

A BIT TOO LONG....

Name: _____

**Earth 50 2nd Midterm Exam
Multiple Choice (2 pts each)**

November 15, 2006

1. The dip of a bedding surface is
A) the angle between the bedding surface and horizontal. Dip is perpendicular to strike.
B) the compass orientation of a horizontal line on a bedding plane.
C) parallel with strike.
D) a vector perpendicular to the bedding surface
E) an east-west direction.

2. The Benioff Zone is a zone of earthquakes associated with
A) deformation in the lower mantle
B) the Moho
C) normal faulting in the upper crust
D) ductile flow in the lower crust
E) faulting in a subduction zone

3. In terms of isostasy, the formation of large volcanic islands on oceanic crust
A) causes the crust to move upward forming a dome.
B) has no effect on the elevation of the oceanic crust near the island.
C) depresses the crust near the volcano forming a moat around the island
D) thickens the crust making it more buoyant
E) Cools the crust making it more brittle and rigid.

4. Ductile deformation of rocks is favored in all situations EXCEPT
A) high confining pressures.
B) high temperatures.
C) shallow depths.
D) flow within the mantle.
E) slow deformation (low strain rates).

5. You are a fisherman on a trawler. Owing to the high cost of gas, you have to choose which parts of the world's oceans are most likely to have productive fishing grounds and high primary productivity. Where should you fish?
A) Areas where the trade winds blow offshore creating coastal upwelling.
B) The middle of the subtropical gyres where there is strong downwelling
C) The equatorial "Western Warm Pool" where tradewinds pile up water causing downwelling
D) The high pressure areas between the Hadley and Ferrell Cells where it is usually

sunny.

6. Eccentricity refers to:

- A) the 41,000 year variation in the tilt of the Earth's spin axis
- B) the ~21,000 year wobble in the Earth's spin
- C) the 100,000 year variation in the circularity of the Earth's orbit**
- D) the oscillation in the Earth's orbit through the galactic plane

7. The epicenter of an earthquake is:

- A) the point of initial movement
- B) the direction in which the wave front moves
- C) a point directly above the focus**
- D) the direction toward the earthquake center

8. The Mohorovicic (Moho) discontinuity is a seismic boundary between:

- A) the upper and lower continental crust
- B) the asthenosphere and lithospheric mantle
- C) the inner and outer core
- D) crust and uppermost mantle**
- E) mantle above and below a down-going slab

9. The oldest meteorites, as measured by radiometric methods, are approximately

- A) 4.5 billion years.**
- B) 545 million years.
- C) 1.8 million years.
- D) 500,000 years.
- E) 6,000 years.

10. Carbon 14 (^{14}C) has a half life of 5,730 years. Charcoal removed from beneath a lava flow has 1/8 the amount of ^{14}C as a living tree. The lava flow is probably no older than

- A) 716 years old.
- B) 2,865 years old.
- C) 5,730 years old.
- D) 17,190 years old.**
- E) 45,840 years old.

11. Magnetic 'stripes' on the ocean floor are indications that

- A) ocean crust is formed by alternating rapid and slow basaltic volcanism under a constant magnetic field direction
- B) ocean crust cools slowly, and continually acquires the Earth's magnetic field direction even far from the spreading ridge.

C) ocean floor is created by volcanism at the mid ocean ridges in the presence of a reversing magnetic field

D) ocean crust is typically ~8 km thick and picks up the Earth magnetic field direction as the lithosphere thickens from below.

