feldspar)
7. Quartz
8. Topaz
9. Corundum
10. Diamond (hardest)

The following levels of hardness can be determined by scratching the mineral with the suggested item:

2 to 3 – Fingernail

3 to 4 – Penny

4 to 6 – Window Glass

5 to 6 – Knife Blade or Nail

6 to 7 – Steel File

Give each member a plastic bag with the three mineral specimens: calcite, quartz, and gypsum (selenite). Do not tell members what they are.

Caution the members to make sure the there is a definite scratch by trying to rub the powder away with their fingers. What appears to be a scratch may be the powder left by the softer of the two minerals.

We are going to test the hardness of these three minerals.

To determine the hardness of each mineral, each of you should experiment by trying to scratch a fresh surface of one of the minerals with a second mineral.

Arrange the specimens in order of hardness, the softest to the hardest.

The next activity involves using a copy of *Kansas Rocks and Minerals*.

Look up the minerals I.D. hardness section.

Provides copies of *Kansas Rocks and Minerals.*

Name a mineral and tell the page where it is found in the book. Have each member look up the mineral. After determining the hardness of the mineral, have a member show where that mineral should be placed on the hardness scale. Discuss which mineral would scratch this mineral and which minerals it would scratch.

Dialogue for Critical Thinking:

Share:

1. How difficult was it to determine the hardness of the three minerals?
2. Why did you have to use the hardness test to identify the three minerals?

Process:

3. When you try to scratch one sample with another, which one receives the scratch?
4. How can you tell a true scratch from a streak?

Generalize:

5. Does the mnemonic sentence make it easier for you to remember the order of the mineral hardness?
6. What other methods of learning or memory aids do you prefer?

Apply:

7. What is the hardest mineral you have collected?
8. What are some common minerals used in everyday situations?

Going Further:

1. Make a hardness kit using a penny, small piece of glass, a pocketknife or nail, and a steel file.
2. Visit a rock shop, or gem and mineral show, to purchase specimens they may not already have to make a special display of the MOHS Scale. This display could be used for a project talk and could also be a special display at the fair.
3. Make a hardness scale using Kansas specimens.

Author: Rita O'Neal, Kansas 4-H Geology Curriculum Team

Reviewed by: Will Gilliland, Environmental Scientist, Division of Water Resources, Kansas Department of Agriculture.

James P. Adams, Associate Professor, 4-H Youth Development, Kansas State University

Possible answers for question No. 8:
Diamonds – saw and drill bits

Marble or granite – tombstones

Talc – Talcum powder

Gypsum – Wallboard

Specific Gravity

Minerals — Geology Level III

What members will learn …

About the Project:

- How to measure the specific gravity of a mineral.

About Themselves:

- The importance of neatness and accuracy in their lives.

Materials:

- Plastic cup with a small hole cut near top
- Small dish with volume equal to plastic cup that will fit on the scales
- Large towel or tray
- Scales
- Mineral specimens for identification (must fit in cup)
- Pencil and paper
- Reference book which lists mineral and their specific gravity

Activity Time Needed: 30–40 minutes

Activity

Equal sized pieces of two different minerals may not weigh the same. The heavier mineral is said to have a higher specific gravity. The specific gravity of a substance is a comparison of its weight with the weight of an equal volume of water. A mineral having a specific gravity of 3.0 is three times as heavy as the same volume of water. Jewelers often use specific gravity as a way to identify gem minerals.

Specific gravity is one of the physical properties of a mineral and can be used for identification. To measure the specific gravity of a mineral, you must first weigh the specimen. Next, you must obtain and weigh an equal volume of water. Compare the weight of the mineral specimen with the weight of the water. Divide the weight of the mineral by the weight of the water to determine the specific gravity of the mineral.

