

## **Rock Deformation (Chapters 7,23)**

1. Contrast the conditions that promote brittle and ductile deformation. What kinds of features are characteristic of each?
2. Compare the structures (faults and folds) formed by extension and compression.
3. What is the relative age of rocks in the center of an anticline compared to those on the limbs? for a syncline?
4. How does the lower portion of the continental crust deform? What is most important in controlling its deformation?
5. How does rock strength and style of deformation vary through the crust and lithosphere?
6. How does the thickness of continental and oceanic lithosphere differ and why?
7. What are the major categories of faults and in what tectonic setting is each most likely to occur?
8. How would you determine the amount of slip on a fault?
9. How does a transform fault differ from a strike slip fault?
10. How would you recognize a plunging anticline/syncline on a geologic map?
11. What is the relationship between a fracture zone and a transform fault?
12. What is the angular relationship between the principal stress directions ( $\sigma_1$  and  $\sigma_3$ ) and resulting faults?
13. How does the depth of oceanic crust vary as a function of age? how does the thickness of the oceanic lithosphere vary as a function of age? why?

## **Earthquakes and Earths Interior (Chapter 18)**

1. What lines of evidence (from rocks to remote sensing) provide information on the composition and structure of earth's interior?
2. What evidence exists to suggest that the earth's magnetic field is not due to permanent magnetism?
3. How do the various types of seismic waves (P,S, and surface) differ in terms of the particle motion and travel time/speed?
4. Why does seismic energy within the earth typically follow curved paths?
5. How does the focus of an earthquake differ from the epicenter of an earthquake?
6. Why is the difference between the P and S wave arrivals used to locate an earthquake?
7. How does the energy release of a Richter magnitude 5 earthquake compare to that of a magnitude 6 earthquake?
8. What is the relationship between the magnitude and frequency of occurrence of earthquakes?
9. In what tectonic settings are earthquakes most common?
10. Most earthquakes occur at very shallow levels. What accounts for the presence of earthquakes deeper than 600-700 km?
11. Sketch a cross section through the earth, showing the depth variation of P and S wave velocities, the major changes in composition, and rheology (strength and mode of deformation). Label the depths of the major layer boundaries.
12. Describe the seismic evidence that suggests the outer core is liquid?

13. What is the typical thickness of oceanic crust and continental crust? What seismic boundary defines the base of the crust?

### **Geomagnetism/Paleomagnetism (Chapter 17)**

1. Why are marine magnetic anomalies apparently symmetric about a spreading center?
2. How does the magnetization of seafloor basalts generate these lineated magnetic anomalies?
3. The youngest part of the magnetic reversal sequence was established by dating subaerial lava flows (with known magnetic polarity) using the K/Ar method. Why was this dating technique not used to establish the polarity sequence older than ~5Ma?
4. How could you establish the dates for the polarity sequence at older ages?
5. What is the difference between magnetic inclination and declination? Which is most useful for determining magnetic polarity? for paleolatitude (i.e. the latitude at which a rock was magnetized)?
6. How would you use magnetic data to determine the drift history of two different continents (plates)?
7. How can you determine the direction and rate of relative plate motions?

### **Geologic Time (Chapter 8)**

1. Definitions: superposition, original horizontality, lateral continuity, formation
2. You should be familiar with the eras, periods (and epochs in Cenozoic) that comprise the geologic time scale as well as the absolute ages that bound the Paleozoic, Mesozoic, and Cenozoic.
3. What geological events can you infer from an angular unconformity? disconformity? nonconformity?
4. Prior to the discovery of radioactivity in 1896, what principles would geologists have used to establish the relative ages of a sedimentary sequence?
5. The Temple Butte limestone in the Grand Canyon occurs as discontinuous lens separated by disconformities both below and above. How would you establish the duration of these unconformities?
6. Element X decays to Y with a half life of 5000 years. After 20000 years, what would the ratio of X:Y be? You may assume that Y is produced only by the radioactive decay of X and that no daughter product is present when the rock formed.
7. What are the properties of a reliable radioactive clock?
8. The half life of  $^{87}\text{Rb}$  is 47 b.y. and the half life of  $^{14}\text{C}$  is 5730 yr. Which one is more suitable for dating mastadon frozen in Pleistocene ice? for dating Cretaceous volcanic ash?
9. Construct a diagram illustrating the following series of geological events: sedimentation of a limestone formation, uplift and folding, erosion of the folded terrain, subsidence and sedimentation of a sandstone formation, intrusion of a dike.
10. What geological event is dated by a radiometric date of a mineral in a schist, granite, sandstone?
11. How might absolute ages be determined for a sedimentary sequence? (list at least two ways)

12. In many radioactive decay systems, some daughter atoms are often present when the radiometric clock begins (e.g. at the time of crystallization of a lava). How is this problem overcome?

### **Atmospheres and Deserts (Chapters 9,16)**

1. Why are there deserts at 30°N and 30°S latitude?
2. Why is there so much rainfall along the equator?
3. Explain the Coriolis force. What direction do moving objects turn in the Northern hemisphere, and in the Southern hemisphere? Is there any Coriolis force at the equator?
4. Why are there usually deserts downwind of mountain ranges? Define orographic desert.
5. Sketch the distribution of atmospheric circulation from the equator to the pole.
6. What changes in the Australian desert would occur if the continent were to drift 2000 km to the north (approximately 20° latitude)?
7. A deep sea core from the central Atlantic is found to contain abundant 1/4 mm well-rounded quartz grains. What is the likely origin of these grains?
8. Which direction do the trade winds blow? why?
9. Why are deserts cold at night?

### **Climate and Ocean Circulation (Chapters 9,14)**

1. What causes the tides? Why are there two high tides per day?
2. What is the gyre circulation and what provides the driving force for it? Define Ekman spiral and Ekman drift.
3. What drives the thermohaline circulation?
4. How might the thermohaline circulation change if the Gulf Stream stopped flowing?
5. Why does water sink in the North Atlantic but not in the North Pacific?
6. Roughly what is the temperature of the deep ocean? why is the deep ocean cold?
7. How long might it take for nuclear waste disposed of in the North Atlantic to surface in the North Pacific?
8. Why is there upwelling off the west coast of the Americas?
9. How might the seasons on earth be different if the spin axis had a more extreme tilt than its present value of 23°?
10. What is eccentricity and how does it affect the climate of the earth?
11. Fifteen thousand years ago large ice sheets covered significant portions of Europe and North America. How would these ice sheets affect sea level?
12. Sea ice was also much more extensive in the Pleistocene. How does the amount of sea ice affect sea level?

### **Mass wasting and Landscape Evolution (Chapter 11)**

1. The Himalayas are on average 5 km above sea level. If you remove 2 km from the top of this mountain range, what would the approximate elevation (relative to sea level) of the mountain range be?

2. What is the difference between uplift and denudation? What are some methods that could be used to estimate each?
3. The Himalayas and Tibetan plateau have very similar average elevations, yet the highest points in the Himalayas are much higher (by up to 4 km) than the highest point on the Tibetan plateau. What might account for this difference in maximum elevation?
4. What is the role of water in mass wasting?
5. In general fluid supported flows travel farther than grain supported flows, yet many large rock falls are inferred to have travelled 10's of km from the mountain source. How is this possible?
6. What changes in the climate and rate of weathering might result from the uplift of the Himalayas?
7. Young volcanic islands are often well-formed shield volcanoes, yet within a few million years the outline is very irregular. Why?