12. Longitudinal dunes form

A) when the sand supply is large and the winds are steady and in one direction

B) when the sand supply is small and the winds are steady and in one direction

C) when the sand supply is small and the winds have variable direction

D) when the sand supply is large and the winds have variable direction

13. Deep ocean water formed in the North Atlantic returns to the surface in the Pacific after about

A) 20-50 years

B) 1500-2000 years

C) 4005-4530 years

D) 5730-6000 years

14. The troposphere (lowest part of the atmosphere from the Earth's surface to ~19 km) contains

A) few clouds [the clouds mostly reside in the overlying stratosphere]

B) about 80% of the mass of the atmosphere and most of the clouds

C) most of the clouds but less than 10% of the atmosphere's mass

D) most of the naturally-produced ozone and ionized gases

15. P-waves move

A) by compressing and expanding the material they pass through

B) by moving the material they pass through up and down

C) by moving the material they pass through side to side

D) by both compression/expansion and up-and down motion

16. Faults develop

A) at 45° angle to the maximum principal stress direction

B) at 30° angle to the maximum principal stress direction

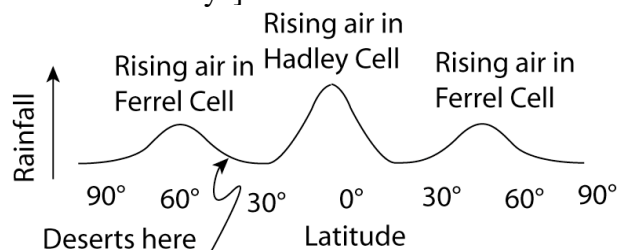
C) parallel to the maximum principal stress direction

D) at right angles to the maximum principal stress direction

Short answer (7 pts each)

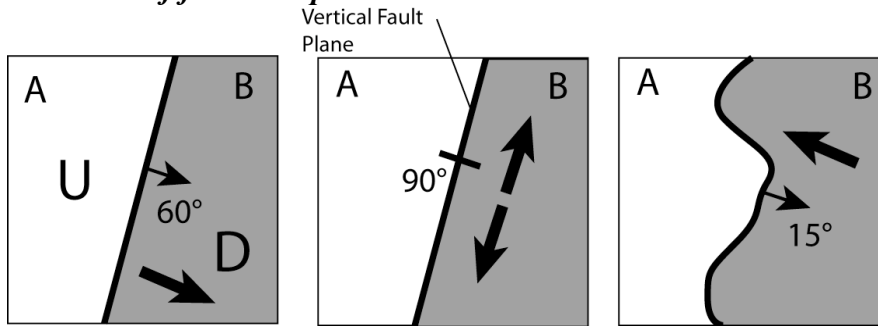
17. The locations of hurricanes and heavy rainfall on Earth are not random.

a. Draw a sketch to show how rainfall varies with latitude... [at what latitudes does most rain fall and why?]



b. Why are there more hurricanes near the Equator than at higher latitude? **The water is warmer at low latitudes than high latitudes and warm water promotes evaporation and strong winds**

18. The figure shows three maps. The solid lines are faults and the dip of the fault plane is shown in each case. **Draw an arrow or indicate which block moved up (U) or down (D) on each of the three maps** to show a reasonable direction of motion of block B (shaded on the right) relative to block A (unshaded on left). **Indicate below each map what kind of fault is depicted.**



normal fault...
Could also be a reversed fault, in which case the U and D and arrow need to be reversed

Strike-slip--either right or left lateral depending upon your arrow

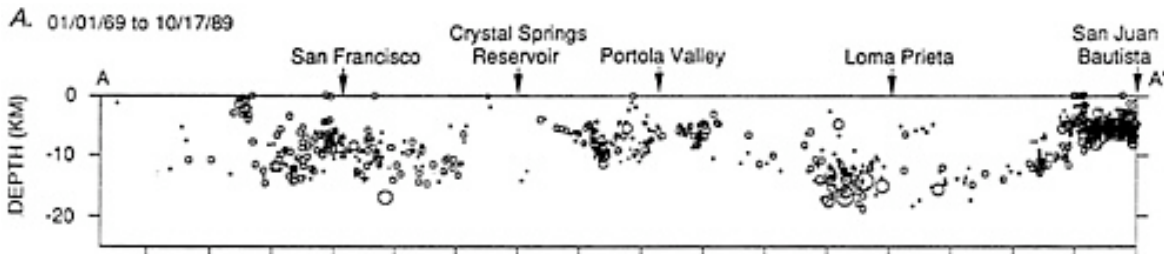
Thrust Fault

19. The image below depicts the depths of recent earthquakes along a portion the San Andreas fault.

a. What accounts for the scarcity of earthquakes *below* about 15-20 km?
The lower crust is undergoing ductile deformation

