CCMR Educational Programs

Title:	**Mineral Properties and Identification**
Date Created:	July 20, 2006
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Appropriate Level:	Regents Earth Science (Grades 8-12)
Abstract:	All materials are a product of the substances of which they are composed. By examining the properties of the materials, we can identify them and draw inferences about how they formed, where and when they originated, and how they compare to other materials with the same or similar characteristics. Various methods, both macroscopically and microscopically, are used to determine the properties of unknown materials.
Time Requirement:	Two 80 minute class periods
NY Standards Met:	• Standard 1-Key Idea 1: Indicators 1 and 4 • Standard 4-Key Idea 3: Indicators 1 and 2
Sections to Document:	1. Lesson Plan 2. Teacher Notes 3. Class Notes 4. Mineral Identification Lab 5. Station Sheets 6. Acknowledgements
Equipment/Materials List:	Mineral Class Notes Copy of Mineral Identification Lab (1 per student) Jewelry and crystal(s) for Introduction Story Sugar and Acid Demo: 70mL granulated Sugar (2 portions) 70mL 18M Sulfuric acid (doesn't have to be 18M as long as its concentrated) Sodium Bicarbonate — Water 300mL Beaker — 1 Liter beaker Glass stirring rod — Spatula Gloves — Goggles Copies of EDS, X-Ray diffraction graphs, and Laue diagrams for 5 minerals (I use Graphite, Hematite, Muscovite, an Amphibole, and Quartz) Nine mineral samples (I use Galena, Magnetite, Pyrite, Gypsum, Sulfur, Calcite, Fluorite, Potassium Feldspar, and Olivine)

For each Lab group:

Penny	Glass plate
Iron nail	Streak Plates (black and white)
Safety goggles	Hydrochloric acid (dilute)
Eyedropper	Bar magnet
ESRT	

Lesson Plan

Lesson Plan: Mineral Properties and Identification

Purpose – To have students understand what minerals are made of, how that composition affects the properties of the minerals, and how those properties can be used to identify unknown minerals. They will also know that by identifying minerals by common properties (classifying) they can make inferences about the origin and formation of those minerals and the rocks in which they are found.

Objectives

1. To examine the components of minerals.
2. To examine the properties of minerals.
3. To determine the identity of unknown mineral samples based on those properties.

Materials

Mineral Class Notes
Copy of Mineral Identification Lab (1 per student)
Copies of EDS, X-Ray diffraction graphs, and Laue diagrams for 5 minerals (I use Graphite, Hematite, Muscovite, an Amphibole (Hornblende), and Quartz)
Nine mineral samples (I use Galena, Magnetite, Pyrite, Gypsum, Sulfur, Calcite, Fluorite, Potassium Feldspar, and Olivine)
For each Lab group:

Penny	Glass plate
Iron nail	Streak Plates (black and white)
Safety goggles	Hydrochloric acid (dilute)
Eyedropper	Bar magnet
ESRT	

Jewelry and crystal(s) for Introduction Story
Sugar and Acid Demo:

70mL granulated Sugar (2 portions)
70mL 18M Sulfuric acid (doesn't have to be 18M as long as its concentrated)

Sodium Bicarbonate	Water
300mL Beaker	1 Liter beaker
Glass stirring rod	Spatula
Gloves	Goggles

Time Budget

2 Class periods (150 minutes)

Schedule

First Class Period

15 minutes – Story on cursed jewelry and healing crystals
20 minutes – Sugar and Sulfuric acid Demonstration
20 minutes – Class notes on Minerals
10 minutes – Presentation of Lab and Lab Directions

Second Class Period

5 minutes – Lab Directions
60 minutes – Mineral Identification Lab
10 Minutes – Discussion of Results and Questions

