

Feldspar Minerals and Triangle Diagrams

**Slides from lecture preceding
Feldspar Triangles Exercise**

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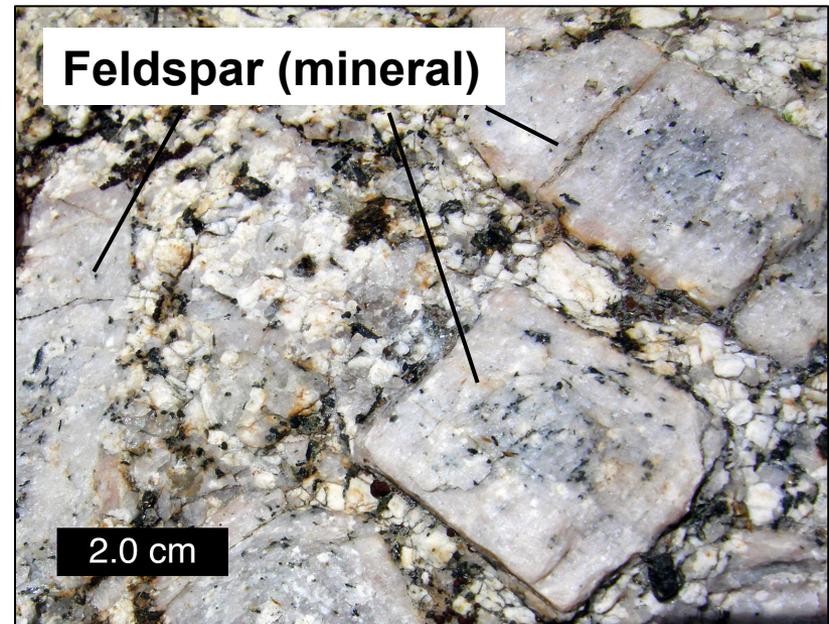
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Why Study Minerals?

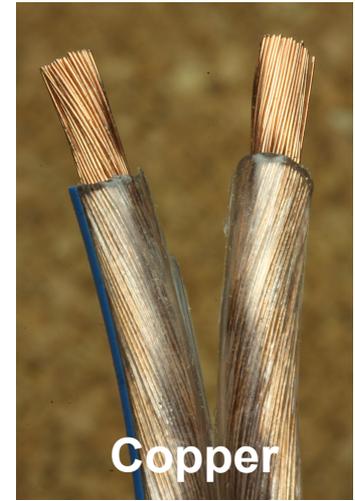
- **Earth is composed of rocks**
- **Rocks are composed of minerals**
 - **Rocks are nature’s “books”**
 - **Minerals are the “words” in the books**
- **Minerals help us read Earth’s history**

Granite (rock)



How Are Minerals Used?

- **Practical applications:**
 - **Industry**
 - **Precious metals**
 - **Health**
- **Geologists specialize...**
 - **Types (clay)**
 - **Places (mantle)**



https://commons.wikimedia.org/wiki/File:Pencil_macro_2_kamranki.jpg

https://commons.wikimedia.org/wiki/File:Lautsprecherkabel_Makro_nah.jpg

https://www.amazon.com/Crayola-Chalk-Assorted-Colors-Sticks/dp/B00441UWT5G/ref=sr_1_6?ie=UTF8&qid=1527535851&sr=8-6&keywords=crayola+chalk

<https://jet.com/product/Special-Kitty-Fresh-Scent-Premium-Clay-Cat-Litter-25-Lb/8831e20707d114d80bec5745920cfd5a>

What Is a Mineral?

