Task 3. Using the data in Table 1, plot Average Wave Breaker Height (y-axis) vs. Wave Period (x-axis) on the blank graph provided in Figure 3 (alternatively, create the graph using the chart wizard in microsoft Excel). Match the wave height data to the wave period data, as they occur on approximately the same day of the month. **Do not** draw lines connnecting your data points, instead...

Task 3A. Draw a "best-fit" line to the wave height vs. period data, extend your line to the y-axis and determine the equation of the linear relationship: the general form of the equation is

$$y = mx + b,$$

where y = wave ht., x = wave period, m = slope of line (rise/run), b = y-intercept (the point on the y-axis where the line intersects it). Write your line equation on the graph.

Question 2.B.1. During which season does the Oregon Coast experience the largest waves and highest wave energy? What processes account for this seasonal relationship?

Question 2.B.2. During which season does the Oregon Coast likely experience the greatest degree of beach erosion and why?

Question 2.B.3. What is the seasonal relationship associated with wave periods at the Oregon coast? What is the relationship between wave height and wave period? How could you quantitatively predict wave height by using wave period?

Part 3. Relative Sea Level Fluctuations

Sea levels fluctuate over time according to climatic and tectonic conditions of the Earth. There are periods in Earth history where sea levels are high, and periods where they are low. There are also small seasonal changes in sea level that are detectable by examining tide-gauge records at monitoring stations. Tide-gauge records are available for historic times, longer sea level records are derived from coastal terraces and fossiliferous geologic deposits (e.g. coral reefs), as well as oxygen isotope records. The exercises below provide an opportunity to think about relative changes in sea level, both on the short-term time scale, and over longer periods of Earth history.

Monthly tide-gauge records for Yaquina Bay (Newport) Oregon during 1982 and 1983 are listed in Table 2 (**Remember**: all tables are available in the "lab data" (Excel file coastdata.xls) section of the class web site). Table 3 is a summary of historic mean annual sea level measurements for four gauge stations around the U.S. (Astoria, OR; Galveston, TX; Juneau, AK; and New York, NY). The longer-time geologic record of sea level fluctuations for the late Pleistocene (back to about 19,000 years ago) are listed in Table 3A.

Task 4. Using the data in Table 2, plot of relative sea level (y-axis) vs. time (x-axis: months in 1982-83) on the graph provided in Figure 4 (alternatively, create the graph using the chart wizard in microsoft Excel). Make two plots on the same graph, one showing the 1982-83 data, and the other showing the historic monthly average data. Use "dots" for the 82-83 data, and "triangles" for the longer-term monthly average data. Draw lines connnecting your data points.

Question 3-1. During which season(s) does the Yaquina Bay gauging station experience the highest relative sea levels? What is the difference between lowest yearly sea levels and the highest sea levels (i.e. what is the maximum sea level difference experienced during the year?).

Question 3-2. Thinking back to Part 2B, what process(es) account for the seasonal changes in relative sea level that you observe?

Question 3-3. 1982-83 was an El Nino year for the Oregon coast. El Nino cycles bring warm ocean currents to the west coast of South America. The current splits at South America, and forces warm ocean water to the north into the western U.S.

How do "El Nino year" sea level cycles compare to the long-term historic monthly average cycles? Are the seasonal sea level changes the same for both El Nino and historic conditions?

Question 3-4. Hypothesize mechanisms in the ocean that may account for your observations in question 3-3.

Task 5. Using the historic mean annual sea level data in Table 3, make a set of plots for Average Relative Sea Level (y-axis) vs. Time (x-axis: years) for Astoria, OR; Galveston, TX; and Juneau, AK. Blank graphs for each plot are provided in figures 5A, 5B, and 5C, respectively (alternatively, create the graph using the chart wizard in microsoft Excel). Draw lines connecting your data points in each graph.

Task 5A. Draw a best-fit line for each of your graphs in Figure 5A, 5B, and 5C.

Task 5B. The slope of the best-fit line (rise / run) equals the rate of sea level change over time (in cm /yr). A negative slope = falling sea level, a positve slope = rising sea level. Calculate the slope of the best-fit line (i.e. the rate of historic sea level change) for each of the graphs in Fig. 5A, 5B, and 5C. Show your work on the graphs.

Question 3-5. From your graph data in Task 5, fill in the chart below.

Location	Rate of Historic Relative Sea Level Change
Astoria, OR	____________
Galveston, TX	____________
Juneau, AK	____________

Question 3-6. Thinking about the historic condition of sea level change in the past 100 years (i.e. what is the modern climate affecting sea level), and the tectonic setting of each of the locations (Astoria, Galveston, and Juneau), systematically explain the processes creating the relative sea level fluctuations shown in Fig. 5A, 5B, and 5C.