Assessment

Lab Questions
Quiz on notes
Identification of 1 Unknown Sample

Teacher Notes

1. To start this topic I would show the students the jewelry and tell them the story that it was supposedly cursed. The jewelry needs to have a mineral in it somewhere. A large ring, earrings, or a brooch works well. I would also show them the crystal explaining that it supposedly has healing powers. A crystal in a "mystic" shape like a pyramid or diamond is good. Ask them how we would determine whether these claims are true.
2. We would then go into a discussion of the properties of materials and what those properties mean for the material. Does color have a huge importance for a material? Are some materials identical in appearance but very different in properties? Does what makes up the material determine how it acts, how it will appear, and what it is used for? Besides the color question, all of the answers are yes.
3. To prove that we have to look closer than just outward appearances, I would do the sugar and acid demonstration:
    a. Prepare the concentrated sulfuric acid beforehand and put it in a graduated cylinder HIDDEN in a sink. Before the students come in!
    b. Put on your gloves and goggles.
    c. When you start the demo, present two more identical grad cylinders to the students. Put one down into the sink and fill it with water. Take it out and put it on the front table. Put the second cylinder into the sink and fill it with water, but leave it in the sink and pull out the grad cylinder with the sulfuric acid and place it on the front table. Make a mark on the base of the cylinder (I use a black wax pencil) with the acid so you know which is which.
    d. As you talk about the properties of materials, ask the students what will happen when you mix water with sugar. I act stupid and say "Are you sure?" I then mix the sugar with the water and stand back.
    e. When there is no reaction (just what the students expect) I say "Huh? That's weird." Or something to that effect. Then I say "I wonder if this water will get a reaction." Some student will always say that it is the same stuff and nothing will happen again.
    f. Then mix the sulfuric acid with the sugar. Act perplexed at first and then STAND BACK!
    g. After the reaction, talk more about how appearances can be deceiving. Explain that we need to look at all of the properties of a substance to determine what it is.

    Please do this reaction on your own, or preferably with your chemistry teacher, before doing it for the class. There is a complete description of this demonstration at http://chemlearn.chem.indiana.edu/demos/TheDehyd.htm. It is where I got my amounts and concentrations.
4. I would then introduce the Rocks and Minerals topic, and present the mineral notes to the students.
5. After they are done with the notes, I would introduce the lab. Explain what each lab group will be doing and show them all of the materials and how they work.

We will already have gone over the main mineral characteristics and what the students should look for. I usually go through one of the nine unknown mineral samples with the class and show them how I would identify the characteristics and use those properties to identify the mineral.

6. I would then show them the five mineral sample stations. Each station would have a mineral sample, accompanied by one or more of the EDS (Energy Dispersive X-Ray Spectrometer) graphs, X-Ray diffraction pattern graphs, or Laue diagrams. The stations would be set up around the room, not at the lab desks. The students would be told that these other sources of gathering data are sometimes invaluable in determining the properties of a mineral. I would also give a brief explanation of what each one is and how the data is collected. They should then use the information at each station to answer the question(s) that are posed at the station.
7. Station 1 – Graphite, Station 2 – Hematite, Station 3 – Muscovite, Station 4- Amphibole, Station 5 – Quartz.
8. After the students are done, I would then go back to my cursed jewelry and healing crystals, and ask the students how they might determine:
    1) What the materials are.
    2) If the materials are any different from ordinary samples of the same material.

Class Notes

I. Atomic Review

A. Protons
1. Found inside the nucleus
2. Have a positive charge
3. Weigh one a.m.u.

B. Neutrons
1. Found inside the nucleus
2. Have a neutral charge
3. Weigh one a.m.u.

C. Electrons
1. Found outside and around the nucleus
2. Have a negative charge
3. So light we say that it has no weight

D. Atoms
1. Always have the same number of protons and electrons
2. They are electrically neutral
3. The combine to form elements and compounds.

E. Elements
1. Made of only one kind of atom
2. Examples are nickel, iron and oxygen

F. Compounds
1. Made up of more than one kind of atoms
2. Examples are water, carbon dioxide, and calcium carbonate

G. Atoms in the Earths crust
1. Of the more than 100 elements known, only a few make up most of the Earths land, air, and water.
2. ESRT pg. 11

II. Minerals

A. Composition of Minerals
1. Minerals are made up of groups of atoms
2. Some minerals are made of only one type of atom. They include copper and sulfur.
3. Some minerals are made up of two or more types of atoms. They include halite and calcite.

B. Minerals form Rocks

1. Some rocks are made of only one type of mineral. They are called monomineralic rocks.
2. Some rocks are made up of two or more minerals. They are called polymineralic rocks.
3. Only 20 – 30 of the known 2,500+ minerals make up most rocks. They are called the rock forming minerals.