1. Naturally occurring (nothing synthetic)

2. Inorganic (not carbon-based)

3. Solid

**(no liquids
or gases)**

Calcite crystal



The Rest of the Definition

4. Chemical composition

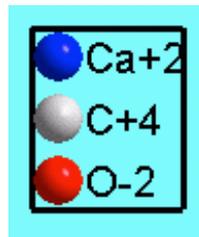
- **Examples:**

calcite = CaCO_3

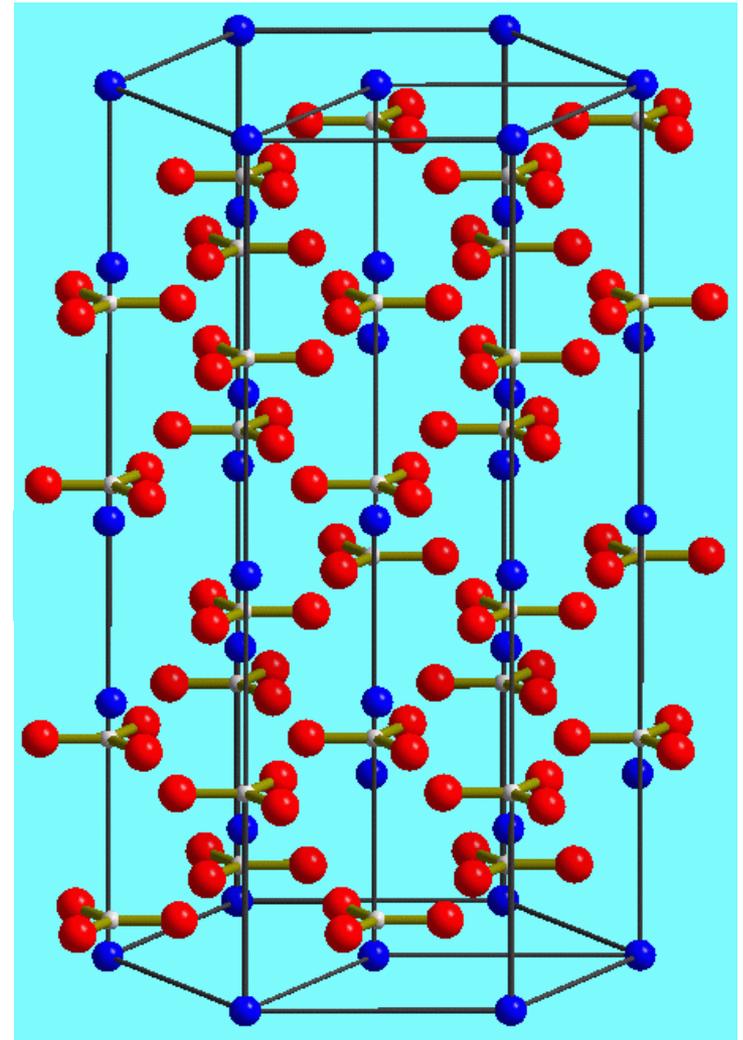
quartz = SiO_2

5. Orderly internal arrangement

- **Atoms form a crystalline structure**



Crystal structure of calcite

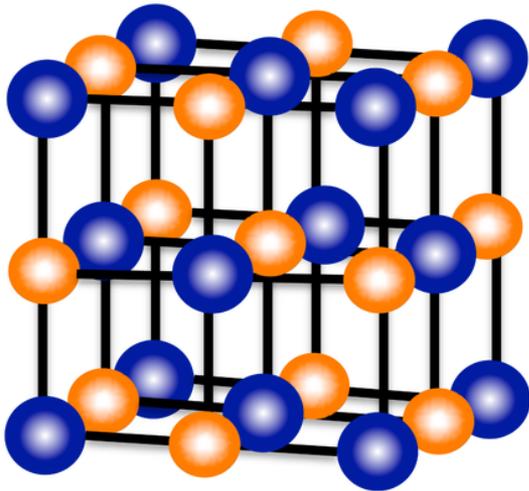


Example: Halite

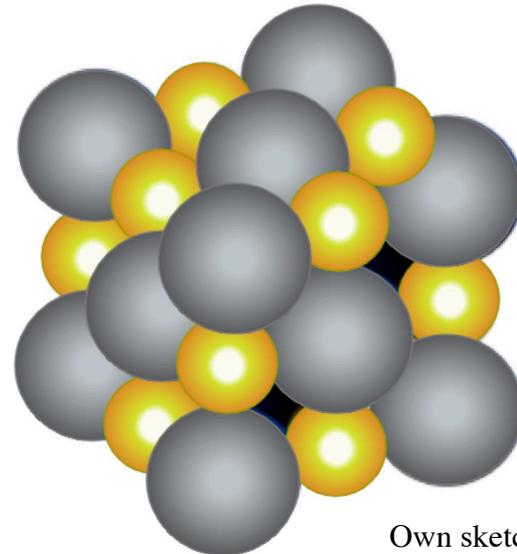
- **Composition**
 - **NaCl (sodium chloride)**
- **Atomic structure**



<http://commons.wikimedia.org/wiki/File:Halite-nb61a.jpg>



https://commons.wikimedia.org/wiki/File:Ccp_structures.png



Own sketch

How To Identify Minerals?

