Student Name: Campus: Grade:

Physical Geology 101 Laboratory
Interpreting Geology Maps I

Introduction & Purpose: The purpose of this laboratory exercise is to become acquainted with and successful at applying the principles learned in the topographic and structural geology labs towards the analyses of geology maps. Students will learn to read a geology map for the purpose of understanding surface and subsurface structural relations and geologic history that may include a record of igneous, metamorphic, and sedimentary rock forming events, mountain building deformation, and surface erosion.

Part I. Review Taking Strike and Dip

Directions: Use the Compass and Inclinometer, provided by your instructor, to determine the strike and dip of two inclined boards that are setup in the classroom. **Note:** Use the boards labeled "**A**", **"B"** and **"C"** for your measurements.

1. **What is the strike and dip of the board labeled "A" strike: _____ dip: _____**

2. **What is the strike and dip of the board labeled "B"? strike: _____ dip: _____**

3. **What is the strike and dip of the board labeled "C"? strike: _____ dip: _____**

Part II – Reading and Interpreting a Geologic Map

Introduction: A geologic map is a greatly scaled-down, two-dimensional abstract representation of the surface geology, structure, and relief of a geographic region of Earth, or even another terrestrial planet. A geologic map typically includes most information found on a topographic map, but most importantly, includes color-coding regions and symbols that denote rock units, contacts, and other structural information. Additionally, all the geologic color-coding and symbols are explained in the legend on a geologic map, including topographic and cardinal information.

A. Reading and Interpreting a Geology Map

Directions: Do a general examination of the entire geologic map of the Devil's Fence Quadrangle. Carefully examine the various rock units represented by the colored regions and related map symbols on the map that portray the surface geology of this area in Montana. Note their shape, aerial extent, and the larger structural patterns formed by spatially- associated outcropping rock units. Use the explanation to the left of the map to decipher the rock units, in terms of formation name, age, and lithology, and structural. Also use the explanation to the left of the map to decipher the structural relations of the various formations, including strike and dip, folding, and faulting. Finally, answer the following questions, based on your analysis of the Devil's Fence Quadrangle.

1) Verbal scale for this map is as follows: One inch of map is equal to _____ miles of real ground.

2) What is the contour interval? _____ ft. **3)** This map covers _____ square miles.

4) What are the minimum and maximum elevations for this area? Min =_____ ft. Max =_____ ft

5) Does this area have gentle or rugged topography (relief)? _____

6) What <u>topographic</u> feature does Devil's Fence correspond with? Valley? Mountain? Ridge? Plain?

7) Does the location and orientation of the Devil's Fence topographic feature (question 6) correspond to specific location and orientation of underlying geologic rock unit(s)? Hint: Underlying geology (nature of rock formations and structures like folds and faults) very commonly controls the overlying topography. Answer: _____

8) List the major types rock types exposed in this area, such as sandstone, schist or granite. Include at least six rock types. List at least one rock type from each of the three major rock groups.

_____, _____, _____, _____, _____, and _____.

9) What's the total age range of the listed rock formations? _____ to _____

10) Find the Colorado Formation unit on the map. What its age? _____Period

11) This rock formation forms the center of what general type of geologic structure, such as a fold or fault? Hint: notice the "V" shaped pattern of rocks) _____.

12) If you answered "fold", is it a syncline or an anticline? _____ Horizontal or plunging?

13) What information did you use to tell whether it was a syncline or an anticline? _____

_____

14) How could you tell whether it's a horizontal or plunging fold? _____

_____

15) Find the Greyson Shale Fm on the map. What's its age? _____Period

16) This rock formation forms the center of what general type of deformational geologic structure? Hint: notice the upside down "V" shaped pattern of rocks) _____.

17) If you answered "fold", is it a syncline or an anticline? _____ Horizontal or plunging?

18) What information did you use to tell whether it was a syncline or an anticline? _____

_____

19) How could you tell whether it's a horizontal or plunging fold? _____

_____

20) Determine the bearing of fold axes_____ Which direction are the folds plunging? _____

21) How many distinct folds are found in this geologic map? Hint: Way more than two!! _____

22) What type of deviatoric stress caused the folding event? Tension? Compression? Or Shear?

23) Which two compass directions did the deviatoric stresses come from to cause the folding? _____

24) What type of fault is the Morse Gulch Fault? _____ How did you come to this conclusion? _____

25) Determine the timing of the regional folding event. **Note:** Folding must have occurred ***after*** the youngest folded rock unit BUT ***before*** the oldest non-folded rock unit). So to determine the age of the folding event, you will need to determine the following rock formation ages:

a) Name and age of YOUNGEST ROCK that is FOLDED?

Formation name: _____ Age: _____ Period

b) Age of OLDEST ROCK that is NOT FOLDED?

