DETERMINING RECENT SEDIMENTATION RATES OF THE TRINITY RIVER, TEXAS

by

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Prepared for the Texas Water Development Board
under Research and Planning Fund Grant Contract No. 93-483-356

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November 1993

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INTRODUCTION

Replacement of wetlands by water and flats in the lower alluvial valley and delta of the Trinity River suggests that relative sea-level rise and reductions in sediment supply have rendered the fluvial-deltaic system incapable of maintaining sufficient elevation to prevent its submergence. The Trinity River transports the greatest load of suspended sediment of all rivers emptying into Texas bays (Longley, 1992a), and therefore it has the greatest potential for delivering enough sediment to offset subsidence.

Objectives

The principal objectives of this study were to determine past rates of sedimentation and relative sea-level rise in a fluvially dominated area immediately upstream of the Trinity River delta. These data are to be used by the Texas Water Development Board to determine the frequency, duration, and magnitude of river flooding necessary to offset submergence of wetlands (Longley, 1992b). Sedimentation rates are based on excess ^{210}Pb activity measured in 12 cores collected in the study area (fig. 1). Rates of relative sea-level rise are based on National Ocean Service (NOS) benchmark releveling surveys, USGS reports, and NOS tide gauge data at Galveston.

Natural Environments in the Study Area

Natural environments of the Trinity River delta and alluvial valley near Interstate Highway 10 consist of brackish to fresh marshes, flats, open water (including lakes and abandoned river channels), fluvial woodlands, and swamps (White and others, 1985). The Trinity River delta has numerous distributary channels, some active but many inactive. Inland parts of the delta are dominated by fluvial processes, in contrast to delta-front areas where estuarine processes are more influential. The Trinity River delta is characterized by salinities generally below 5 ppt, with salinities decreasing up the valley. In the study area, which is upstream of the delta, marshes are reflective of brackish to fresh conditions.

Human Modifications Potentially Affecting Sedimentation

Among major human modifications in the Trinity River alluvial valley west of the river are Interstate Highway 10, the original (but abandoned) dam for Wallisville Lake, and the non-over-

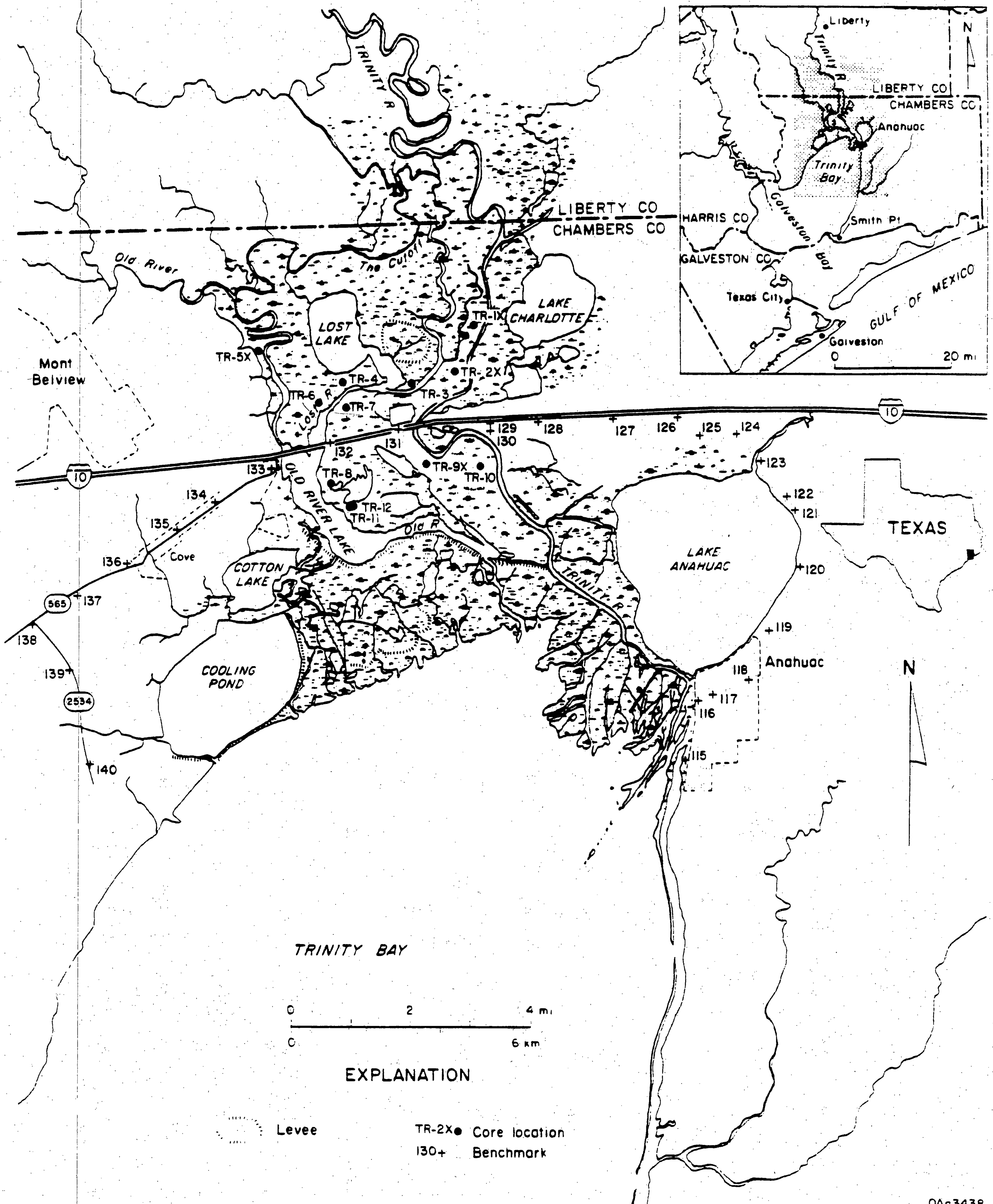


Figure 1. Index map of study area showing locations of coring sites and benchmarks.

flow dam for the approved alternate plan for Wallisville Lake (fig. 2). Other modifications within the project area include Lost Lake oil field and surrounding levee, modified natural levees (artificially elevated) along the west bank of Trinity River south of IH-10, locally dredged and straightened abandoned channels north of IH-10, and canals dredged for pipelines that cross the valley. Diversion or control structures have also been placed on Old River and Lost River (fig. 2). Major alterations caused by IH-10 include approximately 2 km (1.25 mi) of elevated road fill between bridges at the Trinity River and Old River Lake. Construction of the non-overflow levee as part of Wallisville Lake has removed approximately 450 acres of marsh and woodlands from the fluvial sediment system (fig. 2). It is anticipated that vegetation between the river and levee will eventually be replaced by open water unless water levels are artificially managed.

Alterations upstream and downstream of the study area have also affected the hydrology and sediment supply in the wetland system. Reservoirs located upstream in the Trinity River drainage basin have dramatically reduced the amount of suspended sediment reaching coastal areas, as illustrated by sediment records at the Romayor monitoring station (fig. 3). Development of Lake Anahuac, east of the Trinity River, is a major alteration downstream of the study area.

The effects of human modifications in the study area on marsh sedimentation are not fully understood. It is obvious that flow patterns during flood events have been altered substantially by IH-10, which extends across the valley, diverting flow around the elevated highway that extends between the Trinity River and Lost River Lake bridges. Sedimentation rates may be slightly higher upstream of IH-10 due to the partial damming effect of the highway, which during flood events may locally reduce currents and elevate water levels upstream, allowing more sediments to settle. However, marshes are being lost both upstream and downstream of the highway. Variations in sedimentation rates seemed to be influenced more by the type of marsh and setting than by location relative to IH-10. Although the human modifications in the study area have some degree of influence on sedimentation and loss of wetlands, the overriding influence, at least in the past, appears to be human-induced subsidence.

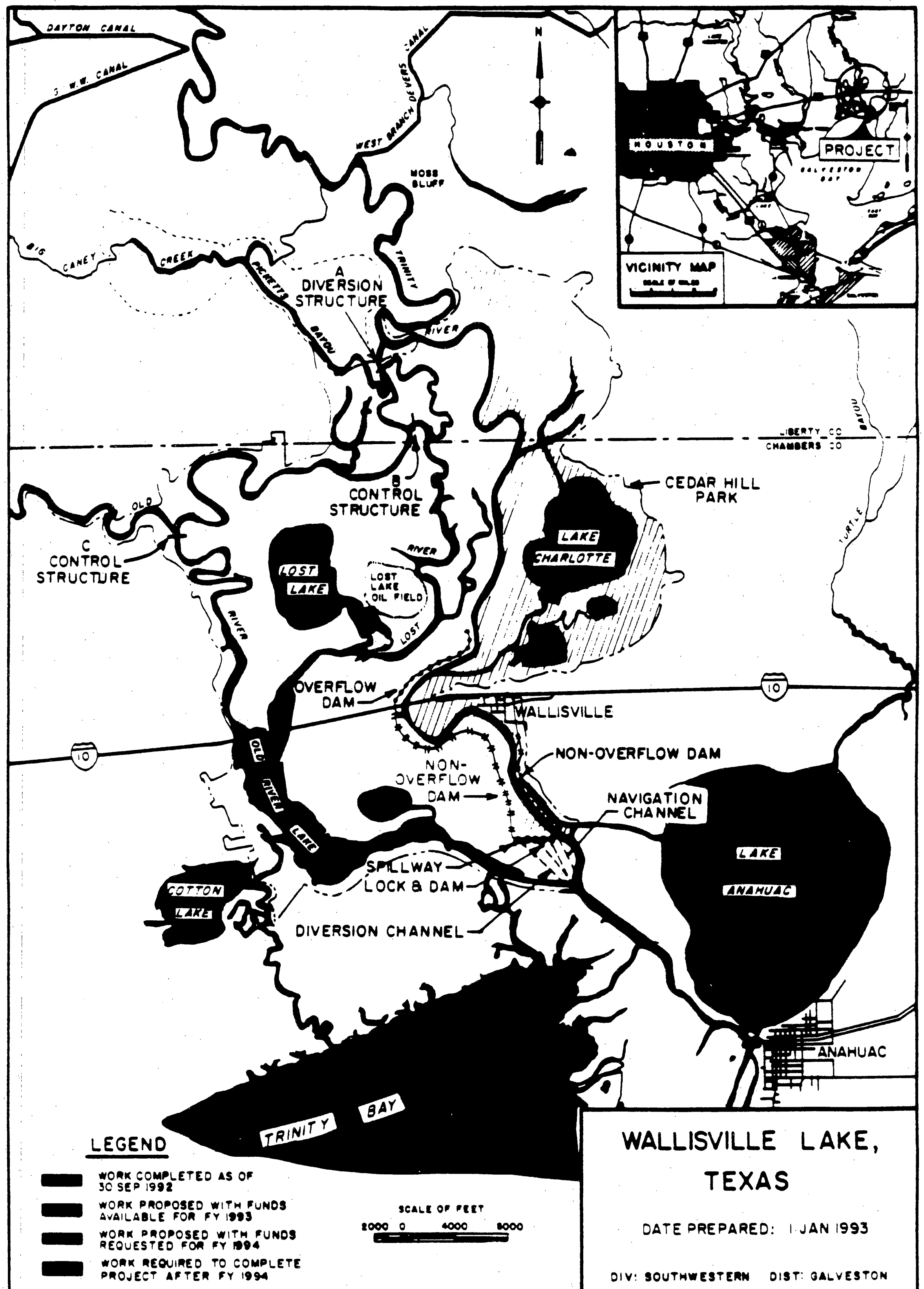


Figure 2. Alterations along the Trinity River associated with Wallisville Lake. From the U.S. Army Corps of Engineers, Galveston District.

