Metamorphic Rocks – Practice Questions and Answers

Revised October 2007

1. Metamorphism is a _____ that involves no melt phase.

2. The protolith of a metamorphic rock is the
   (a) sibling
   (b) brother
   (c) parent
   (d) daughter
   (e) none of the above

3. Fabric refers to the way _____ in a rock are arranged.

4. Foliation is defined by the _____arrangement of minerals.

5. Typical platy minerals (sheet silicates) defining a foliation include (select all that apply)
   (a) chlorite
   (b) muscovite
   (c) biotite
   (d) hornblende
   (e) pyroxene

6. Directed pressure during metamorphism produces a _____.

7. If elements do not enter or leave a rock during recrystallization, then the rock system is described as _____ or _____.

8. Marble is a metamorphic rock composed of coarse-grained
   (a) dolomite
   (b) quartz
   (c) calcite
   (d) epidote
   (e) garnet

9. Quartzite is a metamorphic rock composed of a dense network of interlocking
   (a) dolomite
   (b) quartz
   (c) calcite
   (d) epidote
   (e) garnet

10. Basalts when metamorphosed at temperatures of ~500^{o}C or higher are transformed into _____.

11. Slates are characterized by a tendency to break into even-parallel sheets due to the parallel alignment of the flat crystal faces of
    (a) garnet and kyanite
    (b) sillimanite and biotite
    (c) chlorite and muscovite
    (d) quartz and epidote
    (e) none of the above

12. The foliation in a slate is called slaty
    (a) schistosity
    (b) gneissosity
    (c) cleavage
    (d) foliage
    (e) none of the above

13. Assuming a mudstone protolith, the transformation to a slate occurs at ~_____ ^{o}C.

14. Phyllites are _____ grained than slates, and when held up to the sunlight exhibit a marked _____, as rays of light reflect off the aligned crystals of _____ and _____.

15. Assuming a mudstone protolith, the transformation to schist occurs at temperatures between about _____ and _____ ^{o}C. The resulting foliation is called _____.

16. Schist derived from a mudstone at temperatures between about 500 ^{o}C and 650 ^{o}C will consist of quartz, feldspar, muscovite, biotite, garnet, and _____. Such a rock would be _____ grained than a phyllite.

17. The coarsest grained metamorphic rock is a
    (a) phyllite
    (b) slate
    (c) schist
    (d) gneiss
    (e) none of the above

18. A foliation in gneiss would be called _____. It forms as ions migrate over microscopic distances at temperatures above _____ to _____ ^{o}C.

19. Metamorphic grade refers to the broad pressure conditions of metamorphism. True or false

20. In general, metamorphic grade is dependent upon the
    (a) geobarometer
    (b) isotherm
    (c) geotherm
    (d) lithobar
    (e) none of the above

21. Given a specific geotherm, low metamorphic grade rocks occur in the _____ part of the crust while higher grade rocks will occur at _____ levels.

22. Given a mudstone protolith, and a geothermal gradient typical of arc-continent collisions, at temperatures over 700 ^{o}C, the stable metamorphic mineral assemblage will consist of quartz, feldspar, and _____.

23. Isotherms are curves or surfaces of equal
    (a) composition
    (b) volume
    (c) pressure
    (d) temperature
    (e) none of the above

24. Isotherms bend downward within
    (a) volcanic arcs
    (b) continental interiors
    (c) divergent margins
    (d) subduction zone settings
    (e) none of the above

25. In volcanic arc settings, isotherms bend downward due to the introduction of hot magma. True or false

26. An envelope of recrystallized rock surrounding a pluton is called a
    (a) rim of hard rock
    (b) envelope of hard rock
    (c) contact metamorphic aureole
    (d) contact metamorphic rim
    (e) none of the above

27. Non-foliated rocks found in contact metamorphic aureoles are called
    (a) granofels
    (b) hornfels
    (c) lithofels
    (d) petrofels
    (e) none of the above

28. Phase diagrams depict the PT conditions under which various minerals are stable. True or false

29. Is andalusite a low or high pressure phase relative to kyanite?

30. Is sillimanite a low or high temperature phase relative to andalusite?

31. Which of the following metamorphic facies represent rocks that were metamorphosed under the lowest PT conditions recognized by geologists?
    (a) eclogite
    (b) amphibolite
    (c) greenschist
    (d) granulite
    (e) zeolite

