

Physical Landscapes and the Geosphere (ACNA 4007)

Introduction to Minerals

Activity Outline:

Making a cake requires that you combine just the right ingredients. If you were to diverge from the recipe and substitute salt for sugar, your cake would not turn out as planned. The rocks that make up the earth's crust function in much the same way that the cake does. Each rock type requires that just the right ingredients be mixed together to produce the desired product. The ingredients that make up rocks are known as minerals. Each mineral carries a unique set of physical properties that allows it to be distinguished from other minerals. Your objectives for this lab are to describe the unique physical properties of several mineral samples and then use those descriptions to identify each mineral by name.

Optional Reading:

1. Introduction to Mineralogy: [intech-an introduction to mineralogy.pdf \(intechopen.com\)](https://www.intechopen.com/openaccessbook/introduction-to-mineralogy)
2. OpenGeology: [Earth Materials – Mineral Identification – Historical Geology \(opengeology.org\)](https://opengeology.org/Earth-Materials-Mineral-Identification-Historical-Geology)

The Physical Properties of Minerals

A mineral's physical properties can be determined in one of two ways - through observations or through simple tests. Some of these properties include:

<u>Observations</u>	<u>Tests</u>	<u>Others</u>
habit	hardness	smell
luster	streak	feel
color	density	taste
cleavage	reaction to specific chemicals	
light transmission	magnetism	
striations	tenacity	
	fluorescence	
	x-ray diffraction pattern	
	response to stresses	

For this lab, you will use just a few of these properties to help you describe and identify the mineral samples.

Luster: The way in which a mineral reflects light is known as luster. Luster is described as **metallic**, or **non-metallic**. Non-metallic luster can be further described with terms such as:

vitreous - like glass

greasy - like an oiled surface

adamantine - brilliant, sparkling pearly - like a pearl
waxy - like wax

Color: Though typically the easiest to determine, color may not be the most reliable property to use in mineral identification. Minerals often occur in many different colorful varieties.

Streak: When a mineral is drawn across an unglazed, porcelain plate, it may leave a line of powdered mineral behind. This is known as the streak of a mineral. The color of the streak is a much better identifying property than the color of the mineral.

Cleavage: The cleavage of a mineral describes the way that it breaks along planar surfaces. Cleavage can occur along as many as 6 planes. When there is more than one plane of cleavage, the planes may intersect at a 90° angle or at some other angle but will always intersect at the same orientation throughout the mineral sample. Cleavage may be poorly developed and not obvious in each sample.

Fracture: The way a mineral breaks can also help you to identify it. Some minerals break with very rough edges without any flat surfaces. Minerals that break in this manner with rough, uneven edges have fracture. Some minerals with fracture, such as quartz, break with smooth but uneven or rounded edges. This is called conchoidal fracture. Conchoidal fracture is like shards of glass from a broken window. The edges are usually smooth and rounded but they are not flat.

Habit: Shape is a mineral's three-dimensional appearance. This is influenced by crystal form, cleavage, and fracture. The same mineral may have very different habits, so this is not a very diagnostic property.

Hardness: This property describes a mineral's resistance to scratching. A mineral should be able to scratch any material with a lower hardness number, and will be scratched by any material with a higher hardness number. The hardness of a mineral can be determined by what materials a mineral can scratch and what materials scratch the mineral. Some materials of known hardness that can be used to conduct these tests are:

fingernail: 2.5	glass : 5.5
copper penny: 3.0	streak plate: 6.5

A mineral is considered soft if it can be scratched with your fingernail. A hard mineral will scratch glass. If the mineral cannot be scratched with your fingernail, and cannot scratch glass, then the mineral is medium in hardness.

Density: The mass of a substance per unit volume. It generally tells how heavy a mineral is for its size. Most minerals with a metallic luster will seem heavy for their size.

Striations: Striations are fine parallel lines on a crystal or cleavage surface. The width and spacing between striations are related to the chemical structure of minerals. Some minerals

will always display striations, while others will never have them. The presence of striations may be critical in distinguishing between some minerals.

Light Transmission: The ability to transmit light is a function of a mineral's optical properties and thickness. Transparent minerals easily transmit light. Translucent minerals transmit some light and look hazy. Opaque minerals transmit no light.

Exercise 1: Mineral Observations (Data Sheet 1)

1) A box of minerals has been placed at each lab table. With the help of the others at your table, fill out the two data sheets on the following pages. The first sheet requires you to make observations of each mineral and data should be recorded as follows;

<u>Luster</u>	metallic / nonmetallic
<u>Cleavage</u>	prominent / not present
<u>Colour</u>	use your own judgment
<u>Light Transmission</u>	opaque / translucent / transparent
<u>Distinctive Shape</u>	present / absent – This includes crystal faces, habit, or repeating patterns like pisolites.
<u>Striations</u>	present / absent
<u>Others</u>	record anything that will help identify the mineral

Exercise 2: Mineral Tests (Data Sheet 2)

The second sheet requires you to perform tests of each mineral and data should be recorded as follows;

<u>Hardness</u>	Enter the whole number or range of numbers, between 1 and 10 that describes each mineral's hardness.
<u>Streak</u>	Use your judgment to describe the colour of the powdered mineral.
<u>Magnetism</u>	yes / no
<u>Density</u>	lighter than quartz / similar to quartz / heavier than quartz - as compared to a quartz sample of similar size.
<u>Reaction to acid</u>	Minerals with a carbonate group (CO ₃) in their chemical formula will fizz when in contact with hydrochloric acid.