Leader's Notes:

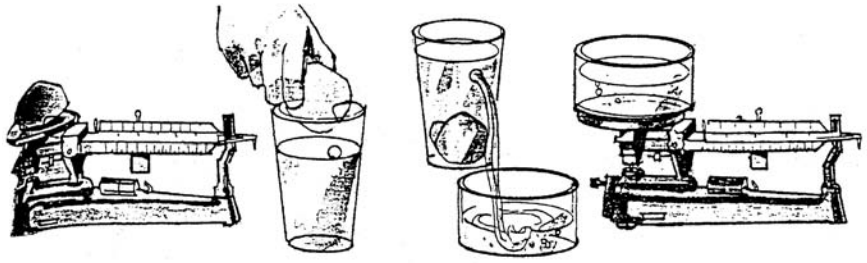
Place a towel, tray or plastic cover on the table to catch spilled water.

Now let's try the procedure one step at a time.

1. Weigh mineral specimen on the scale, while it is dry and record weight.
2. Fill plastic cup with water up to the hole in the side.
3. Place cup of water in a dish to collect displaced water.
4. Place mineral specimen into plastic cup
5. Collect the water which is forced out through the hole, it is equal to the volume of the specimen
6. Weight the displaced water and record its weight.
7. Divide the weight of the mineral specimen by the weight of the displaced water. This is the specific gravity of the mineral specimen.

If you don't know what the specimen is, look up the specific gravity in a geology book. This list will identify the unknown material.

The illustration below shows a way that can be used to get a volume of water equal to that of the specimen being tested.



Dialogue for Critical Thinking:

Share:

1. What problems did you have while weighing certain specimens or their displaced water?
2. How easy or difficult was it to determine the specific gravity of your specimen?
3. Was your specimen an unknown or were you verifying a known mineral? How accurate were you?

Process:

4. Why is specific gravity important?

Generalize:

5. What did you learn about yourself while doing this activity?
6. How important are neatness and accuracy? Why?

Apply:

7. Where else might specific gravity be important? Why?
8. What other areas of your life are neatness and accuracy important? Why?

Going Further:

1. Determine the specific gravity of other minerals such as: orthoclase, feldspar, galena, calcite, quartz, chalcopyrite, magnetite, talc, hematite, limonite, etc.
2. Keep a record of your specific gravities for a personal identification reference.
3. Research and give a demonstration of other methods of determining specific gravity.
4. Write a paper about the Greek mathematician, Archimedes, who discovered the facts of specific gravity. Read the story about how Archimedes determined that the goldsmith who made a crown for the king replaced some of the gold with silver.

Author: Rita O'Neal, Kansas 4-H Geology Curriculum Team

Reviewed by: Will Gilliland, Environmental Scientist, Division of Water Resources, Kansas Department of Agriculture.

James P. Adams, Associate Professor, 4-H Youth Development, Kansas State University

Flame It, Fizz It

Minerals — Geology Level IV

What members will learn …

About the Project:

- Minerals have unique chemical properties that can be used to identify them.
- Two tests that can be used to determine chemical properties of minerals.

About Themselves:

- The importance of safety when working with chemicals or fire.
- The value of experimentation.

Materials:

- Propane torch
- Platinum loop
- Dilute (30%) Hydrochloric Acid (Muriatic Acid is already diluted and is available at most hardware stores)
- Baking soda
- Hammer
- Water solution
- Evaporating dish or something similar
- Safety glasses
- Safety matches
- Samples of galena, calcite, celestite, sphalerite, halite
- Activity Sheet 17, *Mineral Identification Reactions*
- Activity Sheet 18, *Mineral Identification Reactions, Leader's Key*
- *Kansas Rocks and Minerals*, Tolsted and Swineford, Kansas Geological Survey, 2nd ed.

Activity Time Needed: 1 hour

Activity

In previous lessons we have learned about physical properties of minerals. Today we will experiment with some chemical properties of minerals. We will be using the following minerals for out tests: galena, calcite, sphalerite, halite and celestite.

Before beginning our experiments we will review the safety procedures. Goggles will be worn during all phases of testing. Hydrochloric acid is very

Leader's Notes:

Have members review the physical properties, such as hardness, cleavage, luster, and streak.

