

Learning Assessment #4 – Metamorphic Rocks

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This assignment is the fourth of a series of in-class activities known as learning assessments. These assignments were used in an introductory physical geology course that is a requirement for geoscience majors but has no pre-requisites and is open to students in all faculties.

The purpose of the learning assessments is to provide students with frequent feedback on their understanding of the fundamental concepts taught in the course. The learning assessments also provide information to the instructors and teaching assistants on student learning which can be used to help direct instruction in the course.

This assignment package includes:

1. Instructions for students
2. Worksheets and relevant figures
3. Checklist of required elements

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Learning Assessment #4: Metamorphic Rocks and Processes

Part 1 - Metamorphic Zone Map (/16)

The Kootenay Mountains in southern British Columbia contain a wide range of metamorphic rocks. Use your knowledge of metamorphic rocks and processes along with the figures from your textbook provided (Fig 8-17 a and b) to label the following on the map:

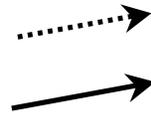
- Label inside each white diamond with the appropriate metamorphic grade, and type of metamorphism.

H = High Grade
 I = Intermediate Grade
 L = Low Grade

R = Regional Metamorphism
 C = Contact Metamorphism



- Draw a dashed-line arrows from low to high-grade zones of regional metamorphism.
- Draw a solid-line arrow from high to low grade zones of contact metamorphism.



Part 2 - Metamorphic Foliations and Minerals (/15)

- Using the table provided of mineral zones answer the following questions. What metamorphic texture would you expect in each of the five foliated zones? What are two other metamorphic minerals might you expect to find in a rock of original protolith of shale each zone?

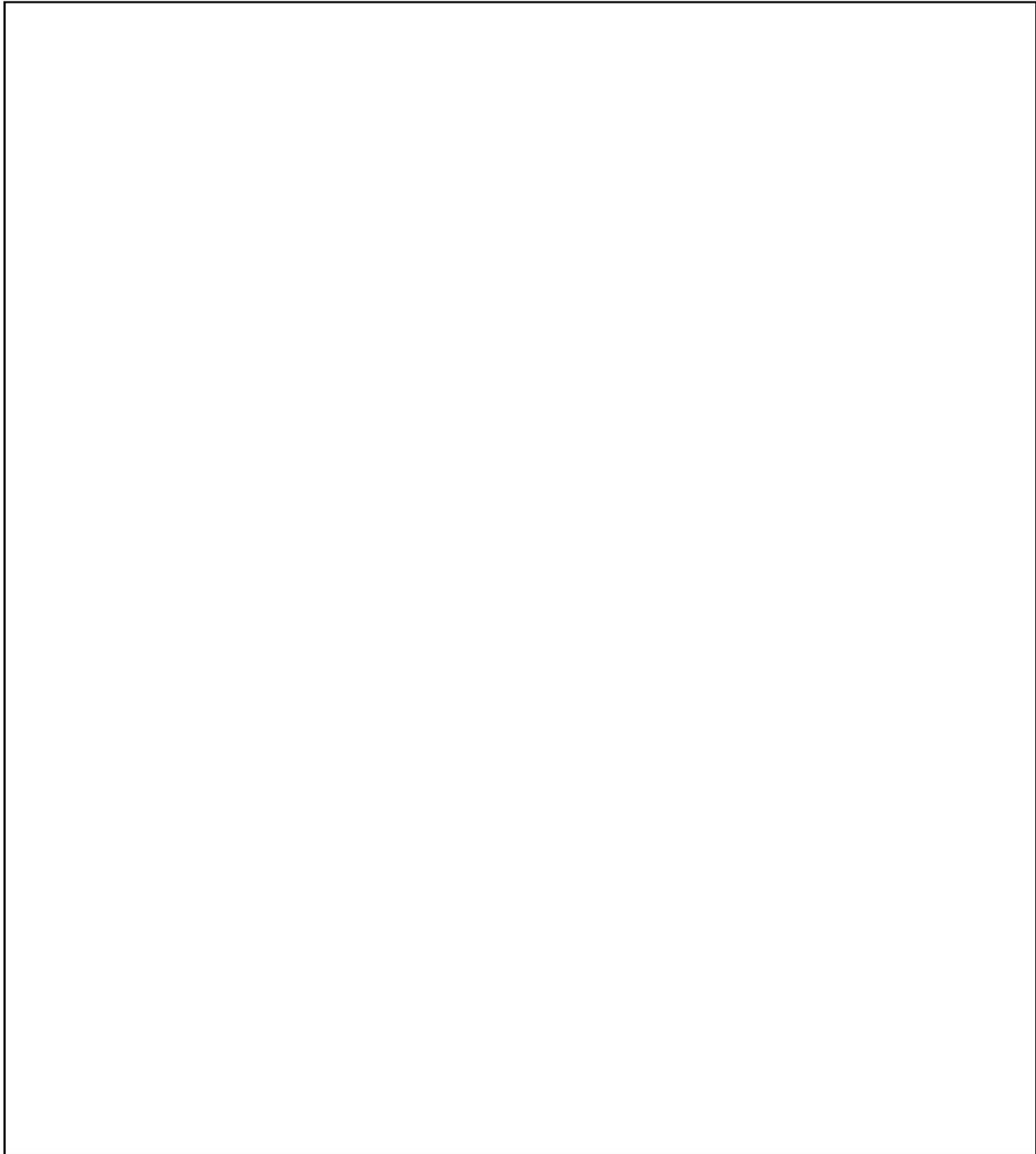
Metamorphic Zone	Type of Foliation	Additional Metamorphic Minerals
Chlorite		
Biotite		
Garnet		
Kyanite		
Sillimanite		

