GEOLOGY 350 STUDY GUIDE FOR FINAL

Final will cover chiefly material from landslides, on. Although I won't ask specific questions about them, I shall assume that you can call on your knowledge of weathering, structure, and landslides as necessary, if they come up as part of an answer to a broader question. I am interested in your grasp of *general concepts and fundamental principles, and your ability to apply them to specific situations*, i.e., your ability to use them to solve problems for which there is no cut-and-dried answer. I am especially interested in developing your reasoning and your ability to express your thoughts clearly and concisely, without B.S. and excess verbiage. Thus my questions will usually require some sort of reasoning from basic principles rather than asking for regurgitation of minor facts from the text or lecture. In your answers, the *reasons* you give for answers will be as important (or more important) than the answer itself.

I will expect you to have kept up-to-date in the reading, even if the topics have not been discussed in lecture.

LAB-RELATED QUESTIONS

1. I will give you segments of four maps. For each map you will be asked to: a) describe the weathering or erosional processes that formed the most important or characteristic features of the landscape; b) suggest the climate that prevailed as the landscape was being formed; c) suggest the type and/or structure of the bedrock, if possible.

   To prepare for this, I suggest that you 1) refer to the small maps I handed out (reproduced from Ch. 7 of Verhoogen: *The Earth*) 2) look at the maps in a good general geology lab manual, such as Hamblin and Howard or Zumberge and Rutford, and 3) look at the labeled maps in the 109 map drawer in VMH 107.
2. There is also likely to be some sort of map interpretation problem which may involve *any* aspect of what we've covered in lab. It would involve using map information to solve a geologic and/or environmental problem.

FORMULAS

It may be helpful to bring a calculator, but I *will not* ask you to do complex calculations or to remember slope stability formulas.

I do expect you to know and ***physically understand*** the following formulas (be sure you know what each term represents and its physical significance):

a. Strength: $S = c' + \sigma' \tan \phi' = c' + (\sigma - u)\tan \phi'$

b. Shear stress (at base of soil mass, on stream bed, in glacier)

$$\tau = \rho g d \sin\beta = \gamma d \sin\beta = \gamma z \sin\beta\cos\beta$$

c. Normal Stress (due to gravity)

$$\sigma = \rho g d \cos\beta = \gamma d \cos\beta = \gamma z \cos^2\beta$$

d. Factor of Safety

$F =$

e. Discharge (water, ice, dirt, etc.)

$Q = A = w$

$=$ mean depth $=$ mean velocity

f. Mean velocity of streamflow

$$\overline{v} = \frac{1.49}{n} d^{0.67} S^{0.5} \text{ (English)} = \frac{1}{n} d^{0.67} S^{0.5} \text{ (metric)}$$

PHYSICAL PROPERTIES OF GEOLOGICAL MATERIALS -- see midterm study guide

SLOPES AND LANDSLIDES -- see midterm study guide

RUNOFF GENERATION

1. What factors determine/affect infiltration rate?
2. By what means does stormflow reach streams? (i.e., by what mechanisms is runoff generated?) What factors determine which mechanisms will dominate in any given area? How do these mechanisms affect type and rate of erosion?

SLOPE PROCESSES

1. What is soil creep? Explain at least three mechanisms by which soil creep occurs. Under what physical conditions would each be most effective? (Consider slope, climate, soil type/depth, vegetation, etc.)
2. What factors are likely to be most important in determining *rate* of soil creep? What sort of evidence would you look for to see if soil was actively creeping?
3. What sort of slope profile would you expect on a hillslope shaped mainly by soil creep? Explain why, in physical terms, and what assumptions are necessary.
4. What are the mechanisms involved in sheet erosion? What factors affect rates of sheet erosion? Suggest ways of reducing these rates. How/why would each method work (give physical reason).
5. What information would you want/need to assess relative surface erosion hazard (e.g., you are making an erosion hazard map.) Where/how could you obtain it?
6. How do rills form? How does rill formation affect local erosion rate? Why?
7. What sort of slope profile would you expect on a hillslope shaped mainly by sheetwash and rilling? Explain why, in physical terms, and what assumptions are necessary.
8. Suggest at least two mechanisms by which gullies form and propagate (i.e., basic mechanics/causes of gully formation and growth.) What factors lead to the formation of gullies? How can gullying be prevented or controlled?

EROSION RATES

1. How are erosion rates calculated? Specifically, suggest two different ways of calculating erosion rates: one for the short term, one for geologic time spans. What *data* would you need in each case?
2. What sort of climatic, lithologic, and scale factors affect erosion rates? Why do erosion rates generally decline with increasing drainage area?

DRAINAGE BASINS

1. What is stream order? How do stream numbers vary with order? How does stream length vary with order? What sort of relations do we find between drainage area and stream length, and why?
2. What is drainage density? What is its physical significance and why is it important?
3. What factors control drainage density? (Consider climate, process, geology, vegetation, topography, time and their interactions.)
4. How does the drainage net of a stream develop? Why does it show regularities in its organization?

