G322 Lab Exercise
Neotectonic and Coastal Processes of Oregon

Part I. Pre-Lab Questions

Use your notes, textbook, wall maps, and reading assignments to answer the following questions.

A. Match the Following Coastal Locations with the terms on the Right. List all that apply.

___________________	1. Oregon Coast	Passive Margin Tectonics (inactive)
___________________	2. Washington Coast	Active Margin Tectonics - subduction
___________________	3. Southern California Coast	Active Margin Tectonics - transform
___________________	4. Northern California Coast	Active Margin Tectonics - rifting / spreading
___________________	5. Aleutian Islands of Alaska	Emergent Coastline
___________________	6. Southeast Alaskan Coast	Submergent Coastline
___________________	7. Gulf of Mexico - Texas	Active Subsidence
___________________	8. Central Atlantic / U.S.	Active Uplift

B. Thinking Questions

9. The last major glaciation (i.e. a pervasive cold-wet climate regime) in the northern hemisphere was at it's peak 18,000 to 20,000 years ago. 100's to 1000' of feet of Ice covered much of Canada and the northern tier of the U.S.

A. From what major hydrologic source does the precipitation that forms glacial ice originate?

B. Describe how this moisture is cycled into glacial ice (what are the processes associated with this part of the hydrologic cycle).

C. What happens to global sea level during a major glacial climate? What happens to global sea level during a major interglacial (i.e. warm / melting) climate?

D. What happens to land surface elevation at convergent tectonic boundaries (i.e. subduction zones), especially where accretionary tectonics is prevalent?

E. What happens to land surface elevation at passive tectonic boundaries, where sediment accumulates over time (think about what happens to water saturated sediment as it accumulates, becoming thicker over time, under increasing weight).

10. If global sea level is rising at a rate of 2 mm/yr, at a passive continental margin, how long will it take for sea level to rise 5 m? Show your math work.

11. If global sea level is rising at a rate of 5 mm/yr, and an active tectonic coastline is experiencing uplift at a rate of 5 mm/yr, what will be the net relative rate of sea level change at this location? Show your math work.

12. If global sea level is rising at a rate of 3 mm /yr, and a passive margin coastline is actively subsiding at a rate of 5 mm /yr, what will be the net relative rate of sea level change at this location? Show your math work. Is this coastline best characterized as "emergent" or "submergent"?

13. If global sea level is rising at a rate of 1 mm/yr and an active tectonic coastline is experiencing uplift at a rate of 5 mm/yr, what will be the net relative rate of sea level change at this location? Show your math work. Is this coastline best characterized as "emergent" or "submergent"?

14. List two dominant oceanic processes associated with the Oregon Coast.

15. List two dominant tectonic processes associated with the Oregon Coast.

16. List three geologic hazards that you can think of, associated with the Oregon Coast (think about the news reports that you hear every year).

17. In terms of temperature as related to the physics of volume expansion / contraction (think hot air baloon), which condition would have a greater volume, warm sea water or cold sea water?

18. In terms of density driven currents: warm sea water is _______________ (more dense or less dense?) compared to cold sea water. Therefore, warm sea water will tend to _______________ (rise or sink), and cold sea water will tend to _______________(rise or sink?).

19. Similarly, in terms of density-driven motion in rock material: hot, young oceanic crust is _____________ (more dense or less dense?) compared to cold, old oceanic crust. Therefore, hot, young oceanic crust will tend to (rise or sink?), and cold, old oceanic crust will tend to _________________ (rise or sink?).

20. Question for you: What would happen to global sea level under conditions of very rapid seafloor spreading? Why?

    What would happen to global sea level under conditions of very slow seafloor spreading? Why?

Part 5. Neotectonics of the Oregon Coast

Western Oregon is the site of plate tectonic covergence, with subduction of the Juan de Fuca plate beneath the North American plate. This convergent zone is associated with accretionary tectonics, compressional strain, and Cascade arc volcanism. As such, neotectonic deformation, crustal motion, and differential uplift/subsidence of the Oregon coast must be reconciled with any geomorphic model of the region.