C. Mineral Properties

1. Minerals have physical and chemical properties that can be used to identify them.
2. These properties depend on the types of atoms that make up the mineral and the arrangement of the atoms within the mineral.
3. Some of these properties are:
   a. Color
   b. Hardness
   c. Luster
   d. Streak
   e. Cleavage or fracture

D. Mineral Structure

1. The structure of the minerals depends on the atoms that come together to form the mineral.
2. The silicate minerals have the basic structure of a silicon-oxygen tetrahedron.
3. The different silicate minerals have different properties depending on how the tetrahedrons fit together.

Mineral Identification Lab

Earth Science   Name ___________________________________

Section _________   Date ___________________

Lab #   – Mineral Identification

I. Purpose – When you have finished this investigation, you should be able to identify mineral samples based on their physical and chemical properties.

II. Materials –
- Unknown mineral samples
- Five Mineral Sample stations with Data
- Penny
- Glass plate
- Streak Plates
- Hydrochloric acid
- ESRT
- Bar magnet
- Iron nail
- Safety goggles
- Eyedropper

III. Procedure – See attached Lab Sheet

IV. Observation and Data Collection – See attached data chart.

V. Conclusion –
a. List the properties that are most useful in identifying minerals.
b. Why are other mineral properties less useful for identification?

Vocabulary

1. **Mineral:**

2. **Crystal:**

3. **Luster:**

4. **Streak:**

5. **Hardness:**

6. **Cleavage:**

7. **Fracture:**

8. **Chemical/Physical Property:**

Procedure A:

1. Observe if the mineral shows cleavage or fracture and record it in the data chart.

2. Test the hardness of the mineral and record it in the data chart.

3. Observe and record the color of the sample.

4. Test the streak of the mineral. Use the white plate for dark minerals and the dark plate for light colored minerals. Record your findings in the data chart.

5. Observe the luster of the sample and record it in the data chart.

6. Note any other characteristics (magnetic? bubbles with acid?) and record them in the data chart.

7. Using the ESRT to identify the mineral sample. Record your answers in the data chart.

Procedure B:

1. Go to each of the five stations set up around the room on the counters. At each station you will find a mineral and some data about the mineral listed or shown in a graph.
2. Use the data to answer the question(s) at each station. Be sure to put all of your answers on the lines below.

1. a)____

   b)____

2. a)____

   b)____

3. a)____

4. a)____

   b)____

5. a)____

Moh's Hardness Scale

Mohs Mineral Hardness Scale

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

* A fingernail will scratch anything softer than 2.5

* A copper penny has a hardness of 2.5 to 3.5

* An iron nail has a hardness of 3.5 to 5.5

Data Chart 1

MINERAL IDENTIFICATION CHART

Sample Letter	Color	Streak	Hardness	Cleavage/ Fracture	Luster	Other	Mineral Name
A							
B							
C							
D							
E							
F							
G							
H							
I							

Questions

1. What is the difference between cleavage and fracture when describing minerals?
2. Why is color alone not a reliable means of identifying a mineral?
3. Why is streak a more reliable property than color in mineral identification?
4. How is the hardness range for a mineral determined?
5. What mineral is usually identified using the acid test.