Make sure the members follow the safety procedures throughout the process.

strong and corrosive and can burn skin and clothing. Be very careful when handling the acid. Since we will be using a propane torch, long hair and loose clothing must be kept away from the flame.

Minerals are divided into groups based on their chemical composition. Halides are minerals that are composed of halogens, such as the elements chlorine, iodine, bromine, and fluorine. Halite, or salt, is composed of sodium chloride (NaCl) and is classified as a halide.

Have the members complete the chemical composition and mineral type section of the Activity Sheet 17, *Mineral Identification Reactions*, as this section is discussed.

Minerals that contain the element sulfur in combination with metal ores are called sulfides. Galena, the principle ore of lead, is composed of lead sulfide (PbS). Sphalerite is composed of zinc sulfide (ZnS) and is a primary ore of zinc. Chalcopyrite ($CuFeS_2$) and pyrite (FeS_2) also fall into the sulfide group.

Oxides are those minerals that combine oxygen with one or more metals. Hematite ($FexO_3$), ilmenite ($FeTiO_3$) and magnetite (iron oxide, Fe_3O_4) are minerals in this group.

Carbonates are those minerals that combine an element with both oxygen and carbon. Calcite or calcium carbonate ($CaCo_3$) is a very common mineral and belongs in this group. Other carbonates include siderite ($FeCO_3$), dolomite [$CaMg(CO_3)_2$], cerussite ($PbCO_3$) and malachite ($Cu_2CO_3[OH]_2$).

Sulfates are minerals that combine an element with both sulfur and oxygen. Celestite is strontium sulfate (SrSO4), which exhibits a distinctive crimson color when exposed to a flame. Gypsum is a common mineral composed of calcium sulfate and water molecules ($CaSO_4+2H_2O$). Barite (barium sulfate, $BaSO_4$) exhibits a distinctive green color in the flame test. Anhydrite ($CaSO_4$) and goslarite ($ZnSO_4+7H_2O$) are also included in the sulfate group of minerals.

If the mineral barite is available, it can be used in the flame test also.

Silicates are mineral compounds containing silicon and oxygen and include quartz (SiO_2), opal (SiO_2+H_2O), feldspar, mica and garnet.

The chemical properties of minerals can aid in their identification. Dilute hydrochloric acid applied to a carbonate mineral will result in fizzing or effervescence. The HCL breaks the chemical bonds of the material releasing carbon dioxide gas (CO_2). When HCL is applied to some sulfide bonds of the minerals it reacts to form hydrogen sulfide gas (H_2S).

These properties will be evident in the acid test.

Certain elements will exhibit characteristic colors when exposed to a flame. If a mineral contains the element, it may exhibit that color. Elements known to exhibit specific colors with HCL in the flame test are: barium – green, calcium – brick red, copper – sky blue, lithium – red, potassium – violet, sodium – yellow, and strontium – red.

These properties will be evident in the flame test.

Acid Test

1. Use the hammer to powder each of the five minerals.
2. Place a small amount of each mineral in separate wells of the evaporating dish.
3. Place a few drops of dilute hydrochloric acid in each well on the crushed minerals.
4. Observe the reactions.
5. Record results on the activity sheet.

IMPORTANT!!! Dispose of the used acid as follows: Dilute the acid carefully with a baking soda and water solution, being careful it doesn't fizz over. It may safely be poured down a drain followed with water.

Flame Test

1. Light the torch by turning on the propane very low and ignite the gas by using a safety match.
2. Dip the platinum loop in the pure acid and touch the loop to the flame to clean it.
3. Allow the clean loop to cool.
4. Dip the loop in the first mineral solution that was used in the acid test.
5. Place the loop in the flame.
6. Observe the color change of the flame (if any)
7. Clean the loop prior to testing each mineral solution.
8. Record the reactions on the activity sheet.

