Name: _____ Lab Section_____

Geology 115: Earth's Climate: Past, Present, Future
Fall 2007
Lab#5: Paleotempestology
Sediment Cores from Succotash Marsh, RI

One of the potential outcomes of a human-induced climate change is an increase in the frequency and intensity of hurricanes. The high concentration of human population in coastal areas (many of whom have flood insurance policies) and the huge hurricanes that have battered the US coastline in recent years have the CEO's of insurance companies concerned about the possibility of a dramatic increase in payments to policy holders in coastal areas in the coming years. They want to know if there is geologic evidence to support the hypothesis that human induced climate change has increased the frequency and intensity of hurricanes.

You, a team of global change scientists, have been hired by a Rhode Island based insurance company to characterize the timing and frequency of past hurricane activity in RI. You have been sent 3 cores from Succotash Marsh, located along the southern coast of Rhode Island (Figure 1), with which to conduct your investigation. From the historical record you know that ***at least*** 5 significant hurricanes have affected this region in the last 400 years. The storms documented in the historical record occurred in: 1635, 1638, 1815, 1938, and 1954 (Hurricane Carol). Each of these hurricanes produced a storm surge of > 3 m, enough of a surge to overtop the barrier island (Figure 2 &3). Therefore, sedimentary evidence of past hurricane events caused by these storm surges should be present in the cores you have been sent in the form of overwash deposits. You, and your team, have lots of time but limited funds to evaluate the cores you have been sent. The insurance company that has hired you wants as much information as it can get from these cores about the history of hurricane events in RI.

The tasks they have asked you to complete are:

1) Take the cores your team has been sent and develop a set of stratigraphic columns that represent not only the sedimentological variations that occur in each core, but also a correlation between the cores of sedimentary layers produced by the hurricane events (see example Figure 4).
2) Use your expertise in global change science to make informed decisions about what sedimentological dating techniques to employ to determine the timing of the hurricane events preserved in these cores. Given that the budget the insurance company has provided is meager to say the least, you need to make some intelligent decisions about what techniques to employ to constrain the ages of the hurricane events. You will also need to use your scientific skills to interpret the data that the lab you sent samples to for dating will send you.
3) Provide answers to the questions that insurance agency has posed about using this technique to assess the frequency and intensity of hurricanes in RI and the viability of this site for further investigation of paleotempestology.

***PART I. Stratigraphy* (see example Figure 4)**

1) Produce a sedimentological log for the core on your table by describing the types of sedimentary units present in the core (i.e. muddy peat, sandy peat, fine to medium sand, coarse sand) and logging the sedimentological variations in the core by recording the distance from the top of the core to the top and bottom of each sedimentary unit.
2) Using the sedimentological log your group has produced and those produced by the other teams for the other two cores (reproduce your log on the front board), reconstruct the stratigraphy of the cores (to scale) in the pre-made stratigraphic columns provided in this handout.
3) To complete your columns describe the sediments (i.e. muddy peat, sandy peat, fine to medium sand, coarse sand) use the different symbols (provided in the introductory lecture) for each sediment type and make a symbol coded key to your columns.
4) Using characteristics of the sediments, such as color, texture, stratigraphic position, and similarities in peat intervals, make preliminary correlations of the overwash sand deposits between the cores. Then, along the left hand margin of your stratigraphic column label each overwash sand deposit (e.g. Fan I, Fan II, etc) starting with the most recent. Be sure to include the associated age of that deposit (i.e. year of the hurricane).

PART II. Dating and Chronology

Confirm the preliminary correlations you have made using these absolute dating techniques. You have been given a budget of $5000 for dating events in these cores and may choose from four kinds of dates below. Chose your dating techniques wisely because you do not have a big enough budget to do each type of analysis for every core. What information do you absolutely need to know for your report to the insurance company?