Report Sheet

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____________________

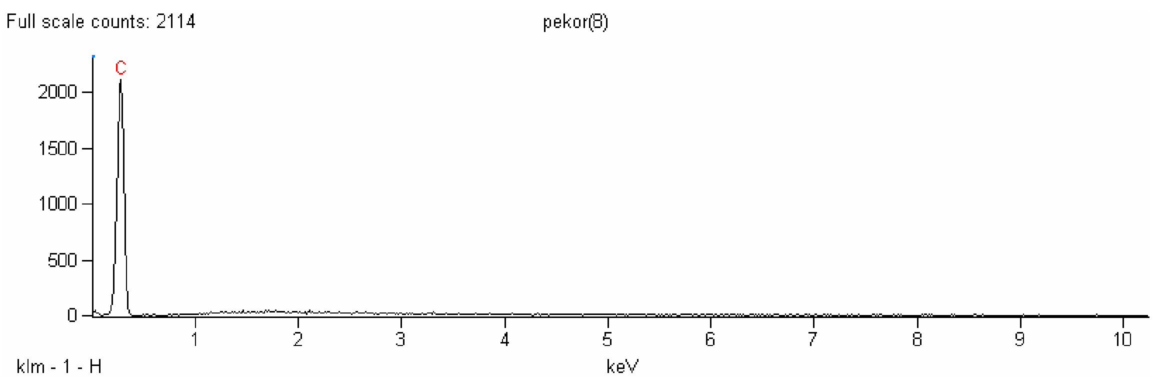
STATION 1

The mineral at this station is GRAPHITE. It has a very simple chemical make-up. It is pure carbon (C). Since there is only a single element in this mineral, you would think that if you subjected it to a lot of very specific testing with an Electron Microprobe it would be very easy to identify. And you would get a very precise answer back from the machine, that this was indeed carbon. The problem is, if you tested diamonds in the Electron Microprobe, it would give you the exact same answer. Obviously, diamond and graphite are not the same mineral.

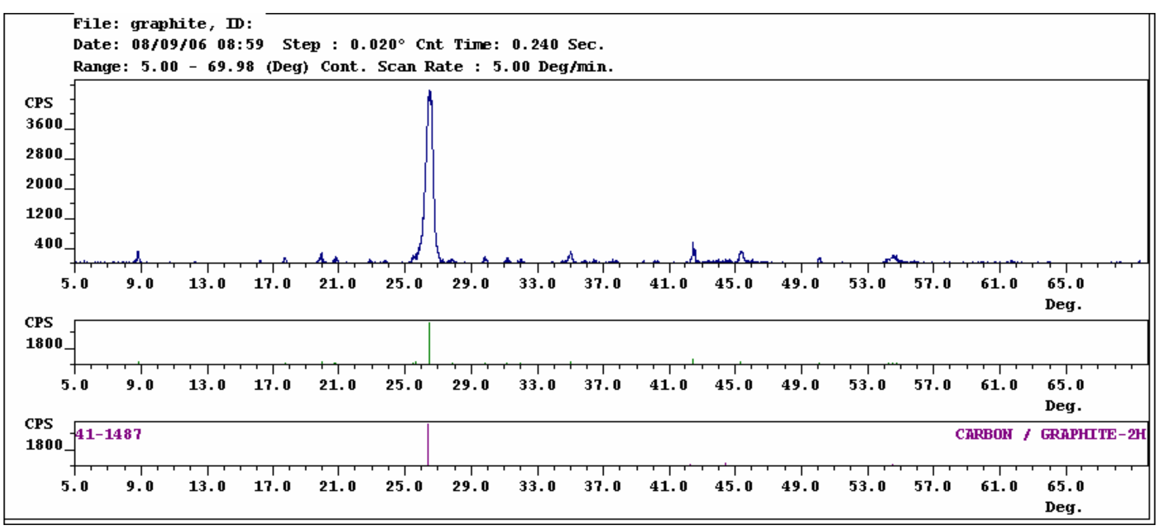
Question:

a) Specifically, what other test(s) could you perform to determine the difference between diamond and graphite?

b) Would the Electron Microprobe present you with the same problem if you tested Calcite and Dolomite?