32. Which of the following metamorphic facies represent rocks that were metamorphosed under the highest pressure conditions recognized by geologists?
    (f) eclogite
    (g) amphibolite
    (h) greenschist
    (i) granulite
    (j) zeolite

33. The hornfels facies forms during _____ metamorphism.

34. In subduction zone settings the geotherm is _____.

35. The geotherm in collisional zones and active regions of continents is about _____.

36. The geotherm in island arcs is about _____.

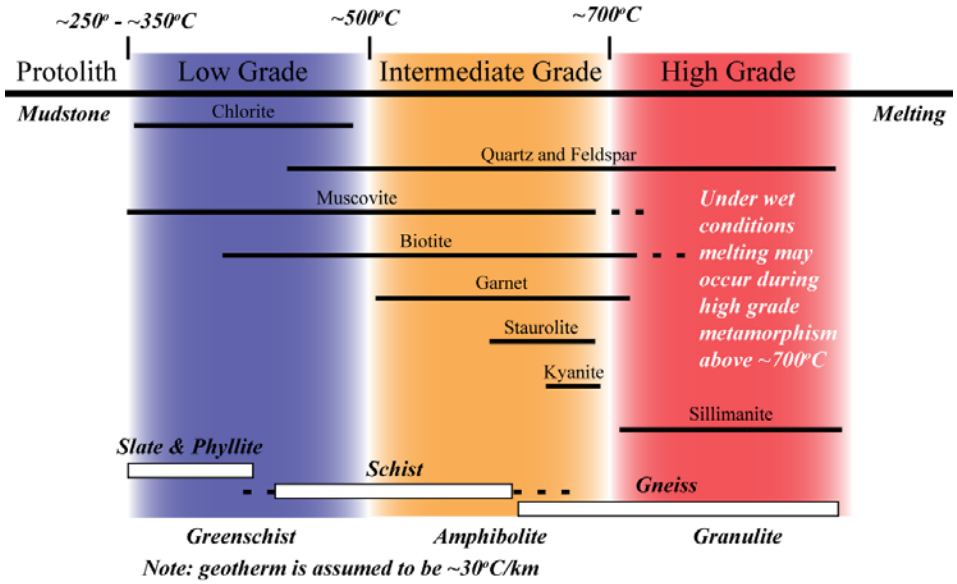
37. Why do isotherms bow upward in island arcs and mid-ocean ridges?

38. Why do isotherms bend downward in subduction zone settings?

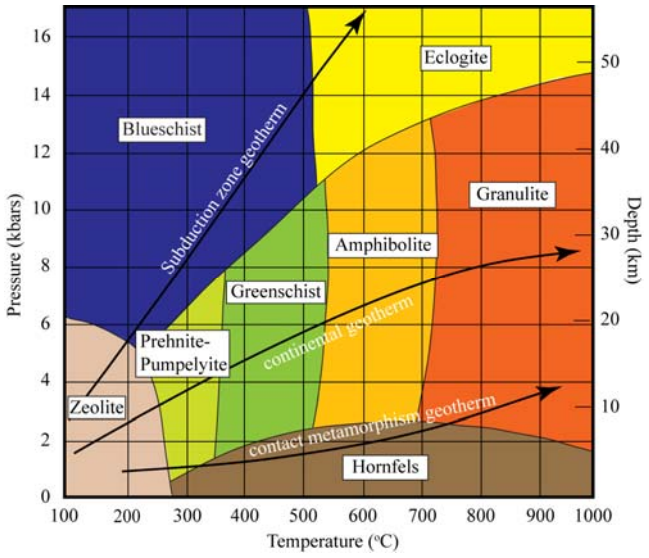
39. How would describe the distribution of metamorphic facies within a zone of collision between an island arc and a passive continental margin?