Task 6. Using the reconstructed global sea level data for the late Pleistocene, in Table 3A, plot change in relative sea level (y axis) vs. calendar age (kyr BP - x axis). Use the blank graph provided in Figure 5D (alternatively, create the graph using the chart wizard in microsoft Excel).

Task 6A. Using the graph / slope method described in Task 5B above, determine the rate of sea level change between 80,000 yr BP and 20,000 yr BP. Show your work and calculation on Figure 5D.

Question 3-7. What has happened to global sea level during the past 120,000 years? Has there been a constant or variable rate of sea level change? What time periods experienced the highest rate of sea level change, how about the lowest rates?

Question 3-8. Thinking about climate change and glacial/interglacial cycles, explain the sea level curve in Figure 5D in terms of late Pleistocene climate. Has the climate been warming, cooling, or what? How do you know, explain your line of reasoning in great detail. Draw diagrams as necessary to support your argument.

Question 3-9. For the sake of simplicity, let's assume that the Oregon coast has been tectonically stable for the late Pleistocene (which, we know is false, but let's make it simple). According to the graph in Fig. 5D, what was the position of relative sea level, compared to modern, along the Oregon coast 120,000 years ago? How about 50,000 years ago?

Task 5C. Figure 5E is a topographic profile of the Oregon coast at the latitude of Newport. Note the position of modern sea level, the continental shelf, and continental slope. Using colored pencils, draw and label the position of sea level along the Oregon coast at 120,000 years ago and 50,000 years ago (refer back to your graph in Fig. 5D).

Question 3-10. Comment on what the topography of the Oregon coast looked like 120,000 and 50,000 years ago, compared to that of today. Were there rocky shorelines and sea cliffs? Was there more or less "beach" area. What did the coastal rivers (e.g. Yaquina, Nestucca, Columbia) look like at those times, compared to today? Draw diagrams as necessary to support your answer.

Part 4. Rates of Coastal Erosion in Oregon.

Coastal Oregon is very dynamic with respect to geomorphic process. Cliff erosion, beach erosion, landsliding, and flooding are common occurrences, particularly during the stormy winter months. Each year, millions of dollars in damage occurs to property along the Oregon coast. The understanding of geomorphic process is critical for the appropriate design of land-use regulations and housing plans.

Figure 6 is a map of the Nye Beach area of Newport, OR. The Jumpoff Joe sea cliff area is a classic example of very active historic erosion along the Oregon coast. By examining historic aerial photographs, it is possible to map out the position of the sea cliffs, and the rate of erosion over time. The map shows sea cliff positions for the years 1868, 1939, and 1967. The black squares represent the position of buildings and houses during this time frame.

Task 6. Using the map data in Fig. 6, determine the historic rates of sea cliff erosion at the Nye Beach area. Fill in the table below for cross-sections A-A', B-B', and C-C'.

Table 2. Monthly Sea Levels Measured with Tide Gauge in Yaquina Bay, Oregon. Data is from the 1982-1983 El Nino Year and from Long-Term Historic Averages (from Komar, 1992).

Date	El Nino Year (82-83) Monthly Relative Sea Levels (cm)	Date	Historic Monthly Average Relative Sea Levels (cm)
05/17/82	8.3	05/17/82	12.6
06/17/82	18.7	06/16/82	12.7
07/17/82	17.8	07/18/82	15.0
08/17/82	21.5	08/16/82	17.7
09/15/82	27.9	09/15/82	22.2
10/15/82	36.1	10/16/82	22.5
11/15/82	51.4	11/14/82	30.1
12/16/82	56.4	12/15/82	36.4
01/15/83	64.5	01/13/83	34.6
02/15/83	67.7	02/13/83	35.1
03/18/83	59.2	03/18/83	28.8
04/16/83	32.3	04/15/83	18.6
05/15/83	24.3	05/15/83	12.7

wou:geomorph:f00:coastdata.xls / yaquina SL 1982-83

Table 3. Relative Changes in Mean Yearly Sea Level for Select Tide Gauge Stations in the U.S. (data from Komar, 1992; after Hicks and others, 1983).