Graphite Energy Dispersive Spectrograph



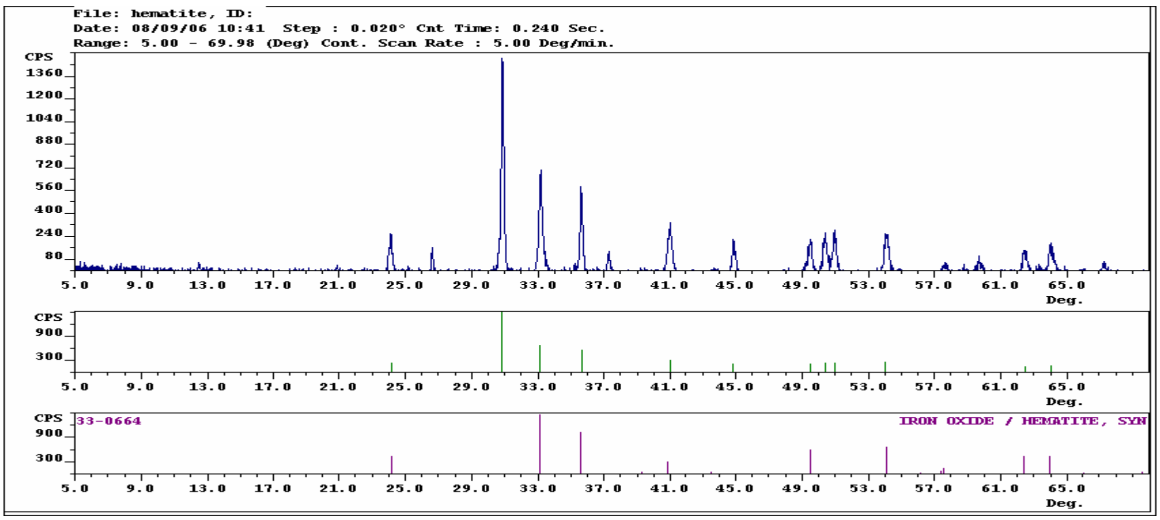
Graphite X-Ray Diffraction Graph

STATION 2

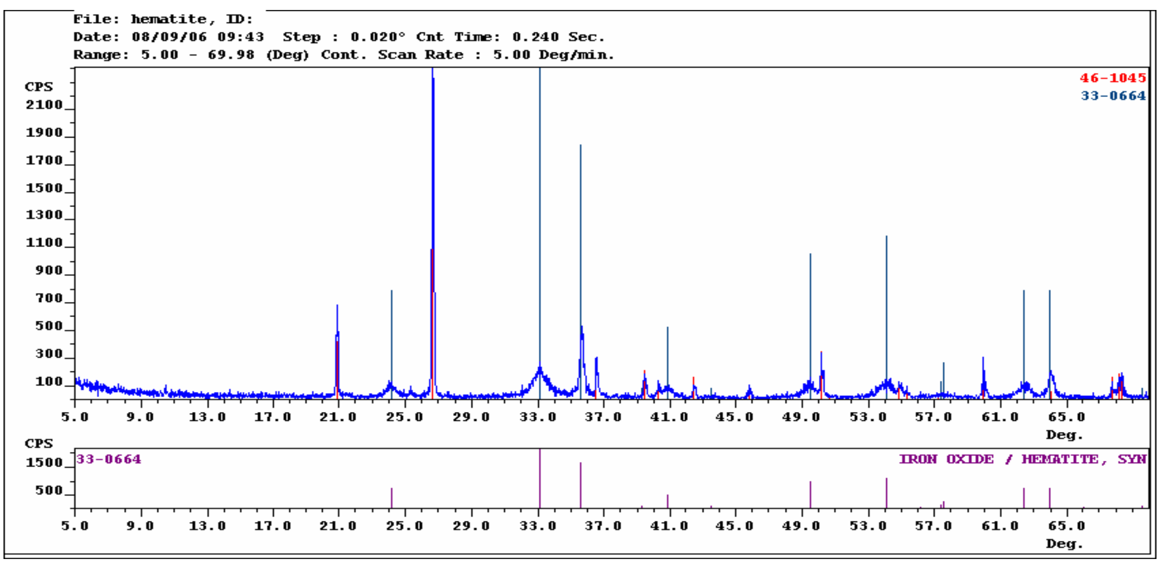
The mineral at this station is HEMATITE. You can see that there are 3 different forms of hematite in the jars, and they all look very different. Also, if you look at the graphs below, the hematite 1 and hematite 2 samples do not appear to be exactly alike.

Question: a) What other characteristics might you look for to confirm that all three samples of hematite are really hematite?

b) What could account for the fact that the graphs below have peaks present other than the peaks that would just be shown for hematite?