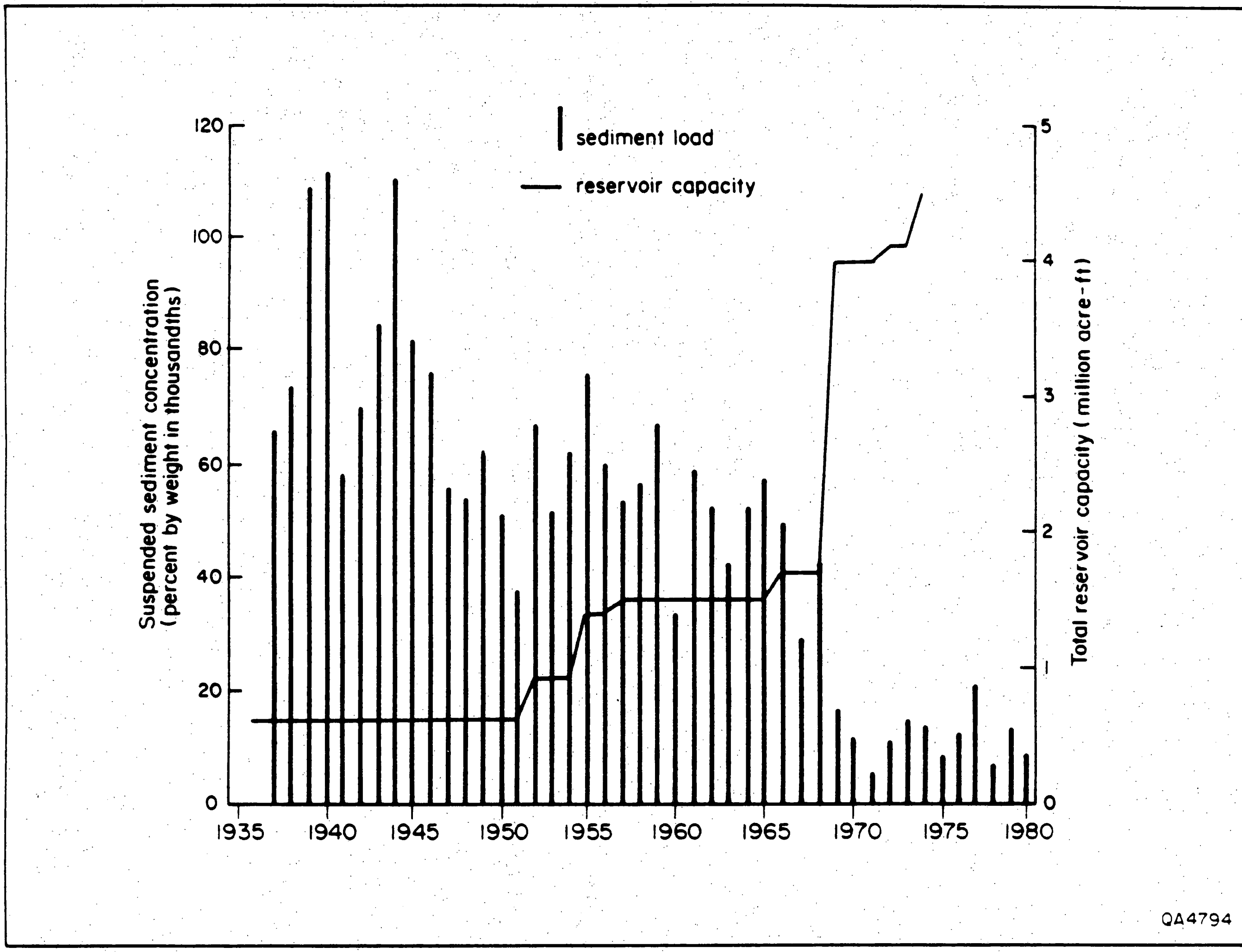


Figure 3. Suspended-sediment load (percent by weight) of the Trinity River at Romayor, and cumulative authorized water storage in reservoirs of the Trinity River basin. From Paine and Morton (1986).

METHODS

Field Methods

Site Selection

Eleven sites, with one additional replicate site, were selected for coring in the Trinity River alluvial valley (fig. 1). Criteria used in selecting sites included location with respect to the modern Trinity River channel and abandoned channels, location with respect to the estuarine system, relative elevations, susceptibility to flooding, types of wetland vegetation, and location with respect to existing and planned human modifications. The approach was to sample several different environments but avoid local human alterations that may have affected sedimentation rates.

Coring sites were positioned across the alluvial valley north and south of IH-10 and west of the Trinity River. Seven sites are located upstream of IH-10 and five are downstream. Four sites are located within 500 m of the river. All sites are north (upstream) of the existing but abandoned Wallisville dam, which places them in wetland areas influenced more by riverine sedimentary processes than estuarine processes.

Site Descriptions

Wetland coring sites varied from brackish-water marshes characterized in some areas south of IH-10 by *Spartina patens* (marsh hay or saltmeadow cordgrass), to fresh-water marshes characterized at one site north of IH-10 by *Zizaniopsis miliacea* (giant cutgrass). The most abundant plant at sites both north and south of IH-10 was *Alternanthera philoxeroides* (alligator weed). It was the dominant species at about half of the coring sites and was part of the vegetation community at 9 of the 12 sites (table 1). Sites were located in low and high marshes. Estimated elevations range from greater than 0.6 m (2 ft) to less than 0.3 m (1 ft). Coring site TR-1X had the highest estimated elevation, and TR-5X the lowest (table 1). Levee flank sites (TR-1X, TR-2X, TR-9X, and TR-10) were generally in high-marsh environments and were the most difficult to core because of increasing stiffness of clay with depth. Low marshes composed predominantly of alligator weed or giant cutgrass were less consolidated and easier to core.

Sites were cored in March and May of 1993 (table 1). When possible, cores were taken at marsh sites with no evidence of surface disturbances such as nutria trails and burrowing. However, the Trinity River was in flood stage during the time the cores were taken, and high water levels at most sites prevented examination of the surface. Sites were selected with

Table 1. Elevation, coring date, habitat, core length, and vegetation at coring sites.

Core number	Approximate elevation (ft)	Coring date	Wetland type	Core length (cm)	Predominant vegetation
TR-1X	>2	5/18/93	high marsh (levee flank)	56	*Paspalum lividum* *Lycium carolinianum* *Alternanthera philoxeroides* *Cyperus articulatus* *Sesbania* sp. *Eleocharis* sp.
TR-2X	1.5–2	5/18/93	low/high marsh (levee flank)	44	Edge of *Scirpus californicus* *Sesbannia* sp.
TR-3	1.5	3/17/93	high marsh/woodlands	56	*Crinum americanum* *Hymenocallis caroliniana* *Salix nigra* *Phragmites australis* *Ulmus crassifolia*
TR-4	1–1.5	3/17/93	low marsh	72	*Alternanthera philoxeroides*
TR-5X	0.5–1	5/19/93	low marsh	78	*Zizaniopsis miliacea* *Alternanthera philoxeroides* *Sagittaria* sp.
TR-6	1–2	3/17/93	low/high marsh	64	*Alternanthera philoxeriodes* *Hymenocallis caroliniana* Scattered *Sesbania*
TR-7	1–1.5	3/17/93	low marsh	66	*Alternanthera philoxeroides* Scattered *Sesbania*
TR-8	0.5–1	3/18/93	low marsh/flat	73	*Alternanthera philoxeriodes*
TR-9X	1–2	5/19/93	high marsh/low marsh (levee flank)	56	*Spartina patens* *Eleocharis* sp. *Alternanthera philoxeriodes* *Sagittaria* sp.
TR-10	1.5	3/17/93	high marsh/low marsh (levee flank)	61	*Spartina patens* *Paspalum* or *Distichlis*
TR-11	1–1.5	3/18/93	low marsh	68	*Alternanthera philoxeroides*
TR-12	1–1.5	3/18/93	low marsh	67	*Alternanthera philoxeroides*

respect to the appearance of the vegetation emerging from the water. Release rates from Lake Livingston were reported at 35,000 cfs on 3/16/93 and 22,000 cfs on 5/16/93 (*Houston Post*). Water levels at the coring sites varied upstream and downstream of IH-10 because of the damming effect of a temporary road constructed by the Department of Transportation below IH-10 across the head of Old River Lake. The road had washed out in several locations, but the level of inundation was at least 30 cm higher upstream of the road than downstream. Water levels at coring sites upstream of IH-10 (sites TR-1X, 2X, 3, 4, 5X, 6, 7, and 8) ranged from approximately 30 to 70 cm above the marsh surface, and water levels at sites downstream of IH-10 (sites TR-8, 9X, 10, 11, and 12) were at or just a few centimeters above the marsh surface. Water levels were higher during the March trip than during the May trip. However, because of the artificial effects caused by the temporary road, water-level measurements were not taken at each site. It would be inadvisable to make comparisons of water levels during the two visits because of variations in the condition of the temporary road (length and number of washouts) that caused the damming effect.

Coring Methods

Cores were taken by twisting, and where necessary driving, a thin-walled, sharpened metal tube, 1 m long and 11.5 cm in diameter, into the marsh substrate. Lengths of cores varied depending on the difficulty of penetrating the substrate and the amount of compression. Some sediment compression occurred in deeper sections of cores where stiff clayey sediments were encountered, especially in high marsh levee-flank environments. Four original cores were discarded because of excessive compression. They were replaced by four additional cores (with "x" suffixes), three of which were taken using slightly modified coring tubes to reduce compression. Cores were dug out of the marsh soils to minimize loss of material during extraction from the substrate. The end of each core was covered with rubber caps that were tightened down with ring clamps and taped. The cores were transported to the BEG Core Research Center for processing.

Sediment Compression Caused by Coring

The volume of unconsolidated sediments normally decreases with depth as a result of physical compaction, dewatering, and loss of organic matter. For some depth-dependent relationships, the natural compaction is taken into account and the data are normalized to equate values near the top of the core with those near the bottom of the core. Physical properties affected by natural compaction, such as water content and bulk density, are used to remove the effect of compaction so that data throughout the core can be compared on a post-compaction basis.

In the wetland literature, few references are made to artificial compaction of wetland sediments caused by the coring operation. Some reports do not address the issue of artificial compaction, and others give only vague qualitative descriptions such as minor compaction. Few studies actually attempt to quantify the magnitude of artificial compaction and to adjust those depth-dependent parameters derived from the core.

In this report we distinguish between natural compaction and artificial compaction by referring to artificial compaction as "compression." Compression commonly results during coring even if steps are taken to minimize it. Adjusting the stratigraphy of the core to remove the effects of compression is necessary because any vertical displacement of the cored sediments with respect to their natural position will result in the calculation of inaccurate sedimentation rates. Sedimentation rates calculated from compressed cores will underestimate the actual rates of sedimentation.

Penetration of the core barrel into unconsolidated sediments typically causes some minor compression of the sediments. The amount of compression depends on the composition and textures of the sediments, their water content, and other physical properties such as bedding. Some muds are susceptible to high compression, whereas well-sorted, water-saturated sands are essentially incompressible. The observed compression can occur in one of two forms. The simplest form of compression is the physical foreshortening of the sediment column as the water and void space are reduced. For this type of compression all the strata are represented and the stratigraphy of the core and surrounding uncompressed sediments is the same except that the strata within the compressed intervals are closer together. The most complex type of compression involves drag along the core barrel and expulsion of sediment so that some strata are bypassed and are not recovered in the core barrel. This type of compression can occur where stiff sediments overlie a zone of soft sediment and the soft sediments are driven aside as the core barrel is shoved into the ground. Drag and bypassing of sediments are observed as distorted strata in the cores. The amount of distortion observed in the core and in the x-radiographs of the core reflects the degree of sediment compression.

Compression of each core from the Trinity River was anticipated because the wetland sediments are composed predominantly of mud. As the core barrel was driven into the ground, the amount of sediment compression was estimated by periodically measuring the distance to the sediment surface on the outside and inside of the core barrel (fig. 4). By making these two

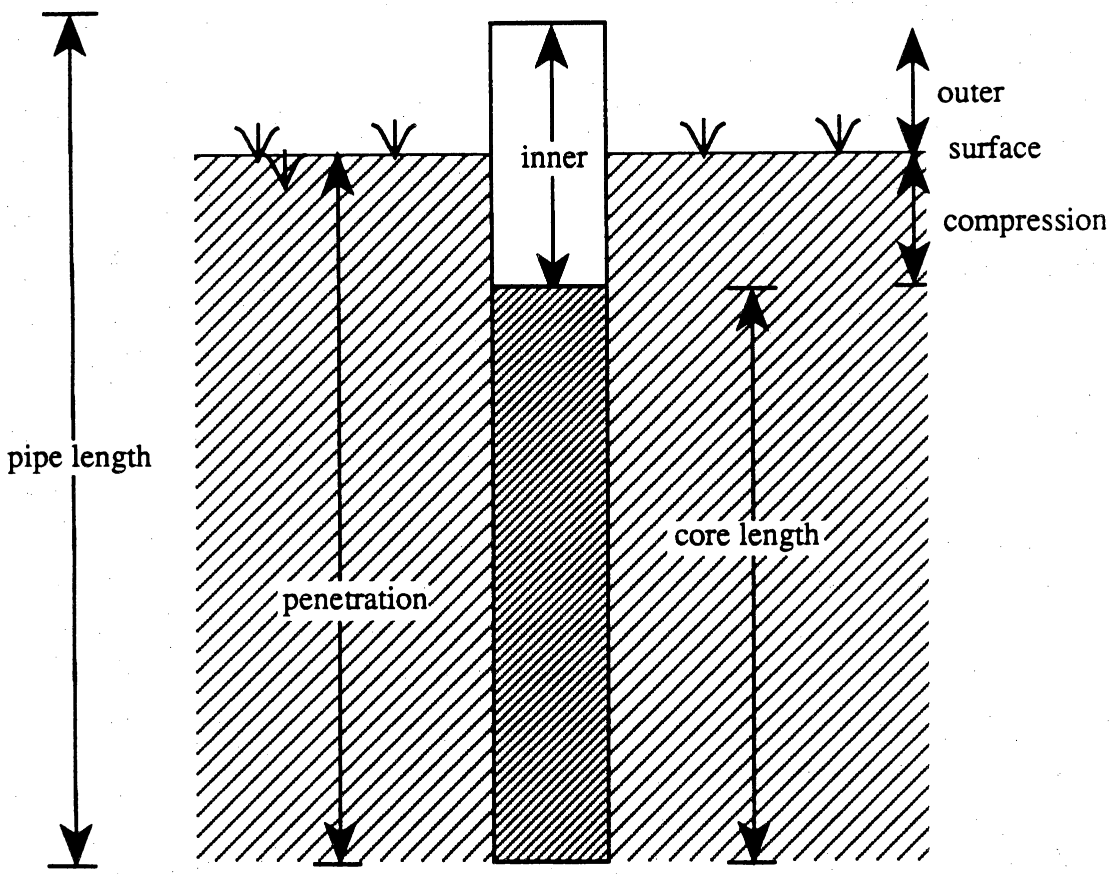


Figure 4. Illustration showing sediment compression that may occur during coring.

measurements and knowing the length of the core barrel, total penetration of the core barrel, and core length, the amount of sediment compression can be calculated (table 2 and appendix A). The interval thickness and the amount of compression for each interval also can be derived from these measurements (table 2) and used to illustrate the percent sediment compression and the depths at which it occurs. The field measurements and derived data also can be used to reconstruct the interval thickness before compression and to calculate restored depths that are corrected for compression (appendix A). The depth corrections are used to adjust the core depths so that the lengths of the compressed intervals are restored to their uncompressed lengths. This is done by calculating the amount of compression (C_i) for each interval (i), calculating the amount of compression for each one centimeter depth increment in the interval being corrected, and adding the fractional proportion of compression to each depth increment. This procedure assumes that the compression is uniformly distributed throughout the interval. The corrected depths have the numerical effect of "stretching" the core to its uncompressed length.