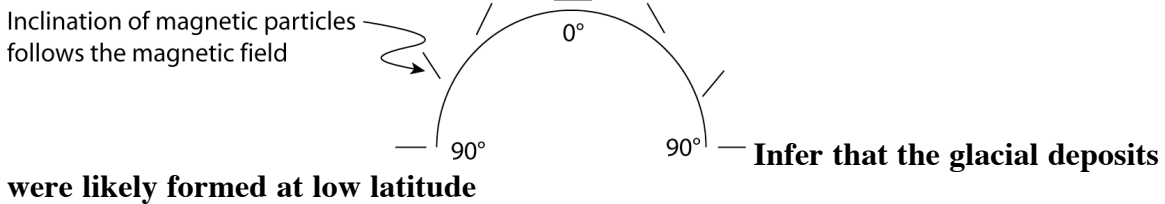
b. What kind of deformation likely is occurring *above* 15-20 km?
Brittle deformation

c. Draw an arrow on the diagram that indicates which part of the fault is most likely to produce a large earthquake. **An area without earthquakes like Crystal Springs Res.**

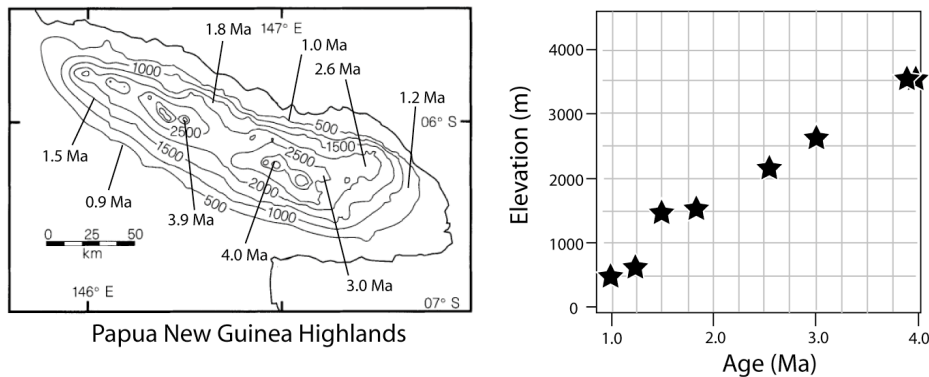


20. It has been suggested that the entire earth may have experienced a runaway cooling event in the late Precambrian, perhaps resulting in the earth being completely covered in ice

(the so called snowball earth). Among the evidence cited for this hypothesis is the suggestion that some glacial deposits were formed at low latitude. To test this idea, you collect paleomagnetic data from glacial deposits of late Precambrian age in southern Australia. The glacial sequence an average magnetic inclination of 3.8° whereas carbonate sediments that overly the glacial sequence produce data with an average inclination of 10.4° . ***Do these paleomagnetic data support the hypothesis that the glacial deposits formed at low latitude (less than 30° north or south of the equator) or do they argue against it? Please explain your answer.*** A sketch showing how inclination varies with latitude would help.



21. The map below shows the highlands of Northeastern Papua New Guinea (After Abbott et al. 1997, *Nature* 385:501), New Guinea is rapidly rising owing to rapid subduction northeast of the mapped area. Samples of marine sediments exposed on the mountain have been dated using biostratigraphy and the locations and current elevations of the samples are shown by the lines. Elevations shown on the contours are in meters.



a. Use the graph (right) to plot the ages and elevations. Approximately what was the rate of uplift between 2 and 3 million years ago (expressed as meters/million years)?