- **Determine...**

- **Exact composition**
 - **Precise structure**
- Time-consuming
and expensive**

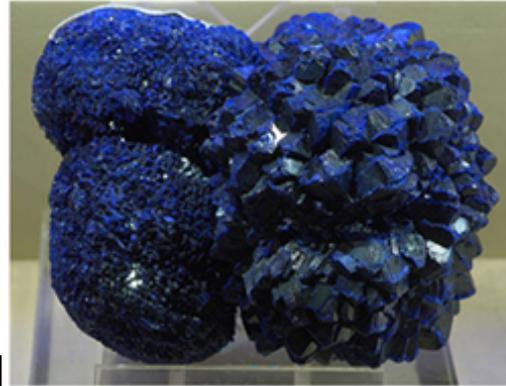
- **Check...**

- **Physical properties**
 - **Each mineral is unique**
- Easy and
low-tech**

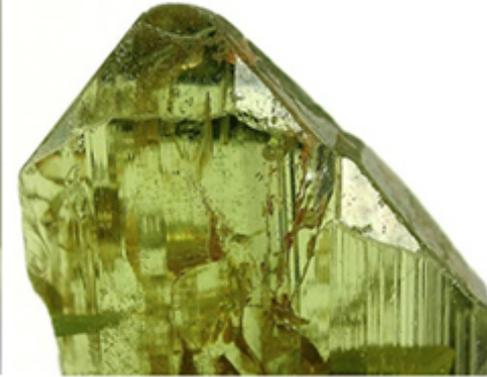
Physical Properties of Minerals

- **Color: easy but not always enough**

Azurite



Olivine



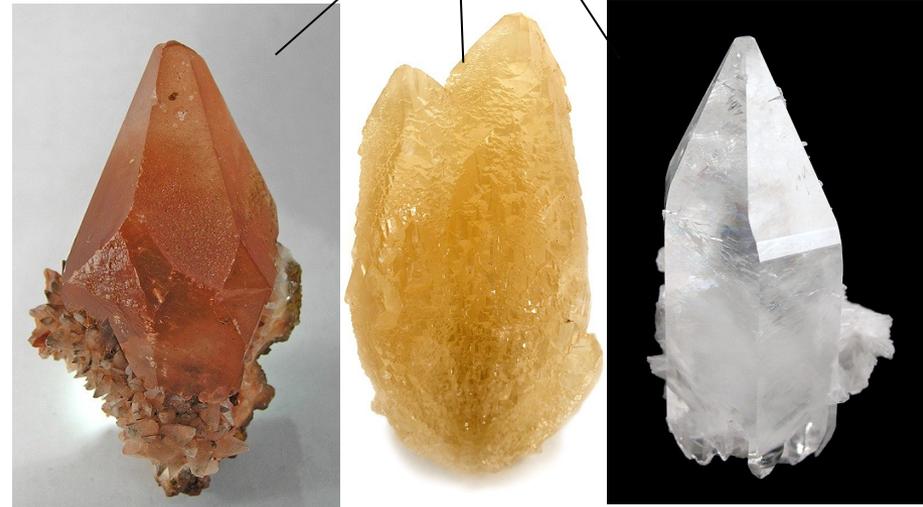
https://commons.wikimedia.org/wiki/File:Azurite_from_China.jpg

<https://commons.wikimedia.org/wiki/File:Forsterite-Olivine-tm14b.jpg>



Quartz

Calcite



<https://commons.wikimedia.org/wiki/File:Calcite-119660.jpg>

<https://commons.wikimedia.org/wiki/File:Calcite-120675.jpg>

<https://commons.wikimedia.org/wiki/File:Calcite-120678.jpg>

https://commons.wikimedia.org/wiki/File:Amethyst_quartz.jpg

https://commons.wikimedia.org/wiki/File:Siim_Sepp-Quartz_2005.jpg

<https://commons.wikimedia.org/wiki/File:QuartzRose.jpg>

Physical Properties: Cleavage

- **Def: tendency to split along flat surfaces**
 - **Due to weakness in atomic bonds**
 - **Cleavage planes develop when a mineral *breaks***

1 direction



<https://commons.wikimedia.org/wiki/File:Muscovite-120514.jpg>

3 direction $\neq 90^\circ$



[https://commons.wikimedia.org/wiki/File:Calcite_10\(Chine\).jpg](https://commons.wikimedia.org/wiki/File:Calcite_10(Chine).jpg)