Historic crustal motion of the Earth is measured via re-leveling surveys of surface elevation (re-leveling = re-measurement of land surface elevation over time), or with satellite positioning systems (GPS = global positioning system). Longer term uplift of coastal areas is reconstructed by examination of wave-cut terrraces and coast terrace deposits, with related application of geologic dating techniques.

Mitchell and others (1994) examined historic re-leveling data of surface elevations along a transect extending from northern California to Washington. They combined the re-leveling data with tide gauge measurements to determine net relative vertical ground motion velocities for coastal regions of the Pacific Northwest. Table 4 is a summary of historical ground motion velocity data for a south-to-north transect, arranged by latitude (degrees north); positive velocities = uplift, negative velocities = crustal subsidence.

Task 7 Using the data in Table 4, plot a south-to-north transect of historic ground motion velocity (y axis) vs. latitude (x axis). Use the blank profile paper provided in Figure 7 (alternatively, create the profile using the chart wizard in microsoft Excel). List the geographic names of the data localities above the profile, for reference.

Question 5-1. Identify regions of coastal PNW that are experiencing rapid historic uplift. Identify regions of coastal PNW that are experiencing no net uplift, or subsidence. Do you see any spatial patterns in terms of uplift / stability / subsidence along the south-to-north transect?

Question 5-2. Assuming that sea level is presently rising, what can you conclude about the rate of tectonic uplift, and rate of sea level rise for the Newport, OR area?

Question 5-3. Examine a tectonic map of the PNW (see the "fractured surface" map on the wall of the lab room). Identify the area of highest rates of tectonic uplift on your profile, and locate that area on the tectonic map. Comment on the relationship between the type of tectonic boundary(ies) and the highest rates of coastal uplift in the PNW.

Question 5-4. Which areas of the coastal transect would you expect to find the highest, and most well-developed flights of coastal terraces? Which areas would you expect to find the most well-developed coast-terrace soils? Why? Draw sketches to support your answer.

Task 8. Figure 8 is a map of interpolated uplift rates for select points in the Pacific Northwest (west of the Cascades). Draw contour lines on the map data connecting points of equal uplift rates. Use a contour interval = 1 mm/year. Using colored pencils, color code the neotectonic domains using the following classification scheme (i.e. color all regions of the map according to uplift rate):

uplift 0-1 mm /yr	blue
uplift 2-3 mm/yr	yellow
uplift 4-5 mm/yr	red

Question 5-5. Identify the zone of highest uplift. What type of tectonic process is occurring in this region.

Question 5-6. Locate Monmouth, OR on the map. What is our historic rate of uplift on campus? Which part of western Oregon is associated with the highest rates of uplift?

Question 5-7. What is the rate of uplift in the Puget Sound region? What other isostatic process(es) must be accounted for in the Puget Sound region, and to the north of that point.

Task 8. Table 5 is a listing of data collected from uplifted marine terraces in southern Oregon. The terraces are formed by wave-base erosion, at or below sea level. They are elevated along the Oregon coast through the process of relative uplift over time. The age of the terrace is derived by numerically dating preserved marine deposits. The original depth of the wave-cut platform is reconstructed from fossil organisms. Paleo-sea level (compared to modern sea level) is derived from the global marine sea level record.

Complete the data in Table 5 by using Microsoft Excel. Download the table from the class web site and use the spreadsheet math functions to determine parameters in columns e, f, and g (total tectonic uplift and average uplift rate). To help in resolving the parameters, draw a cross-sectional sketch of modern sea level, paleo-sea level, original depth of terrace, and present elevation. Calculate the total tectonic uplift that the terrace has experienced, combine that with the age data to determine the long-term average rate of uplift on the southern Oregon Coast.

Question 5-8. How do the long term average uplift rates in Table 5 compare with the historic uplift rates presented in Table 4, and Figures 7-8? Explain the differences or similarities that you observe.

