UPDATED JAN. 25, 2018 [WINTER 2011] CORRECTIONS / KEY

ES202 Lab 2 - Overview of Minerals, Rocks, and Plate Tectonics

Part 1 - Mineral Properties

SPECIMENS RENUMBERED TO TEMPLETON SYSTEM

A ES202 lab mineral set is assembled in a tray at the back of the room. The tray consists of a number of mineral specimens that are numbered on the bottom of individual boxes. Each box contains several samples of each specimen, giving multiple students access to a given specimen at a given instant. **This exercise is keyed to the 8th Edition of the AGI Geology Lab Manual.**

Familiarize yourself with the specimen numbers and look at the variety of specimens that you see. Complete the tasks below. Place answers in the space provided.

1-1. Mineral Cleavage and Fracture (**p. 52-55** of lab manual)

Some minerals display a characteristic cleavage pattern when they are broken into pieces. The type of cleavage is dependent upon the way in which atoms are organized in the crystal structure of the mineral, thus providing a diagnostic property that can be used to identify the mineral.

A. Specimen ~~11~~ 12 BIOTITE is a dark, platy-looking mineral that has a very well-defined cleavage pattern.

1 ______ How many "breaking planes" or "cleavage directions" do you observe for specimen ~~11~~ 12? **(p. 55)**

1 ______ What other specimen (answer by specimen number) is similar in appearance to ~~11~~ 12 with respect to number of cleavage directions?

COLOR ______ What is the main physical difference that you see between ~~this~~ specimen 1 and no. ~~11~~ 12 above?

B. Specimen ~~15~~ 4 HALITE is a translucent mineral (it passes light through it) that has a common usage in everyday life.

3 ______ How many different "breaking planes" or "cleavage directions" do you observe in specimen ~~15~~ 4? **(p. 55)**

90° ______ What is the angle of intersection between the "breaking planes" or "cleavage planes" of this mineral (less than 90 degrees, 90 degrees, or more than 90 degrees)?

SALTY ______ Touch specimen ~~15~~ 4 to your tongue, what is the characteristic taste of this mineral?

C. Refer to specimen ~~16~~ 8 CALCITE and answer the questions below

3 ______ How many different "breaking planes" or "cleavage directions" do you observe in specimen ~~16~~ 8? **(p. 55)**

RHOMBIC (<90°, >90°) ______ What is the angle of intersection between the "breaking planes" or "cleavage planes" of this mineral (less than 90 degrees, 90 degrees, or more than 90 degrees)?

EFFERVESCENCE/ FIZZ ______ Place a small drop of dilute hydrochloric acid (in the small dropper bottles) on specimen ~~16~~ 8, what do you observe? Wipe the acid from the sample with a paper towel when you are finished. **(see page 58, Fig. 3.18)**

NO FIZZ ______ What happens when you place a small drop of HCl on specimen ~~8~~ 3 QUARTZ? Wipe the acid from the sample with a paper towel when you are finished.

SPEC. NO. = NAME
1 = MUSCOVITE
2 = PYRITE
3 = QUARTZ
4 = HALITE
5 = ORTHOCLASE
7 = AMPHIBOLE
8 = CALCITE
10 = [illegible]
11 = GALENA
12 = BIOTITE
15 = GYPSUM
21 = GARNET
22 = TALC

D. Refer to specimen ~~8~~ 3 QUARTZ and answer the questions below.

CONCHOIDAL FRACTURE How would you best describe the "breaking characteristics" of specimen ~~8~~ 3 (choose one): breaks into well-defined cleavage planes (list the no. of directions if you think this is correct), OR breaks or "fractures" like glass with no well-defined cleavage planes (better known as conchoidal fracture).

QUARTZ Can you take a guess at what the name of this common silicate mineral is?

1-2. Mineral Luster and Light Transmission (p. 50-51 of lab manual)

The luster or appearance of reflected light from a mineral is another diagnostic property that is used to identify minerals. Two luster types that are relatively easy to recognize are (1) metallic (shines like metal), and (2) non-metallic (does not shine like metal... for example glassy or dull).

The ability of a mineral to transmit light through it is also important. Some minerals allow light to pass through them, while others do not. Some options for light transmission characteristics include: (1) opaque (does not transmit light), (2) transparent (perfectly clear, like glass), and (3) translucent (allows some light to pass through, but not images).

Refer to the appropriate mineral samples and answer the questions below.

A. Specimen ~~12~~. 11 GALENA

OPAQUE Is this mineral opaque, transparent or translucent?

METALLIC Is the luster metallic or non-metallic?

B. Specimen ~~7~~. 2 Pyrite

OPAQUE Is this mineral opaque, transparent or translucent?

METALLIC Is the luster metallic or non-metallic?