^{137}Cs	Nuclear weapons testing fallout – first deposition 1954, peak values 1964. Both organic-rich and organic-poor sediments. $500 / core
^{210}Pb	Evidence of industrialization mid to late 1800's (1850-1880). Organic-rich sediments only. $500 / core
Pollen (Rx)	Rumex pollen marks the arrival of Europeans in New England (e.g. land clearance activities). This horizon dates to ~1700. Organic-rich sediments only. $500 / core
^{14}C	Provides and absolute age (before 1700 is best); Organic material only. $1000 /sample

As you purchase each age analysis indicate on the appropriate core of you stratigraphic column the information provided by that analysis. Use the appropriate abbreviation from above. After you have exhausted your budget obtaining dates for your cores, reassess the correlations you have made between cores and make any necessary changes to your initial interpretation.

III. Insurance Company Deliverables

1) Your stratigraphic columns and correlation of hurricane events between cores (50 pts: 10/core; 15 correlations; 5 pts key).
2) Illustration on your stratigraphic columns of the dates you bought (5 pts).
3) Responses to the following questions (45 pts):

A) What is the evidence for hurricane events in these cores and what kind of deposits do these represent (2pts)?

B) For the CEO of the insurance company who funded this research provide an explanation of the process by which this record of past hurricane events was preserved in these sediments (HINT: see Figure 2) (10 pts)?

C) How many hurricane events did you find recorded in these cores (1pt)?

D) In what years do you estimate these events occurred (2pts)?

E) What is the average recurrence time of large hurricanes in southern RI (# of year in the record/ # of events) (2pts)?

F) Why did you choose to purchase the particular dates that you bought? In other words, for each date you bought explain why you purchased it and how that date was used to aid in your interpretation of both the core you purchased the date for as well as your correlation to other cores (10 pts)?

G) Can you make any interpretation about the intensity of past hurricane events based on these cores? If yes, explain how. (HINT: think about the thickness and landward extent of each overwash sand layer) (6pts)

H) How could the shape of the barrier beach (See Figure 2) or the direction from which the hurricane made landfall potential impact you ability to assess the intensity of past hurricane events? (6pts)

I) Is this site worth pursuing for further study of the frequency and intensity of hurricane activity in RI (1pt)? Why or why not (5pts)?

