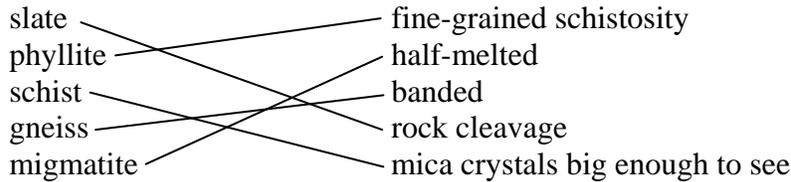


Name: \_\_\_\_\_ KEY \_\_\_\_\_

Examine all possible answers; some may not satisfy the question criteria and should be left blank.

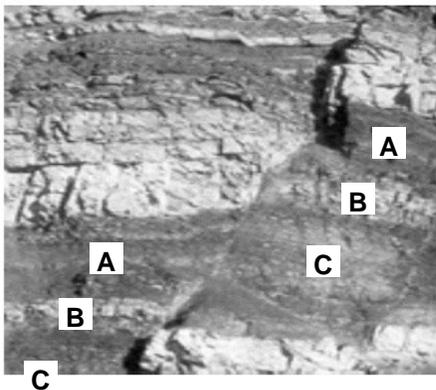
1. Match the metamorphic rock with its foliated texture. [10 pts]



2. A region is characterized by numerous anticlines and synclines. There are also several faults present that appear to have formed at the same time as the folding. Without looking at any details, what type of faults would you assume them to be? Why? [8 pts]

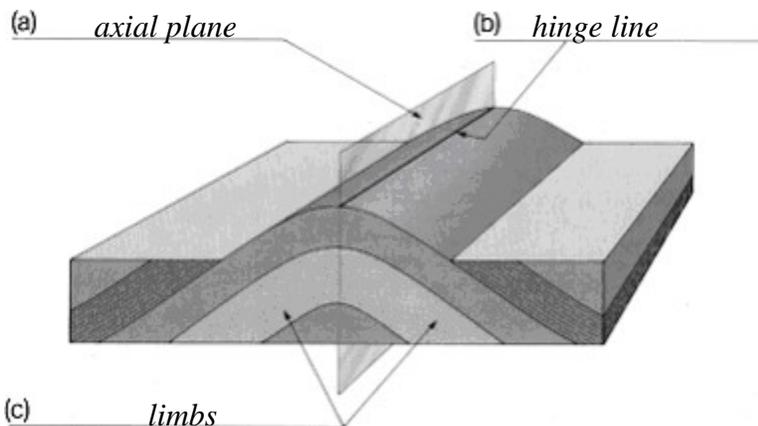
*The faults would be reverse faults and thrust faults, because these faults form when rocks are compressed, which is the same stress state that causes rock folds.*

3. What kind of geologic structure is shown in the photograph below? Explain why you chose your answer. [12 pts]



*Normal fault, because the hanging wall has moved down relative to the footwall.*

4. On blanks a-c below, write the name of the specific feature that has been labeled. [12 pts]



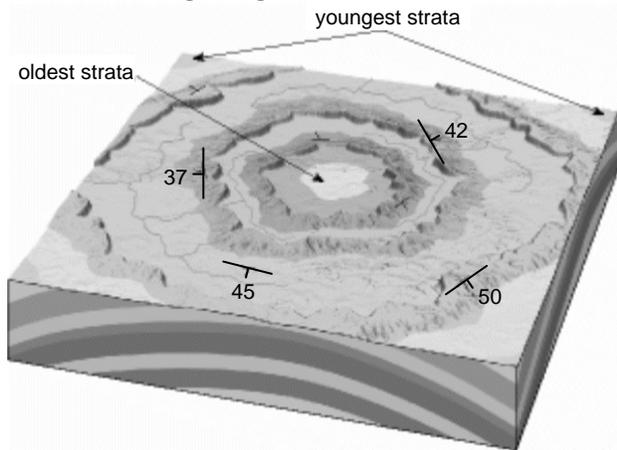
(d) Name the entire structure:

\_\_\_\_\_ anticline \_\_\_\_\_

5. Match the metamorphic rocks on the left with their immediate parent rocks on the right. [14 pts]

- |                           |                     |
|---------------------------|---------------------|
| <u>E</u> marble           | A) slate            |
| <u>B</u> gneiss           | B) schist           |
| <u>A</u> phyllite         | C) phyllite         |
| <u>G</u> slate            | D) quartz sandstone |
| <u>C</u> schist           | E) limestone        |
| <u>F</u> metaconglomerate | F) conglomerate     |
| <u>D</u> quartzite        | G) shale            |

6. (a) Name the geologic structure shown in the block diagram below. [4 pts]



*This question is not included in the exam total, due to the mixup in labeling the ages of the strata. This has been corrected at left, so the ages and the dips of the strata both agree that it is a dome.*

(b) Explain what the  $\frac{\text{---}}{20}$  symbols mean. [8 pts]

*The long line shows graphically the bearing (azimuth) of a horizontal line within a 3D plane (in other words, the strike of the plane). The short line, which is perpendicular to the strike line, shows the direction of the dip (the inclination of the plane below horizontal). The number is the dip angle itself. In this case, the plane is the rock layer on which the symbol is drawn.*

7. The a is a direct measure of the distance from a seismic receiving station to the focus of a distant earthquake. [5 pts]

- (a) time interval between the first P-wave and the first S-wave arrivals
- (b) magnitude of the ground acceleration of surface wave passing a receiving station
- (c) time elapsed between the first P-wave arrivals from the first and last aftershocks
- (d) time interval between the first P-wave and the last surface wave
- (e) length of the P-wave

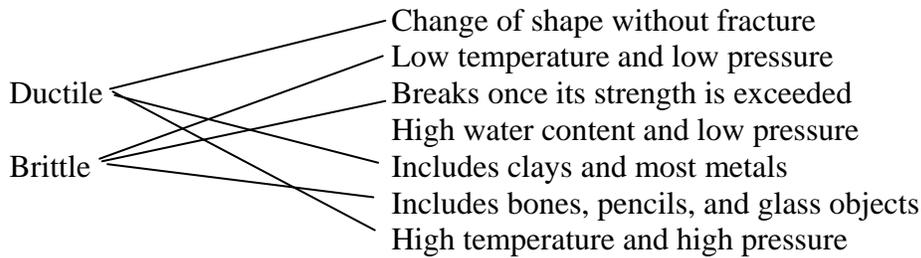
8. A d fault has little or no vertical movements of the two blocks. [5 pts]

- (a) stick-slip
- (b) oblique slip
- (c) dip slip
- (d) strike slip
- (e) side slip

9. Explain why a vertical dip-slip fault cannot be classified as a reverse fault or a normal fault. [5 pts]

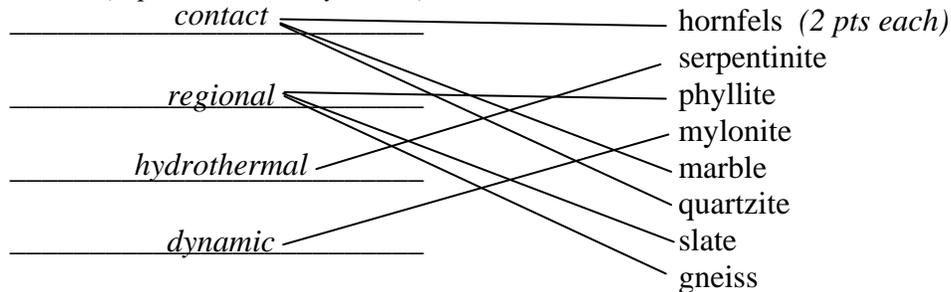
*Because there is no distinction between the hanging wall and the footwall when the fault is vertical.*

