Study Guide for GEOL 285 - Petrology Final Exam – Fall 2005
The exam will be held at 8-10 am, Wednesday, Dec. 14, 2005 in Room 310, White Hall
Dr. Lang will be available to answer questions on Monday, Dec. 12, and Tuesday, Dec. 13, at most times between 10am and 5pm (except lunchtime) in 308 White Hall.

Questions on the final will be selected from the subjects and content of these questions. However, questions on the final will be more specific and will refer to specific diagrams that you will be given (like other tests). They won’t match these questions exactly.

Comprehensive (Review) Questions on Igneous Rocks

1. Given the Streckeisen (QAPF) diagram for naming igneous rocks, how do you plot and name a plutonic igneous rock with a given percentage of plagioclase, quartz, alkali feldspar, orthoclase, feldspathoid, hornblende, pyroxene, biotite, etc.?

2. The box on the right of the QAPF diagram near P=plagioclase contains the three names: diorite, gabbro, and anorthosite. What are the two mineralogical characteristics that allow you to give the correct name to a rock that plots in that box, and what do they mean?

3. Be able to completely describe the equilibrium crystallization of any liquid on the Diopside-Anorthite, Forsterite-Enstatite-SiO2, or the Albite-Anorthite phase diagram (discussed in class). At any temperature, be able to say what phases would be present, and tell the composition and proportion (amount) of each.

Questions on the characteristics and generation of subduction-related andesitic magmas at convergent margins (not covered on Midterm exam)

4. What are three characteristics (describe each in detail) of subduction-related magmas (like the Cascades) that must be explained by any good model for generation of those magmas?

5. What is bimodal volcanism, and what may happen in a shallow magma chamber to cause it?

6. Describe in detail the zoned ash flows exposed at the Pinnacles in the river valley south of Crater Lake. What is thought to have happened in the shallow magma chamber beneath Mount Mazama to cause those zoned ash flows?

7. According to J.K. Gill’s model (presented in class) for the generation of subduction related andesites, magmas produced above a subducting slab typically get trapped in a magma chamber at the base of the continental crust. Why do they get trapped?
8. What happens in the magma chamber that allows the magma to rise and gives it the characteristics described in Question 4, above? (Critical element of Gill’s model, be specific)

**Questions on Dr. Penny L. King’s talk on Volatiles in Magmas (Friday before Thanksgiving, see link to talk on 285 class Web-site)**

9. Discuss in detail one of the reasons presented by Dr. King for why we, as geologists, should care about the volatiles in magmas.

**Weathering, sediments and Sedimentary Rocks**

10. What are the two main aspects of weathering? Which is most important for the eventual breakdown of rocks?

11. What unusual properties of water contribute to each of the above aspects of weathering? (Be able to discuss.)

12. What is Goldich’s Weathering Series and why does it resemble Bowen’s reaction series?

13. What minerals or groups of minerals do all silicate minerals weather to form? What happens to iron that weathers out of silicate minerals?

14. Grain size is an important characteristic of detrital or clastic sedimentary rocks. What is the Phi(ø)-scale? What equation relates the size in millimeters to a corresponding phi size?

15. How would you determine the range in phi-sizes of grains from a given sample of loose sediment? What tools would you need to do this accurately? How would you determine the range in phi-sizes of grains from a sample of lithified sandstone? What tools would you need for this?

16. Clay minerals in sedimentary rocks can be either detrital or authigenic. What is meant by each of these terms, and how can you tell if the clay in a particular rock is detrital or authigenic.

17. What is meant by sorting, rounding, sphericity as they apply to sand grains? What might these characteristics tell you about the history of a sandstone?

18. What are the three most common sand-sized grain types in sandstone?

19. On the Folk sandstone classification diagram used in class, what grain types are at the corners of the front triangle used for naming Arenites? Given the diagram, you should be able to plot and name any arenite.
20. What is the maximum amount of detrital clay (mud) that a sandstone can contain, and still be classified as an arenite?

21. What are the abundant grain types in a litharenite? What are the abundant grain types in an arkose?

22. Does a lithic arkose contain more or less feldspar than a feldspathic litharenite?

23. What are the sandstones that contain between 15% and 50% mud matrix called, as a group? What are the three possible names of sandstones in this group, and what are the major sand grain types in each?

24. What is meant by the concept of textural maturity as it is applied to sandstones? What characteristics (and direction of change) of a sandstone indicate increasing textural maturity?

25. What are the characteristic properties, rock name, grain types, etc., of a supermature sandstone?

26. What are the characteristic properties, rock name, grain types, etc., of an extremely immature sandstone?

27. What might the textural maturity of a sandstone tell you about the transport, source area, depositional area and other aspects of the history of a sandstone?

28. What is meant by diagenesis, and under what conditions does it take place?

29. What are the two most important processes in the diagenesis of sandstones, and which is most important for the lithification of sandstones?

30. What are the four most common types of cements in sandstones? What can you say about the conditions in the solutions that passed through the sandstones that precipitated each cement (composition of solution, pH (acidity of solution), oxidation state of solution, etc.)?