3 directions = 90°



<https://commons.wikimedia.org/wiki/File:Galena-207232.jpg>

Physical Properties: Striations

- **Def: very thin parallel lines on cleavage planes or crystal faces**
 - **Form by regular variations in atomic structure**

Pyrite



<https://commons.wikimedia.org/wiki/File:Pyrite-Tetrahedrite-Quartz-184642.jpg>

Tourmaline



<https://commons.wikimedia.org/wiki/File:Elbaite-118179.jpg>

Minerals on a Triangle Graph

- **Graphs**
 - **1 variable: line**
 - **2 variables: plane (X- & Y-axes)**
 - **3 variables?**
- **To use a triangle diagram...**
 - **$A + B + C = 100\%$**
 - **Let A, B, and C = vertices**
 - **Points = combinations of A, B, and C**

Triangle Diagrams

- Vertices

- 100% A (or B or C)

- Blue lines

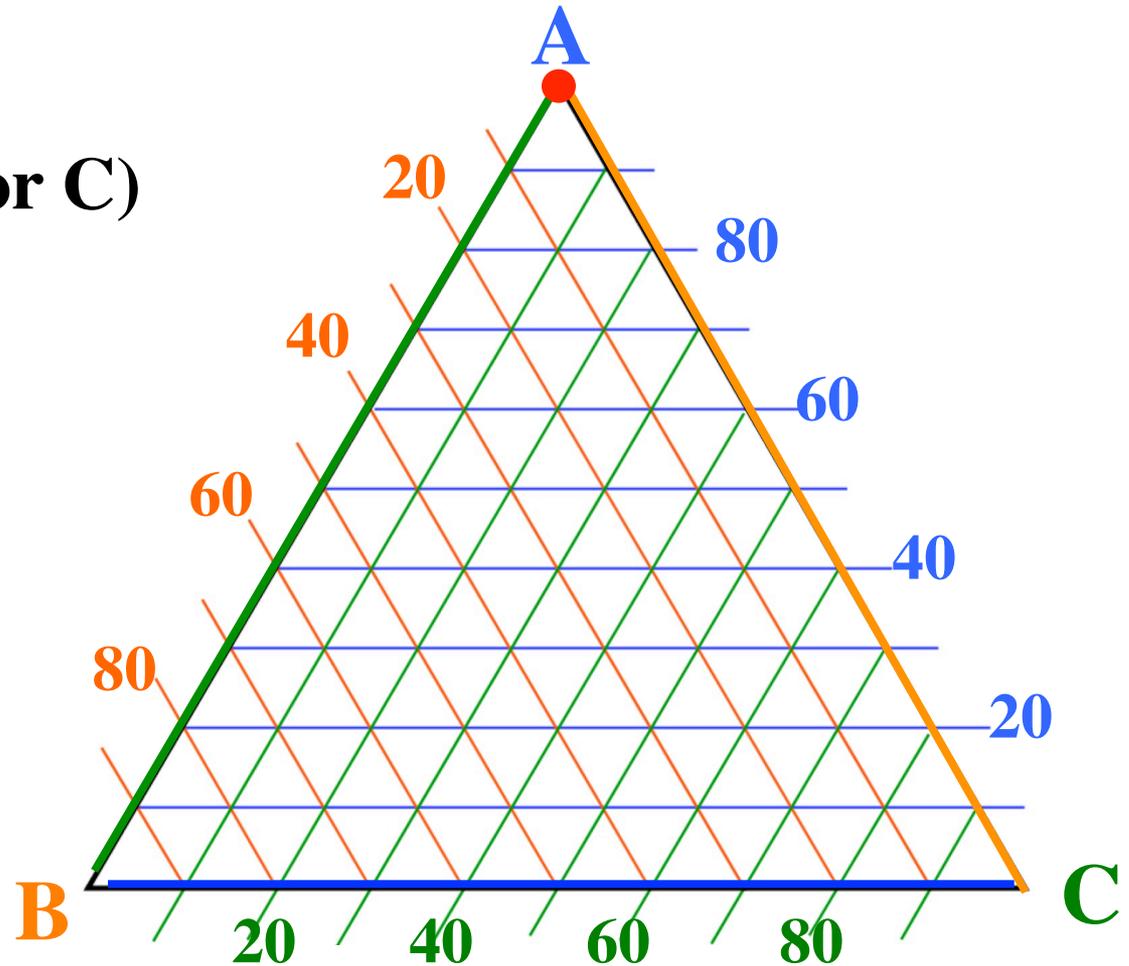
- 0-100% A

- Orange lines

- 0-100% B

- Green lines

- 0-100% C



Points on a Triangle

- Points on sides

- 50% A, 50% B

- 30% A, 70% C

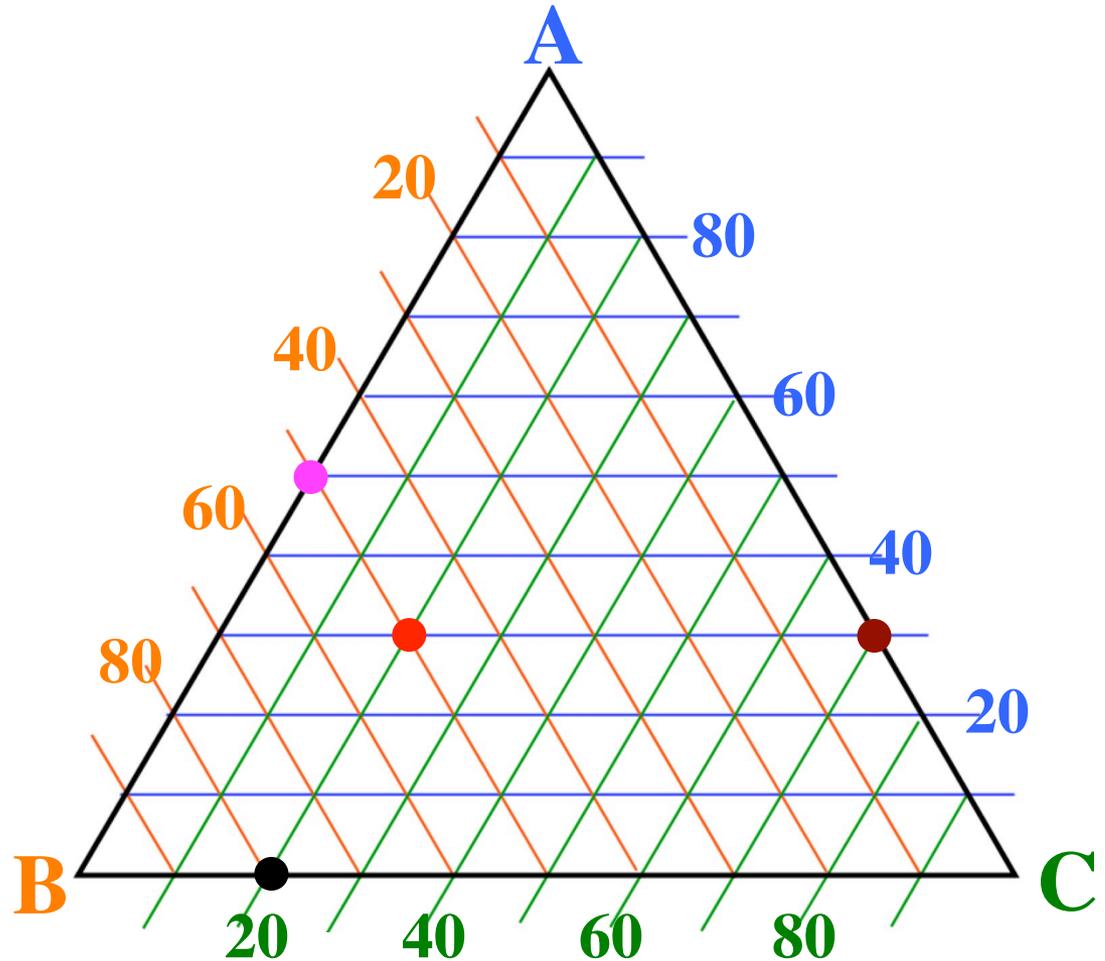
- 80% B, 20% C

- Interior points

- 30% A

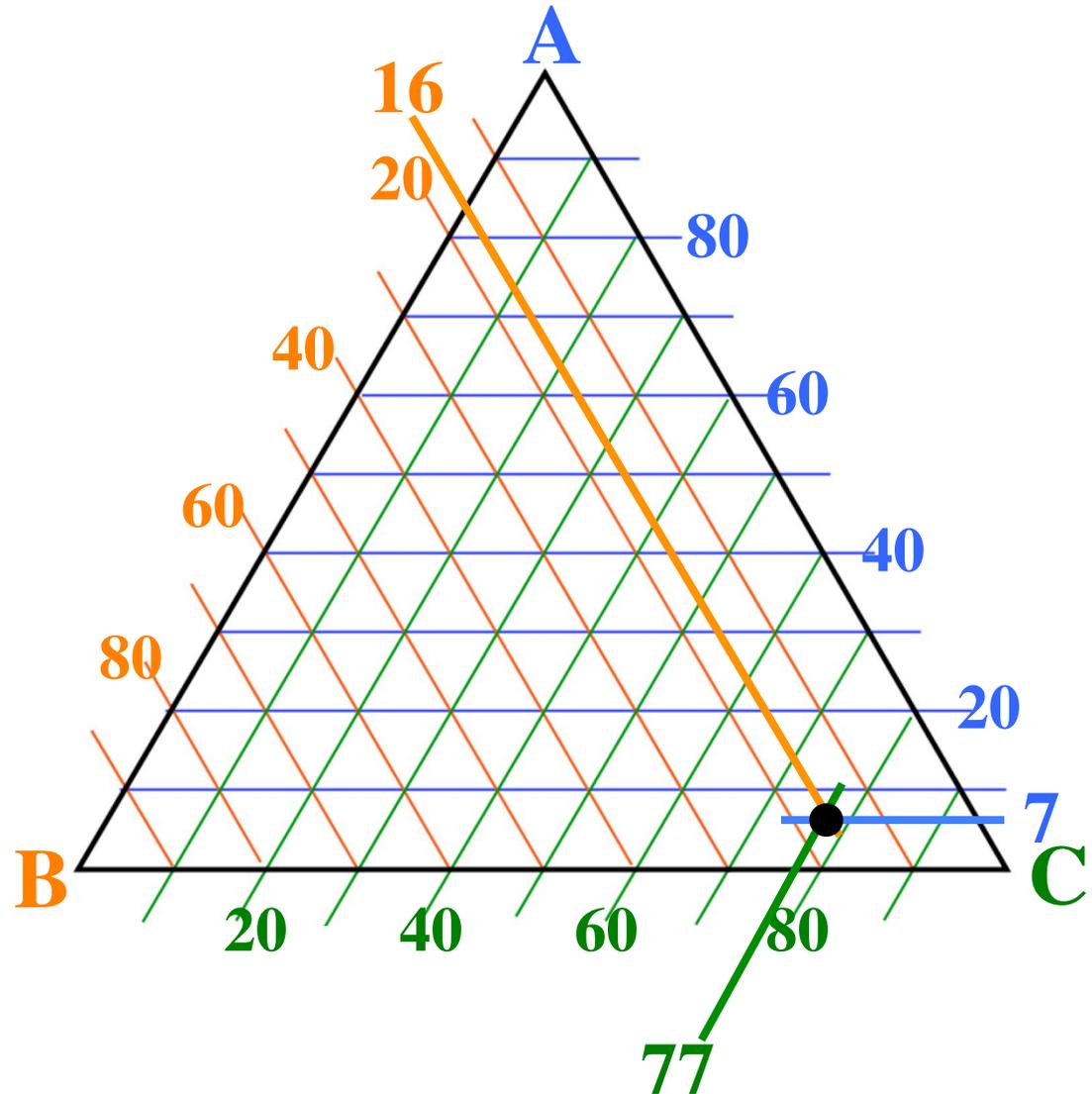