About 1000 m/million years

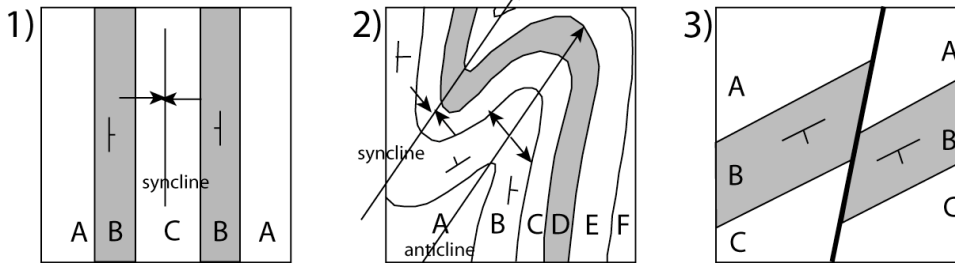
b. Based upon the data, has the rate of uplift increased, decreased, or stayed the same over the past 4 million years? What evidence shows this? **Has been fairly constant except around 1.5 Ma when the rate slowed and then sped up until ~1.2 Ma. Reduced uplift shown by flattening of the curve between 1.5-1.8 Ma.**

c. The fossils used for biostratigraphy were corals that originally grew in reefs just below sea level. Would your estimate of uplift rate still be valid if the dates were K-Ar radiometric dates on unfossiliferous volcanic ash? Why or why not?

No because you would have nothing to tie the ash beds to a particular elevation when they were deposited. Need original elevation as well as age to determine uplift.

22. On each of the maps below, draw the strike and direction of dip of Formation B assuming that Formation B is older than Formation C. For folds, draw the fold axis or

axes, type of fold(s) (anticline or syncline) and, if need be, the direction of plunge of the fold axis or axes. Assume the amount of dip of all the layers is 45°.



24. You are a seismologist and work for the International Atomic Energy Agency (IAEA). You are charged with detecting earthquakes associated with possible North Korean nuclear tests. The figure below shows the location of your seismic station in Switzerland relative to the North Korean nuclear testing site.

- a. Would you be able to detect any direct (i.e. along a simple path) P-wave seismic energy produced by a Korean test from your station in Switzerland?

Yes, the station in Switzerland is outside the P-wave shadow zone

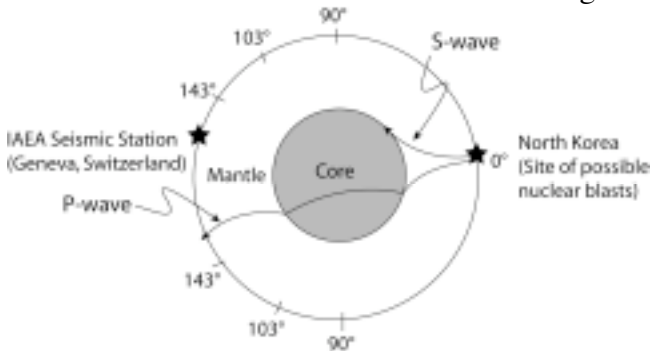
- b. Would you be able to detect direct S-waves produced by a North Korean test?