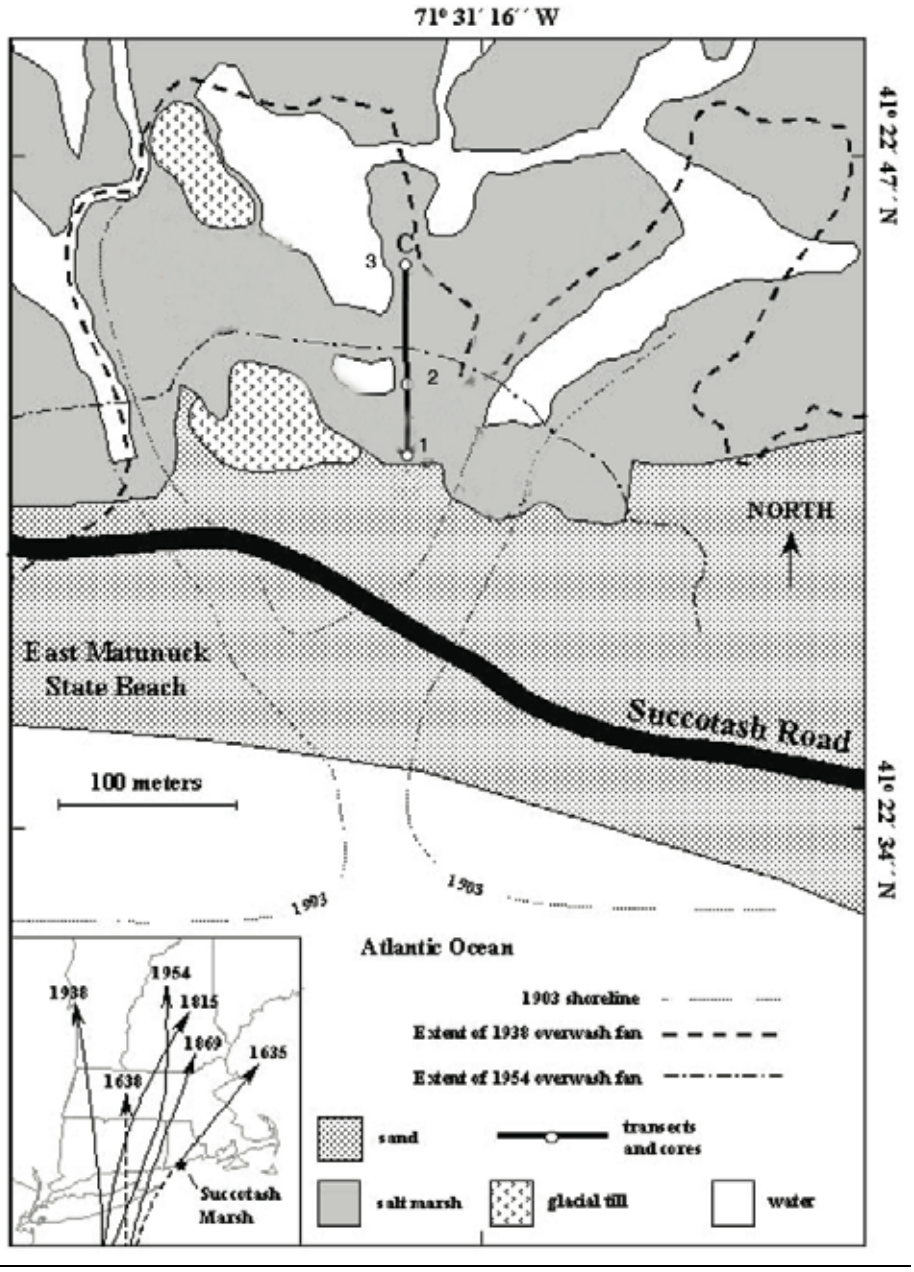


Figure 1. Location of Succotash Marsh and storm tracks of historic hurricanes in the region (map lower left). Map of Succotash Marsh located in East Matunuck, RI, showing core locations. Dashed lines indicate the extent of overwash deposition with Succotash Marsh associated with the two most recent major hurricanes in this region those that occurred in 1954 and 1938. The dotted line represents the configuration of the inlet in 1903 (from Donnelly et al. 2001).

