

Name:

Grade:

GEOL 101 - Physical Geology Laboratory METAMORPHIC ROCK CLASSIFICATION AND IDENTIFICATION

PRELAB SECTION – To be completed before labs starts:

I. Introduction & Purpose:

The purpose of this laboratory exercise is to become familiar with identifying common metamorphic rocks and understanding their depositional origin. In this lab you will learn to identify metamorphic rocks in hand samples from their physical properties. You will become familiar with the common metamorphic rock-forming minerals and processes. The nature and origin of metamorphic rocks, the major types of metamorphic rocks, and their structures, and the connection between plate tectonics and metamorphic rocks in the rock cycle will be explored.

II. General Overview and Classification of Metamorphic Rocks

A. Defining Metamorphism:

Directions: Answer the following (from lecture and lab text: see page 133):

- 1) Define "metamorphism" _____
- 2) Every metamorphic rock has a _____ rock (or protolith) - the original rock type that was metamorphosed into the resultant metamorphic rock, i.e. the source rock.

B. Conditions of Metamorphism:

Metamorphic rocks form as a result of changing crustal conditions, e.g. increasing pressures and/or temperatures, that are between that of igneous and sedimentary rock-forming environments.

1). The four major agents of change that cause rocks to metamorphose (see page 133):

- a) _____, b) _____, c) _____, and/or d) _____

C. Processes of Metamorphism:

Metamorphic processes that are forming the metamorphic rocks occur at various scales within the Earth, and the type of internal earth agents involved is used to define the type of metamorphism. One type is related to magmatism, and the other type is related to faulting and mountain building.

1) The two major types of metamorphism that are agent-dependent (page 134):

- a) _____, and b) _____

2) **Question:** Very briefly describe the differences between these two types of metamorphism:

D. Classification and Identification of Metamorphic Rocks

1) Classification and identification of metamorphic rocks are based upon two major physical criteria:

- a) _____, and b) _____

2) Metamorphic rocks are divided into two major groups based on whether the rock has a *layered* versus *non-layered* texture. See Figure 7.4, page 136. Special alternative names for these are:

- a) Layered = _____ and b) Non-layered = _____

E. Foliated Metamorphic Rocks

1) Metamorphic rocks that possess a foliated and/or layered fabric have a crystalline texture consisting of elongate and/or platy crystals that all share a **preferred orientation** within the rock. Metamorphic rocks that have foliated/layered fabrics originate in two types of metamorphic environments: Regional Metamorphism (RM) and Dynamic Metamorphism (DM).

- 2) There are four common types of metamorphic rocks that have foliated-layered textures. Each foliation type is unique and represents a progressive increasing scale of intensity of regional metamorphism as go from slate to gneiss. The textural character of foliated and/or layered metamorphic rock can vary greatly as a function of 1) grain size, 2) degree of preferred orientation of the rock's mineral crystals, and 3) degree of layered segregation of light minerals from dark minerals.
- 3) The foliated/layered metamorphic rocks are classified primarily upon texture, with mineralogy a secondary criteria. There are four visually distinctive types of foliated rocks (listed below).

Directions: Describe the texture and mineralogy of the four foliated rock types (see Figure 7.15)

<u>Rock Name</u>	<u>Textural Features</u>	<u>Rock Mineralogy</u>
1. Slate _____	_____	_____
2. Phyllite _____	_____	_____
3. Schist _____	_____	_____
4. Gneiss _____	_____	_____

Please note that there are infinite shades of gray between these four types – no sharp divisions

F. Non-Foliated-Non-Layered Metamorphic Rocks

- 1) Metamorphic rocks that have non-foliated (non-layered) textures originate in two types of metamorphic environments: regional metamorphism (RM) and contact metamorphism (CM). **Note** that the nonfoliated metamorphic rocks that form by regional metamorphism RM are mostly *mono-mineralic (mostly of one mineral type)*, having mineral crystals that are neither platy nor tabular, such as quartz and calcite. Note that amphibolite and serpentinite may exhibit foliation.
- 2) As noted above, the non-foliated (non-layered) metamorphic rocks consist of equant shaped mineral crystals that have no preferred orientation or arrangement. These rocks have a massive, homogenous "crystalline" texture, much like that of either, *phaneritic* granite, or *aphanitic* basalt. The non-foliated metamorphic rocks are classified primarily upon mineral composition.
- 3) There are four common types of metamorphic rocks that have non-foliated/ non-layered fabrics:
Directions: Describe the texture and mineralogy of the four non-foliated rock types (see Fig. 7.15)

<u>Rock Name</u>	<u>Textural Features</u>	<u>Rock Mineralogy</u>
1. Quartzite _____	_____	_____
2. Marble _____	_____	_____
3. Amphibolite _____	_____	_____
4. Serpentinite _____	_____	_____

METAMORPHIC ROCKS IDENTIFICATION - IN-LAB SECTION

I. Preliminary Examination of the Metamorphic Rock Types:

A. Introduction: The instructor has assembled **2 reference collections** of metamorphic rocks for you to become familiarized with the two major types of metamorphic rocks: foliated and nonfoliated.

