Activity 21: Cleavage and Fracture

Maine Geological Survey

Objectives:

Students will recognize the difference between cleavage and fracture; they will become familiar with planes of cleavage, and will use a mineral's "habit of breaking" as an aid to identifying common minerals.

Time:

This activity is intended to take one-half (1/2) period to discuss cleavage planes and types and one (1) class period to do the activity.

Background:

Cleavage is the property of a mineral that allows it to break smoothly along specific internal planes (called cleavage planes) when the mineral is struck sharply with a hammer. Fracture is the property of a mineral breaking in a more or less random pattern with no smooth planar surfaces. Since nearly all minerals have an orderly atomic structure, individual mineral grains have internal axes of length, width, and depth, related to the consistent arrangement of the atoms. These axes are reflected in the crystalline pattern in which the mineral grows and are present in the mineral regardless of whether or not the sample shows external crystal faces. The axes' arrangement, size, and the angles at which these axes intersect, all help determine, along with the strength of the molecular bonding in the given mineral, the degree of cleavage the mineral will exhibit.

Many minerals, when struck sharply with a hammer, will break smoothly along one or more of these planes. The degree of smoothness of the broken surface and the number of planes along which the mineral breaks are used to describe the cleavage. The possibilities include the following.

	Number of Planes		
Degree of Smoothness	One	Two	Three
Perfect			
Good			
Poor			

Thus a mineral's cleavage may be described as perfect three plane cleavage, in which case the mineral breaks with almost mirror-like surfaces along the three dimensional axes; the mineral calcite exhibits such cleavage.

Cleavage/fracture, along with density, hardness, and streak are among the most useful of the physical mineral tests. Often cleavage is so distinct that it can be used as THE diagnostic property for a given mineral species; muscovite with its perfect one-plane cleavage is a good example. Cleavage tendencies and patterns are also useful in the cutting of gem stones, the growth and utilization of silicon chips, and the production of synthetic crystals for use in lasers.

Materials:

Students should work in groups of 2 or 3; each group will need the following

- A copy of the cleavage "chart" which they can copy off the board or overhead
- A small one-pound hammer
- Approximately 2-inch sized, pure, labeled samples of each of these minerals - feldspar, calcite, muscovite, galena, and quartz
- An old mitten or glove
- Newspapers

It may be useful to have an "anvil" of some sort available to the class as a whole; a 1-foot piece of railroad rail is ideal. ALL students should wear safety glasses for the duration of this activity.

Procedure:

Students should examine the specimens and note the nature of the sides BEFORE doing any cleaving of their own; specimens were broken down out of larger masses to get them to their present size; this can give clues as to what to expect when they are cleaved again.

Using a mitten to protect their hand, and with ALL students wearing safety glasses, one student in each group should select a sample and holding the sample in the gloved hand, rap the specimen sharply with the hammer. When the specimen breaks, students should examine the sides for the degree of smoothness and the number of sides which show the cleavage. Sides that are parallel to each other represent the same direction of cleavage; sides that are perpendicular to each other represent different planes. Students should test all specimens, recording data as they continue. All students should practice the actual cleaving of the samples. Specimens that are very resistant to breaking can be carefully trimmed on the anvil. You may wish to demonstrate "correct" cleaving or hammering technique to the whole class prior to students starting the activity. Newspapers should be used to catch the debris if a lab room is not being used.

Special Safety Procedures:

Students need to wear safety glasses/goggles for the duration of this experiment. If you demonstrate the technique before starting the activity most students will be able to use the right amount of force to cleave the specimens without a large amount of flying debris.

Follow-Up:

See activities #19 (The Density of Minerals) and #20 (Testing the Hardness of Common Minerals).

Expand the list of minerals tested to include some showing all the varieties of cleavage. While minerals that fracture often exhibit no pattern, very pure samples may develop non-linear patterns due solely to the tenacity of the molecular structure. Research examples of conchoidal, earthy, hackly, splintery, and other types of fracture.

Demonstrate these to the students, or have them do the research and make a poster display for permanent classroom use.

You may wish to save some of the cleaved fragments for use in density tests; a quick screening with .8 and .5 inch mesh screens will produce a number of fragments in just the right size range to slide down a 50 ml graduated cylinder.

References:

Activity developed by Duane Leavitt.

Name___________________________

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Student Sheet

Purpose:

In this activity you will learn how some minerals behave when struck and broken apart with a hammer. You will use this property as a diagnostic test for minerals.

Materials:

Students will work in groups; each group will need the following - a copy of the cleavage "chart" which you have probably copied off the board, a small hammer, one piece of each of the following minerals - feldspar, calcite, muscovite, galena, and quartz. Each group will also need an old mitten or glove, and some newspaper. Each student will need safety glasses, pens, and notebook.

Procedure:

If minerals break smoothly, along predetermined planes, the minerals are said to have cleavage. If a mineral does not have any degree of cleavage, it is said to have an irregular breakage pattern called fracture. Before starting the actual testing part of the activity, students should copy the cleavage chart into their notebook.

Examine the sides of each specimen before doing any cleaving; the shape and smoothness of the sides may give you some clues as to HOW the mineral will break when struck; record these observations in the data table.

Before ANY hammering on specimens starts, ALL students should put on safety glasses/goggles and KEEP them on for the duration of this activity. Using an old glove or mitten on one hand, take one of the specimens and, holding it in the gloved hand, rap it sharply with the hammer. If it breaks, examine the broken surfaces and record the information in the data table. Tap the mineral on a side at right angles to the direction of the first break; observe and record. Repeat the process with all specimens provided by your teacher; if you have problems breaking a particular sample or are unsure of your results, consult with your teacher.

When you have tested all of the specimens dispose of the materials as directed by your instructor.

Mineral	Prior Observations	Cleavage Plane 1	Cleavage Plane 2	Cleavage Plane 3	Fracture
Calcite					
Microcline					
Quartz					
Galena					
Muscovite					

Questions:

1. Which of these specimens, if any, exhibited 3 planes of cleavage; what do you notice about specimens that have three cleavage directions?

2. What is the nature of muscovite's cleavage? What uses did/does muscovite have that are related to its cleavage?

3. What is the nature of quartz with respect to cleavage/fracture?

4. What is the most likely cause of cleavage in minerals?