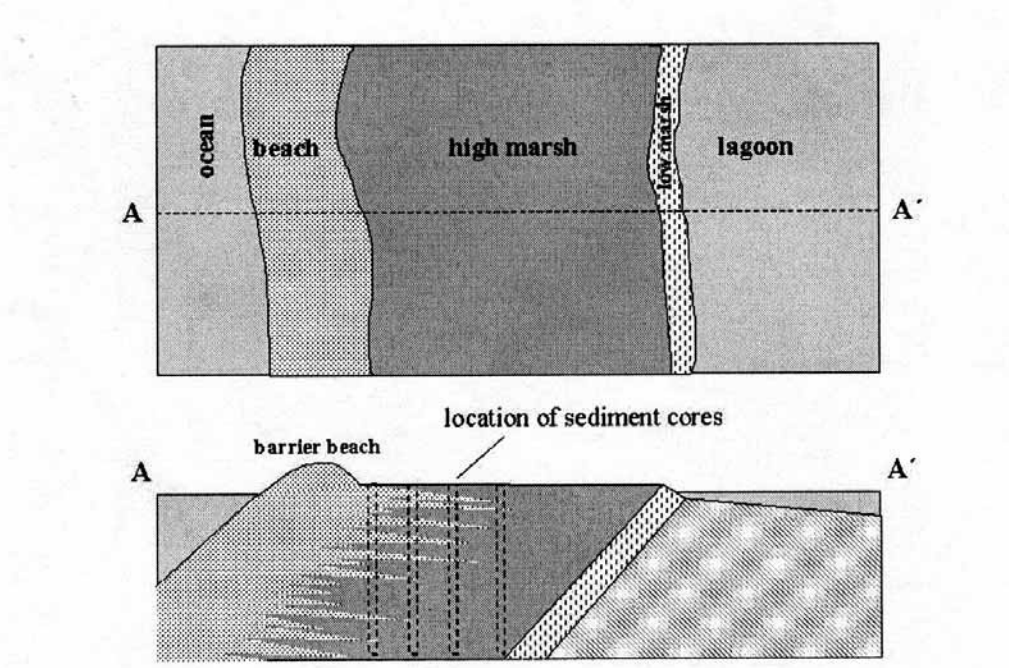


Figure 2. Map view and cross section of overwash deposition and the landward movement of the barrier beach-marsh system as sea level rises (i.e. a marine transgression). Overtopping of the barrier beach by a storm surge results in overwash fan deposits across the marshes located behind the barrier beach (from Donnelly et al. 2001).

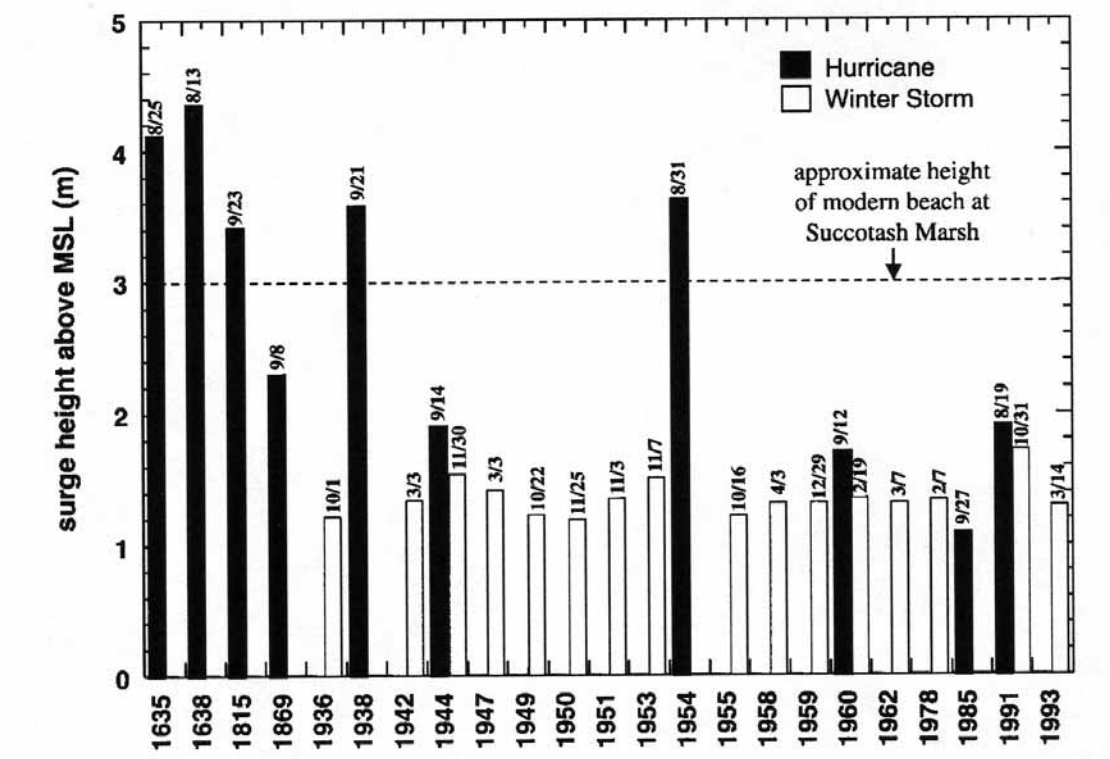


Figure 3. Storm surge heights in southern Rhode Island relative to modern mean sea level (MSL) (from Donnelly et al. 2001).