Year	Yearly Average Relative Sea Level (cm) for Astoria, OR	Year	Yearly Average Relative Sea Level (cm) for Galveston, TX	Year	Yearly Average Relative Sea Level (cm) for Juneau, AK	Year	Yearly Average Relative Sea Level (cm) for New York, NY
1925	13.7	1908	10.1	1935	45.6	1892	0.1
1926	11.8	1909	2.9	1936	44.2	1893	1.0
1927	20.5	1912	14.7	1939	45.3	1894	-0.3
1929	3.2	1914	9.8	1939	48.9	1897	3.6
1933	16.4	1915	10.4	1942	37.3	1897	4.0
1934	16.8	1916	4.0	1945	33.5	1899	3.6
1935	10.5	1917	5.6	1948	30.4	1900	0.2
1936	10.0	1918	17.0	1951	20.7	1901	6.8
1937	12.4	1919	14.1	1951	27.1	1902	7.5
1939	8.2	1920	23.1	1952	27.3	1903	5.5
1940	14.5	1921	18.3	1954	15.1	1904	1.3
1941	16.3	1922	19.0	1956	14.2	1905	0.3
1942	12.8	1923	10.9	1957	17.5	1906	3.0
1943	12.2	1924	10.4	1958	14.6	1907	2.2
1944	3.9	1925	11.3	1959	16.4	1908	1.2
1945	11.5	1926	19.0	1960	16.4	1909	4.3
1947	10.9	1927	13.9	1961	13.8	1910	6.1
1948	25.5	1928	25.2	1962	15.8	1912	0.5
1949	16.6	1930	10.8	1964	7.0	1914	4.3
1951	16.6	1932	23.0	1965	9.6	1915	6.3
1952	11.8	1934	15.3	1966	6.4	1916	5.6
1952	14.7	1934	19.7	1967	8.8	1917	6.2
1954	15.1	1935	20.1	1968	7.0	1918	5.9
1955	9.3	1936	23.4	1969	0.5	1919	10.6
1956	12.9	1937	22.2			1919	9.1
1957	13.6	1939	16.8			1921	10.0
1957	16.9	1940	26.7			1922	6.2
1960	9.6	1942	27.4			1924	7.1
1961	11.1	1944	34.6			1925	4.6
1961	9.4	1945	35.1			1927	7.7
1963	11.4	1946	33.3			1928	3.8
1963	9.5	1948	38.2			1929	4.4
1965	13.6	1949	38.5			1930	3.8
1966	10.1	1950	29.9			1931	7.7
1967	11.4	1951	32.2			1932	8.0
1968	15.3	1952	32.4			1933	10.4
1970	8.4	1954	27.8			1934	6.5

Table 3. Relative Changes in Mean Yearly Sea Level for Select Tide Gauge Stations in the U.S. (data from Komar, 1992; after Hicks and others, 1983).

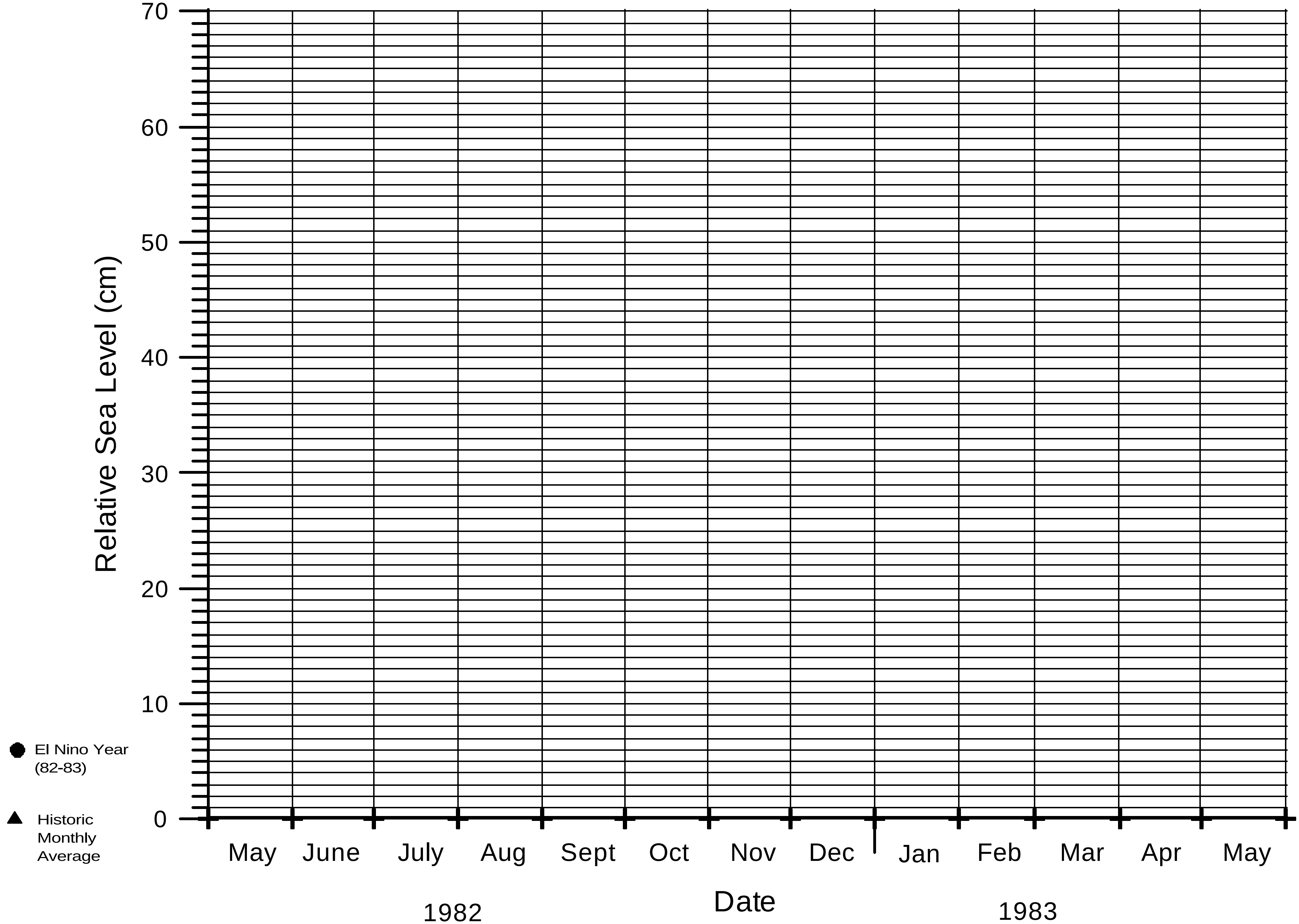
Year	Yearly Average Relative Sea Level (cm) for Astoria, OR	Year	Yearly Average Relative Sea Level (cm) for Galveston, TX	Year	Yearly Average Relative Sea Level (cm) for Juneau, AK	Year	Yearly Average Relative Sea Level (cm) for New York, NY
		1955	32.1			1935	10.0
		1956	29.5			1936	8.7
		1956	38.6			1937	12.8
		1957	38.0			1940	13.3
		1959	36.5			1941	11.4
		1961	41.2			1942	14.5
		1962	31.7			1944	12.9
		1964	33.1			1945	16.9
		1964	39.5			1947	14.9
		1965	37.6			1948	18.2
		1966	41.5			1950	12.6
		1967	40.0			1951	17.9
		1968	41.8			1953	17.8
		1969	41.0			1954	16.1
						1956	19.7
						1957	15.9
						1958	22.0
						1958	20.5
						1959	16.6
						1960	20.8
						1961	19.1
						1962	21.6
						1963	16.0
						1965	19.5
						1966	19.4
						1966	21.9
						1968	19.7
						1969	21.9