Question 5-9. In looking at degree of soils development on the Whiskey Run, Cape Blanco, and Pioneer terraces; explain which terraces would have more well-developed soils, and which less. Describe the physical and chemical characteristics of the soils that you would expect to sea when visiting all three of the localities.

Question 5-10. If you were asked to find these marine terraces on a map and in the field, what types of topographic and geologic evidence would you look for (how would you go about doing this from scratch?)? Explain how county soils surveys would help in this process.

Table 4. Average Vertical Ground Motion Velocities for a South-to-North Transect Along the Coast of the Pacific Northwest

(Data derived from Mitchell et al., 1994 via releveling surveys).
(Note: positive velocity = uplift, negative velocity = subsidence)
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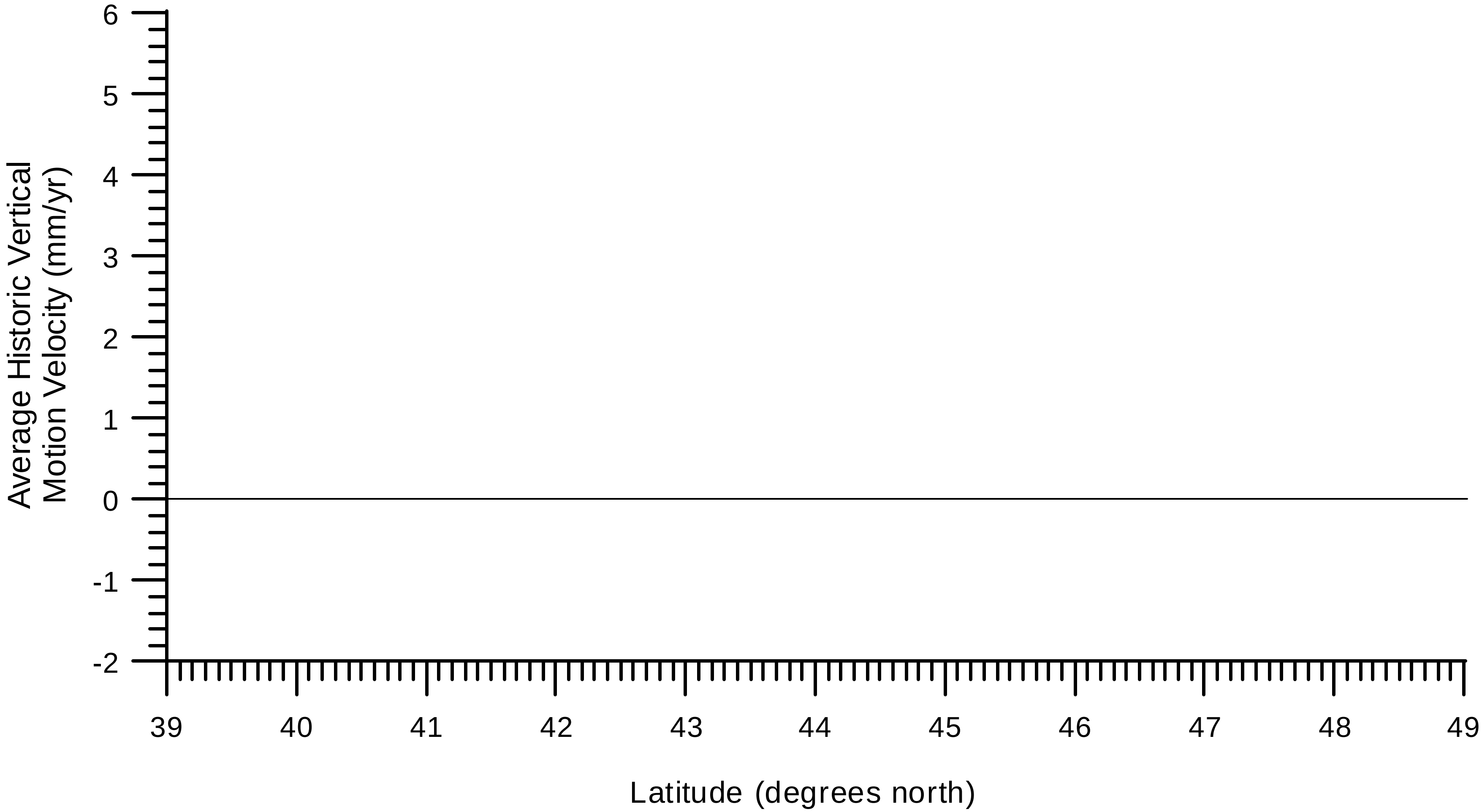
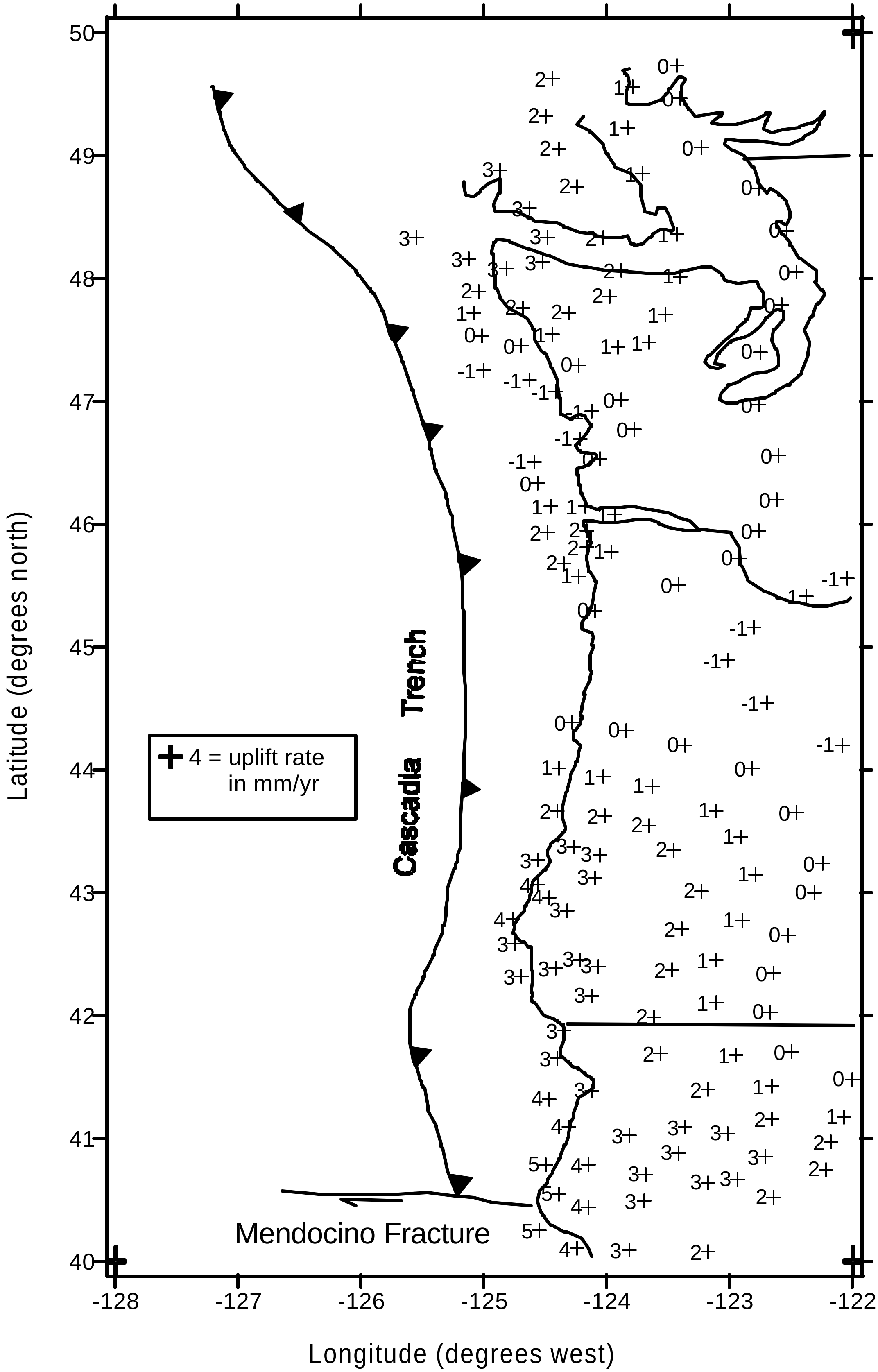
Latitude (degrees N)	Historic Average Vertical Ground Motion Velocity (mm/yr)	Approximate Geographic Location
44.0	0.9	Florence, OR
44.2	0.6	
44.3	0.2	
44.4	0.0	
44.6	-0.1	Newport, OR
44.7	-0.2	
44.9	-0.2	Lincoln City, OR
45.2	-0.3	
45.5	-0.4	Tillamook, OR
45.6	-0.1	
45.7	0.2	
45.9	0.5	
45.9	1.2	
46.0	1.5	Seaside, OR
46.1	1.6	
46.1	1.5	
46.2	1.0	
46.4	0.4	
46.5	0.0	Willapa, WA
46.7	-0.6	
46.8	-0.8	
47.0	-1.0	Aberdeen, WA
47.2	-1.1	
47.3	-1.2	
47.4	-1.1	Queets, WA
47.6	-0.7	
47.7	-0.4	
47.7	0.3	
47.8	1.1	
47.9	1.8	La Push, WA
48.0	2.6	
48.1	3.2	Lake Ozette, WA