The depth correction equation is given by:

$$D_c = P_{i-1} + (D_u - D_{u,i-1})(1+(C_i - C_{i-1})/(D_{u,i} - D_{u,i-1}))$$

where D_c = corrected depth

D_u = uncorrected depth

$C_i = I_i - O_i$ = compression of interval i

$P_i = O_0 - O_i$ = penetration of interval i

and the uncorrected depth of the lower boundary of the core for which corrections are being made is $D_{u,i} = P_i - C_i$.

Before applying the above equation, the appropriate interval (i) for D_u must be determined so that the proper values for compression and penetration are used to calculate the correction factor.

Core compression normally increases with depth, but it is not linear. In fact, the compression curve for each core is different (appendix A), and some cores are compressed more in the middle than at the top or the bottom. Although compression is not linear for the entire core, it is assumed to be linear over the interval being corrected. This assumption is necessary because we do not have any information that would permit a more accurate correction.

Table 2. Total compression and penetration of Trinity River cores and percent compression calculated for each interval.

Core Interval i	Outer Reading O_i (cm)	Inner Reading I_i (cm)	Total Compression C_i	Total Penetration P_i	Depth of Compressed Interval $(D_{u,i})$	Interval Compression %
			TR1X			
0	107.0	107.0	0.0	0.0	0.0	0.0
1	75.0	78.0	3.0	32.0	29.0	9.4
2	67.0	73.0	6.0	40.0	34.0	37.5
3	58.0	65.0	7.0	49.0	42.0	11.1
4	48.0	56.0	8.0	59.0	51.0	10.0
5	40.0	51.0	11.0	67.0	56.0	37.5
			TR2X			
0	107.0	107.0	0.0	0.0	0.0	0.0
1	82.0	83.0	1.0	25.0	24.0	4.0
2	74.0	75.0	1.0	33.0	32.0	0.0
3	60.0	63.0	3.0	47.0	44.0	14.3
4	57.0	60.0	3.0	50.0	47.0	0.0
			TR3			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	62.0	64.0	2.0	39.0	37.0	5.1
2	54.0	57.0	3.0	47.0	44.0	12.5
3	44.5	49.5	5.0	56.5	51.5	21.1
4	41.0	47.0	6.0	62.0	56.0	18.1
			TR4			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	46.0	49.0	3.0	55.0	52.0	5.5
2	36.0	42.0	6.0	65.0	59.0	30.0
3	23.0	29.0	6.0	78.0	72.0	0.0
			TR5X			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	63.0	64.0	1.0	38.0	37.0	2.6
2	51.0	52.0	1.0	50.0	49.0	0.0
3	45.0	46.0	1.0	56.0	55.0	0.0
4	39.5	40.5	1.0	61.5	60.5	0.0
5	37.0	38.0	1.0	64.0	63.0	0.0
6	25.5	29.0	3.5	75.5	72.0	21.7
7	18.0	22.0	4.0	83.0	79.0	6.7
			TR6			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	74.0	74.0	0.0	27.0	27.0	0.0
2	58.0	60.0	2.0	43.0	41.0	12.5
3	46.0	49.0	3.0	55.0	52.0	8.3
4	31.0	37.0	6.0	70.0	64.0	20.0

Table 2 (cont.)

Core Interval i	Outer Reading O_i (cm)	Inner Reading I_i (cm)	Total Compression C_i	Total Penetration P_i	Depth of Compressed Interval $(D_{u,i})$	Interval Compression %
			TR7			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	49.0	51.0	2.0	52.0	50.0	3.8
2	40.0	42.0	2.0	61.0	59.0	0.0
3	31.0	36.0	5.0	70.0	65.0	33.3
4	30.0	35.0	5.0	71.0	66.0	0.0
			TR8			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	55.0	55.0	0.0	46.0	46.0	0.0
2	35.0	36.5	1.5	66.0	64.5	7.5
3	31.0	33.0	2.0	70.0	68.0	12.5
4	24.0	28.0	4.0	77.0	73.0	28.6
			TR9X			
0	107.0	107.0	0.0	0.0	0.0	0.0
1	73.0	76.0	3.0	34.0	31.0	8.8
2	68.0	72.0	4.0	39.0	35.0	20.0
3	59.5	65.0	5.5	47.5	42.0	17.6
4	50.5	57.0	6.5	56.5	50.0	11.1
5	40.0	48.0	8.0	67.0	59.0	14.3
6	30.0	39.0	9.0	77.0	68.0	10.0
			TR10			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	69.0	70.0	1.0	32.0	31.0	3.1
2	55.0	60.0	5.0	46.0	41.0	28.6
3	44.0	52.0	8.0	57.0	49.0	27.3
4	34.0	46.0	12.0	67.0	55.0	40.0
5	27.0	40.0	13.0	74.0	61.0	14.3
			TR11			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	75.5	76.0	0.5	25.5	25.0	2.0
2	53.0	55.0	2.0	48.0	46.0	6.7
3	41.0	45.0	4.0	60.0	56.0	16.7
4	39.0	44.0	5.0	62.0	57.0	50.0
5	34.5	40.0	5.5	67.5	62.0	9.1
6	30.0	35.5	5.5	72.0	66.5	0.0
			TR12			
0	101.0	101.0	0.0	0.0	0.0	0.0
1	79.0	80.0	1.0	22.0	21.0	4.5
2	59.0	60.0	1.0	42.0	41.0	0.0
3	45.0	48.0	3.0	56.0	53.0	14.3
4	38.0	42.0	4.0	63.0	59.0	14.3
5	35.0	41.0	6.0	66.0	60.0	66.7
6	28.0	34.0	6.0	73.0	67.0	0.0

All cores from the Trinity River underwent some compression, and most of the cores are compressed from 4 to 6 cm (table 2 and appendix A). Core 2X is the least compressed (3 cm), whereas core 10 is the most compressed (13 cm). Core lengths estimated from the compression and penetration measurements generally agree within 1 cm of the actual core length. Larger discrepancies between the depth of penetration and the length of core recovered at sites 2X and 9X suggest that some of the sediment dropped out of the end of the core barrel as it was being retrieved.

Laboratory Methods

Core Preparation and Handling

Cores were split in half by first cutting horizontally down each side of the metal tube and then by cutting the core in half with a thin wire. The top section of each core was cut with a fine-toothed band saw to limit disturbance of the root-matted zone. The two half cores were then separated, each half retained in the half tube. One half of the core was wrapped in plastic wrap and sealed in an air-tight clear plastic liner. This half of the core was transported to the USGS laboratory in Denver for x-radiography and analysis of ^{210}Pb activity, moisture content, loss-on-ignition, and bulk density.

The other halves of the cores were archived and retained in the BEG Core Research Center, where they were subsampled for physical and chemical analysis. Immediately after the cores were split, a measured volume of material was collected from near the top, middle, and bottom of each core for analysis of moisture content, total organic carbon (TOC), and bulk density.

Each half core was trimmed with an osmotic knife and physically described. Information recorded on core description sheets included core depth, sediment color, sediment type (visual description), nature of contacts, textural trends, sedimentary structures, state of oxidation, and presence of accessories (organic material). The cores were then photographed to produce large-format color prints and 35 mm slides.

After preliminary results of ^{210}Pb activity for cores TR-4, TR-11, and TR-12 were obtained, these cores were subsampled at various horizons (based on ^{210}Pb distribution) for textural and geochemical analysis. When not in use, the half cores were covered with plastic wrap, placed in labeled boxes, and stored in a climate-controlled room. The archived core half serves as a permanent record of the sediment types encountered and the types of material sampled for textural and geochemical analyses.

Analytical Methods

^{210}Pb Analysis (USGS). Isotopic analysis of cores (appendix B) was completed by Dr. Charles Holmes of the U.S. Geological Survey using procedures developed by the USGS (Holmes and Martin, 1976). The specific activity of ^{210}Pb was measured indirectly by determining the activity of the granddaughter isotope ^{210}Po. Samples were analyzed at 1-cm-intervals along the entire core or to the depth where activity levels were constant, indicating that background levels had been reached. Logarithmic plots of excess ^{210}Pb activity against depth were used to determine variations in sedimentation rates.

Moisture Content, Organic Matter, and Mineral Matter (USGS). Samples collected at 1-cm intervals along the core were dried at a temperature of 60° C for 24 hr and reweighed to determine moisture content. The samples were then reheated to 450° C for 12 hr to determine organic matter as estimated from weight loss-on-ignition (LOI). The remaining sediment was assumed to be mineral matter, and its percent by weight was determined. Water content, LOI, and mineral matter data are presented in appendix B. It was assumed that sediments in the cores were carbonate free, but two cores (TR-1 and TR-6) contain minor concentrations of carbonates in the form of caliche nodules in the lower half of the core. Abnormally high LOI values near the base of core TR-6 (appendix B) are apparently caused by losses other than organic matter and may be related to the presence of carbonates.

Bulk Density (BEG). A measured volume of material was obtained by subsampling each half core with a cork borer of known diameter and measuring the thickness of the core. Three subsamples were taken from each core near the top, middle, and bottom. The subsamples were placed in pre-weighed containers and weighed to determine total weight, then dried at 105° C to constant weight. From these data dry bulk density and moisture content were determined (appendix C).

Organic Carbon (BEG). The samples collected for bulk density measurements were also used to measure organic carbon. Additional organic carbon samples were collected at selected horizons in three other cores (appendix C). The dried solids were pulverized in a diamonite mortar and pestle and analyzed for total carbon content using a coulometric carbon analyzer (950° C, pure oxygen atmosphere, standard scrubbers, approximately 50 mg sample size, blank corrected). In the absence of carbonates, the recovered carbon is assumed to be all organic carbon. Core TR-6 contained caliche nodules in two zones in the lower half of the core, but three subsamples taken for carbon analysis apparently missed the carbonate zones. Results of the carbon analysis were not abnormally high.

Textural Analysis (BEG). Samples were taken at specified 1- to 2-cm intervals along selected cores for analyses of percent sand, silt, and clay (appendix C). Disaggregated samples were wet sieved to separate particles larger than sand size (gross organics), sand, and mud (silt and clay). After the large particles were removed, sand was separated with a 230 mesh (62.5-micron) sieve. Sand percent was determined after treating the sample with hydrogen peroxide to remove remaining organics. Percent silt and clay were determined using pipette measurements.

RESULTS

Results of the ^{210}Pb activity (dpm/g) are presented in appendix B along with measurements of water content, LOI, and mineral matter. Analyses were completed at 1-cm intervals; relative comparisons of constituents in a core can be made on a percentage basis for each centimeter. Unfortunately, because of the interference of plant roots and other large organics, the volume of material sampled at each centimeter could not be determined with certainty, so volumetric data and bulk densities for each sample cannot be presented. Bulk densities (appendix C) for 36 samples (3 per core) with measured volumes were determined from BEG analysis. These samples were taken from the top, middle, and bottom of each of the 12 cores.

Excess ^{210}Pb Activity Profiles

Excess ^{210}Pb activity (unsupported ^{210}Pb) was determined for each sample by subtracting background activity (supported ^{210}Pb) from total ^{210}Pb activity. Geochemists at the U.S. Geological Survey (Dr. Charles Holmes) determined background activities. Because background levels were not reached in most cores, the value 0.492 dpm/g, which is the average of the lowest eight activities in core TR-4, was used as background for all cores but TR-4 and TR-5X. For core TR-4, 0.45 dpm/g was used because it is the lowest single value in the core; using 0.492 dpm/g would have resulted in a negative activity for this sample. For TR-5X, which was the last core analyzed, the average of the three lowest activities is 0.43 dpm/g. However, the minimum activity in samples from this core is 0.32 dpm/g. Accordingly, 0.3 dpm/g was used as background for TR-5X to avoid negative activities.