wou:geomorph:f00:coastdata.xls / yearly sea level- U.S.

Table 3A. Reconstructed Global Sea Level Data for the Late Pleistocene (data reconstructed from coral assemblages in Tahiti, New Guindea, Barbados).

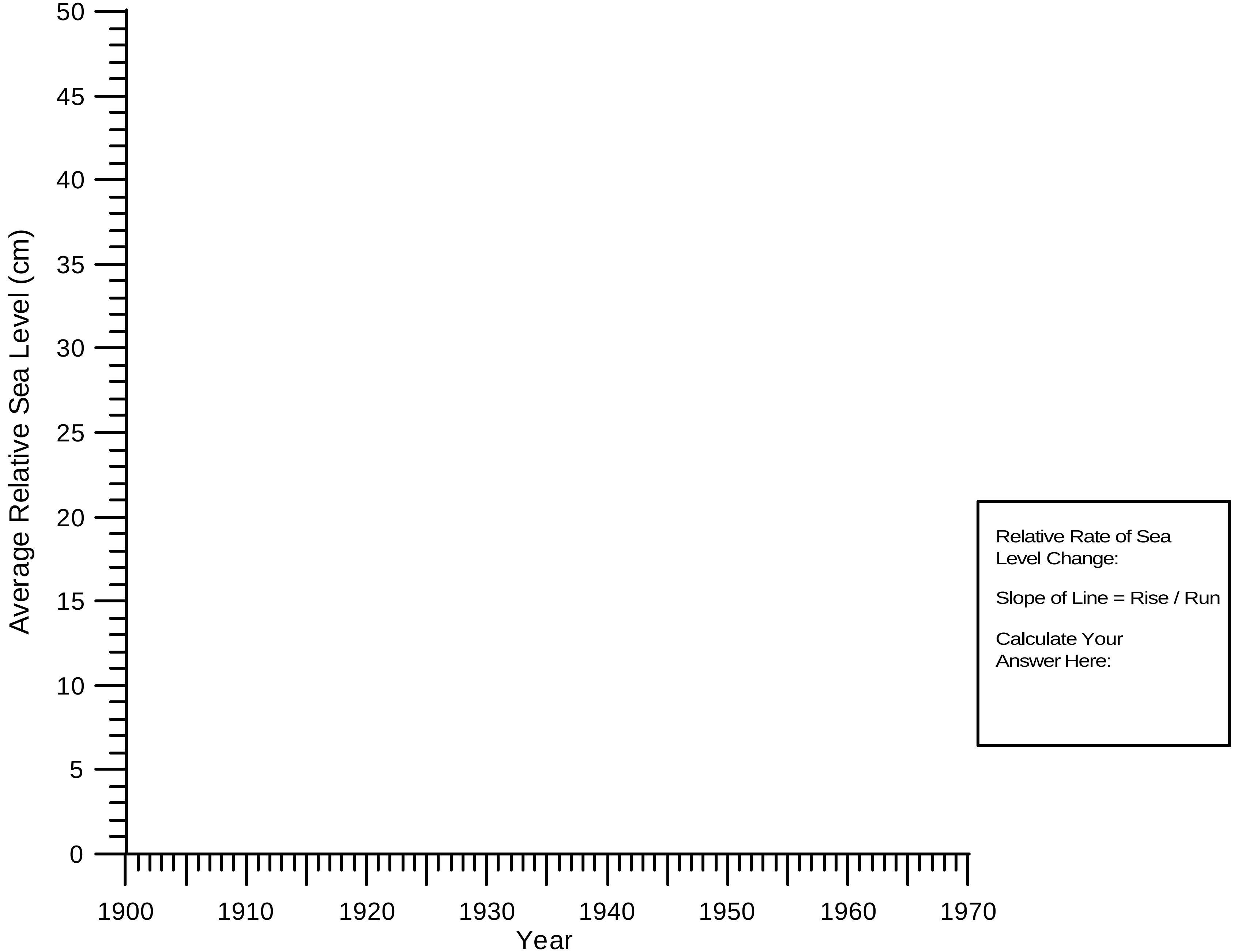
Calendar Age (kyr BP)	Reconstructed Relative Sea Level Compared to Modern (meters)
3.0	-0.07
5.8	-0.60
6.8	-4.19
7.3	-6.90
7.8	-11.43
8.2	-15.46
9.0	-22.71
9.5	-29.89
10.1	-39.79
10.5	-43.03
11.0	-48.90
11.5	-55.47
12.2	-61.60
12.8	-68.48
13.3	-74.56
13.9	-79.86
14.3	-93.12
14.6	-96.44
14.9	-98.87
16.8	-109.32
17.8	-112.38
18.4	-116.09
19.0	-118.24