Figure 7. Plot of South-to-North Average Uplift Rate Profiles Along the Coast of the Pacific Northwest



wou:geomorph:f00:coastlab:fig7blnk.grf (uplift.dat)

Figure 8. Map of Interpolated Uplift Rates for the Pacific Northwest, West of the Cascade Range (data derived from Mitchell et al., 1994)



wou:geomorph:f00:coastlab:pnwup2.srf (pnwup.dat)

Table 5. Worksheet Calculation of Late Quaternary Uplift Rates in the PNW, as Derived from Marine Terrace Data (data derived from Muhs et al., 1990).

Terrace Name	Location	Terrace Age (ka)	Present Elevation (m)	Original Depth of Wave-Cut Platform (meters)	Paleo-Sea Level (meters)	Total Tectonic Uplift (meters)	Average Uplift Rate (m/kyr)	Average Uplift Rate (mm/yr)
		a	*b*	*c*	*d*	*e*	*f*	*g*
Whiskey Run	Coquille Point, OR	80	17	14	-19			
Whiskey Run	Coquille Point, OR	80	17	48	-19			
Whiskey Run	Coquille Point, OR	80	17	14	-5			
Whiskey Run	Coquille Point, OR	80	17	48	-5			
Cape Blanco	Cape Blanco, OR	80	53	10	-19			
Cape Blanco	Cape Blanco, OR	80	53	28	-19			
Cape Blanco	Cape Blanco, OR	80	53	10	-5			
Cape Blanco	Cape Blanco, OR	80	53	28	-5			
Pioneer	Cape Blanco, OR	105	57	26	-9			
Pioneer	Cape Blanco, OR	105	57	90	-9			
Pioneer	Cape Blanco, OR	105	57	26	-2			
Pioneer	Cape Blanco, OR	105	57	90	-2			

Explanation of Data:

Column a: "ka" = kiloans = 1000's of years ago (how long ago the wave-cut platform was formed)
Column b: "present elevation" = present day elevation of coastal terrace above sea level
Column c: "original depth" = original depth of wave-cut platform below sea level, at time of wave erosion
Column d: "paleo-sea level" = level of sea, relative to present, at time wave-cut platform was eroded
Column e: total tectonic uplift of wave-cut platform from time in column a to present.
Column f: tectonic uplift rate of terrace in meters per 1000 yrs
Column g: tectonic uplift rate of terrace in millimeters per yr

c:wou:geomorph:f00:coastlab:neotect.xls / table 5 terrace data