Because the objective of this investigation was to determine sedimentation rates based on excess ^{210}Pb activity, emphasis is placed on ^{210}Pb results. Accordingly, results of other physical and chemical analysis are discussed only in terms of their influence on the distribution of ^{210}Pb activity within a core. Excess ^{210}Pb activity profiles were completed for each core and examined carefully to determine trends and probable causes of variations in trends.

Variations in ^{210}Pb and Probable Causes

Plots of ^{210}Pb activity against depth indicate substantial scatter and local variations from linear trends for many of the cores. Pronounced variations in slope of the plots should define variations in sedimentation rates, which can be correlated with sediment deposition by the Trinity River. But many variations in excess ^{210}Pb activity involving individual samples or a few samples are not fully understood. Some are apparently related to bioturbation, textural and organic properties, presence of carbonates, and other changes in sediment chemistry.

Bioturbation. The relatively uniform ^{210}Pb activity in the surface layers (top 3 to 6 cm) of most cores (see fig. 14) indicates a zone of bioturbation and mixing of sediments (fig. 5, Nittrouer and others, 1979). Cores where the surficial bioturbation zone is obvious include TR-1X, 2X, 3, 5X, 6, and 7. In others, the trend is not as well defined, but in all cores but TR-4, the relatively low activities in the top 1 or 2 cm indicate that these shallow samples should not be included in slope calculations.

Texture. Textural variations can influence excess ^{210}Pb activity (fig. 6). Activity levels are higher in finer sediments, apparently because Pb, like many other metals, is sequestered by fine-grained particles such as clay minerals, organic matter, and Fe-Mn oxides (Nittrouer and others, 1979). However, sediments in cores taken in this study are relatively homogeneous and fine grained (mud). Sand is a minor constituent overall. Only in two cores was sand abundant enough to be visually described, and in those cores the sand was concentrated in thin layers. Statistical correlation of ^{210}Pb activity with sediment textures (sand, silt, clay, or mud) shows very weak to no association (figs. 7 and 8). Where sand was concentrated in thin layers, however, there was a decrease in the ^{210}Pb activity (fig. 9).

Organics (Weight Loss-On-Ignition). The association between ^{210}Pb activity and organic content based on weight loss-on-ignition (LOI) varied from core to core, but overall there was a positive correlation, and the square of the correlation coefficient (R^2) ranged from 0.7 to 0.9 in 60 percent of the cores. Core TR-5X had the highest positive correlation (R^2 = 0.910, fig. 10), and TR-4 the lowest (R^2 = 0.154, fig. 11). Even though the correlation between ^{210}Pb and organics may be low overall, local variations in ^{210}Pb activity may be caused by variations in the concentration of organics (LOI) (fig. 12).

Calcium Carbonate (Caliche Nodules). Caliche nodules had the largest influence on ^{210}Pb activity. Fortunately, large nodules (1–2 cm in diameter) were found in only one core, TR-6. Small carbonate particles (< 0.5 cm in diameter) were found near the bottom of core

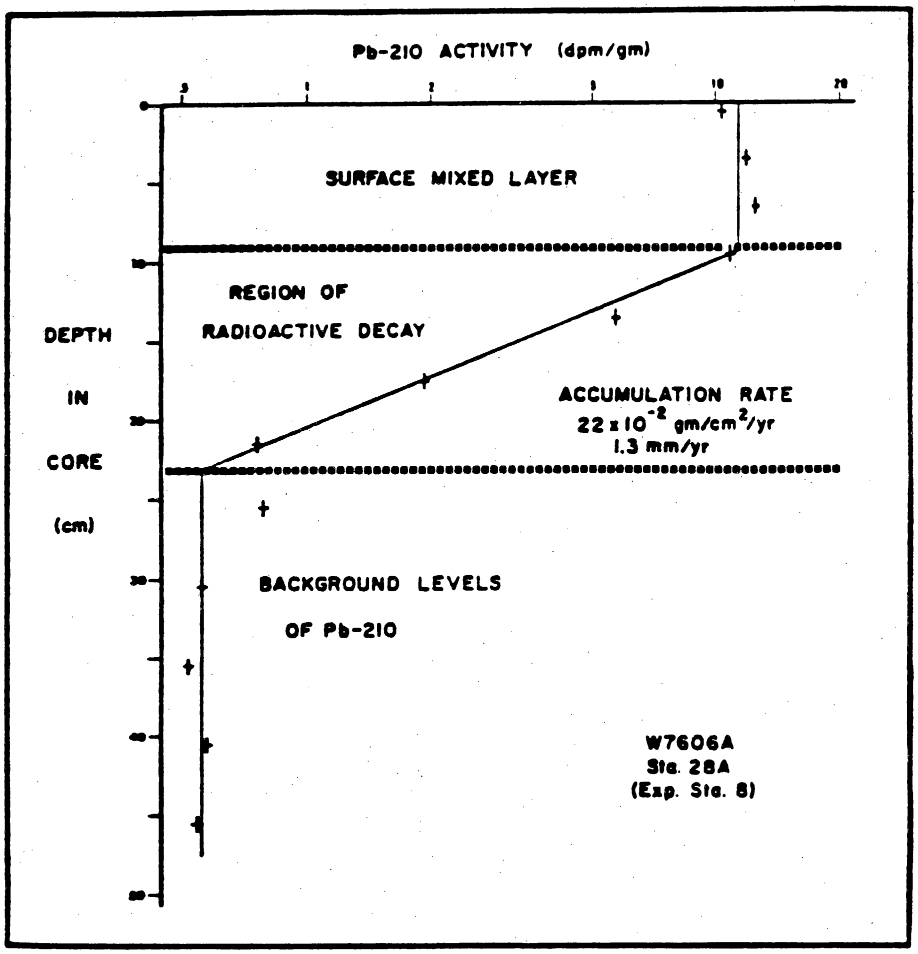


Figure 5. Profile of ^{210}Pb activity for a sediment core from the Washington continental shelf illustrating the mixed surface layer. Bioturbation in marsh surface layers can produce similar "flat" activities. From Nittrouer and others (1979).

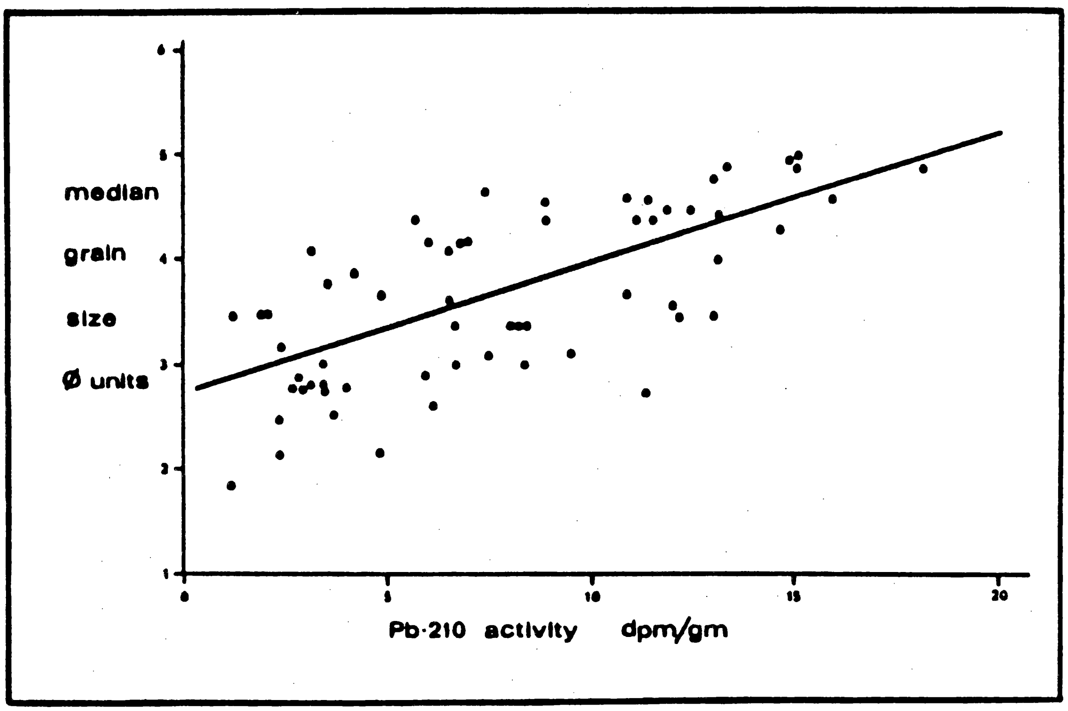


Figure 6. Relationship between grain size and initial ^{210}Pb activity. From Nittrouer and others (1979).

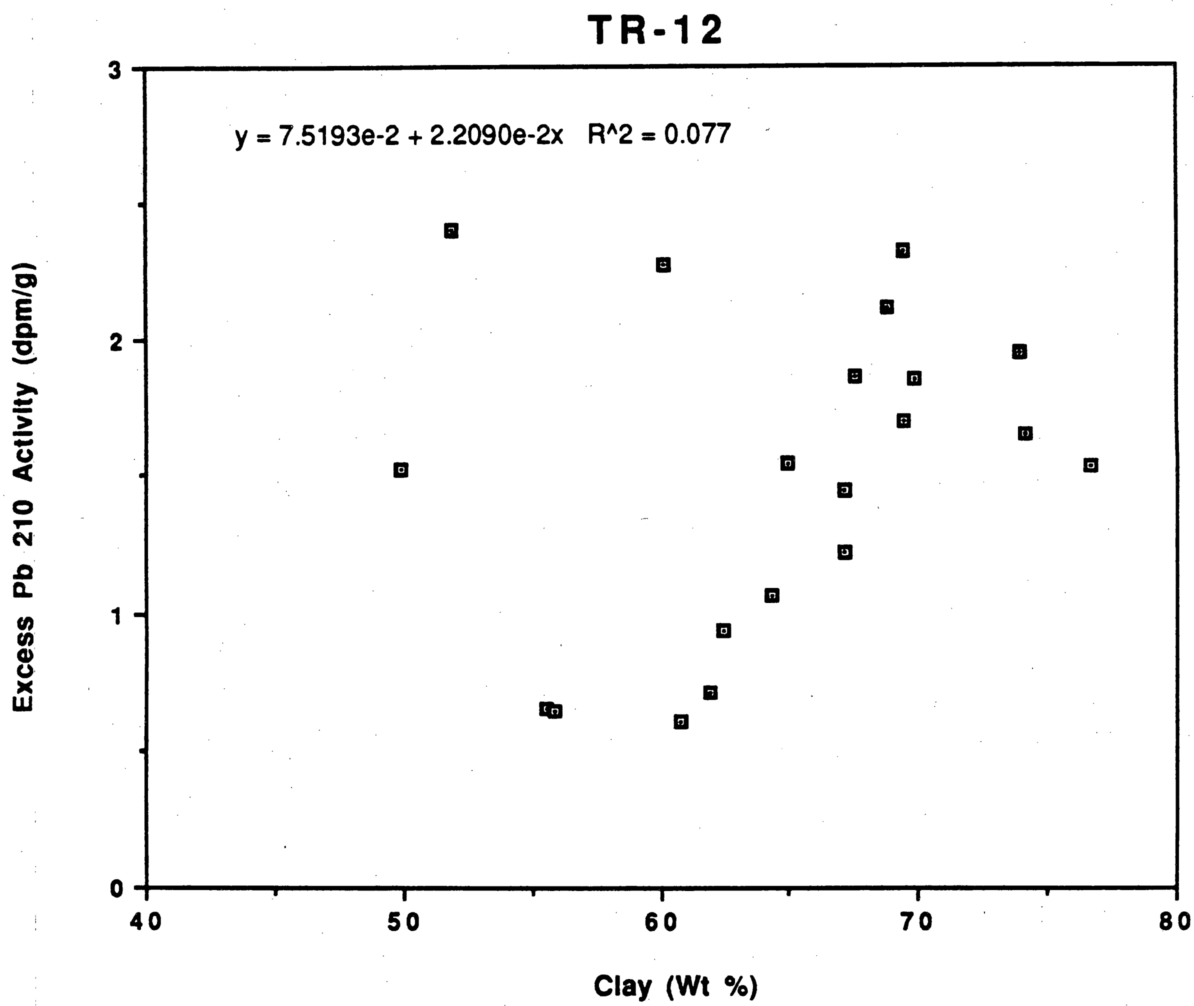


Figure 7. Relationship between clay percent and excess ^{210}Pb activity in core TR-12.