31. Which cement is most soluble, and how does that affect its relative permanence in sandstones?

**Limestones**

32. Which of the common carbonate minerals are polymorphs? What is their chemical formula? Which one is most stable at the Earth’s surface? Is it true that some organisms make their hard parts out of the other one anyway?
33. What is meant by the term allochemical particle (allochem) as it is applied to limestones? What are the four major allochems in limestones (describe each briefly)? What is the prefix for each allochem that is used in Folk’s limestone classification?

34. What is meant by the term orthochemical particle (orthochem) as it is applied to limestones? What are the two major orthochems in limestones (describe each briefly)? What is the suffix for each orthochem that is used in Folk’s limestone classification?

35. What can you tell me about the contents and possible depositional setting of a limestone that is named an crinoidal biomicrite (or other Folk name)?

36. What is the mineralogical difference between micrite and detrital mud in some sandstones?

37. According to Dunham’s field classification of limestones, which of the following contain some mud?
   - Packstone
   - Grainstone
   - Boundstone
   - Mudstone
   - Wackestone
   Arrange those that do contain mud in order of increasing mud content. Tell which are mud-supported and which are grain-supported, and what is meant by these terms. What is the dividing line between the two names of limestones that are mud-supported?

38. What are stylolites and how are they formed?

39. What is likely to happen to aragonite during diagenesis and why?

40. What characteristics of dolomitic limestones suggest that they are secondary and are formed by some diagenetic process?

41. What solution characteristics are required for any mechanism that causes the replacement of calcite or aragonite with dolomite?

42. What is meant by Dorag in Persian? Explain the model of formation of dolomites that is called the Dorag model. Tell in what environment Dorag dolomitization can take place, and why it is sometimes a more attractive model than Evaporative Reflux.

43. Describe in detail the evaporative reflux model for the formation of dolomites. In what environment they form, and what characteristics they must have for this model to be attractive.

**Metamorphism and Metamorphic Rocks**
44. What are the boundaries between diagenesis and metamorphism and between metamorphism and igneous processes? (On what basis is each defined, and at about what conditions do they occur?)

45. What is burial metamorphism and under what conditions does it occur? What are the characteristics of burial metamorphic rocks?

46. What is subduction zone metamorphism and under what conditions does it occur? What are the characteristics of subduction zone metamorphic rocks?

47. What is regional metamorphism and under what conditions does it occur? What are the characteristics of regional metamorphic rocks?

48. What is contact metamorphism and under what conditions does it occur? What are the characteristics of contact metamorphic rocks?

49. How are regional metamorphic rocks and regions distinguished from contact metamorphic regions and rocks?

50. What is meant by the protolith of a metamorphic rock? What are some of the indicators of protolith? What is the prefix for metamorphic rocks with an igneous protolith? those with a sedimentary protolith?

51. Describe some characteristic metamorphic textures.

52. What is meant by the geothermal gradient?

53. What is the approximate increase in pressure that corresponds to 1 kilometer increase in depth beneath average crustal rocks?

54. What is the definition of an isograd, and who defined the term?

55. What is the definition of a metamorphic facies and who defined this term?

56. What type of rocks are the names of the metamorphic facies based on?

57. What triangular diagram did Eskola invent that successfully displays the mineral assemblages in metamorphosed mafic rocks? What is plotted at each corner of that diagram?

58. Given the ACF diagram for a given metamorphic facies, be able to list all of the minerals in various rock compositions that can be represented on the diagram.

59. Given a blank Pressure-Temperature diagram for the metamorphic facies, be able to fill in the names of all of the metamorphic facies (you can omit prehnite-pumpellyite and zeolite facies).
60. List the key metamorphic minerals in metamorphosed mafic rocks of each of the following metamorphic facies:
   blueschist
   greenschist
   eclogite
   epidote amphibolite
   amphibolite
   granulite

61. What are two factors that make metamorphosed shales (pelitic rocks) particularly informative about metamorphic conditions?

62. Why is the ACF diagram not particularly useful for displaying rock compositions and mineral assemblages in metamorphosed shales (pelitic rocks)?

63. What is the new triangular diagram proposed by J.B. Thompson for displaying mineral assemblages in metamorphosed pelitic rocks? What mineral did he project from to make this diagram a triangle?

64. What are the names of the three polymorphs of Al$_2$SiO$_5$? Give one characteristic or diagnostic physical property of each that can be observed in hand specimen and one property that can be observed in thin section.

65. Be able to sketch the phase diagram that displays the Pressure Temperature relations of the three Al$_2$SiO$_5$ polymorphs. Label the triple point and give the best current estimate of its pressure and temperature.

66. What is a pseudomorph (like those observed in the Snow Peak area)?

67. What is the definition of the term porphyroblast?

68. If you have AFM diagrams for the assemblages on both sides of an isograd, how do you determine the metamorphic mineral reaction that took place at the isograd? What extra minerals can you use to balance the reaction, and how do you determine which is the high temperature side of the reaction?

69. What is the appearance of staurolite in the Snow Peak thin sections (several properties)?

70. Which Al$_2$SiO$_5$ polymorph is found in some of the Snow Peak samples, and what does this say about the pressure during metamorphism?