Hematite 1

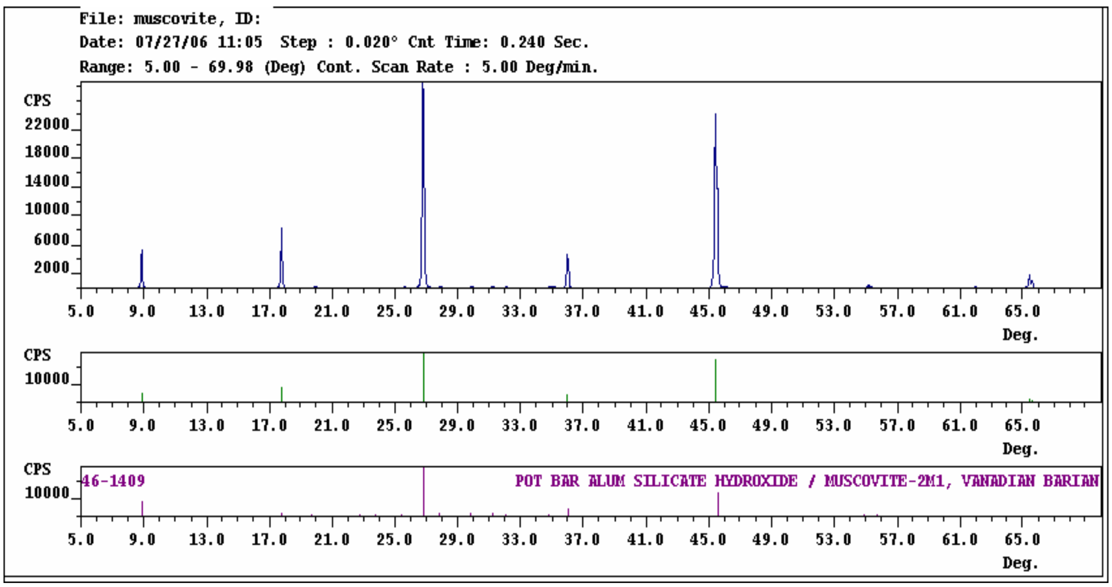


Hematite 2

STATION 3

The mineral at this station is MUSCOVITE (MICA). As you can see, it is very similar in appearance to the Biotite (Mica) that you identified in the first part of the lab. If you look at the graph below this, you will see that when you subject the Muscovite to X-Ray diffraction studies, there are several peaks at very regular intervals (one peak at about every 9 degrees).

Question: a) Describe the relationship of the physical structure of the Muscovite to the **pattern** shown in the X-Ray diffraction data?