Figure 4. Plot of Average Monthly Relative Sea Levels at Yaquina Bay -
El Nino Year (1982-1983) Compared to Long-Term Historic Data



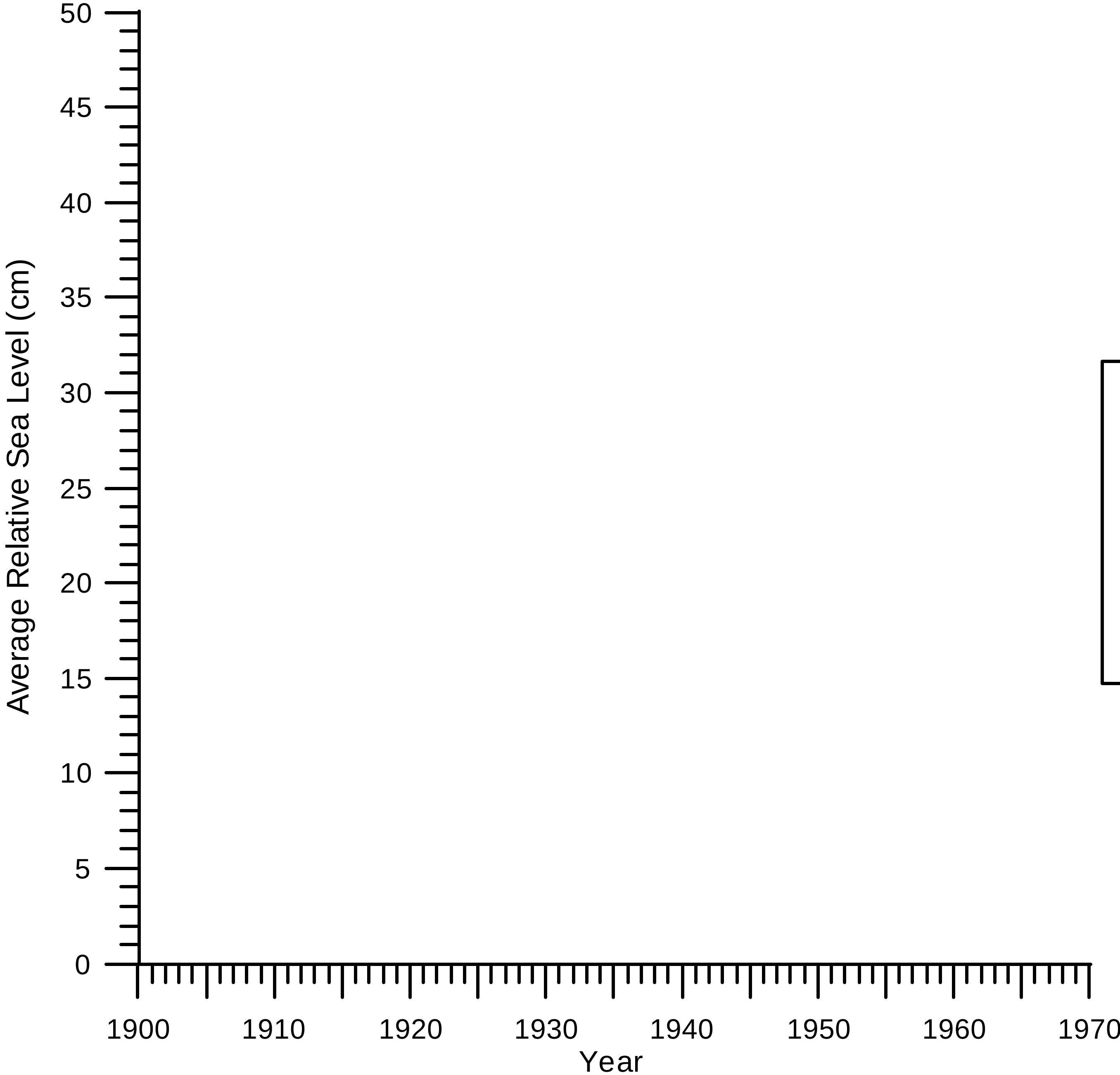
wou:geomorph:f00:coastlab:fig4blnk.grf

Figure 5A. Plot of Yearly Changes in Average Relative Sea Levels at Astoria, Oregon