FLUVIAL PROCESSES

1. What factors interact to control the velocity of water in a stream? How and why do these factors interact? What sort of feedback occurs between these factors?
2. How does a stream dissipate the energy it derives through its travel downhill? Which of these mechanisms are most important?
3. What are the sources of resistance to flow in a channel? How do they affect the velocity profile (vertical velocity distribution) and the distribution of velocity across the channel (i.e., as seen at right angles to the flow.) Under what circumstances is each most important?
4. What is the *hydraulic geometry* of a stream? What does it tell us, i.e., what is its significance? (Consider both at-a-station and downstream hydraulic geometry). What factors would affect/control the relations at a station?
5. What is *bankfull discharge*? How often does it typically occur? What is its geomorphic significance?
6. What is a flood recurrence interval? What does it mean? What is the typical recurrence interval of $Q_{bankfull}$?
7. Briefly explain the ways in which sediment is transported by a stream. Under what circumstances is each most important?
8. What determines *how much* sediment is transported by a stream? What determines the *maximum sizes* the stream transports?
9. What is a floodplain? How are floodplains formed, and what is our evidence/arguments for the mechanisms you propose? What are fluvial terraces and how can they be formed (suggest several ways). How could you distinguish a terrace from a floodplain?
10. Explain the mechanics of formation of 1) a meandering stream and 2) a braided stream. What factors would lead to developing one rather than the other? Compare the width, depth, slope, cross-sectional shape, roughness (resistance to flow), erodibility, sediment load, and particle size of braided vs. meandering channels.
11. What are pools and riffles? How are they formed and maintained? How do velocity, depth, and tractive stress, particle size, and resistance to flow vary over them? How do these quantities change over them with increasing discharge? What hydraulic factors is pool-riffle spacing related to?
12. What hydraulic factors affect the wavelength of meanders? How is the meandering pattern generated and maintained?
13. Distinguish between an *alluvial fan* and a *pediment,* both in terms of appearance in cross-section and plan, and in terms of mechanism of formation. What factors would control whether you got a fan or a pediment?
14. What is an *inselberg*? How are they formed (suggest ways)?

GLACIERS

1. What is the necessary and sufficient condition for forming a glacier? What factors affect relative rates of accumulation and ablation?
2. By what mechanisms does a glacier flow? What does the velocity profile of a glacier (both across-valley and in an individual vertical) look like? What is the maximum shear stress (τ) at the base of a glacier?
3. What is meant by warm-base and cold-base glaciers? Under what conditions would you be likely to find each? What differences would you expect in the nature of erosion, transport, and deposition done by each?
4. Explain the chief mechanisms of glacial erosion. What factors would control the type, occurrence, and and effectiveness of each mechanism?
5. What factors affect the velocity of a glacier? What controls its growth (advance) and recession?
6. How would you distinguish areas shaped by glacial erosion? By glacial deposition? Consider both valley and continental glaciers.

PERIGLACIAL

1. Understand what *permafrost, solifluction (*or *gelifluction), frost polygons, stone polygons, ice wedges, pingos*, and the *active layer* are and how they form.
2. How could you recognize periglacial areas on a map or air photo?

CLIMATE CHANGE AND CLIMATIC EFFECTS

1. Be sure to review p. 364-393 in Easterbrook.
2. Be familiar with the factors which can cause climatic change (e.g. continental drift, astronomical causes, variations in solar radiation, volcanic activity, carbon dioxide concentration, etc.) and understand *how /why* they cause the change.
3. What sort of evidence/techniques are used to determine climatic conditions in the past? What sort of evidence do we have for climatic change? How do we determine past temperatures?
4. How are oxygen isotopes used to deduce past climate?
5. What is the Milankovich theory? According to it, what factors affect the amount of solar radiation reaching the earth's atmosphere? How well do its predictions correspond with observed climatic fluctuations from the geologic record?
6. What do we think are the chief causes for the repeated glaciations the earth has experienced in the last 2 million years? How do these work? What sort of evidence do we have to support this?
7. How might changes in climate affect weathering and erosional processes? Think here about the relation of sediment production to climate. In particular, what sort of climatic shifts might cause a stream to aggrade (deposit)? to degrade (downcut), and why?

ARID REGION/AEOLIAN

1. In what parts of the globe are deserts most common? Why do they form where they do? (i.e., think about atmospheric/meteorologic causes for the distribution of deserts)
2. What climatic/physical conditions are necessary to make wind an effective agent of erosion? (hint: consider such factors as vegetation, wind intensity and duration, particle size of materials available for transport, etc.)
3. What sorts of areas are likely to be subject to significant deflation? What sorts of human activities will lead to increases in deflation and why?

COASTS

1. How are *marine terraces* formed? What affects their elevation with respect to sea level? How can their relative ages be assessed? How can they be correlated with sea-level stands? What problems arise in such correlations?
2. How would you distinguish an emergent coast from a drowned coastline?
3. How has sea-level varied during the Pleistocene? Why?