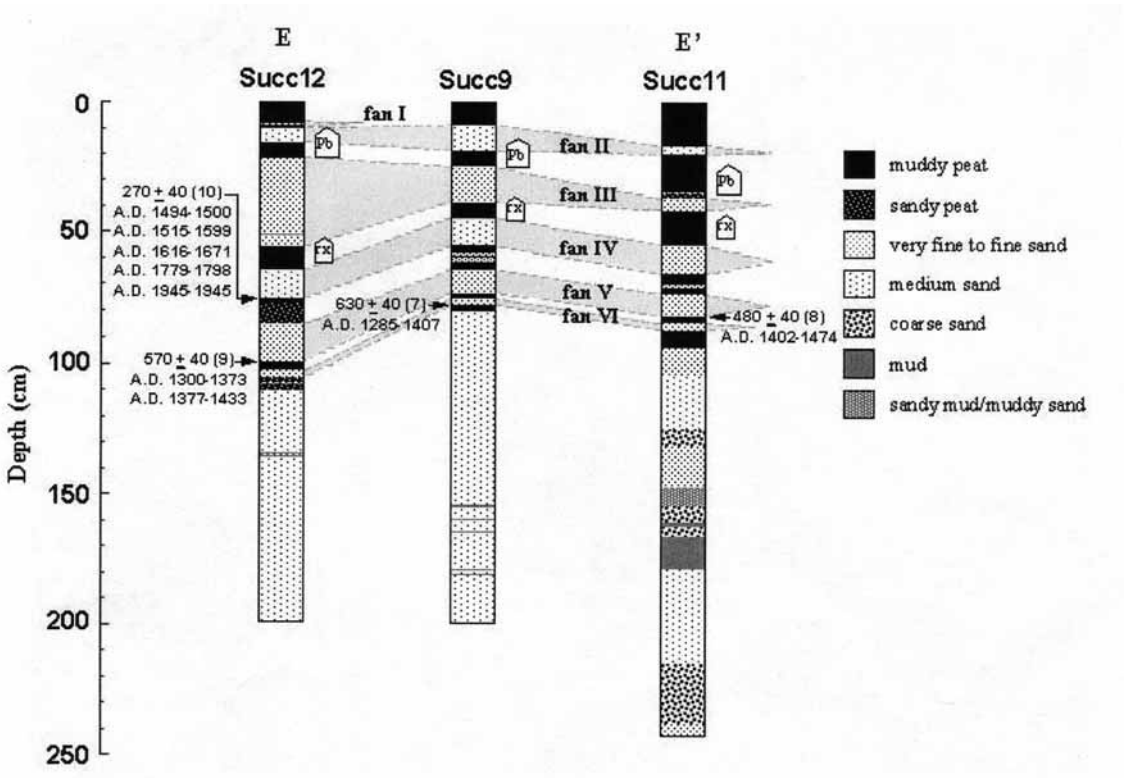


Figure 4. Logs of sediment cores from a previous transect of Succotash Marsh. Overwash fans have been correlated between the cores and labeled. Large arrows labeled Pb indicate the stratagraphic interval where the concentration of lead increases dramatically as a consequence of the industrial revolution (~1850-1880 A.D.). Arrows labeled rx indicate the stratagraphic interval where Rumex pollen increase above 3%, indicating the start of widespread European style clearance of the landscape (~1700 A.D.). Small solid black arrows indicate locations of radiocarbon (^{14}C) dated samples.