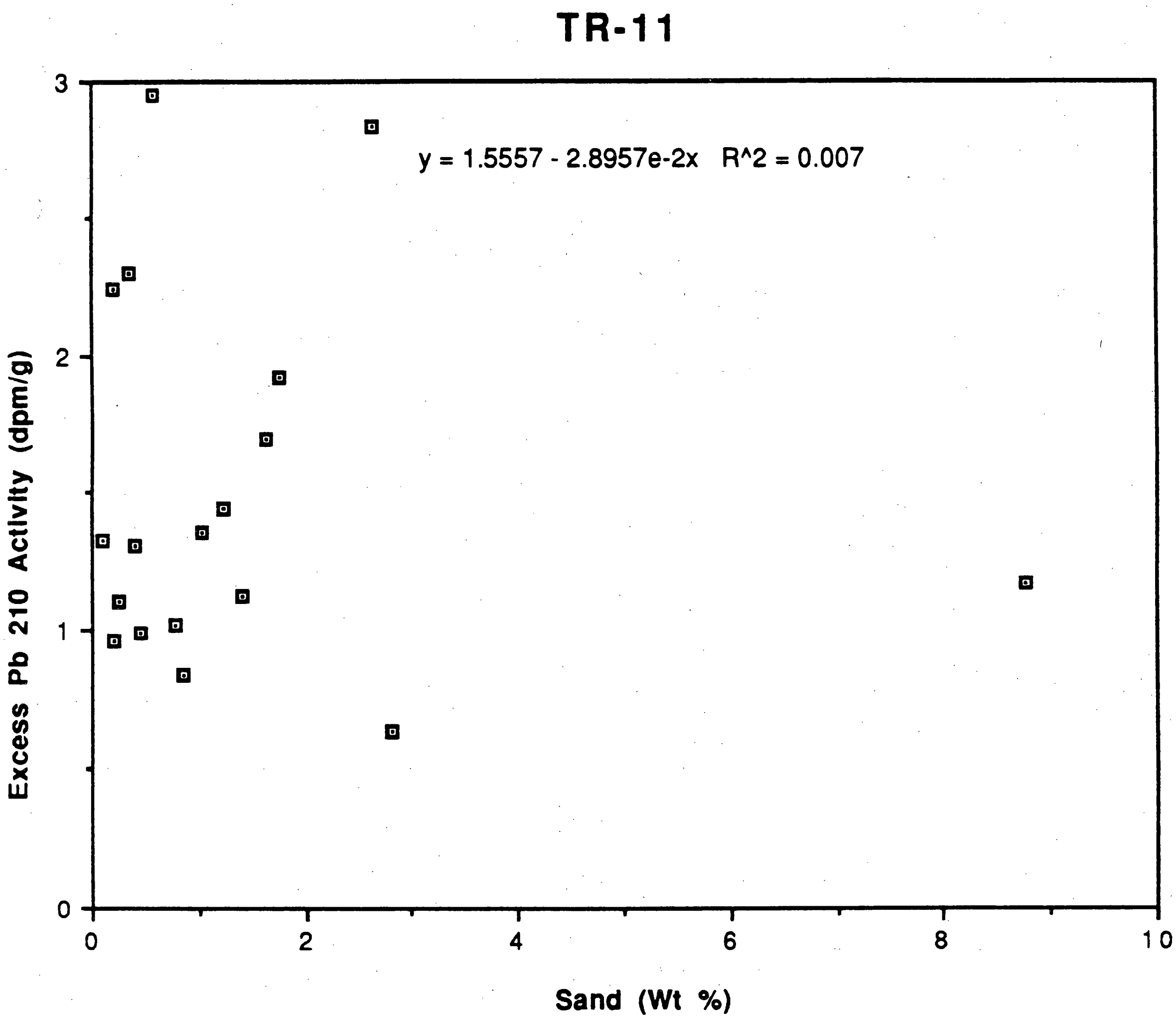


Figure 8. Relationship between sand percent and excess ^{210}Pb activity in core TR-11.

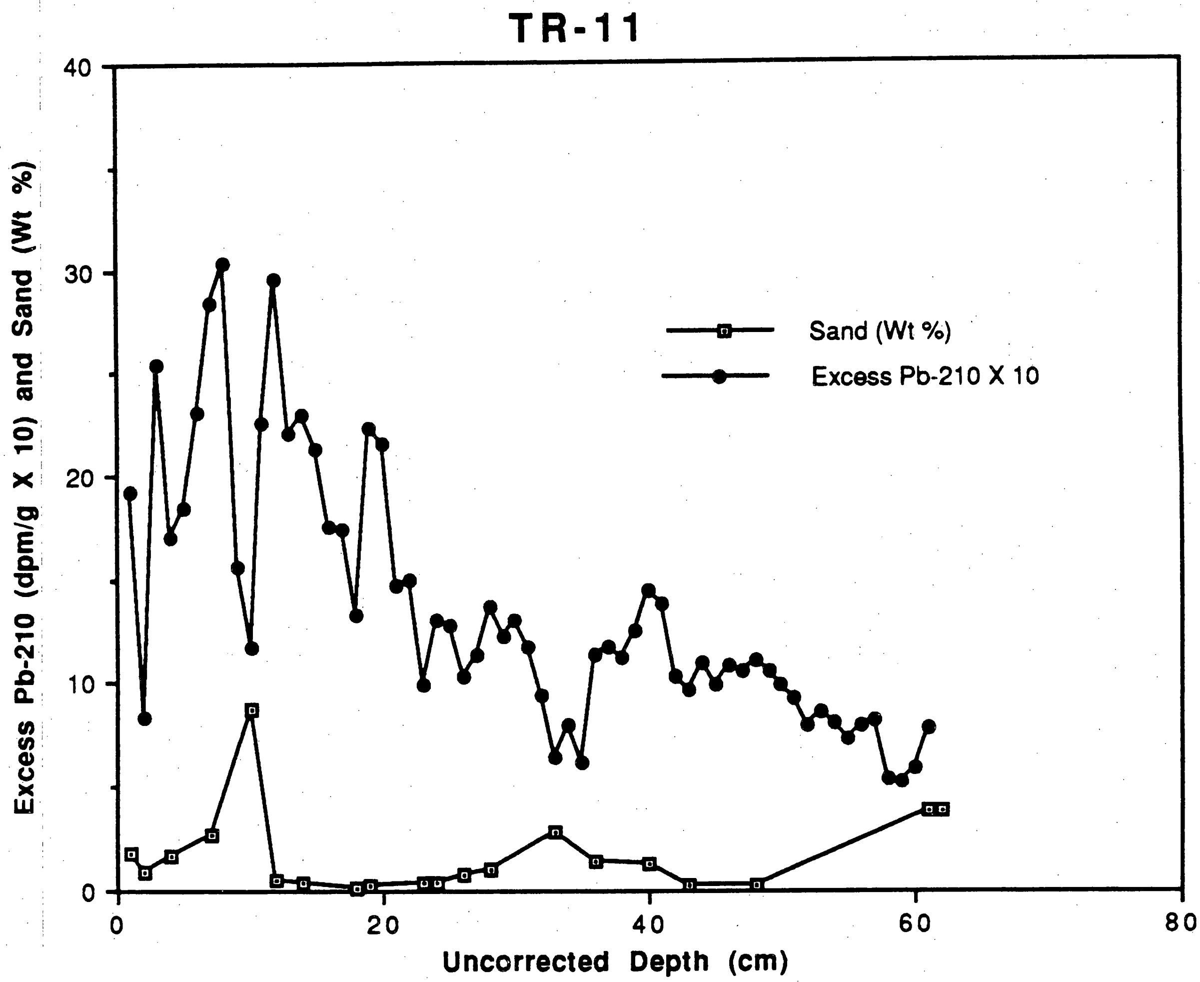


Figure 9. Depth plot of sand percent and excess ^{210}Pb activity for core TR-11. Note downward deflections in ^{210}Pb activity profile at 10 and 32 cm where sand percentage increases.

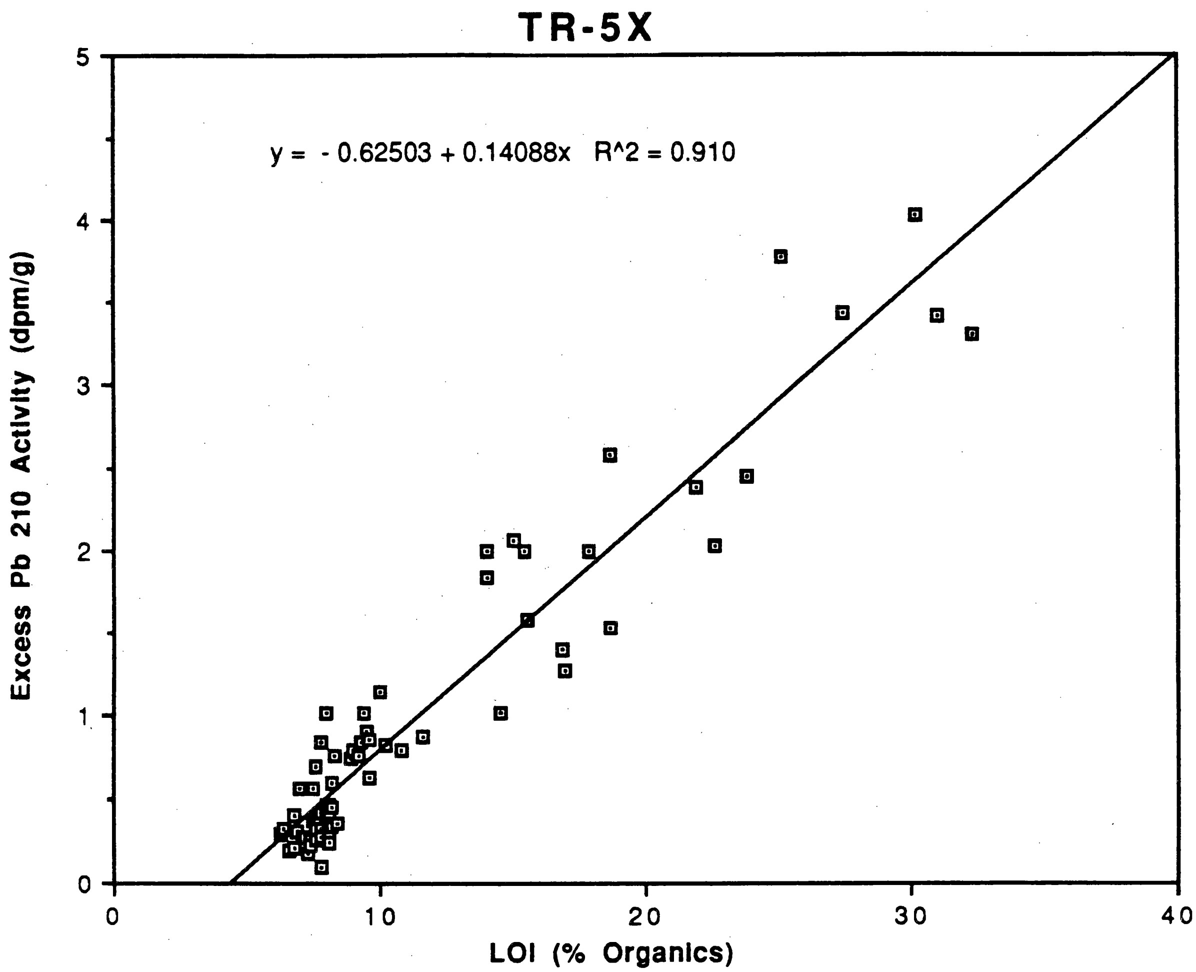


Figure 10. Relationship between excess ^{210}Pb activity and percent organic matter (weight loss-on-ignition, LOI) for core TR-5X.