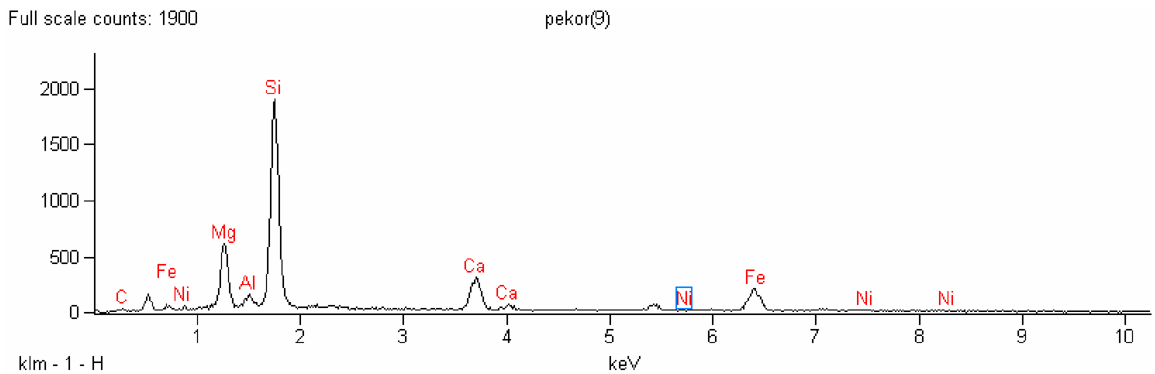
Muscovite X-Ray Diffraction Graph

STATION 4

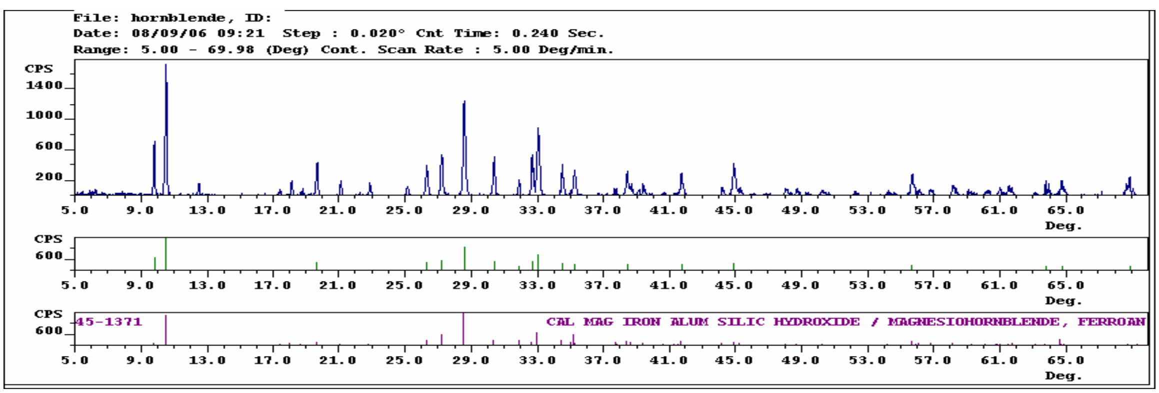
The mineral at this station is an AMPHIBOLE (HORNBLENDE). Amphibole is the name for a group of minerals, hornblende being on of those minerals. They tend to have a very complex chemical and physical structure as can be seen in the Electron Microprobe EDS graph and the X-Ray diffraction graph below.

Question: a) Would you expect hornblende to be hard or easy to identify if you had an unknown sample?

b) Explain why you chose your answer to Question A.



Hornblende Energy Dispersive Spectrograph

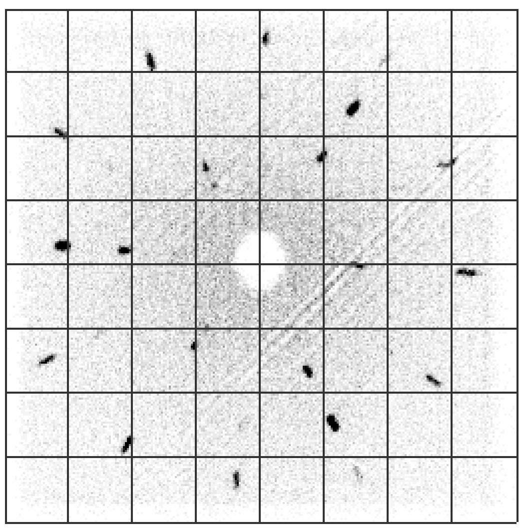


Hornblende X-Ray Diffraction Graph

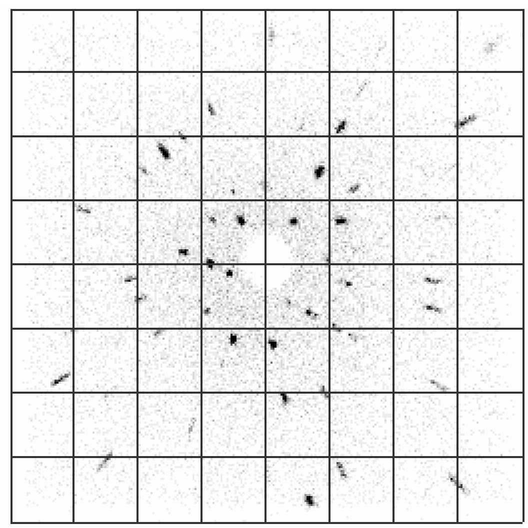
STATION 5

The mineral at this station is QUARTZ. It is one of the more common minerals that are found in the earth's crust. It is composed of silicon and oxygen, bonded in the silicon-oxygen tetrahedron that was talked about in class. This regular crystal structure can be seen in the picture at the bottom of the page. This picture was taken on a Back Reflection Laue machine. However, if you place a piece of glass in the Laue machine, the picture is very different, as seen below. Although glass is exactly the same as quartz chemically, both being made of silicon and oxygen, there is not a nice, regular pattern.

Question: a) What possible reason could you come up with that would account for the fact that glass and quartz, both with the same chemical make up, would have such very different patterns on the Laue machine?



Quartz



Glass

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