C. Specimen ~~8~~. 3 QUARTZ

TRANSPARENT - TRANSLUCENT Is this mineral opaque, transparent or translucent?

NON-METALLIC Is the luster metallic or non-metallic?

D. Specimen ~~9~~. 15 Gypsum

TRANSLUCENT Is this mineral opaque, transparent or translucent?

NON-METALLIC Is the luster metallic or non-metallic?

Question to think about and answer (and talk to the instructor about if you need to): What do you think is the primary factor that controls the physical appearance of a given mineral? That is, why are different types of minerals, well, different from one another?

ATOMIC COMPOSITION AND GEOMETRIC ARRANGEMENT OF ATOMS

1-3. Mineral Color (p. **50-51 of lab manual**)

The color of a mineral may POSSIBLY be a diagnostic criteria to aid in identifying the specimen. Color is a function of the photo-atomic reaction of light energy with the atoms composing the substance. When all components of the visible spectrum of light are combined together, we refer to this as "white light". When select wavelengths of light are absorbed by atoms, and others are reflected, then "white light" is separated into it's component spectrum (i.e. colors of the rainbow ROY G BIV... you know).

So the color of a mineral (or any substance for that matter) represents the select wavelengths of light that are reflected back to our eyes. For example a "green" color suggests that all other wavelengths are absorbed at the atomic level, but only the green part of the spectrum is reflected to our eyes. In sum, mineral color is variable, depending on the specific atoms and elements that comprise the specimen (for example, iron tends to give a red coloration, copper a bluish-green, iron-magnesium a black, etc.).

Refer to the appropriate mineral samples and answer the questions below.

Specimen ~~8~~ 3 QUARTZ

ROSE/PINK
CLEAR
SMOKY GRAY
WHITE /MILKY

How many different colors of specimen ~~8~~ 3 are evident in the sample box? List them.

Mineral specimens can be separated into general composition categories by observing whether their color is "light" (e.g. pink, white, clear) or "dark" (black, dark gray, dark greenish-gray). Fill in the table below for the listed mineral specimens, identifying them as either "light", "dark", or "clear".

Specimen No.	Color I.D.	
~~8~~ 3	LIGHT/CLEAR	QUARTZ
~~17~~ 5	LIGHT	K-SPAR
~~24~~ 1	LIGHT	MUSCOVITE
~~5~~ 7	DARK	Amphibole
~~11~~ 12	DARK	BIOTITE
~~15~~ 4	LIGHT	HALITE
~~20~~ 22	LIGHT	TALC

Think about this question again (do you have it down yet?): What do you think is the primary factor that controls the color (or any physical property) of a given mineral?

ATOMIC COMPOSITION AND ATOMIC ARRANGEMENT

1-4. Mineral Hardness (Resistance to Scratching) (p. **52-53 of lab manual, Fig. 3.8**)

Hardness of a mineral is it's resistance to scratching. Some minerals are very soft (scratch easily) while others are very hard (do not scratch easily). Hard minerals are commonly used as abrasives in industry (e.g. sand paper, diamond-tipped drill bits, etc.).

The relative hardness of a mineral can be determined by conducting a hardness test. A standard reference scale of mineral hardness was established by the head of the Three Stooges (Moe Howard), prior to their famous run as a vaudevillian entertainment troop. Moe was actually a famous mineralogist in the early 1900's before he turned his attention to comedy... thus we have Moe's Hardness Scale as shown on p. 33 of your lab manual (.... I'm kidding, it's really Moh's hardness scale, and Moe of the Three Stooges was actually a famous Physicist, not a Geologist, before entering comedy...).

Moh's hardness scale is set up from 1-10, with 1 being the softest mineral, while 10 is the hardest. Thus, harder objects will scratch softer objects, and the relative hardness of an object can be determined. For example, a fingernail has a hardness of 2.5, so it would easily scratch gypsum or talc (H= 2 and 1, respectively), but not quartz (H = 7).

Examine Figure **3.8 on p. 53** of the lab manual, and fill in the hardness of the items below.

Item	Moh's Hardness Value
Diamond	10
Corundum	9
Topaz	8
Quartz	7
Streak Plate	6.5
Orthoclase	6
Glass	5.5
Apatite	5
Iron Nail	4.5
Fluorite	4
Copper Penny	3.5
Calcite	3
Fingernail	2.5
Gypsum	2
Talc	1

Using the hardness testing tools available in the lab, determine the relative hardness of the following specimens (e.g. if a specimen is harder than a penny, but softer than a nail, you could say H = 3.5-4.5. or you could say H < 2.5, etc.)

Specimen No.	Relative Hardness	
~~8~~ 3	7	Quartz
~~16~~ 8	3	Calcite
~~20~~ 22	1	Talc
~~21~~ 21	7-8	Garnet
~~24~~ 1	3-4	Muscovite

1-5. Mineral Identification with Identification Charts.