Directions: Carefully study each rock's: 1) **physical characteristics**, including texture and composition, and 2) **metamorphic origin**: the rock's metamorphic environment and parent rock. Make observational notes of the samples. Discuss your observations with your group.

II. Foliated-Non-Layered Metamorphic Rocks

A. Exercise 1 - Sample Group “X” has representative hand samples of each of the **foliated** rock types. Study each sample carefully and make some brief descriptions of the rock's character (texture, foliated fabric & minerals). Carefully study pages 137-139 for reference.

Observational Notes

Sample #s X1 and X2 = Slate _____

Sample #s X3 and X4 = Phyllite _____

Sample #s X5, and X6 = Schist _____

Sample #s X7 and X8 = Gneiss _____

B. Exercise 2 – Compare and contrast the foliated metamorphic rocks in **Sample Collection “X”**.

Question: How does slate differ from both phyllite and schist?

Question: How does gneiss differ from the other three foliated rocks?

Question: What are the main criteria you use to distinguish between these four rock types?

III. Non-Foliated-Non-Layered Metamorphic Rocks

A. Exercise 1 - Sample Collection “Y” has representative hand samples of the **nonfoliated** rock types. For each hand sample, briefly describe the rock's character (texture, fabric, minerals)

Observational Notes

Sample #s Y1 = Quartzite _____

Sample #s Y2 = Marble _____

Sample #s Y3 = Amphibolite _____

Sample #s Y4 = Serpentinite _____

B. Exercise 2 – Compare and contrast nonfoliated metamorphic rocks in **Sample Collection “Y”**.

Question: How does quartzite differ from marble? How are they similar?

Question: How does amphibolite differ from serpentinite? How are they similar?

Question: What are the main criteria you use to distinguish between these four rock types?

IV. Procedure for Describing and Identifying Metamorphic Rocks:

A 4-Step chart for the analysis and classification of metamorphic rocks is found in Figure 2.33 on page 32. Use this chart, and the additional directions found on page 32 to help you learn to identify metamorphic rocks both, in hand sample and in the field.

A. Four-step Identification Procedure - A brief description of the 4 determinant steps:

Step 1: Texture = a) Foliated or Non-Foliated? AND b) Coarse-, medium-, or fine-grained?

Step 2: Rock Composition = Identifiable Minerals?

Step 3: Name the Rock.

Step 4: Name the Most Likely Parent Rock.

V. Identifying 9 Unknown Metamorphic Hand Samples

Instructions: **Sample Collection "Z"** has nine unknown metamorphic rock samples. Using the 4-step procedure outlined above, complete the worksheet chart below for all eight unknown samples. Be sure to Circle only the appropriate texture and mineralogy. List rock name and parent rock.

Unknown Metamorphic Rock Hand Samples Worksheet – Collection "Z"

Sample# Z1

a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?

b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.

c) Other distinctive features = _____

d) Rock name _____

e) Most likely parent rock _____

Sample# Z2

a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?

b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.

c) Other distinctive features = _____

d) Rock name _____

e) Most likely parent rock _____

Sample# Z3

a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?

b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.

c) Other distinctive features = _____

d) Rock name _____

e) Most likely parent rock _____

Sample# Z4

a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?

b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.

c) Other distinctive features = _____

d) Rock name _____

e) Most likely parent rock _____

Sample# Z5

- a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?
- b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.
- c) Other distinctive features = _____
- d) Rock name _____
- e) Most likely parent rock _____

Sample# Z6

- a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?
- b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.
- c) Other distinctive features = _____
- d) Rock name _____
- e) Most likely parent rock _____

Sample# Z7

- a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?
- b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.
- c) Other distinctive features = _____
- d) Rock name _____
- Most likely parent rock _____e)

Sample# Z8

- a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?
- b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.
- c) Other distinctive features = _____
- d) Rock name _____
- e) Most likely parent rock _____

Sample# Z9

- a) Texture: Foliated or Non-foliated? **AND** Fine-Grained. or Medium-Gr. or Coarse-Gr.?
- b) Mineralogy: Quartz; Feldspar; Mica; Amphibole; Carbonate; Garnet; Serpentine; None Obs.
- c) Other distinctive features = _____
- d) Rock name _____
- e) Most likely parent rock _____

VI. METAMORPHIC ROCK LABORATORY REFLECTION

Directions: Write a 120 word minimum reflection of the lab activity, explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this lab (3 points possible). Answer the following 3-point question reflection set on a separate sheet of paper:

- 1) *What was the purpose of this lab? What did you actually discover and learn during this lab?*
- 2) *What did you enjoy most about this lab? Also, what was challenging or thought-provoking?*
- 3) *What are your constructive comments about the design and execution of this lab? What's good? What's bad? Offer suggestions for making the lab better.*