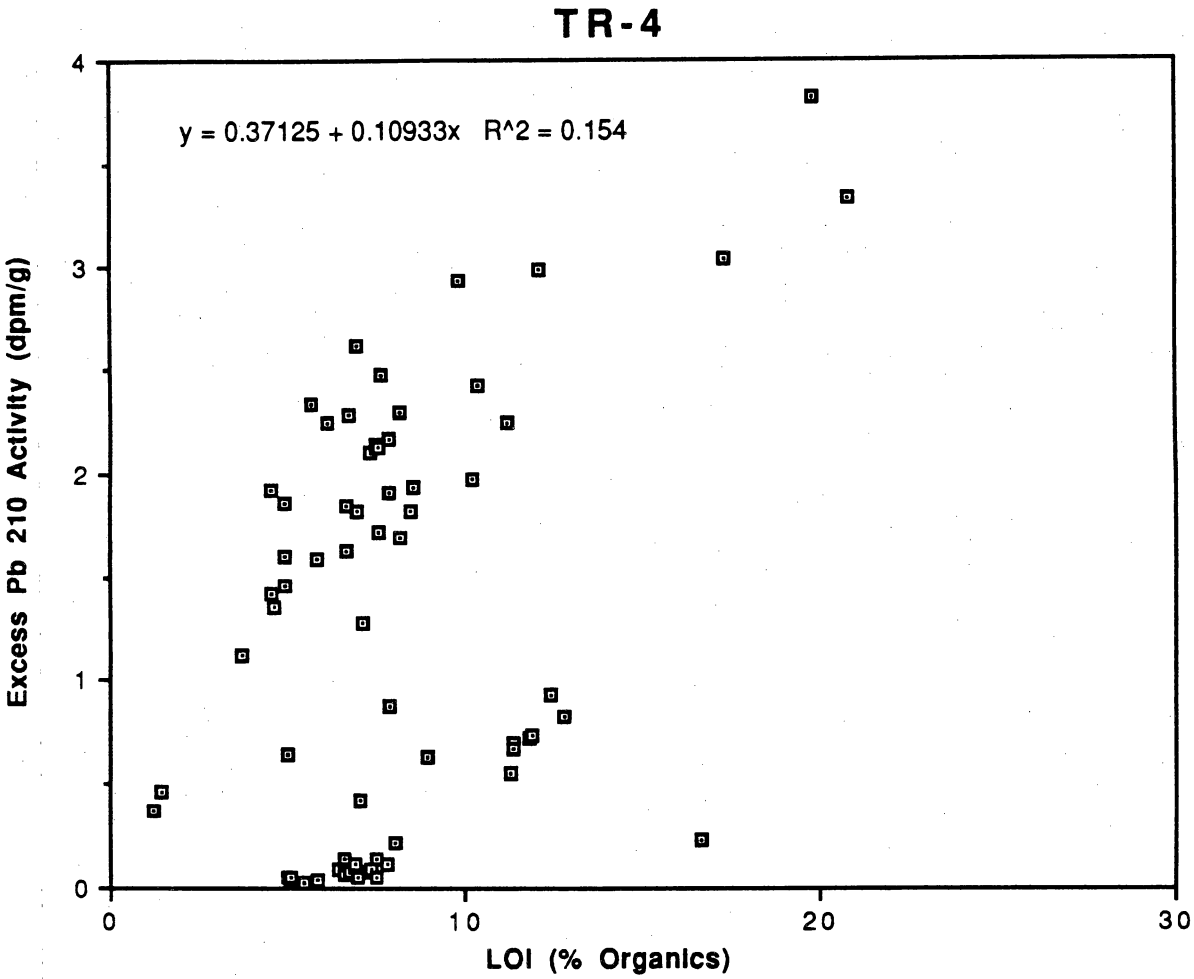


Figure 11. Relationship between excess ^{210}Pb activity and percent organic matter (weight loss-on-ignition, LOI) for core TR-4.

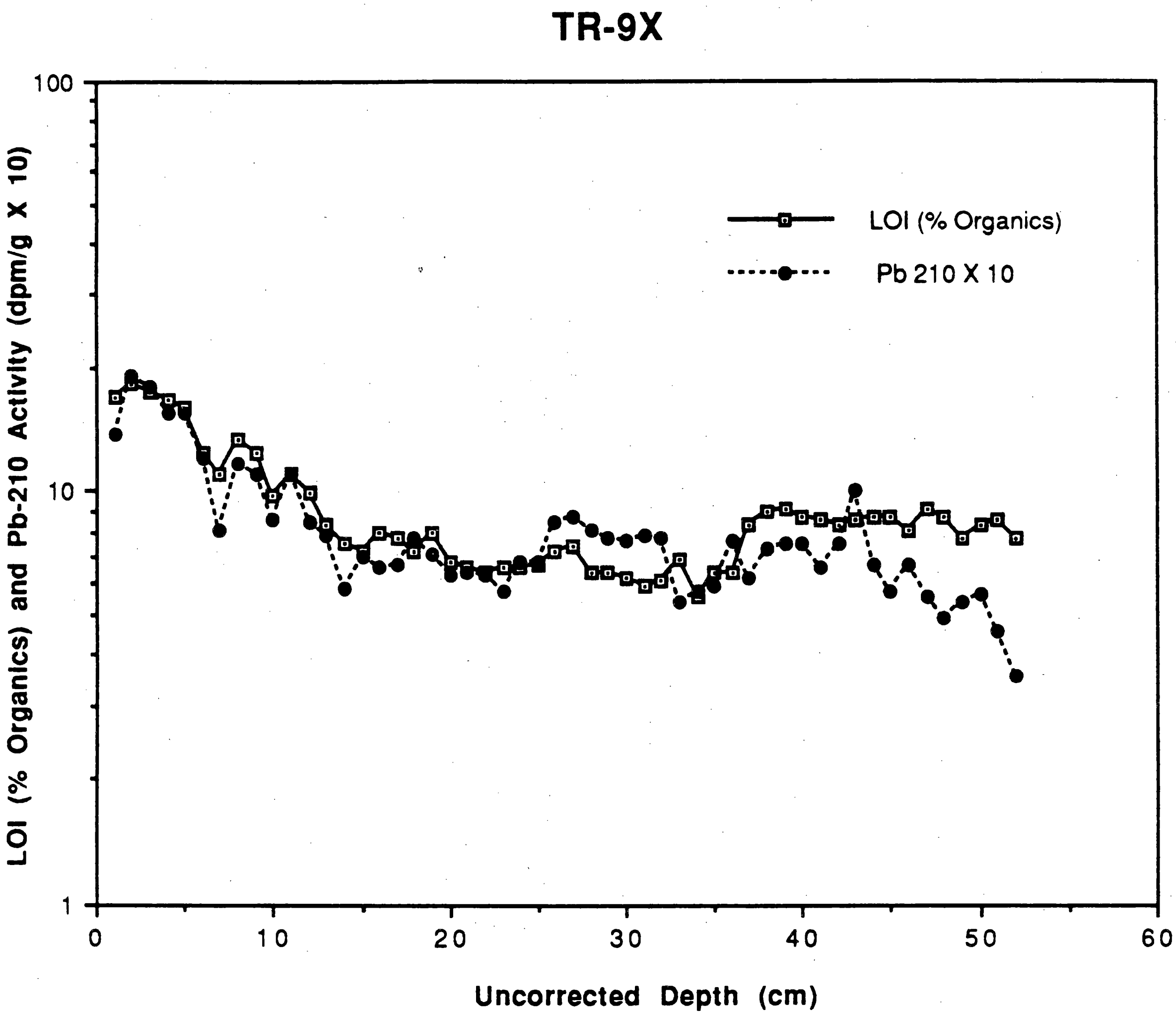


Figure 12. Relationship between organic matter (LOI) and ^{210}Pb activity profiles in core TR-9X. R^2 for ^{210}Pb and LOI for this core is only 0.771, but there is a relatively close relationship between the two profiles in some parts of the core.

TR-1X. Analysis of nodules from TR-6 indicated that they are "hot spots" where ^{210}Pb activity is substantially higher than in surrounding sediments (Charles Holmes, personal communication).

Visible Physical and Chemical Variations. In several instances, changes in ^{210}Pb activity correspond to visible changes in the cores, for example, color changes at boundaries between oxidized and reduced zones. This relationship suggest that changes in activity may be related to physical or chemical variations in the core.

Accuracy of Analysis at Low ^{210}Pb Concentrations. Fluctuations in ^{210}Pb activity in the lower part of a core may be a result of low concentrations of ^{210}Pb as background levels are approached. According to Charles Holmes (USGS), the analytical variance (error bar) for samples with activities below approximately 0.5 disintegrations per minute per gram (dpm/g) is larger than for samples with higher concentrations. Therefore, some of the sample-to-sample variations are simply related to counting errors.

Annotated Plots of Probable Causes of Variance in ^{210}Pb Activity

Plots of excess ^{210}Pb activity against depth (figs. 13 through 24) are annotated to indicate probable causes of local variations in excess ^{210}Pb activity. The plots were compared with the actual cores, core descriptions, x-radiographs, organic matter (LOI), and textural properties in an effort to explain some of the variations in ^{210}Pb activity. Note that depths used in these illustrations are actual core depths and are not corrected for compression.

Relative Sea-Level Rise

Relative sea-level rise as used here is the relative vertical rise in water level with respect to the land surface, whether it is caused by a rise in mean water level or subsidence of the land surface. In the Trinity River delta and alluvial valley, both processes are part of the relative sea-level rise equation. Subsidence, especially associated with pumpage of ground water and oil and gas, is the overriding component.

Long-term tide-gauge records and benchmark releveling surveys provide data for determining relative sea-level rise. The nearest tide gauge with a long-term record is at Galveston. More site specific data for the study area are available from benchmark releveling surveys, which include benchmarks located along IH-10 across the Trinity River valley. Both sets of data are useful in determining the components of relative sea-level rise.

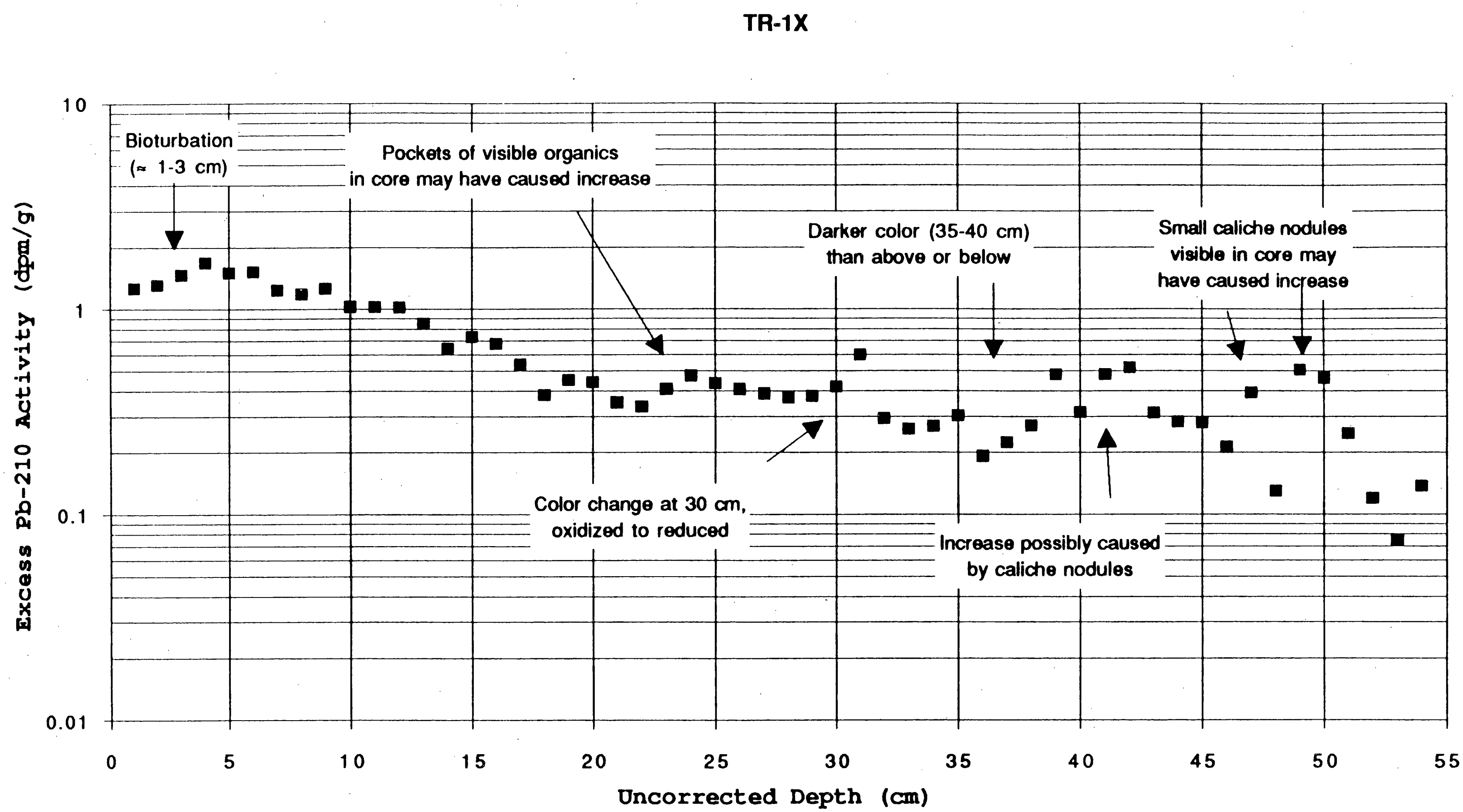


Figure 13. Core TR-1X annotated profile.

