Mineral identification I and Crystal chemistry

Lab groups:

Topic	1	2	3	4	5	6
A	Carlile	Wheeler	Brady	Bowerman	Darst	Messer
B	Ault	Sayler	Bratz	Kaemingk	Lembrick	Lykken
C	Leighton	Marrs	Futch	Isaacson	Johnson	Benedetti
D	Williams	Marshall	Walter	Henrichs	Montgomery	Youngquist

Instructions for this exercise

The main goal of this lab is introducing you to the first set of minerals you will learn about in detail. In the last lab, you learned (and taught) a number of techniques that you can use to differentiate minerals from each other. In this and the next few labs you will use these techniques to make a catalog from which you can study.

Your task is to learn the important features of each mineral. One important feature of every mineral is its chemical composition. Most geologists, in identifying a mineral, will ask what other minerals it was found with, or what rock type it was found in. This is because minerals that form together frequently share aspects of their chemistry.

← For each mineral, you should therefore record:

1. Name
2. Chemical formula (if the formula is complex, then only the elements, not their proportions – see below)
3. Geologic occurrence (not locations, but environments. e.g., Pyrite – sulfide ore deposits)
4. Identifying Characteristics. This is the key. What is it important to know about this mineral to be able to identify it? To distinguish it from most minerals is easy, but what about minerals that share many features? (i.e., for pyrite, the important features are not those that distinguish it from quartz, but those that distinguish it from chalcopyrite and pyrrhotite – see Plate II in your text)

Cooperative strategy:

We will be doing the same type of exercise as in the last lab. You are a member of a team (1-6), and you must become an expert on a topic (A-D). You will develop answers to your topic material first on your own, then you will share your answers with the other experts on that topic from the other 5 teams. Finally, we will go through four rotations in which each expert will teach their topic to the other members of their team.

Each team will turn in a single lab report, but you are responsible for knowing all the material in this lab. In addition, you must **critically review** the results of the other experts on your team while they are teaching.

Topic A, Mineral Identification

Using your text and any other reference materials you wish, learn to identify the following minerals and distinguish them from similar ones. Turn in a sheet with the four items mentioned above for each mineral.

← Graphite
← Sulfur
← Chalcocite
← Bornite
← Galena
← Molybdenite

Note: Only perform destructive tests on mineral samples if your professor says it is okay to do so!

Topic B, Mineral Identification

Using your text and any other reference materials you wish, learn to identify the following minerals and distinguish them from similar ones. Turn in a sheet with the four items mentioned above for each mineral.

- ← Sphalerite
- ← Chalcopyrite
- ← Stibnite
- ← Pyrite
- ← Marcasite

Note: Only perform destructive tests on mineral samples if your professor says it is okay to do so!

Topic C, Coordination Number & Polyhedra

Examine the ball-and-stick model labeled "Mica" (it is Muscovite). In this model, the gold balls are K, the gray balls are Al, the light green balls are hydroxls (OH^{-1}), the red balls are oxygen, and the black balls are both Al and Si (3/4 of them are Si, 1/4 are Al). Be gentle with these models! They are expensive!

- ← What is the coordination number of the Si? What would we call its coordination polyhedron?
- ← Examine figure 11.33 (p. 466) in your book, which shows a diagram of this same structure, but with the black balls replaced by their coordination polyhedra. Visualize the correspondence between these two renderings of the same crystal structure. Which do you think is easier to understand?
- ← What is the coordination number of the Al represented by the gray balls? Name its polyhedron.
- ← What is the coordination number of K?

Examine the two sphalerite models (be very gentle, particularly with the ball-and-stick model!)

- ← Compare the two models. What element forms the corners of the tetrahedra?
- ← In what orientation should the ball-and-stick model be placed to be analogous to the polyhedral model? (A description or a rough sketch would be fine)
- ← The ball-and-stick model represents a unit cell of the structure (i.e., by repeating the model in three dimensions, one would replicate the whole crystal structure). The formula for sphalerite is ZnS. Why, if the formula requires there to be as many Zn atoms as S, are there so many more Zn balls in the model than S? Resolve this apparent contradiction.

Examine the two Halite (NaCl) models

- ← Compare the two models. If white balls represent Cl in both, then how many **complete** octahedra are in the ball-and-stick model?
- ← What is the coordination number of Na?

Thinking about all three ball-and-stick models in this topic,

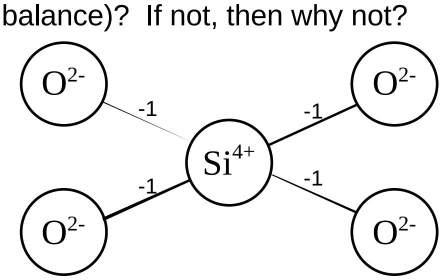
- ← Are the sizes of the atoms/ions in the models correct relative to the distances between the atoms/ions?

Topic D, Local Charge Balance

Examine the diamond and graphite models. Every atom is carbon.

- ← Do they obey Pauling's Rule of electrostatic valency (i.e., local charge balance)? If not, then why not?

We can diagram local charge balance around a cation or anion. Here is the diagram for Si^{4+} in quartz:



Examine the Kaolinite model. In it, the gray balls are Al, the red are O, the black are Si, and the light green are hydroxyl (OH^{-1}).

- ← Are the sizes of the atoms/ions in the models correct relative to the distances between the atoms/ions?
- ← Show charge balance around a Si, as in the diagram above. On each oxygen, what is the charge that is not balanced by the central Si in your diagram?
- ← There are two types of oxygens: those linked to one other Si, which receives all the remaining charge, and those linked to 2 Aluminimums, which must split the remaining charge between them. Be sure you understand this, and them show the charge balance around an Al.

In lizardite, a closely related mineral, the Al is replaced by Mg, and there are more of them (each two Al are replaced by three Mg). This means that the oxygens that were bonded to 2 Aluminums are, in lizardite, bonded to 3 Magnesiums instead. (If you sight along the Aluminums in the model in the right direction, you can see holes where the third Mg would go). In addition, each hydroxyl is shared not by two Al (as in Kaolinite) but by 3 Mg.

- ← Show the local charge balance around one of these Mg in lizardite.