- 50% B

- 20% C



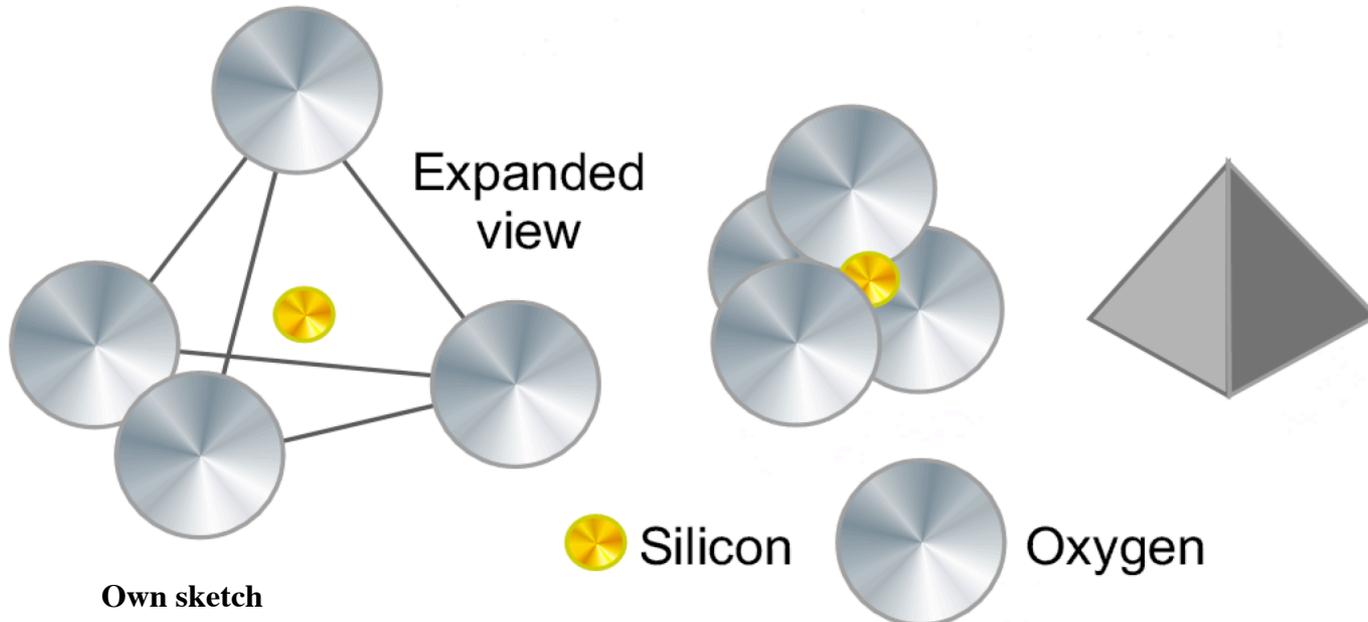
Coordinates of Black Point?

- **A = 7**
- **B = 16**
- **C = 77**



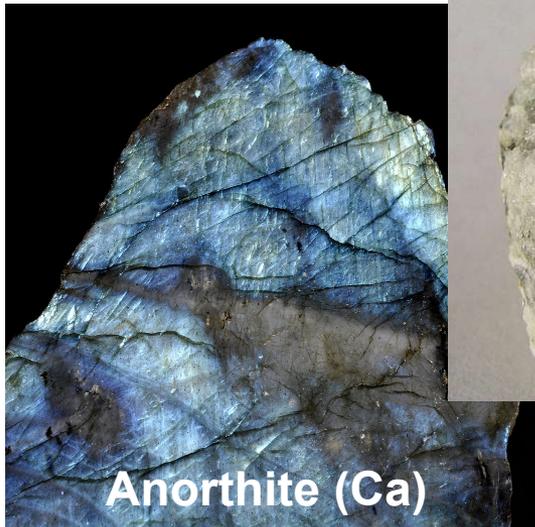
Silicate Minerals

- **Def: contain silicon (Si) + oxygen (O)**
 - **Elements arranged in a tetrahedron**
 - **Most common and largest group** *(95% of crust)*