Table 1: Mineral Observations

Mineral	Lustre	Cleavage	Colour	Light Transmission	Distinctive Shape	Striations	Other
Quartz							
Orthoclase Feldpar							
Biotite Mica							
Muscovite Mica							
Apatite							
Hematite							
Magnetite							
Rock Crystal							
Fluorite							
Calcite							
Gypsum							
Barytes							
Pyrite							
Chalcopyrite							
Galena							
Talc							

Table 2: Mineral Tests

Mineral	Hardness	Streak	Magnetism	Density	Acid Test	Striations	Other
Quartz							
Orthoclase Feldpar							
Biotite Mica							
Muscovite Mica							
Apatite							
Hematite							
Magnetite							
Rock Crystal							
Fluorite							
Calcite							
Gypsum							
Barytes							
Pyrite							
Chalcopyrite							
Galena							
Talc							

Exercise 3: Mineral Identification

- a. Number from 1 to the total number of mineral samples down the left-hand column of the **Mineral Identification Worksheet (below)**. Each mineral lies in a numbered box. When recording data, make sure that the number in the box matches the number on your sheet.
- b. For each mineral, record the appropriate descriptions for each physical property in the correct space on the worksheet.
- c. Once the physical properties for each mineral have been described, use this information along with the provided flow chart, on the following page, to identify each of the minerals. The name determined for each should be placed in the correct space on the worksheet.

Mineral Number	Hardness	Streak	Colour	Other properties	Mineral Name
1					
2					
3					
4					
5					
6					
7					
8					

Metallic (Luster) Minerals					
Hardness	Streak	Color	Other Properties	Name	Formula
6 -6.5	Green - black Brown - Black	Brassy yellow	May be tarnished; no cleavage; grows in cubes; density around 5 g/cm ³	Pyrite	FeS ₂
6	Black	Gray to black	No clear cleavage; attracts a magnet; density around 5.2 g/cm ³	Magnetite	Fe ₃ O ₄
5.5	Red - brown or red - gray	Silver-gray to black	Tarnish may be reddish; streak is characteristic; density around 5.2 g/cm ³	Hemetite	Fe ₂ O ₃
2.5	Gray	Highly lusterous gray	Cleavage good in three directions (cubic); density high - 7.5 g/cm ³	Galena	PbS
About 1	Black	Dark gray	Very soft; marks paper; feels slippery; low density - 2.2 g/cm ³	Graphite	C

Non-Metallic (Luster) Minerals					
Hardness	Streak	Color	Other Properties	Name	Formula
9	Scratches streak plate	White, pink, gray	No cleavage; six-sided, barrel-shaped crystals; common colors: blue=sapphire, red=ruby	Corundum	Al ₂ O ₃
7	White	Clear, white, rose, smokey	Breaks in conchoidal shapes; six-sided crystals; striations	Quartz	SiO ₂
6.5 - 7	White	Shades of green	Aggregate of small crystal grains; conchoidal fracture; sandy or sugary texture	Olivine	(Fe,Mg) ₂ SiO ₄
7	White	Variable; commonly red	Conchoidal fracture; grows in dodecahedral (12 sided) shapes (or 24 or 36 sides)	Garnet	(Mg,Fe) ₃ Al ₂ (SiO ₄) ₃
6 - 6.5	White	White to blue-gray	Striations are common, two cleavage faces near 90° to each other	Plagioclase Feldspar	NaAlSi ₃ O ₈ to CaAl ₂ Si ₂ O ₈
6 - 6.5	White	White, pink, gray	No striations; two cleavage faces near 90° to each other	Orthoclase Feldspar	KAlSi ₃ O ₈
5 - 6	Light green - dark brown	Dark green to black	Two direction of cleavage near 60° and 120°; crystals are usually elongate	Hornblende	Ca ₂ (Mg,Fe,Al) ₅ Si ₈ O ₂₂ (OH) ₂
5.5	Red to brown-red	Brown-red to red	Earthy luster; streak is distinctive; irregular surface	Hemetite	Fe ₂ O ₃
2.5 - 3.5	White	Opaque green	Slippery; massive	Serpentine	(Mg,Fe) ₃ Si ₂ O ₅ (OH) ₄
4	White	Purple, blue, yellow	Good cleavage in four directions; cubic shape; State mineral of Illinois	Fluorite	CaF ₂
Varies (3.5 - 4)	Yellow to light brown	Yellow-brown, Root beer	Cleavage in six directions	Sphalerite	ZnS
Varies (3.5 - 4)	Pale green	Bright green	May react to acid, may occur as coating on another rock	Malachite	Cu ₂ (CO ₃)(OH) ₂
3	White	Clear, white, pink, gray	Reacts to acid; good cleavage in three directions	Calcite	CaCO ₃
Varies (2 - 2.5)	White	Clear, white	Cubic cleavage; tastes salty	Halite	NaCl
2.5 - 4	White	Clear to yellow tint	Exellent cleavage into thin sheets	Muscovite Mica	KAl ₂ (AlSi ₃ O ₁₀)(OH) ₂
2 - 3	Brownish gray white or gray	Black to dark brown	Exellent cleavage into thin sheets	Biotite Mica	K(Mg,Fe) ₃ (AlSi ₃ O ₁₀)(OH) ₂
2.5 - 4	White to pale brown	Rusty to brown-gray	Earthy rust colored spheres (pisolites); also considered a rock	Bauxite	Aluminum hydroxides
2	White	Clean to white	Good cleavage in one direction; soft; low density (light weight)	Gypsum	CaSO ₄ - 2H ₂ O
2 - 2.5	White	White	Earthy mass; fine clay particles; soft; hydrophillic	Kaolinite	Al ₂ (Si ₂ O ₅)(OH) ₄
1.5 - 2.5	Light yellow to white	Yellow	Earthy mass; soft; smalls bad	Sulfur	S