

Name: \_\_\_\_\_

Lab day (circle one): Tuesday Wednesday Thursday

## CEEES/SC 10110L-20110L Planet Earth Laboratory

### Laboratory #6: METAMORPHIC ROCKS

**Note: In order for these labs to be marked and returned to you before your lab test next week, you must ensure that it is completed and turned in at the end of the lab period. Total = 76 Points**

*Readings:* <http://www.nd.edu/~cneal/PhysicalGeo/Lab-Metamorphic/index.html>

IMPORTANT: Tables 5.1 and 5.2, lab manual; Tables 7.1 & 7.2, this lab handout.

*Introduction:* Metamorphism is a solid-state transformation of pre-existing rock into a new rock that is texturally and/or mineralogically distinct. Temperature, pressure, and the presence of fluid (primarily water & CO<sub>2</sub>) are the variables that determine the nature of the metamorphic rock that develops. In *contact* metamorphism, temperature is the dominate factor, with confining (uniform) pressure playing a less determinative role. In *regional (dynamothermal)* metamorphism, both temperature and directed pressure (either compressive or shearing) play important roles in determining the types of rocks that develop. Confining pressure plays a secondary role in regional metamorphism. It is possible to distinguish between rocks that have undergone contact or regional metamorphism, and to determine the approximate temperature ranges at which they formed.

The *metamorphic grade* is a measure of the intensity of the metamorphism that the rock has experienced, which is primarily related to the temperature of metamorphism. Index minerals are only stable under a very limited range of pressures and temperatures and so are very important for identify the conditions under which the rock was metamorphosed (see Fig. 5.10 in your lab manual and Box 7.3 *Index Minerals* attached). For example, if you cannot identify any minerals with or without the hand lens, the metamorphic grade will be generally *low*. If you can identify new minerals, use Figure 5.10 as a guide.

### Part I Identification of Rocks

Identify the following rocks using the key to metamorphic rocks handout provided. Be sure to identify these rocks as **accurately** as possible. Many metamorphic rocks contain *porphyroblasts*, minerals much larger than the surrounding matrix (the metamorphic equivalent of phenocrysts in igneous rocks). Other metamorphic rocks are dominated by only one or two minerals. For regionally metamorphosed rocks, the complete rock name **must** include the identity of the porphyroblasts, **and/or** the dominant minerals in the rock, e.g., a garnet schist, a quartz-biotite gneiss. The names of very fine-grained regionally metamorphosed rocks include the color, e.g., green slate, brown phyllite. The mineralogy of quartzites and marbles is implied in the name, but they should also be further identified by their color, i.e., white quartzite, pink marble. Remember to consult your course textbook/notes for the textural terms that we went over in class! Below is a reminder:

#### **TEXTURAL TERMS:**

General Textures: *Foliated, Non-Foliated;*

Specific Textures: *Granoblastic* (non-foliated, equigranular texture), *Porphyroblastic* (large porphyroblasts in a finer grained groundmass), *Slaty, Phyllitic, Schistose, Gneissic.*

## Identification of Metamorphic Rocks

### Is the rock *foliated* or *non-foliated*?

#### 1. If the rock is *foliated*:

A) Does the rock split easily along bedding planes, but individual mineral grains are not visible?

Yes → it's a *slate*

No ↓

B) Are the platy minerals aligned so that the rock appears shiny, but the mineral grains are barely macroscopic?

Yes → it's a *phyllite*

No ↓

C) Are the platy minerals visibly parallel to one another?

Yes → it's a *schist*

No ↓

D) Are the light and dark minerals separated into distinct layers or lenses?

Yes → it's a *gneiss*

#### 2. If the rock is *non-foliated*, but has a crystalline texture:

A) Does the rock react to cold dilute HCl?

Yes → it's marble

No ↓

B) Is the rock hard (scratches glass)?

Yes → it's quartzite

No ↓

C) Is the texture similar to a conglomerate? (may or may not be foliated)

Yes → it's a metaconglomerate

**Rock 1:** (see Page 78)

- A) What is the metamorphic grade of this rock? (1) \_\_\_\_\_
- B) What is the specific texture of this rock? (1) \_\_\_\_\_
- C) What is the distinctive feature of this rock? (1) \_\_\_\_\_
- D) What was the *protolith* (or parent rock) prior to being metamorphosed (Table 5.2)? (1)  
\_\_\_\_\_
- E) What type of rock is it? (2) \_\_\_\_\_

**Rock 2:** (see Pages 77 & 78)

- A) What is the *porphyroblast* in this rock? (1) \_\_\_\_\_
- B) What is the metamorphic grade of this rock? (1) \_\_\_\_\_
- C) What is the specific texture of this rock? (1) \_\_\_\_\_
- D) What type of rock is it? (2) \_\_\_\_\_
- E) What was the *protolith* (or parent rock) prior to being metamorphosed (Table 5.2)? (1)  
\_\_\_\_\_