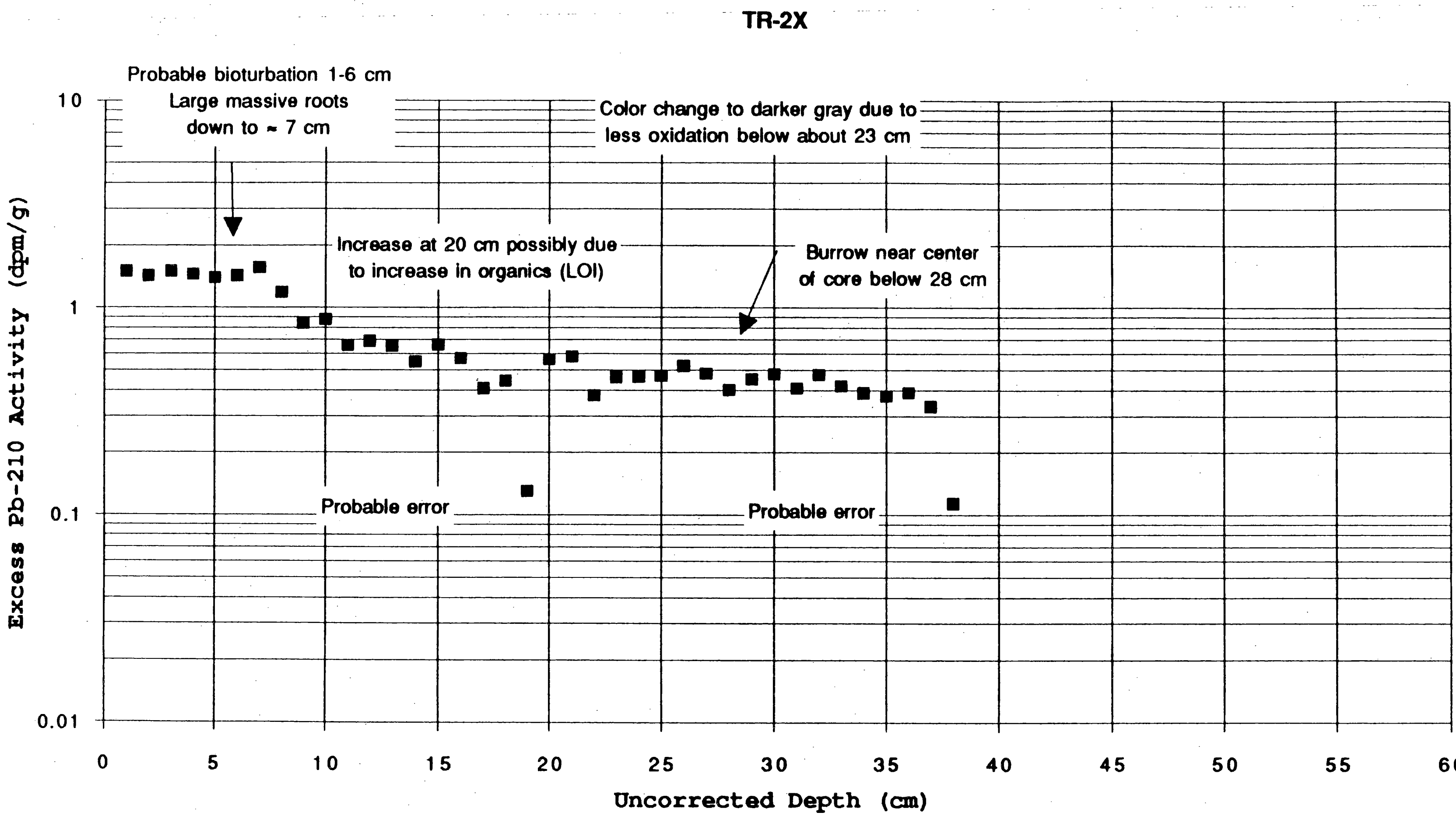


Figure 14. Core TR-2X annotated profile.

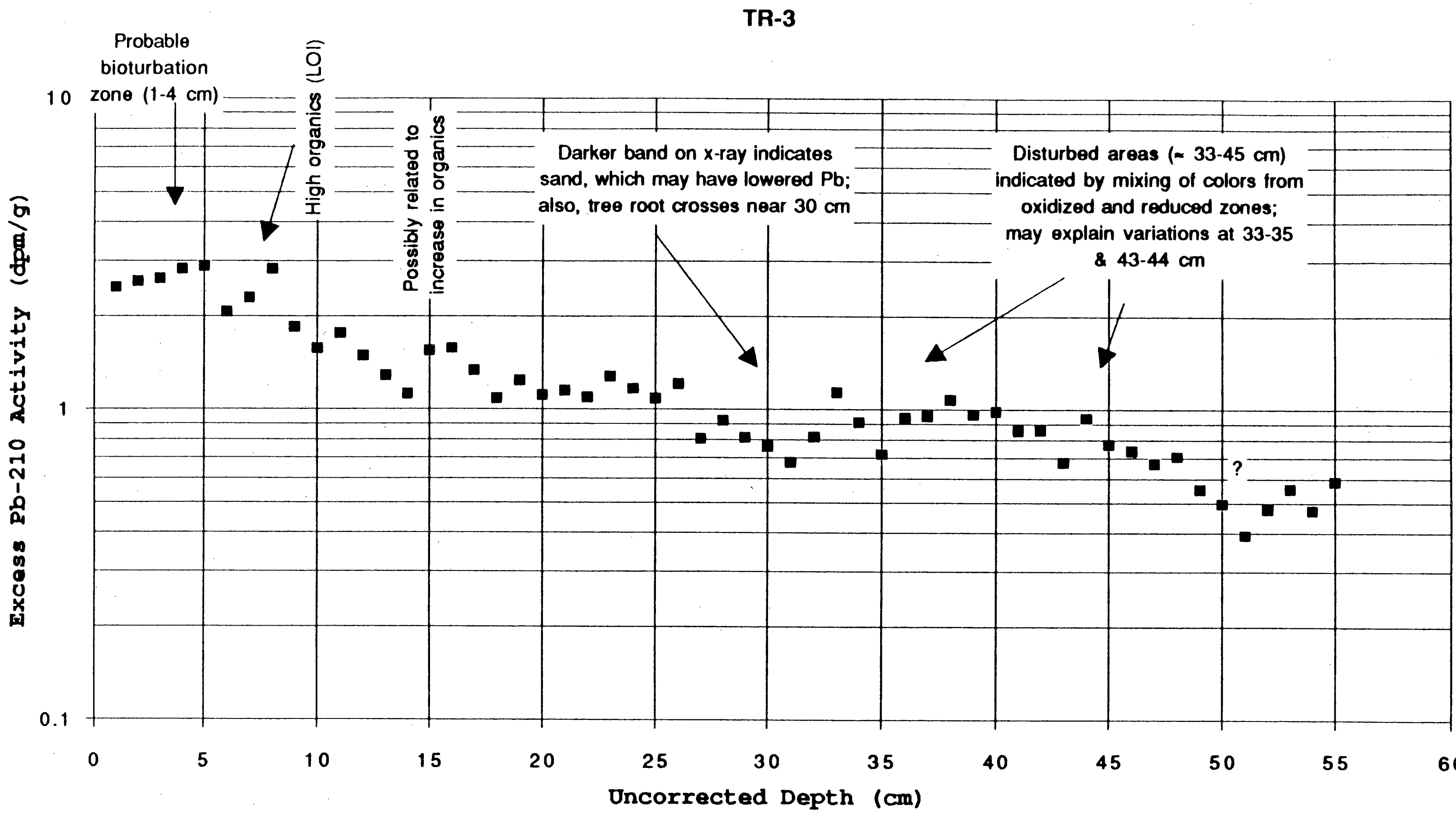


Figure 15. Core TR-3 annotated profile.

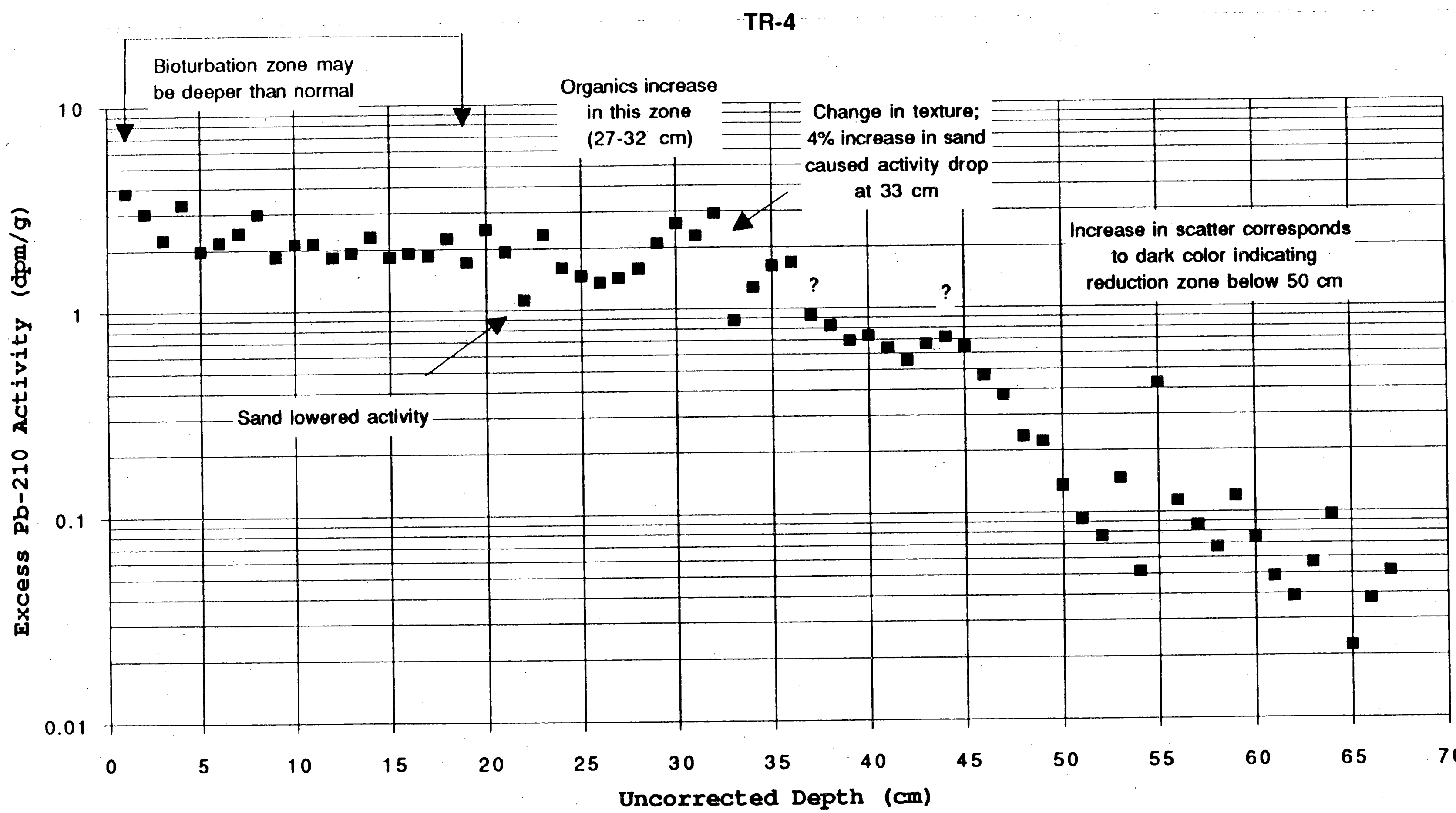


Figure 16. Core TR-4 annotated profile.

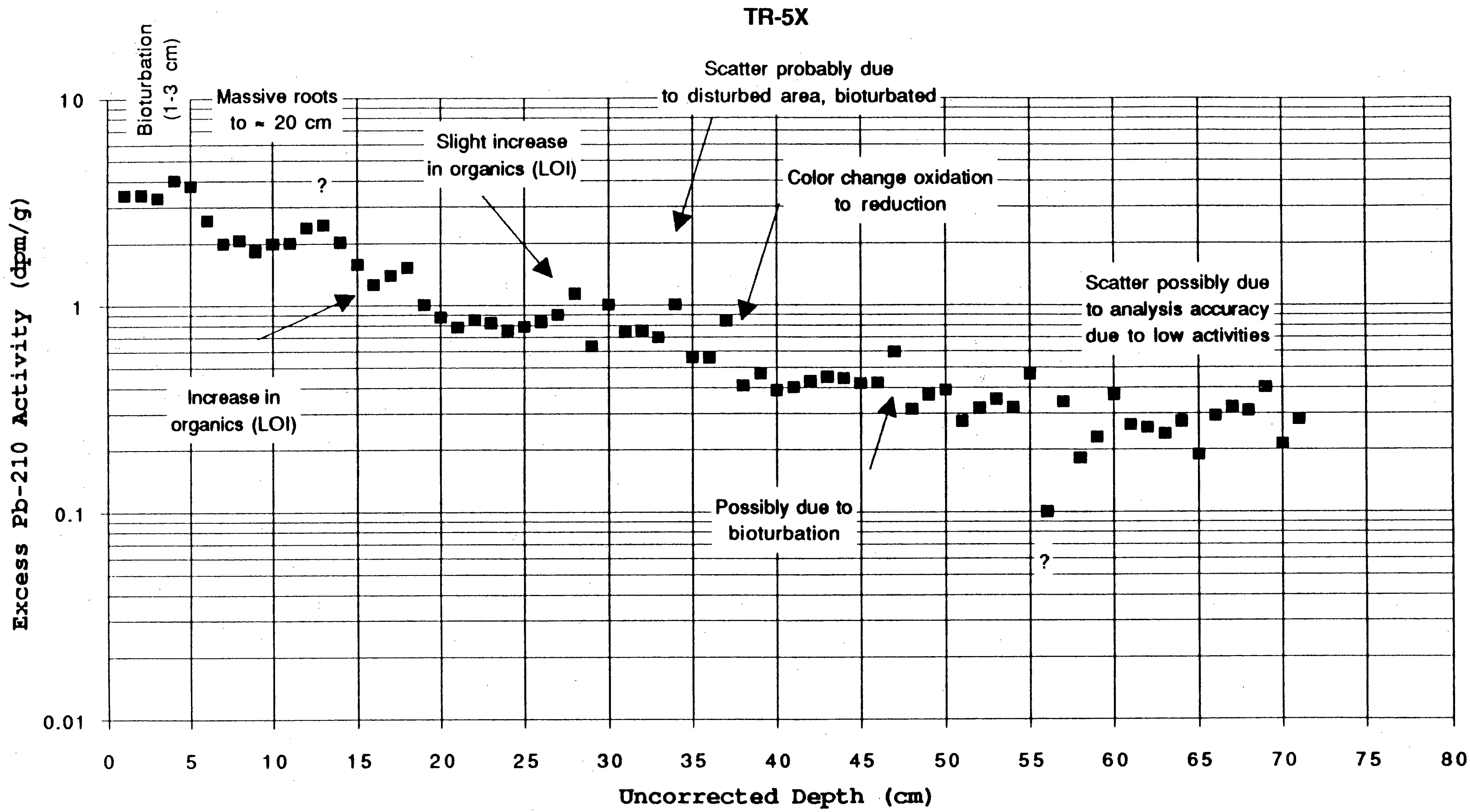


Figure 17. Core TR-5X annotated profile.

