2013-14 NATURE Sunday Academy

What Parts of Computers are Mined

<u>Activity B:</u> Ore Body Mystery

In this activity students will explore the processes of core drilling and geological testing. Students will collect core samples, analyze them for mineral content, map the extent of the ore body and determine its approximate area and volume.

Materials

- Two colors of playdough
- 2-inch pieces of clear drinking straws
- A blunt stick (lollipop stick) that will fit inside the straw and is longer than 2 inches
- Graph paper and pencils
- Calculators
- Rulers
- Real rock core samples (optional)
- Magnifying glasses (optional)
- Blunt knife (optional

Procedure:

1. Take a piece of graph paper and draw a rectangle that almost completely covers the graph paper, but leaves one or two rows of grid squares visible along the edge. The lines of the rectangle should be drawn along the graph paper grid lines. Label the horizontal edge of the rectangle with letters – one in each grid square (i.e., A,B,C,D,…). Label the vertical edge of the rectangle with numbers (i.e., 1,2,3,…). Prepare two more sheets of graph paper with the exact same rectangle dimensions and labeling (one will be the answer sheet and one will be the recording sheet).
2. Take two colors of playdough. One color will represent the ore body and the other color will represent the surrounding base rock.
3. Build an ore body on top of the graph paper within the boundaries of the rectangle. Place the ore body playdough color in several places within the rectangle boundary, not extending to the edges. Vary the thickness of the playdough in each pocket.
4. Map the ore body onto the answer sheet of graph paper and give it to the teacher.
5. Now spread the base rock color playdough on top of the whole structure, extending to the edges of the rectangle. You should end up with a structure where you only see the base rock color of playdough from the top and sides.

6. Switch positions so that you are now working on another student's ore body.
7. Take core samples from the ore body by pushing the straw straight down into the playdough structure, pulling it up, poking the core sample out with a stick, and examining it. Use the grid squares and associated numbers and letters on the axes of the graph paper to accurately locate the position of your core samples.
8. Record core sample results on the recording sheet of graph paper. If no mineral colors are visible, enter O in the grid square.
9. If the ore body color is visible, measure the depth of the ore body using a ruler. Use millimeters as your unit of measurement and record the depth measurement in the grid square.
10. Continue sampling until you think you have enough information to map out the pockets of the ore body and determine each pocket's approximate volume.
11. Record the number of core samples taken.
12. Map the ore body on the recording sheet of graph paper and compare to the answer sheet for that ore body.
13. Count up the number of full and partial grid squares occupied by each pocket of the ore body to calculate the area of each pocket and the total area of the deposit. Count each partial grid square as one-half of a square.
14. Determine the approximate volume of each pocket using an average of the recorded depth measurements.
15. Now draw a straight line through the playdough structure. Collect core samples along the line and measure the distance from the top of each core sample to the ore body, and the depth of the ore body. Use this information to draw a cross-section of the ore body.
16. Slice through the playdough structure along the line and compare the cross-section diagram to the actual cross-section.

Discussion:

After observing the other students results, answer the following questions:

How accurate was each student in determining the shape of his/her ore body?

_____

_____

_____

Which student had the most accurate ore body map? _____

Which student used the least number of core samples to generate his/her map? _____

Based on the area and volume calculations, which property would be the most profitable to mine? _____

Where should mining begin within that property? _____

Thinking of how this exercise relates to core sampling in a real ore body, why is it important to accurately determine the shape of the ore body? _____
_____

Why is it important to limit the number of core samples used to determine the shape of the ore body? _____
_____

<u>Activity C:</u> Mineral Identification

You will explore some of the physical properties of minerals and how these properties can be used to identify minerals.

Keywords: Mineral, inorganic, crystal, element, magnetism, hardness, streak, cleavage, fracture, and effervescence

Materials

- Mineral identification key
- Mohs hardness scale
- Mineral Identification Table
- 5+ numbered mineral samples (good quality)
- Hand lens or magnifying glass
- Streak plates
- Copper pennies
- Steel files or nails
- Bar magnets
- Diluted hydrochloric acid/vinegar & eyedropper
- Glass microscope slides
- Safety goggles and gloves (if necessary)

Introduction

Color is often the first property you notice about a mineral, but it may not be the most diagnostic feature. Often color can be misleading because some minerals have a variety of colors. Therefore, it should be used in conjunction with other characteristics.
Luster is a description of the way the surface of a mineral reflects light. The easiest distinction to make is whether a mineral has metallic or non-metallic luster. Metallic minerals will have a luster similar to aluminum foil or jewelry. If the mineral is nonmetallic, its luster can be further described as:

- Vitreous (like glass)
- Pearly (like a pearl)
- Waxy (like wax)

- Resinous (like resin)
- Greasy (like an oiled surface)
- Earthy or dull (no real sheen on the surface)
- Adamantine (brilliant, sparkling, gemlike)

Cleavage is the tendency of a crystal to break along flat planar surfaces. Cleavage is related to planes of weak chemical bond strength within the mineral. Cleavage is characterized by the number of cleavage planes and angles that the cleavage planes form. Cleavage is also characterized by how well the mineral cleaves (i.e. perfect, good, fair, or poor). Some minerals do not have cleavage. Instead, they fracture into jagged pieces.

Streak is the color of particulate dust left behind when a mineral is scraped across an abrasive surface. Streak color is more reliable than surface color as an indicator. The streak color will be constant, but the surface color may vary.

Hardness is a measure of the mineral's resistance to scratching or abrasion. It is measured using the Mohs Hardness Scale. This is a scale that measures the hardness of minerals relative to each other. The scale ranges from 1 to 10, with 1 being the softest and 10 being the hardest. A mineral should be able to scratch any mineral with a lower hardness number and can be scratched by any mineral or material with a higher hardness number. The following simple tools with known hardness values can be used to determine mineral hardness:

- Fingernail – hardness of 2-3
- Copper penny – hardness of 4-5
- Steel file/nail – hardness of 5-6
- Glass – hardness of 5-6

Magnetism identifies specific iron rich minerals. Only a few minerals such as magnetite or pyrrhotite are magnetic.

Effervescence results when weak acid is applied to some minerals that contain calcium carbonate. Carbon dioxide is released in this reaction and the acid will bubble on the surface of the mineral.

Activity I

The objective of this activity is to identify mineral samples by testing various physical properties.

1. Color: Look at the mineral and decide what colors are present on the mineral surface. Write the color(s) in the appropriate spot in the Mineral Identification Table.
2. Luster: Observe how your mineral reflects light. First decide whether your mineral has a metallic or non-metallic luster by answering the following questions:
Does it sparkle when light reflects off of its surface?

Does it look like a metal? If yes, then it has a metallic luster.

If it is dull or shiny, but not like a metal, then it has a non-metallic luster. If the luster is non-metallic, try to further classify it as dull, earthy, waxy, pearly, vitreous, resinous or adamantine. Record the luster on the Mineral Identification Table.

3. Cleavage: Look at the broken surfaces of your mineral with a hand lens and answer the following questions:
How does your mineral look on the surfaces where it has been broken?

Did the mineral break along flat surfaces? *(Please do not break the samples, just make observations)*

If yes, then your mineral has cleavage. If no, then your mineral does not have cleavage. Write "yes" or "no" in the cleavage box on the Mineral Identification Table. If the mineral does not have cleavage, it will fracture into jagged pieces. If the mineral has cleavage, look more closely to see how many directions it cleaves in and how well it cleaves (perfect, good or poor). Add these descriptions to the Mineral Identification Table.

4. Streak: Hold the streak plate on the table with one hand. Grasp the mineral in your other hand, press it firmly against the streak plate and pull it towards you to make a streak. If you press too lightly, it will not streak properly. Record the color of the streak in the streak box on the Mineral Identification Table. If no streak is visible on the streak plate, record "none". Try a couple of different surfaces of the mineral to make a streak.

5. Hardness: Conduct a series of tests with hardness tools to identify the hardness range for your mineral. Begin with the softest tool, your fingernail, and proceed up to glass. Each time evaluate whether your mineral is harder or softer than the material you are attempting to scratch. If the hardness tool can scratch you mineral, your mineral is softer than that tool. If the mineral can scratch the hardness tool, your mineral is harder than the tool. You may have to use a hand lens to see the scratch. *True scratches do not rub off with your finger*. Look up the hardness values of the hardness tools and record whether your mineral is greater than or less that those values in the Mineral Identification Table.