**Rock 3:** (see Page 79)

- A) What is the metamorphic grade of this rock? (1) \_\_\_\_\_
- B) What is the specific texture of this rock? (1) \_\_\_\_\_
- C) What was the probable protolith (or parent rock) prior to being metamorphosed (Table 5.2)? (1)  
\_\_\_\_\_
- D) What type of rock is it? (2) \_\_\_\_\_

**Rock 4:** This rock contains a blue mineral called *glaucoophane*, a Na, Mg amphibole. The distinctive color is used in the rock name.

- A) Is it formed as the result of contact or regional metamorphism? (1) \_\_\_\_\_
- B) What type of rock is it? (2) \_\_\_\_\_
- C) Using Figure 1.51 (last page of this lab), under what temperature **and** pressure conditions (high, high; low, high, etc.) would this rock form? (2) \_\_\_\_\_
- D) What plate tectonic environment would you expect to find this type of metamorphic rock? (2)  
\_\_\_\_\_
- E) What is the specific texture of this rock? (1) \_\_\_\_\_

**Rock 5:** (see Page 78)

- A) What is the name of this mineral that makes up the bulk of this rock? (1) \_\_\_\_\_
- B) Using Figure 5.10, under what *metamorphic grade* is this mineral stable? (1) \_\_\_\_\_
- C) What is the specific texture of this rock? (1) \_\_\_\_\_
- D) What type of rock is it? (2) \_\_\_\_\_

**Rock 6:** (see Page 78) This rock contains a mineral called ***kyanite***, an aluminum silicate ( $\text{Al}_2\text{SiO}_5$ ). It forms under a very specific set of temperatures and pressures.

- A) Using Figure 1.52 (last page of this lab), under what temperature and pressure conditions would ***kyanite*** form? (1) \_\_\_\_\_
- B) Under what pressure and temperature conditions would you expect the mineral polymorphs kyanite, andalusite, and sillimanite to appear in the same rock? (2) \_\_\_\_\_
- C) What are “*mineral polymorphs*”? (2) \_\_\_\_\_
- D) What type of rock is it? (2) \_\_\_\_\_
- E) What was the *protolith* (or parent rock) prior to being metamorphosed (Table 5.2)? (1)  
\_\_\_\_\_

**Rock 7:** (see Page 81)

- A) What is the specific texture of this rock? (1) \_\_\_\_\_
- B) Is this rock the result of contact or regional metamorphism? (1) \_\_\_\_\_
- C) What type of rock is it? (2) \_\_\_\_\_
- E) What was the *protolith* (Table 5.2) prior to being metamorphosed? (1)  
\_\_\_\_\_

**Rock 8:** (see Page 81)

- A) What is the specific texture of this rock? (1) \_\_\_\_\_
- B) Is this rock formed as the result of contact or regional metamorphism? (1) \_\_\_\_\_
- C) What was the likely *protolith* (Table 5.2) prior to being metamorphosed? (1)  
\_\_\_\_\_
- D) What type of rock is it? (2) \_\_\_\_\_

**Rock 9:** (see Page 81)

- A) What was the likely *protolith* (Table 5.2) of this rock prior to it being metamorphosed? (1)  
\_\_\_\_\_
- B) If this rock was broken, would it *typically* break **around** the meta-clasts or **through** the meta-clasts? (1)  
\_\_\_\_\_
- C) What is the name of this rock? (2) \_\_\_\_\_
- D) What is the grade of metamorphism experienced by this rock? (2) \_\_\_\_\_

**Rock 10:** (see Page 78)

- A) What is the specific texture of this rock? (1) \_\_\_\_\_
- B) What type of rock is it? (2) \_\_\_\_\_
- C) What was the likely *protolith* rock prior to being metamorphosed (Table 5.2)? (1)  
\_\_\_\_\_
- D) What was the grade of metamorphism? (1) \_\_\_\_\_

## **Part II Questions of Understanding**

Question (2): How can you distinguish shale from slate?

Question (2): How can you distinguish marble from quartzite?

Question (2): How does contact metamorphism differ from regional metamorphism?

Question: (10): Which samples (just give the sample #) have the following specific textures?

SLATY: \_\_\_\_\_

PHYLLITIC: \_\_\_\_\_

SCHISTOSE: \_\_\_\_\_

GNEISSIC: \_\_\_\_\_

GRANOBLASTIC: \_\_\_\_\_

Which one(s) do not fit into these categories? \_\_\_\_\_

**Assignment for next week: LAB TEST!** Watch your e-mail for times of review sessions for the lab test!