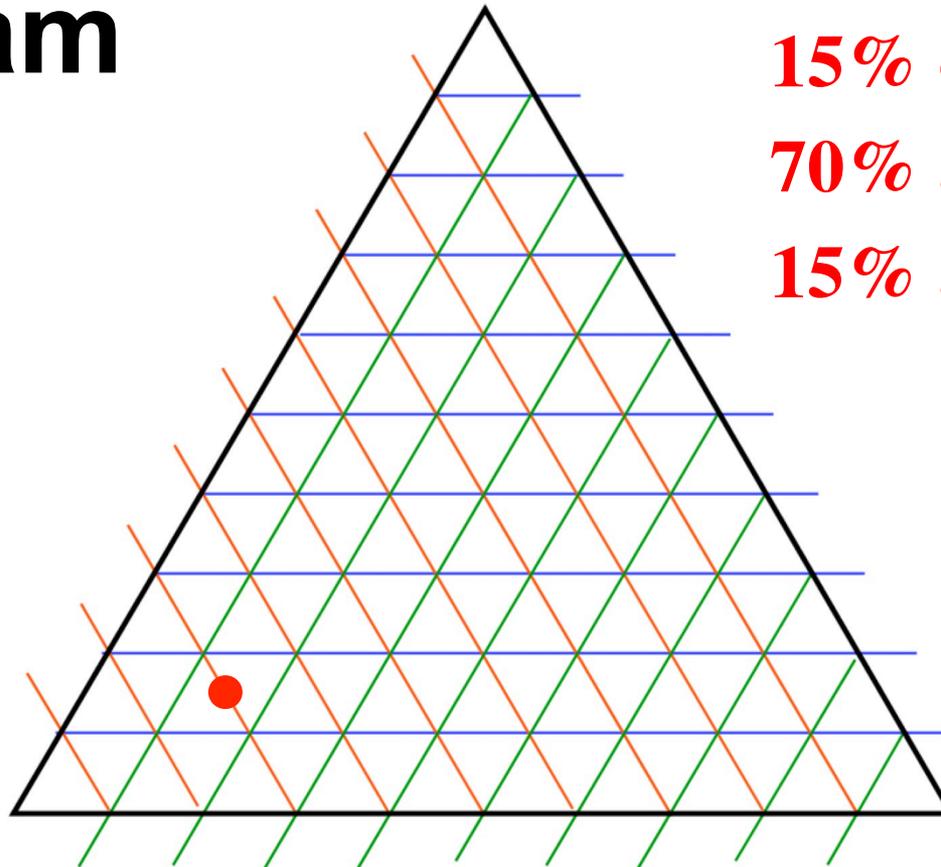
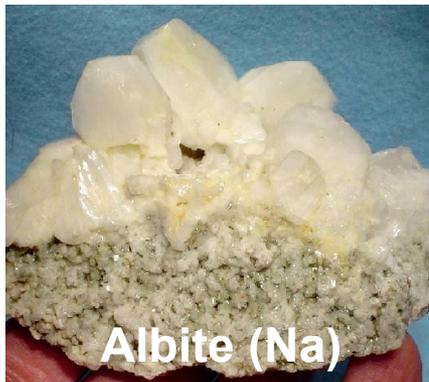
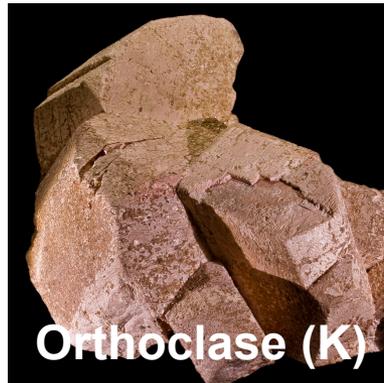


Feldspars

- Subgroup of silicates with several closely related minerals
 - Slightly different compositions/mixtures



Feldspars on a Triangle Diagram



15% orthoclase
70% albite
15% anorthite

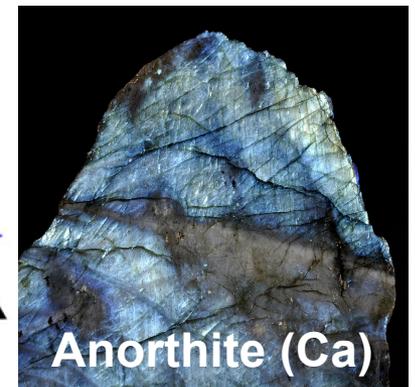


Image sources on previous slide

Teaching Notes and Tips

This exercise is divided into three complementary sections. The exercise may be completed in one extended laboratory period, or individual sections may be assigned as separate, shorter activities or as homework.

The Excel workbook file includes two worksheets that contains the key. The workbook given to students should have only the K-Na-Ca feldspars and Ba feldspars worksheets.

In Part II, students would ideally handle physical specimens of orthoclase, albite, and anorthite. If samples are available, each one should illustrate the two cleavage directions at 90° for feldspars.

Using the labradorite form of plagioclase to represent anorthite is recommended because of its color, iridescence, and striations. Alternatively, the instructor may provide the sample images and tests illustrated in the Feldspar Properties file (PDF) either in electronic form or as hard copy.

Some students may not be familiar with the concept of charge balance in chemical formulas. Although three examples are presented in the Student Instructions, the instructor may explain the formulas and discuss another one in the introduction to the exercise.

Because computer software changes so rapidly, the instructions for accomplishing certain tasks with Excel might differ from those given in the student instructions. Thus, the instructor should be aware of possible difficulties using Excel.