10. Match the properties in the left column with the appropriate descriptions on the right. [14 pts]



11. List the four types of metamorphism, and match them to the appropriate metamorphic rocks. [24 pts]

(2 pts each, in any order)



12. Which wave will show up first when dealing with earthquakes? [4 pts]

S-wave     P-wave     tidal wave     surface wave

13. List the agents of metamorphism; that is, the things that make rocks metamorphose. [12 pts]

*heat, pressure, chemically reactive fluids*

14. What platy, parallel mineral grains are the most visual aspect of foliated metamorphic rocks? [5 pts]

feldspars     micas     amphiboles     carbonates     quartz

15. Order the following descriptions, from least (1) to greatest (4) of the Modified Mercalli Intensity scale. [12 pts]

- 3 Some well built wooden structures destroyed. Most masonry and frame structures destroyed. Ground badly cracked.
- 1 Not felt except by a very few people under especially favorable circumstances.
- 2 Felt by nearly everyone. Many awakened. Disturbances of trees, piles, and other tall objects noticed.
- 4 Damage total. Waves seen on ground surfaces. Objects thrown upward into air.

16. True or False? Any rock with the appropriate mineral content, including shale, can be metamorphosed into gneiss. [4 pts]

*True*

17. Which would result in the largest area of ground shaking damage? [5 pts]

- very deep-focus quake beneath the Aleutian Islands
- deep-focus quake off the coast of North Africa
- shallow-focus quake along the San Andreas Fault
- a shallow-focus quake along the New Madrid Seismic Zone
- a moderate-focus quake beneath the Andes Mountains

18. Explain your answer for the preceding question. [6 pts] *Shallow quakes cause more damage than deep ones, and shaking is more intense where surface materials are deep and unconsolidated, as they are in the New Madrid Seismic Zone, which is along the Mississippi River.*

19. What are the smaller magnitude quakes that follow a major earthquake? [4 pts] *aftershocks*

20. How is energy stored in rocks adjacent to the site of a future earthquake? [5 pts] *elastic strain*

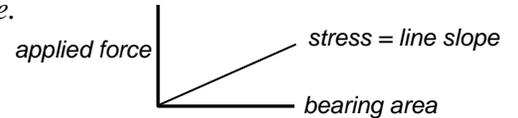
21. How many directions of shaking can be monitored by a single seismograph? [5 pts]

- X one     two     three     32     100

22. Explain how stress is related to force. Use an equation, a diagram, a written description, or any combination of the three. [6 pts]

$$\sigma = \frac{F}{A} \quad \text{where } \sigma = \text{stress, } F = \text{force, } A = \text{bearing area (applies to both normal and shear)}$$

Stress magnitude is force normalized to the area to which it is applied, or force divided by the area to which it is applied. Stress results from force, it is not a type of force.



23. Change this sentence to make it true: Compressive stress causes the crust to become longer because it causes brittle rock to fold and ductile rock to break into reverse faults. [8 pts]

*Compressive stress causes the crust to become shorter because it causes ductile rock to fold and brittle rock to break into reverse faults.*

OR

*Tensile stress causes the crust to become longer because it causes ductile rock layers to become thinner and brittle rock to break into normal faults.*

24. Define rock joints. [5 pts]

*A rock joint is a break in the rock fabric. It can be called a crack, fracture, or discontinuity. There is no relative parallel motion between the two sides of a joint, as there is with faults.*

25. Indicate the earthquake factors that are measured by the Richter scale (**L**) and the Moment Magnitude scale (**W**). [15 pts]

<u>W</u> fault zone displacement	___ population density
<u>W</u> shear strength of faulted rock	___ severity of ground shaking
<u>L</u> largest seismic wave amplitude	<u>W</u> area of fault surface rupture
___ type of surface geologic materials	___ building design
<u>L</u> type of seismograph used	<u>L</u> quake-seismograph distance