Formation name: _____ Age: _____ Period

c) Age of folding? Folding occurred between _____ Period and _____ Period

26) What type of rock makes up the Sagebrush Park stock? _____

27) What's the age of the Sagebrush Park stock? _____ Period

28) Determine the timing between the intrusion of the Sagebrush Park stock and the regional folding event. Did the intrusion occur BEFORE, DURING, or AFTER the folding? **Note:** To confidently answer the above question, you will need to know both, the age of folding and the age of intrusion.

a) Age of folding event _____ Period

b) Age of Sagebrush Park intrusion? _____ Period

Based on the above noted ages, did the intrusion occur ***BEFORE, DURING***, or ***AFTER*** the folding?

c) Sagebrush Park stock intruded the sedimentary rock package _____ the folding.

29) Based upon your study of the geology and structure of the Devil's Fence region, what was the most likely tectonic plate boundary setting (***divergent, convergent, or transform***) that would most-likely generate the combination of folding, reverse faulting and granodiorite intrusions?

Answer: _____ **Why?** _____

30) If you picked convergence, was it subduction-related, or was it a continental collision scenario

Answer: _____ **Why?** _____

31) If you picked subduction, was it ocean-ocean subduction, or was it ocean-continental?

Answer: _____ **Why?** _____

Part III. Munger Mountain Quadrangle Geology Map Analysis

Directions: Study and interpret the Munger Mountain Quadrangle geology map, including the cross-sections and map explanation. The following questions pertain to the geology of this mapped region. Choose the answer that best completes the statement or answers the question.

1. The verbal scale is 1 inch of map equals _____mile(s) of real ground.

2. How many square miles does this geology map cover? _____ sq. miles

3. The contour interval is _____ feet.

4. The geologic cross sections indicate that this region has what range of topography relief?

In other words, what's the total range of elevations across the map? _____ ft to _____ ft

5. When was the geology mapped? _____

6. Which direction does the Snake River flow? _____ to _____

7. What is the *oldest sedimentary* rock unit? _____

8. What is the *youngest sedimentary* rock unit? _____

9. The <u>total age range</u> listed for the various rock units? _____period to _____period

10. During which Era did <u>most</u> of the rock formations form? _____

11. What is the listed age of the Phosphoria Formation? _____

12. Which of these rock formations appears to be the thickest in this region? _____

13. What is the <u>most common</u> rock type listed within formation descriptions? _____

14. What type of large-scale fold is found in the <u>eastern half</u> of the map? Note that this fold includes virtually all the rock formations listed on this map. But note: there are several smaller-scale folds within that fold. Hint: Make sure to look at the geologic cross section too. The instructor will point it out on the projector. _____

16. What is the general bearing of the strike of the fold axes? N-S? W-E? _____

17. Which direction does the fold plunge? _____

18. What were the stress directions that were applied to create this folded structure? _____

19. Which direction is the Darby Thrust fault dipping? West or east? Hint: Check the cross-section! _____

20. Which direction did the hanging wall move on the Darby Thrust fault? Hint: Make sure to look at the geologic cross-section of this fault. Eastward & Up? Eastward & Down? Westward & Up? Or Westward & Down?

21. Roughly how much thrust movement (offset) appears to have occurred on the Darby Thrust fault? Hint: Make sure to look at the geologic cross-section of this fault. Use the bar scale for measure (in miles).

_____ miles

22. Which direction is Absaroka Thrust fault dipping? West or East? Hint: Check the cross-section!

_____

23. Which direction did the hanging wall move on the Absaroka Thrust fault? Hint: Make sure to look at the geologic cross-section of this fault. Eastward & Up? Eastward & Down? Westward & Up? Or Westward & Down?

24. What type of fault is mapped 1 mile east of the Absaroka Thrust fault? Hint: geologic cross-section _____

25. What's the likelihood that the three faults, noted above, were syn-tectonic with folding event? In other words, was it likely or unlikely that the three major faults on this map were active with the folding event in this region? Hint: Think about orientation of all features and their associated stress. _____

26. Which period did the folding and faulting occur in this region? _____

27. Which type of tectonic plate setting was most likely responsible for the deformation event(s) mapped in this region? _____

28. Is there any evidence found on this map to indicate that this region was definitely involved in subduction-related plate tectonics? Yes/No? _____ Evidence: _____

29. Based on your study of the both, Mungar Mountain geology map of western Wyoming and the Devil's Fence map of southwestern Montana, what is the likelihood that the deformation events of both these area are closely related, in terms of plate tectonic history of Western North America? Hint: Think

about types and orientations of structural features AND their associated tectonic stresses, and the timing of both events. Likely? Unlikely? _____ Evidence: _____

_____

Part IV - Geologic Map Laboratory Reflection

Directions: Write a 3-paragraph lab reflection explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this geologic map lab (*3 points possible*). Answer the following 3-point question reflection set below.

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.

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