Now that you know some of the basic physical properties of minerals, let's try identifying them using flow charts on pages **61-68** of the lab manual. Use the following procedure to identify the mineral specimens listed below:

Step 1 - decide if the mineral is light colored or dark colored, metallic or non-metallic luster.

Step 2 - read the specimen description and compare to the appropriate chart, determine the mineral name.

Look at the specimens and fill in the table below.

Specimen No.	Key Physical Properties	Mineral Name	
~~8~~ 3	Non-metallic, light color, fractures like glass, cleavage absent, may form crystals, may be colorless, smoky gray or pink, hardness >5.5.	______________	Quartz
~~17~~ 5	Non-metallic, light color, excellent cleavage, hardness >5.5, pink or white, sometimes green	Feldspar	K-spar
~~24~~ 1	Non-metallic, light color, excellent 1 direction of cleavage, splits into thin sheets, hardness 2-2.5	______________	Muscovite
~~11~~ 12	Non-metallic, dark color, hardness <5.5, black, excellent 1 direction of cleavage, splits into thin sheets	______________	Biotite
~~16~~ 8	Non-metallic, light colored, hardness <5.5, white, fizzes with drop of acid, 3 directions of cleavage not at 90 degrees (rhombohedrons)	______________	Calcite
~~15~~ 4	Non-metallic, light colored, hardness ~2.5, tastes salty, 3 directions of cleavage - breaks into cubes.	______________	Halite
~~7~~ 2	Metallic, hardness > 5.5, brass yellow color, sometimes shows 5-sided polygonal crystals.	______________	Pyrite
~~9~~ 15	Non-metallic, light colored, soft (H< fingernail), white to light gray color, sometimes needle-like crystals	______________	Gypsum

Part 2 - Overview of Rocks

A ES202 lab rock set is assembled in a tray at the back of the room. The tray consists of a number of rock specimens that are numbered on the bottom of individual boxes. Each box contains several samples of each specimen, giving multiple students access to a given specimen at a given instant.

Familiarize yourself with the specimen numbers and look at the variety of specimens that you see. Complete the tasks below. Place answers in the space provided.

2-1. Igneous Rocks

A. Igneous Rock Texture

Igneous rocks form from the cooling of magma (under ground) or lava (volcanic eruptions at the surface). As the magma cools, the mineral crystals that make up the rock take on characteristic sizes and shapes. *Texture refers to the size, shape, and arrangement of mineral crystals in a rock.*

Examine the following specimens, and match their texture with the terms and descriptions below. Write the texture of the specimen in the space provided.

Textural Terms and the processes that form them (**refer to Fig. 5.2 on p. 92**) ✓

Phaneritic - can easily see separate mineral crystals with the "naked" eye. Phaneritic texture is associated with slow cooling magma beneath the Earth's surface.

Aphanitic - microscopic mineral crystals that can NOT be readily viewed with the naked eye. Aphanitic texture is associated with fast cooling lava ejected from a volcano.

Porphyritic - larger mineral crystals floating in a matrix of smaller mineral crystals. Porphyritic rocks represent two-phase cooling of magma, with some crystals formed before eruption (the larger ones), and then rapid cooling of the remaining lava, once ejected from a volcano.

Glassy - glassy appearance to rock. Represents very rapidly cooled lava... cools so rapidly that mineral crystals do not have time to physically form.

Vesicular - volcanic rocks with holes and air pockets throughout. Vesicular texture represents very gas-charged, frothy lava in which the gas rapidly escapes during cooling. The results is a very porous rock, with many air holes.

Fill in the Table Below **Using Fig. 5.2 on p. 92 for Comparison** ✓

Rock Specimen Number	Texture (match from above)	Interpretation of how the rock formed (match with above)
1 ~~1A~~ GRANITE	PHANERITIC	SLOW COOLING OF MAGMA
9 ~~9A~~ GABBRO	PHANERITIC	SLOW COOLING OF MAGMA
5 ~~5A~~ BASALT	APHANITIC	FAST COOLING OF LAVA
6 ~~6A~~ PORPHYRITIC ANDESITE	PORPHYRITIC	2-PHASE COOLING OF MAGMA/LAVA
o.k. 10 OBSIDIAN	GLASSY	VERY FAST COOLING OF LAVA
o.k. 4 PUMICE	VESICULAR	COOLING OF GAS-CHARGED LAVA
o.k. 7 ~~VES BASALT~~ SCORIA	VESICULAR	COOLING OF GAS-CHARGED LAVA

B. Igneous Rock Composition and Rock Color

Igneous rocks are comprised of common silicate rock-forming minerals. The overall color of the rock is directly related to the types of minerals that comprise the rock. Dark minerals will make for a dark rock, and vice versa. Since this is only an introduction to rocks and minerals, we are probably not that great at mineral identification yet, but we can use the color of the rock to make some generalizations about what it is made of.