40. What would happen to a mudstone if it were metamorphosed at temperatures in excess of 700^{o}C under wet conditions?

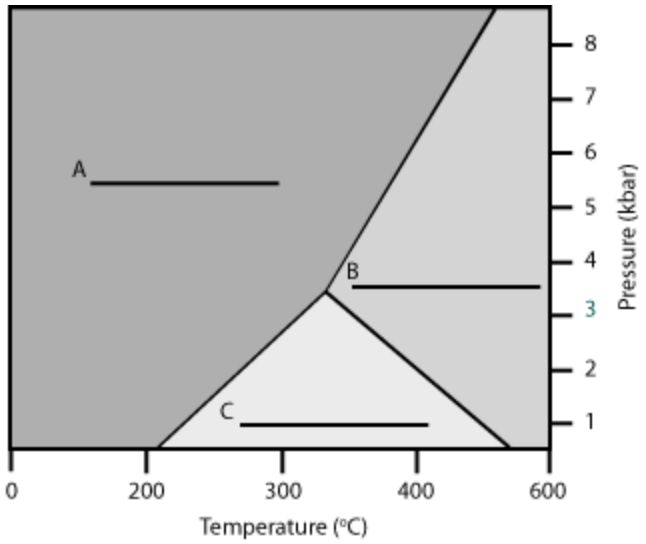
41. Using the illustration shown below, please answer the following questions.
    (a) What minerals would be stable at temperatures around 400°C, 600°C and 710°C?
    (b) What is the relationship between textural type of metamorphic rock and metamorphic grade?
    (c) What is the relationship between metamorphic grade and facies development?
    (d) What is the average temperature for the onset of metamorphism?
    (e) If a mudstone undergoes metamorphism under wet conditions at temperatures above ~700°C, then what will happen?



42. In the illustration shown below, the continental geotherm is broadly representative of collisional and other active regions of the crust. Please answer the following questions.
    (a) What is the metamorphic facies series for a geotherm typical of subduction zone settings?
    (b) What is the metamorphic facies series for a geotherm typical of continental regions?
    (c) What is the metamorphic facies associated with geotherms around cooling magma?



43. In the following illustration what do the fields labeled A, B, and C represent?



Answers

1. solid-state recrystallization
2. (c) parent
3. minerals
4. plane or planar
5. (a) chlorite, (b) muscovite, (c) biotite
6. foliation
7. closed, isochemical
8. (c) calcite
9. (b) quartz
10. amphibolite
11. (c) chlorite and muscovite
12. (c) cleavage
13. 300
14. coarser, sheen, chlorite, muscovite
15. 400, 500, schisosity
16. staurolite, coarser
17. (d) gneiss
18. gneissosity, 600, 650
19. False, metamorphic grade refers to the relative temperature conditions under which rocks were metamorphosed
20. (c) geotherm - note that this is sometimes referred to as the geothermal gradient
21. upper, deeper
22. sillimanite
23. (d) temperature
24. (d) subduction zone settings
25. False
26. (c) contact metamorphic aureole
27. (b) hornfels
28. True
29. low pressure
30. high temperature
31. (e) zeolite facies
32. (a) eclogite
33. contact
34. 10^{o}C/km
35. 25^{o} - 35^{o}C/km
36. 50^{o}C/km
37. Isotherms bow upward in island arcs and mid-ocean ridges because hot magma is introduced in these regions.
38. Isotherms bend downward in subduction zone settings because the cold subducting lithospheric plate descends at a rate faster than it can equilibrate (warm up) to the temperatures of the over ridging plate.

39. Zeolite and prehnite-pumpellyite facies would occur along the flanks. Moving progressively toward the interior of the zone of collision, you would encounter greenschist, amphibolite, and granulite facies.
40. The mudstone probably would melt.

41.
    (a) @ 400^{o}C chlorite, muscovite, and biotite would be stable
        @ 600^{o}C quartz, feldspar, muscovite, biotite, garnet, and staurolite would be stable
        @ 710^{o}C quartz, feldspar, biotite, sillimanite, and possibly muscovite would be stable
    (b) Low grade rocks are going to be composed largely of slates, phyllites, and schists while intermediate grade rocks are going to be schists and gneisses. High grade rocks are going to consist primarily of gneisses.
    (c) Greenschist facies rocks will be composed primarily of slates, phyllites, and schists. Amphibolite facies rocks will be mostly schists and gneisses, while high grade metamorphic rocks will be dominated by gneisses.
    (d) ~300^{o}C
    (e) It will melt

42.
    (a) Zeolite, blueschist, ecologite facies
    (b) Zeolite, prehnite-pumpellyite, greenschist, amphibolite, and granulite facies
    (c) Contact

43. A = kyanite. B = sillimanite. C = andalusite.