CORE #:

(Possible sediment types are: muddy peat; sandy peat; fine to medium sand or coarse sand)

Sediment Description	Depth to top (cm)	Depth to bottom (cm)

CORE #:

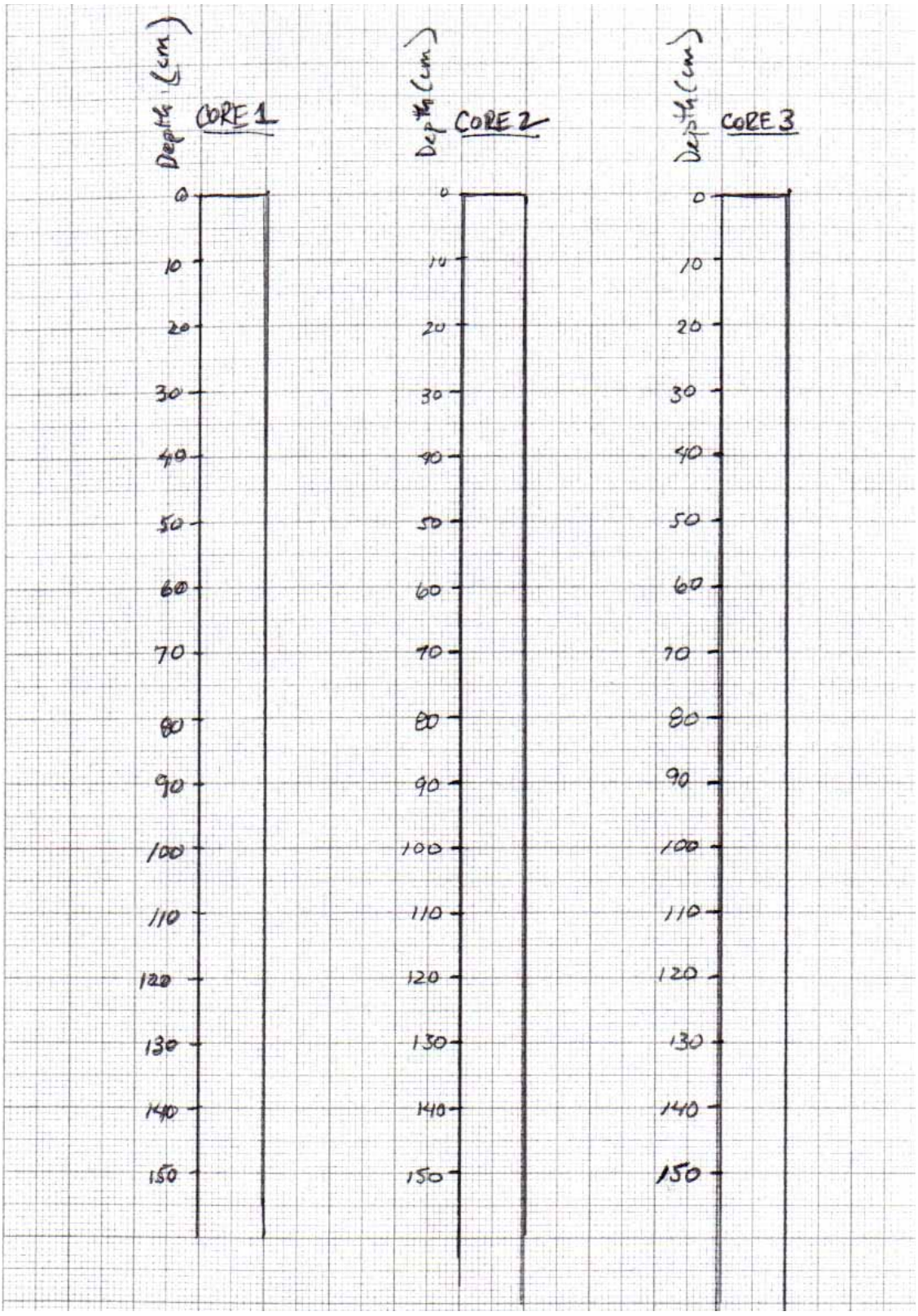
(Possible sediment types are: muddy peat; sandy peat; fine to medium sand or coarse sand)

Sediment Description	Depth to top (cm)	Depth to bottom (cm)

CORE #:

(Possible sediment types are: muddy peat; sandy peat; fine to medium sand or coarse sand)

Sediment Description	Depth to top (cm)	Depth to bottom (cm)


Depth (cm)
CORE 1
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (cm)
CORE 2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (cm)
CORE 3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150