Refer to pages **92-93** of the lab manual. The Figures show the general relationships between rock color, mineralogy, and rock classification. The three basic color - mineral composition options are:

(1) Felsic Igneous Rocks - made up of primarily light colored minerals (white, pink, light gray), with less than 15% dark minerals.

(2) Intermediate Igneous Rocks - "salt and pepper" appearance, medium gray colors, made up of admixtures of light and dark-colored minerals (15-45% dark minerals).

(3) Mafic Igneous Rocks - made up mostly of dark-colored minerals (black, dark-green, dark gray).

Match the terms felsic (light), mafic (dark), and intermediate with the following specimens, fill in the table below.

Rock Specimen Number	Rock Color / Mineral Composition
~~1A~~ 1	Felsic
~~9A~~ 9	Mafic
~~5A~~ 5	Mafic
~~6A~~ 6	Intermediate
4 — o.k.	Felsic

C. Igneous Rock Classification and Naming

Igneous rocks are classified and named on the basis of their (1) mineral composition (i.e. rock color), and (2) texture (what the mineral crystals look like).

Examine the specimens listed below, use the summary descriptions, and look at **Figure 5.2 on p. 92** to derive the name of the rock. Fill out the table... you know what to do.

Rock Specimen No.	Summary Description	Rock Name
1A 1	Felsic (light colored minerals), phaneritic (coarsely crystalline)	GRANITE
9A 9	Mafic (dark colored minerals), phaneritic (coarsely crystalline)	GABBRO
5A 5	Mafic (dark colored minerals), aphanitic (finely crystalline)	BASALT
6A 6	Intermediate (medium gray), porphyritic (larger black crystals in aphanitic matrix)	ANDESITE PORPHYRY
10 — o.k.	glassy volcanic rock	OBSIDIAN
7 — o.k.	vesicular texture, mafic color (dark minerals) aphanitic mineral matrix (finely crystalline)	VESICULAR BASALT (SCORIA)

2-2. Sedimentary Rocks

CUT-N-PASTE [illegible] Key

We are not going to spend much time with sedimentary rocks here, since we will focus on them in the next two labs. However, here's a couple quick questions to get you thinking about them, answer in the space provided. Use your lab manual, **p. 77-79** to answer the following questions.

A. How are sedimentary rocks different from igneous rocks? Which type of rock would you consider the "parent" rock (i.e. which rock type precedes the other in the life cycle of the Earth)?

B. What is the difference between detrital, chemical, and biochemical sedimentary rocks. Focus you answer on how these different types of sedimentary rocks form.

2-3 Metamorphic Rocks

Metamorphic rocks result from the physical and chemical alteration of pre-existing rocks. The primary agents of metamorphism are (1) heat, (2) pressure, and (3) chemically active fluids. In essence, any pre-existing rock can be metamorphosed by heating it up, squeezing it (pressure), or circulating hot, chemically-charged fluids through it. With heat and pressure over long periods of time, a rock can be altered with respect to it's composition (mineralogy) and texture. The "parent" of a metamorphic rock refers to the type of original, pre-existing rock that was altered to form the new metamorphic rock product.

A. Metamorphic Textures (see **p. 137-140** of lab manual)

Like igneous and sedimentary rocks; the size, shape, and arrangement of minerals can be used to classify and organize metamorphic rocks.

There are basically two textural options for metamorphic rocks:

(1) Foliated - the rock has a layered or color-banded appearance (color banding = alternating layers of light and dark minerals)

(2) Non-Foliated - the has a massive appearance (without distinct layering or color banding).

Identify the following specimens as either foliated or non-foliated:

Rock Specimen No.	Metamorphic Texture	
2 — ok.	FOLIATED	~~SCHIST~~ GNEISS
20 1	NON-FOLIATED	MARBLE
3 — ok.	NON-FOLIATED	QUARTZITE
6B 5	FOLIATED	SLATE

B. Naming and Classifying Metamorphic Rocks

Use the Metamorphic Rock Classification Chart in **Fig. 7.15 (p. 143)** of the lab manual to name the following specimens. Fill in the table below (hint: use the summary descriptions below to help you... you've done this before!)... see next page for table.

Specimen No.	Summary Description	Metamorphic Rock Name	Parent Rock
2	Foliated, color banded with alternating light and dark colored minerals, medium- to coarse grained	Gneiss	Schist or Granite
~~20~~ 1	Non-foliated, massive texture, medium grained, sugary / crystalline appearance, fizzes with drop of HCl	Marble	Limestone
3	Non-foliated, massive texture, fine grained, sandy-like texture, hard	Quartzite	Sandstone
~~6B~~ 5	Foliated (thin layers), dull luster, breaks into thin layers	Slate	Shale