wou:geomorph:f00:coastlab:fg5ablnk.grf (coastdat.dat)

Figure 5B. Plot of Yearly Changes in Average Relative Sea Levels at Galveston, TX



Rate of Relative
Sea Level Change:

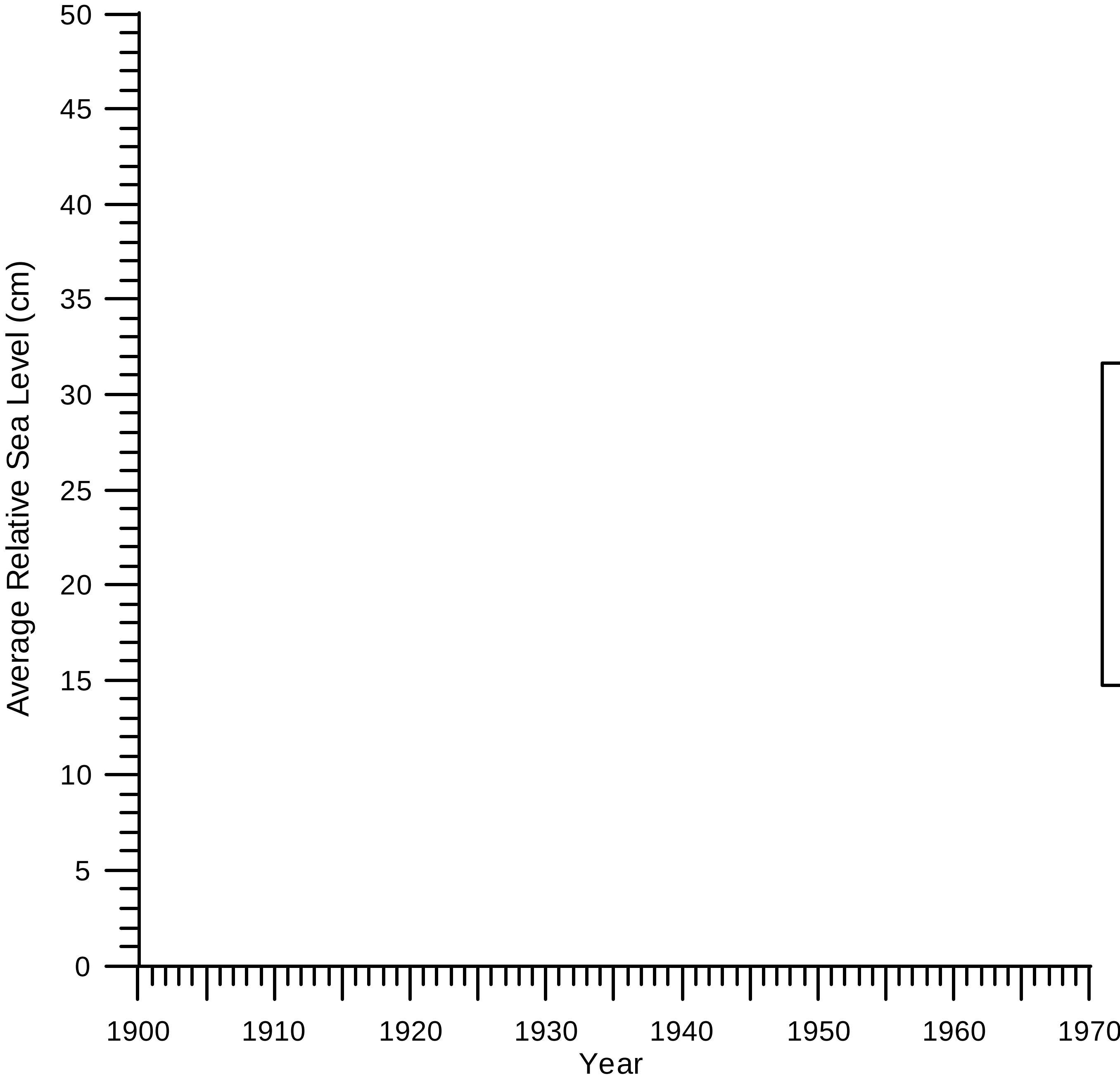
Slope of Line:

rise/run

Calculate Your Answer:

wou:geomorph:f00:coastlab:fg5bblnk.grf (coastdat.dat)

Figure 5C. Plot of Yearly Changes in Average Relative Sea Levels at Juneau, AK



Rate of Relative
Sea Level Change:

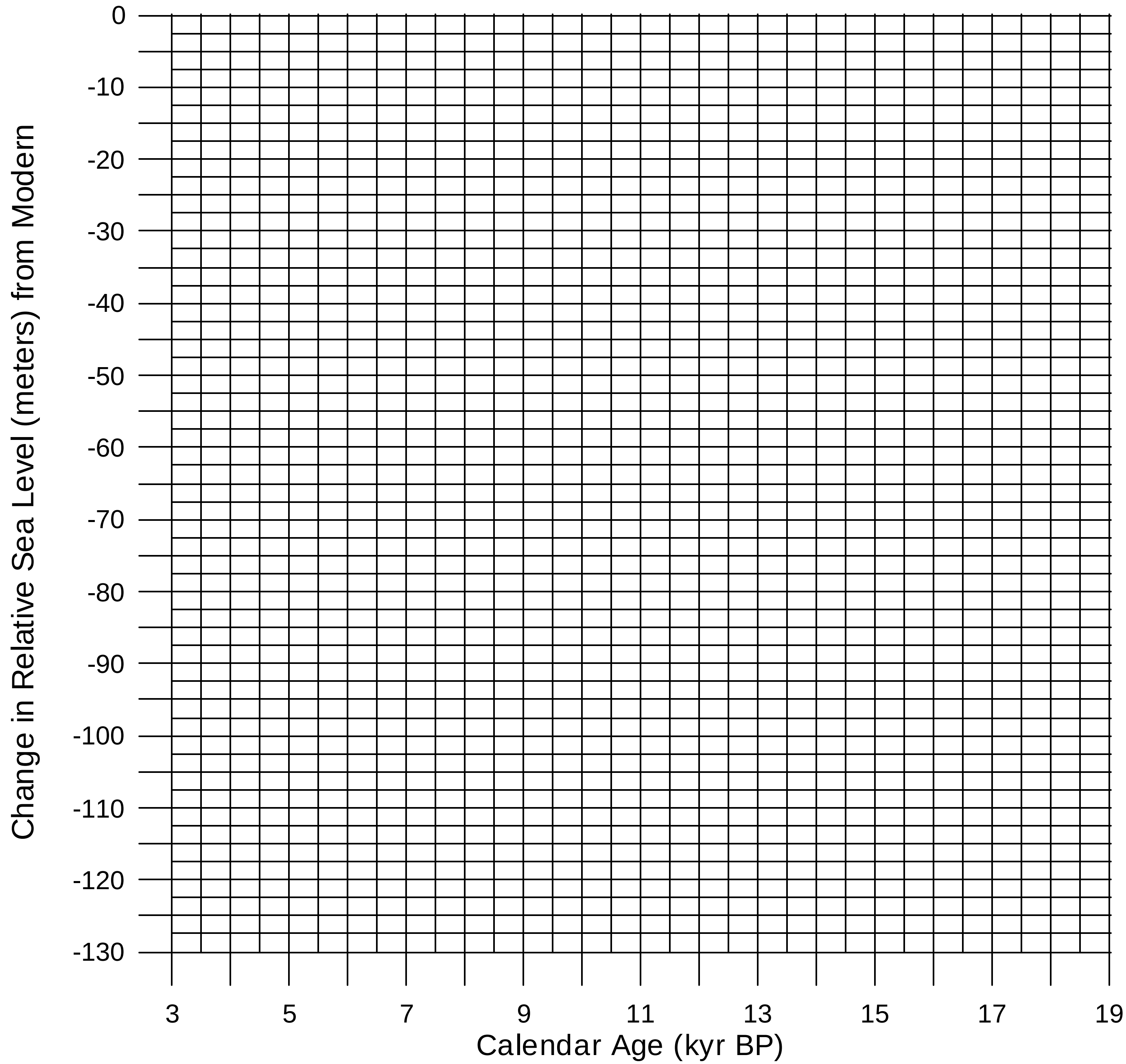
Slope of Line:

rise/run

Calculate Your Answer:

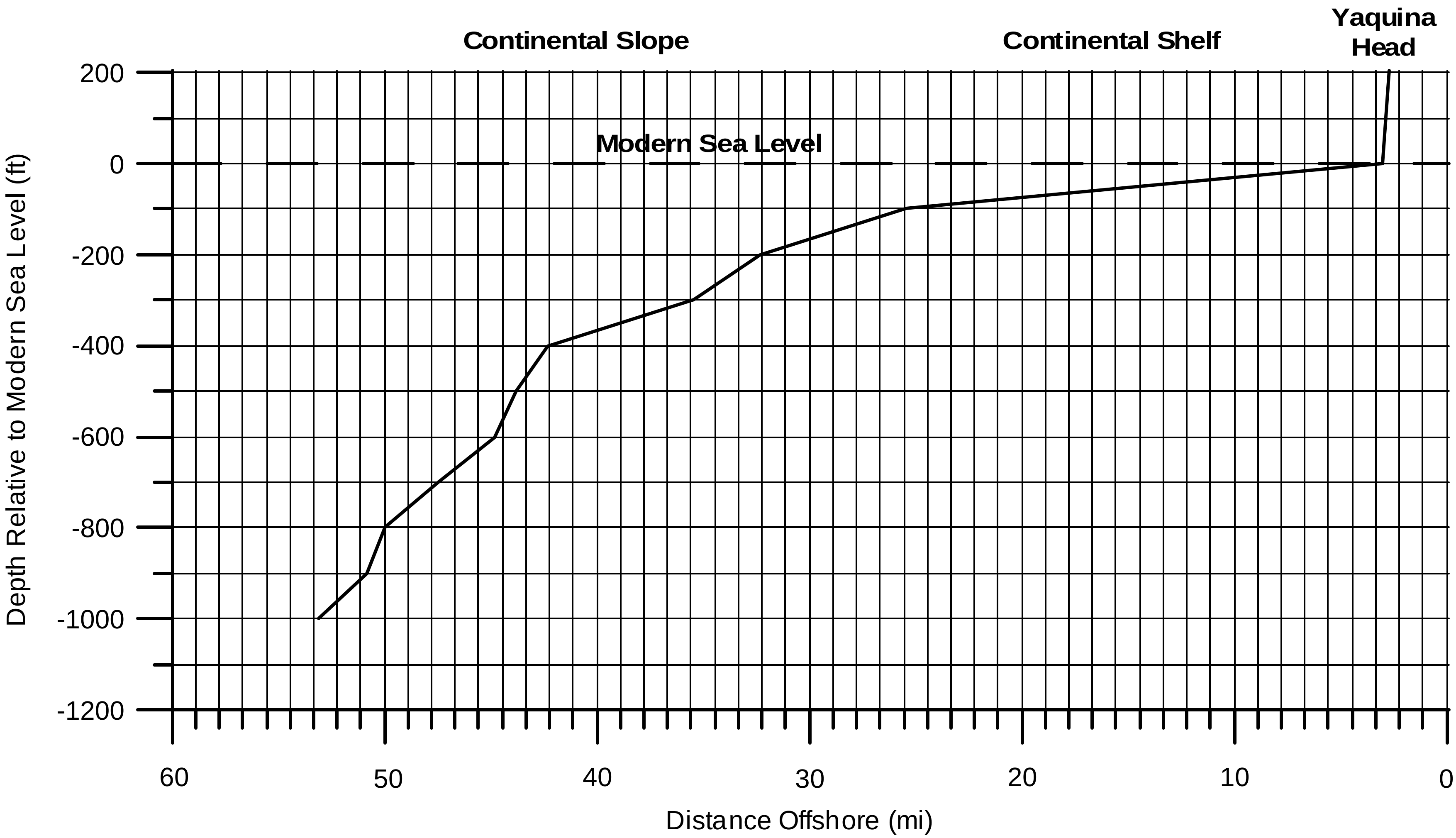
wou:geomorph:f00:coastlab:fg5cblnk.grf (coastdat.dat)

Figure 5D. Reconstructed Global Sea Level Curve for the Late Pleistocene.



c:wou:geomorph:f00:coastlab:fg5dblnk.grf (coastdat.dat)

Figure 5E. Profile of the Continental Shelf, West of Newport Oregon.



c:wou:geomorph:f00:coastlab:shlfprof.grf (shlfprof.dat)