26. True or False? Earthquakes always occur either on pre-existing faults or during the creation of new faults. [4 pts]

*True*

27. What is the difference between elastic rebound and ductile (plastic) deformation? [6 pts]

*The difference is in what happens after the force that produces the deformation is removed. Elastic materials rebound; that is, they return to their original configuration (shape and size). Ductile (plastic) materials remain deformed permanently.*

28. Describe how a seismograph works, and how one that is designed to detect horizontal ground motion is different from one designed to detect vertical ground motion. [15 pts]

*Your description has to include the role of inertia, some indication that the motion being measured is horizontal, and how it is recorded. It had to be clear that you understood and were not just copying words and/or drawings from the book.*

29. List, and describe, the types of damage you would expect a large, nearby earthquake to cause in the town of Rolla. Be specific. [16 pts]

*Failure of buildings and dams due simply to ground vibrations, even for structures on competent bedrock. Amplification of seismic waves in valley-fill sediments and construction fill, leading to failure of structures built on those materials. Liquefaction of poorly constructed fills (probably old ones created before geotechnical regulations were in place). Seiches in the ponds and reservoirs in town (Ber Juan, for example, if the dam held). Landslides of soil and regolith on the many slopes in town, especially newly created ones along I-44 and south 63. Ground subsidence, particularly as undetected caverns collapse, filled sinkholes further compress, or poorly compacted fills fail. Fire, as ground shaking causes gas line leaks and spills combustible materials near ignition sources. Failure of public drinking water and sewer systems. No tsunami damage would be expected.*

30. All rocks – sedimentary, igneous, and metamorphic – are named according to what two general criteria? [6 pts]

*texture and mineral composition*

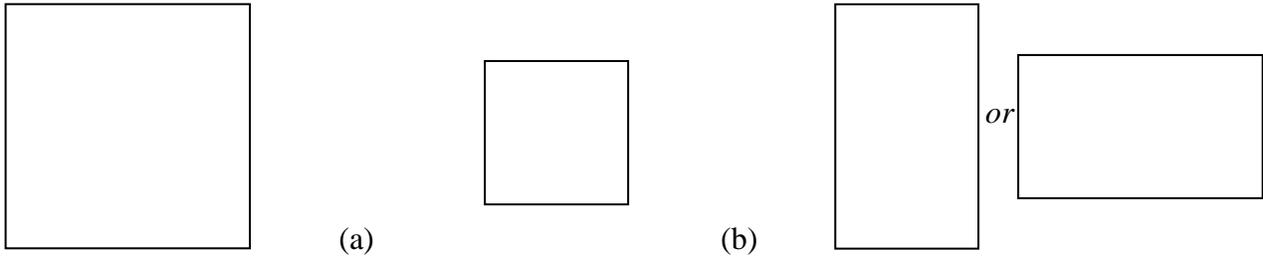
31. As metamorphic grade increases, what happens to nonfoliated metamorphic rock textures? [4 pts]

*The grains grow progressively larger; in other words, the texture becomes coarser.*

32. True or False? Most metamorphic rocks have different overall chemical compositions from their parent rocks. [4 pts]

*False*

33. Show how this square would look if it were subjected to (a) Confining pressure, and (b) Differential stress. [8 pts]



BONUS: What is metamorphism? [+4 pts]

- Low temperature and pressure alterations of sediment after burial.
- The process in which substances dissolved in pore water precipitate out to cement grains of sediment together.
- The mineralogical, textural, chemical, and structural changes that occur in rocks from exposure to higher temperatures and/or pressures.
- Reduction of pore space in sediment from the weight of overlying sediments.

BONUS: Put the four regional metamorphic facies in order from lowest to highest temperature and pressure. [+8 pts]

3 amphibolite facies    2 greenschist facies    lowest (1) zeolite facies    highest (4) granulite facies

<i>Zeolite facies</i>	<i>L temp and pressure</i>
<i>Greenschist facies</i>	↓
<i>Amphibolite facies</i>	↓
<i>Granulite facies</i>	<i>H temp and pressure</i>