Caution members to not leave the loop in the flame too long or it will melt.

The color changes in the flame will be very brief, so advise the members to observe closely.

Dialogue for Critical Thinking:

Share:

1. Which mineral test was easiest to do? Why?
2. Which mineral test had the most vivid or distinct results?

Process:

3. What other geologic items can you identify with the acid test? (rocks, limestone and chalk)
4. What mineral produces the rotten egg odor?
5. What causes the carbonates to fizz when tested with HCL (hydrogen chloride)?

Generalize:

6. Why is it necessary to wear goggles when working with acid?
7. What safety precautions should you take when working with a torch?

Apply:

8. Who might use these tests in their business or career? Why? When?
9. What minerals or rocks might be identified by a "Taste Test?" (halite, salt, sandstone, shale)

Going Further:

1. Try the Acid and Flame tests on other minerals you have collected and chart the results.
2. Identify any other special properties of minerals that may aid in their identification and research methods to test for those special properties (for example: magnetism).

References:

Buchanan, R.C. *Kansas Geology*, Lawrence, University Press of Kansas, 1984.

Tolsted, L.L., Swineford, A. *Kansas Rocks and Minerals*, Lawrence, University Press of Kansas, 1986.

Pellant, Chris. *Rocks and Minerals*, New York, Dorling Kindersley Limited, London Text, 1992.

Wooley, Alan. *Illustrated Encyclopedia of Minerals*, New York, Gallery Books, 1990.

Author:

Megan McCoy, Kansas 4-H Geology Curriculum Team

Reviewed by: Will Gilliland, Environmental Scientist, Division of Water Resources, Kansas Department of Agriculture.

James P. Adams, Associate Professor, 4-H Youth Development, Kansas State University

Flame It, Fizz It

Activity Sheet 17, Mineral Identification Reactions

Minerals — Geology Level III

Sample	Galena	Sphalerite	Halite	Calcite	Celestite
Chemical Formula					
Mineral Type					
Acid Test Reaction					
Flame Test Reaction					

1) In the acid test, what causes the rotten egg odor of the Galena and the Sphalerite?

2) What reaction takes place when the acid is placed on the Calcite?

3) What element in Halite categorizes it as a Halide?

4) Oxygen and carbon are found in minerals of the _____ group.

5) A mineral in the sulfide group contains which element?

6) Sulfur and oxygen are found in minerals of the _____ group.

7) What element in the Celestite causes the color change in the flame test? Why?

8) Draw lines to match the color reaction to the element in the flame test.

Barium	Yellow
Calcium	Crimson
Sodium	Brick Red
Strontium	Green

Flame It, Fizz It

Activity Sheet 18, Mineral Identification Reactions Leader's Key

Minerals — Geology Level III

Sample	Galena	Sphalerite	Halite	Calcite	Celestite
Chemical Formula	PbS	ZnS	NaCl	$CaCO_3$	$SrSO_4$
Mineral Type	Sulfide	Sulfide	Halide	Carbonate	Silicate
Acid Test Reaction	Rotten egg odor	Rotten egg odor	Dissolves	Fizzes	None
Flame Test Reaction	None	None	Yellow	Brick red	Crimson red

1) In the acid test, what causes the rotten egg odor of the Galena and the Sphalerite?

Hydrogen Sulfide gas is produced by the HCl reacting with the sulfur.

2) What reaction takes place when the acid is placed on the Calcite?

The HCl breaks the chemical bonds of the Calcium carbonate to form carbon dioxide gas.

3) What element in Halite categorizes it as a Halide?

Chlorine or Chloride

4) Oxygen and carbon are found in minerals of the **Carbonate** group.

5) A mineral in the sulfide group contains which element?

Sulfur

6) Sulfur and oxygen are found in minerals of the **Sulfate** group.

7) What element in the Celestite causes the color change in the flame test? Why?

Strontium – the atoms are supercharged and excited by the heat to produce the crimson color

8) Match the color reaction to the element in the flame test.