No, the direct S-waves would not pass through the core

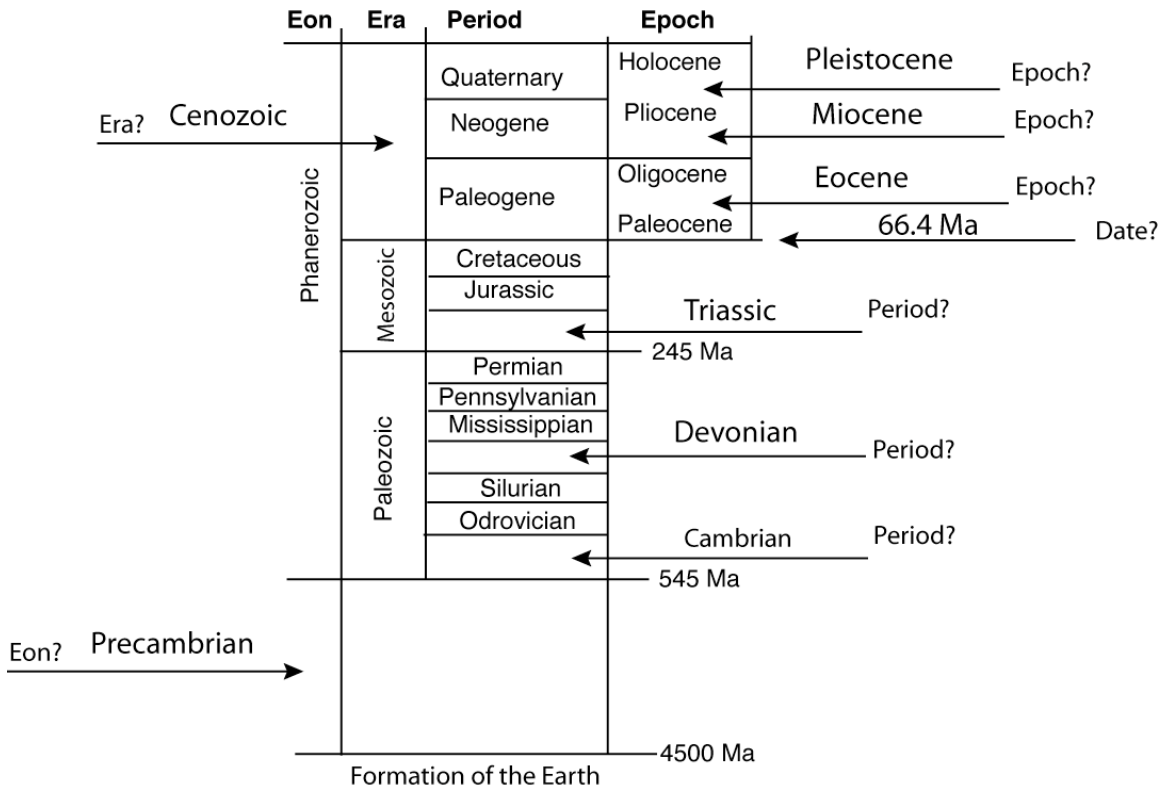
- c. Could you detect any surface waves produced by a large nuclear test in N. Korea?

Yes, the surface waves would radiate all around the Earth

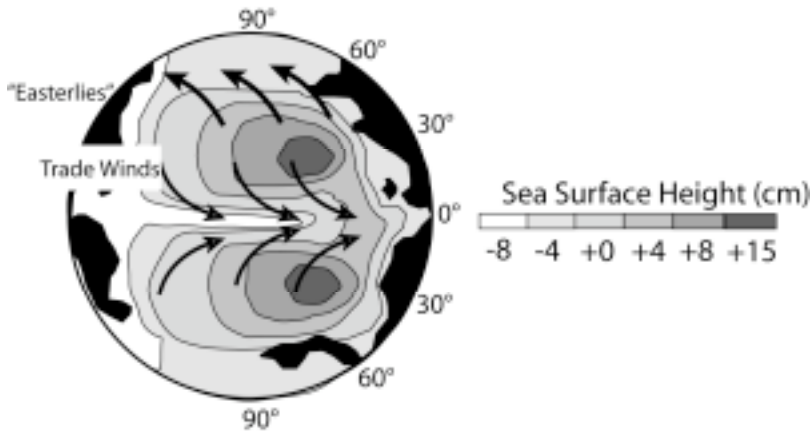
- d. Draw, and label, a typical ray path *starting in N. Korea that intersects the core* for an S-wave and for a P-wave on the diagram below.



25. Fill in the blanks on the time scale (9 pts)



Part 3: (Do ONE of the following three questions [#26, 27 OR 28]; 10 pts)



26. A new planet has been discovered in the nearby star system of Alpha Centauri and the first radar altimetry map is plotted above. Black areas are exposed land and all other areas are ocean. A stunning observation is the map of the height of the ocean surface (scale bar at right). The map clearly shows two areas of relatively high sea surface elevation at latitudes of about 30° in the northern and southern hemisphere and a trough along the equator.