> a. Fingernail test: Try to scratch the mineral with your fingernail. If your fingernail scratches the mineral, find the hardness of a fingernail on the hardness scale and record that the mineral's hardness is less than that number in the box on the Mineral Identification Table and proceed to Step 7. If your fingernail does not scratch the mineral, go to b.
> b. Penny test: Attempt to scratch a copper penny with your mineral. If the copper penny does not scratch, the penny is harder than your mineral. Find the hardness of a copper penny in the hardness scale and record that the mineral's hardness is less than that number and proceed to Step 7. If the mineral scratches the penny, go to c.

c. Steel file/nail test: Attempt to scratch a steel file or nail with your mineral OR you can try to scratch your mineral with the file or nail. If the mineral does not scratch the file/nail OR the file/nail scratches the mineral, your mineral is softer than steel. Find the hardness number of the steel file/nail on the scale and record that the mineral's hardness is less than that number and proceed to Step 7. If the mineral is harder than the steel nail/file, go to d.
d. Glass test: Attempt to scratch a glass plate with your mineral. If the mineral scratches the glass plate, record that the mineral has a hardness greater than the hardness of glass. If the mineral cannot scratch the glass plate, record that its hardness is less than the hardness of glass.

6. Magnetism: Hold a bar magnet next to your mineral: If the magnet moves toward the mineral, write "yes' in the magnetic box on the Mineral Identification Table. If not, record "no".

7. Effervescence: *Put on safety goggles and gloves.* Add a drop of diluted hydrochloric acid or vinegar onto the mineral. Examine the reaction using a hand lens. If the mineral fizzes or bubbles, the mineral is effervescent. If there is no reaction, the mineral is not effervescent. Record "yes" or "no" in the box on the Mineral Identification Table.

8. Compare your test results to a Mineral Identification Key and try to identify mineral type.

Activity II

The purpose of this activity is to further explore how mineral identification tests can help to distinguish between similar looking samples and how color is not the best diagnostic feature.
a. Each group will complete all of the tests described in Activity I and determine the mineral type of each sample. What was the one diagnostic test that was the best for distinguishing between the two mineral types?

AND/OR

b. Each group should complete all of the tests described in Activity I and determine the mineral type of each sample.

Discussion

Activity I:
Which properties were the most helpful for identifying each mineral sample?

Which property was the least helpful?

Which mineral do you think was the easiest to identify?

Activity II:
What was the best diagnostic test to distinguish between the two samples?

Why is it important to do the diagnostic tests to identify minerals, rather than just identifying the sample visually?

Mineral Identification Key (Some Common Minerals)

Mineral	Color	Luster	Cleavage	Streak	Hardness	Magnetic	Effervescence
Bauxite	Red, brown, yellow	Earthy, dull	No	Light brown, white	1-3	No	No
Calcite	Varies[1]	Vitreous, pearly	Yes (perfect, 3 directions)	White	2.5-3	No	Yes
Chaloopyrite	Yellow-gold	Metallic	Yes (poor, 1 direction)	Greenish-black	4	No	No
Dolomite	Varies[2]	Vitreous, pearly	Yes (perfect, 3 directions)	White	3.5-4	No	No
Feldspar	Varies[3]	Vitreous, pearly	Yes (90° angle)	White	6	No	No
Fluorite	Varies[4]	Vitreous	Yes (perfect, 4 directions)	White	4	No	No
Garnet	White to dark gray, red	Vitreous, pearly	No	None	6.5	No	No
Hematite	Red-brown, gray, black	Metallic	No	Reddish-brown	5-6[6]	No	No
Hornblende	Dark green, black	Vitreous, dull	Yes (perfect, 2 directions)	None	5-6	No	No
Magnetite	black	Metallic	No	Black	6	Yes	No
Pyrite	Yellow-gold	Metallic	No	Greenish-black	6	No	No
Pyrrhotite	Yellow-gold	Metallic	No	Dark-gray-black	3.5-4.5	Yes	No
Quartz	Varies[5]	Vitreous	No	White	7	No	No
Talc	Gray, white	Pearly, greasy	Yes (prefect, 1 direction)	White	1	No	No

(1) White, colorless, brown, green-black
(2) White, colorless, pink, brown, gray
(3) Pink, gray, white, red, green, blue, colorless, black
(4) White, colorless, purple, pink, yellow, brown
(5) Light green, purple, yellow, colorless
(6) May appear softer

Mohs Hardness Scale

Mineral Type	Hardness	Hardness Tool Test
Talc	1	Scratched by fingernail
Gypsum	2	
Calcite	3	Scratched by copper penny
Fluorite	4	Scratched by steel file/nail
Apatite	5	
Feldspar	6	Scratches glass
Quartz	**7**	
Topaz	**8**	
Corundum	**9**	
Diamond	**10**	

Mineral Identification Table

Property	**Sample Number**				
	1	**2**	**3**	**4**	**5**
Color					
Luster					
Cleavage					
Streak					
Hardness					
Magnetic					
Effervescent					
Mineral Type					