Name: _____

ID: _____

Part 3 - Metamorphic History (/10)

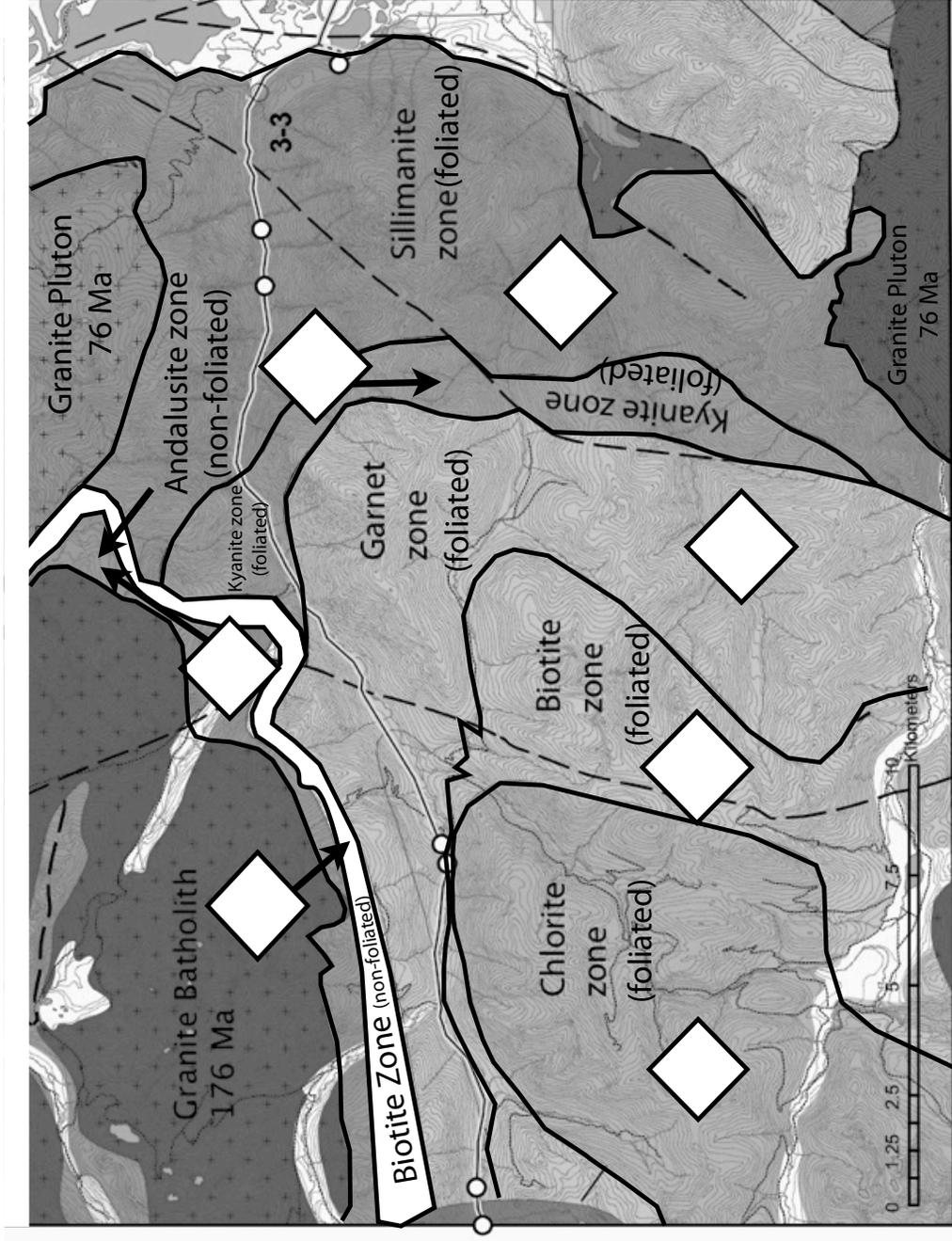
Describe the metamorphic processes that caused the rocks in this area to form. What tectonic scenarios might have existed here in the past? What igneous processes have been involved in metamorphism? How do the different metamorphic zones relate to each other? How deep might some of these rocks been buried? How did these rocks become exposed at the surface?