- a. When you make your report to NASA headquarters, how do you explain the variation in ocean surface height? [If need be, you can sketch in the wind directions that would produce the observed pattern]

The high points on the gyres (at ~20-30° latitude) are where water is piled up by the winds. The direction of transport of water is 90° to the left of the wind

direction in the Northern Hemisphere (just the opposite of Earth because this planet spins the opposite direction of Earth) so the trade winds and “easterlies” [on this planet] pile water up in the gyres. The surface height is higher in the eastern part of the equator than the western part because the trade winds push equatorial water to the east.

b. Why is there a trough in sea surface height running along the equator?

Transport of water is away from the equator since the water is always transported at to the left [in the northern hemisphere, to the right in the S. hemisphere] of the dominant wind direction. Water is moved away from the equator leaving a trough in surface height.

c. Does this planet have a surface wind field anything like Earth? Why or why not?

It is very much like Earth in the basic dynamics, but because the trade winds blow to the east, rather than to the west, the location of the warm pool and maximum surface height is in the eastern basin instead of in the western basin as it is on Earth.

d. Would you expect the sea surface temperature to be warmer on the east side (right) of the ocean or the west side (left) of the ocean (at the equator) or would the temperature be the same?

Water temperature should be colder on the west side of the ocean and along the trough of the equator than on the east side of the basin. The warm water is pushed east by the winds leaving cool water to upwell to the surface on the west side of the basin.

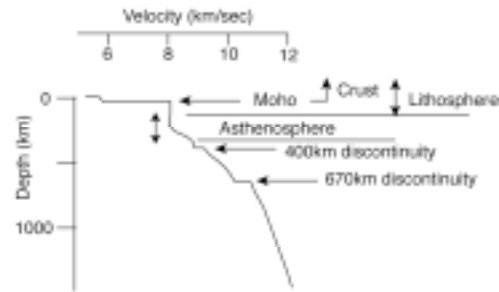
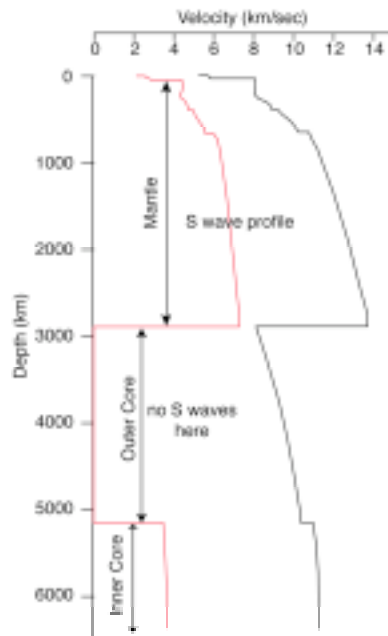
e. Which direction does the planet spin? (a labeled arrow is sufficient)

The planet revolves counter-clockwise (right to left on the diagram above or clockwise when viewed from the north pole), the exact opposite direction from Earth.

27. The diagram below (with expanded upper portion (to the right)) shows the variation of P-wave velocities within the earth. Using this information as a guide,

a) Sketch the S-wave velocity profile.

b) Label the following features on either the full plot (left) or expanded plot (right): Moho, inner core, outer core, mantle, lithosphere, crust, asthenosphere



23. The block diagram below illustrates a sedimentary sequence that has been disrupted by faulting and subsequently eroded to produce the flat surface of the block. Assuming that slip along the fault *has been primarily vertical*:

a. Which of the blocks has been uplifted relative to the other?

Block A

b. What type of fault is depicted?

Normal Fault

c. Label the hanging wall and the footwall on the diagram.

A is the footwall, B is the Hanging Wall

d. What type of observations could be used to determine whether the fault motion included any strike slip component?

Slickensides, surface tie points across the fault like offset stream valleys, offset alluvial fans, roads, fences, etc....

e. If the fault was primarily a strike-slip fault, would it likely be a right-lateral or left-lateral fault?

Left lateral