Metamorphic Zones of the Southern Kootenay Mountains, British Columbia, Canada

Legend

- Major Fault
- Road
- Metamorphic Zone Boundary



Base Map Derived from Doughty et al., 1997 Metamorphism of the Creston map area, southeastern British Columbia (82F/ British Columbia Ministry of Energy, Mines and Petroleum Resources Open File 1997-5, scale 1:50 000, 14 p.

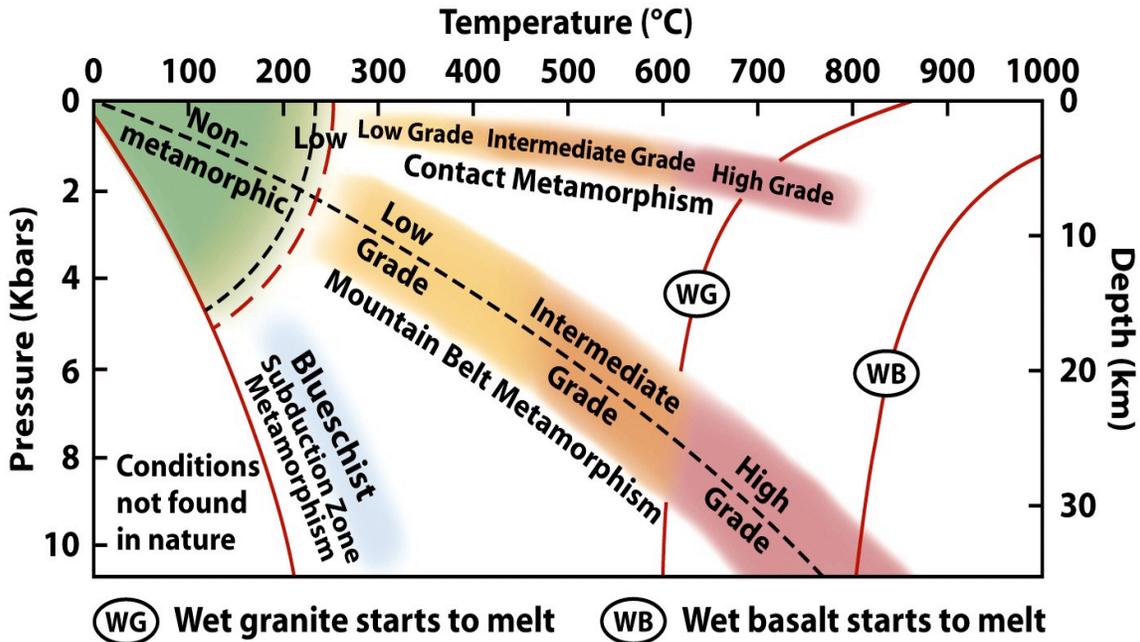


Figure 8-17a Earth: Portrait of a Planet 3/e
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Grade	NONMETAMORPHIC (PROTOLITH)	LOW GRADE	INTERMEDIATE GRADE	HIGH GRADE	PARTIAL MELTING*	
Rock name	Basalt	Greenschist	Amphibolite	Mafic Granulite	(not common)	
Mineral occurrence		Zeolite Chlorite Epidote NoAl	Amphibole	Al Garnet Pyroxine		
Rock name	Shale	Slate	Phyllite	Schist	Gneiss	Migmatite
Mineral occurrence	Clay	Chlorite	Quartz/Feldspar Muscovite Biotite	Garnet Staurolite Kyanite	Sillimanite	

***NOTE:** The temperature at which partial melting depends on rock composition and water content. Mafic rocks begin to melt at higher temperatures than do pelitic rocks. Wet rocks melt at lower temperatures than do dry rocks.

Figure 8-17b Earth: Portrait of a Planet 3/e
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LEARNING ASSESSMENT #4 (METAMORPHIC ROCKS) STUDENT CHECKLIST

Part 1: (16 marks)

Metamorphic Zone Map

- Biotite non-foliated
- Andalusite non-foliated
- Chlorite foliated
- Biotite foliated
- Garnet foliated
- Kyanite foliated
- Sillimanite foliated

- Regional grade direction
- Contact grade direction

Part 3: (10 marks)

Metamorphic History

- In order, used numbered list, organized answer
- Event/Process 1
- Event/Process 2
- Event/Process 3
- Event/Process 4
- Event/Process 5
- Event/Process 6
- Event/Process 7
- Event/Process 8
- Event/Process 9

Part 2: (15 marks)

Metamorphic Textures

Chlorite:

Foliation Mineral 1 Mineral 2

Biotite:

Foliation Mineral 1 Mineral 2

Garnet:

Foliation Mineral 1 Mineral 2

Kyanite:

Foliation Mineral 1 Mineral 2

Sillimanite:

Foliation Mineral 1 Mineral 2

Total: 41 marks