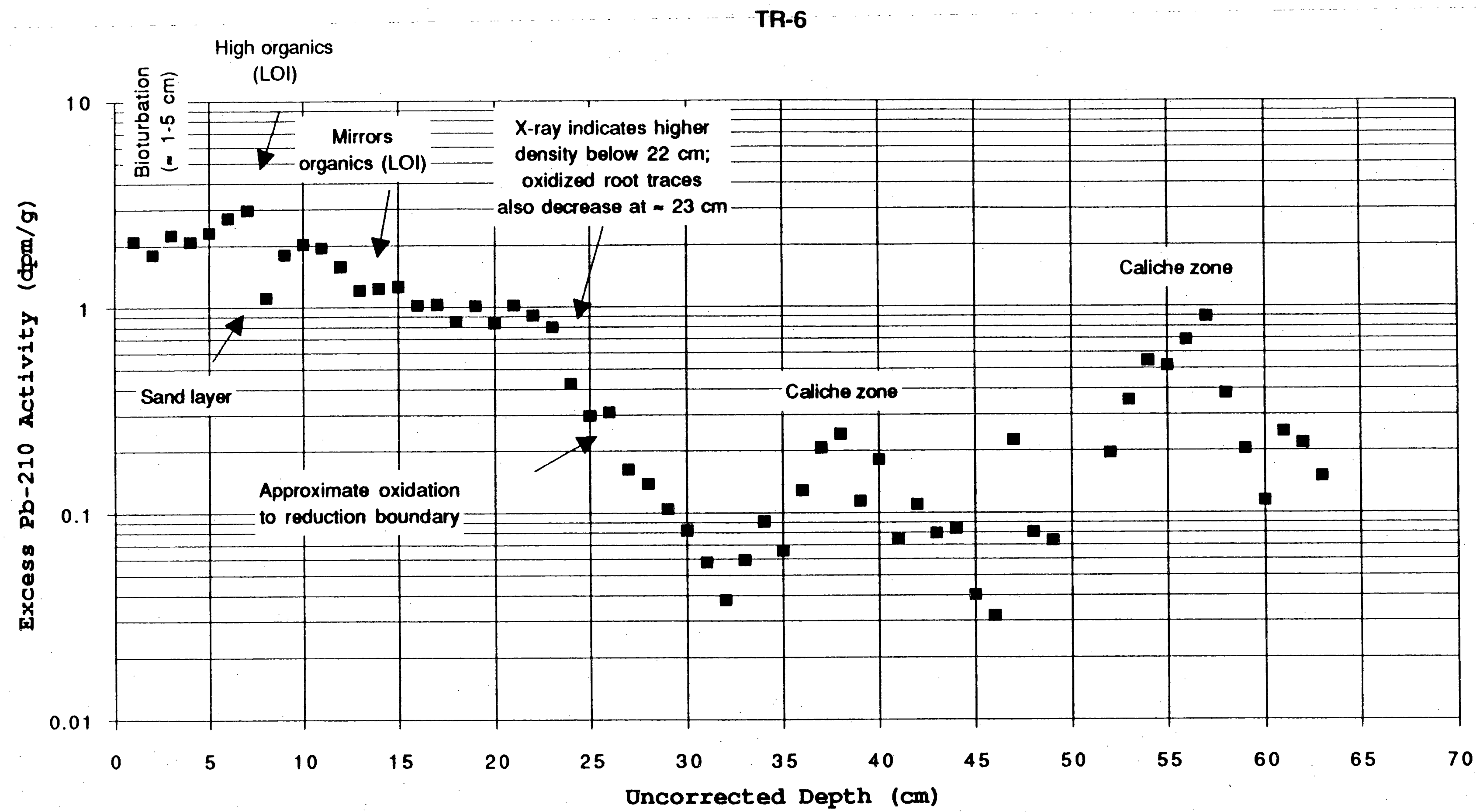


Figure 18. Core TR-6 annotated profile.

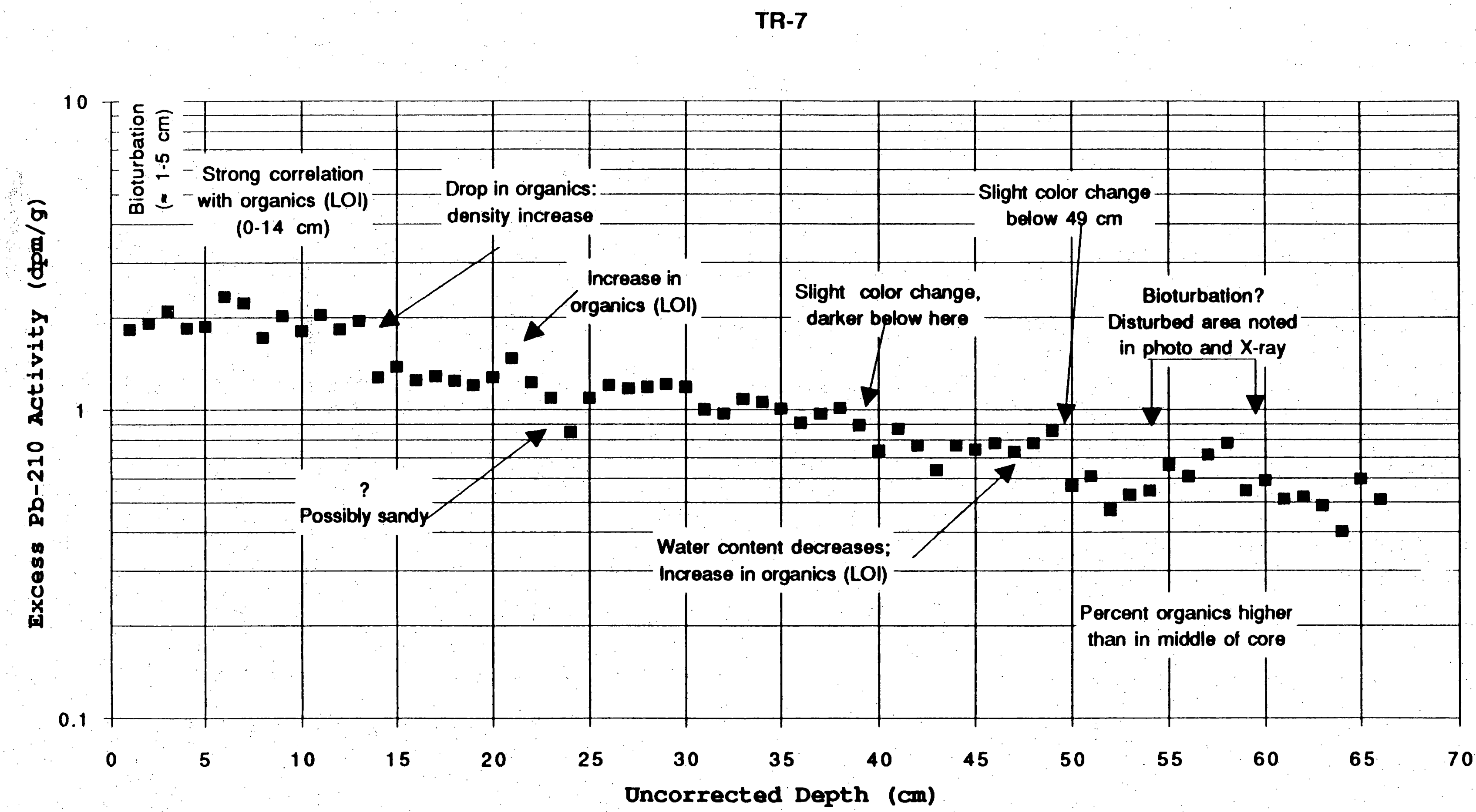


Figure 19. Core TR-7 annotated profile.

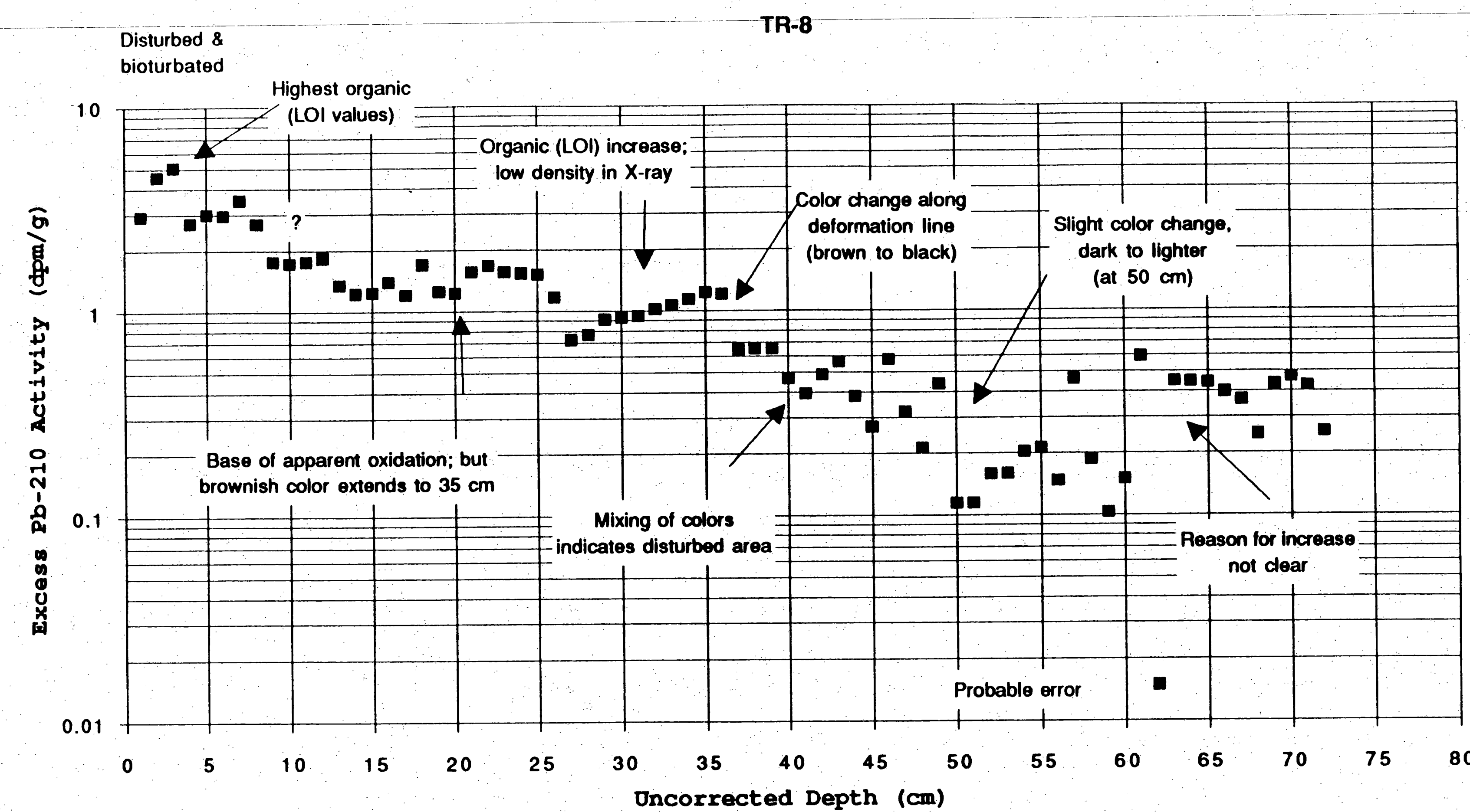


Figure 20. Core TR-8 annotated profile.

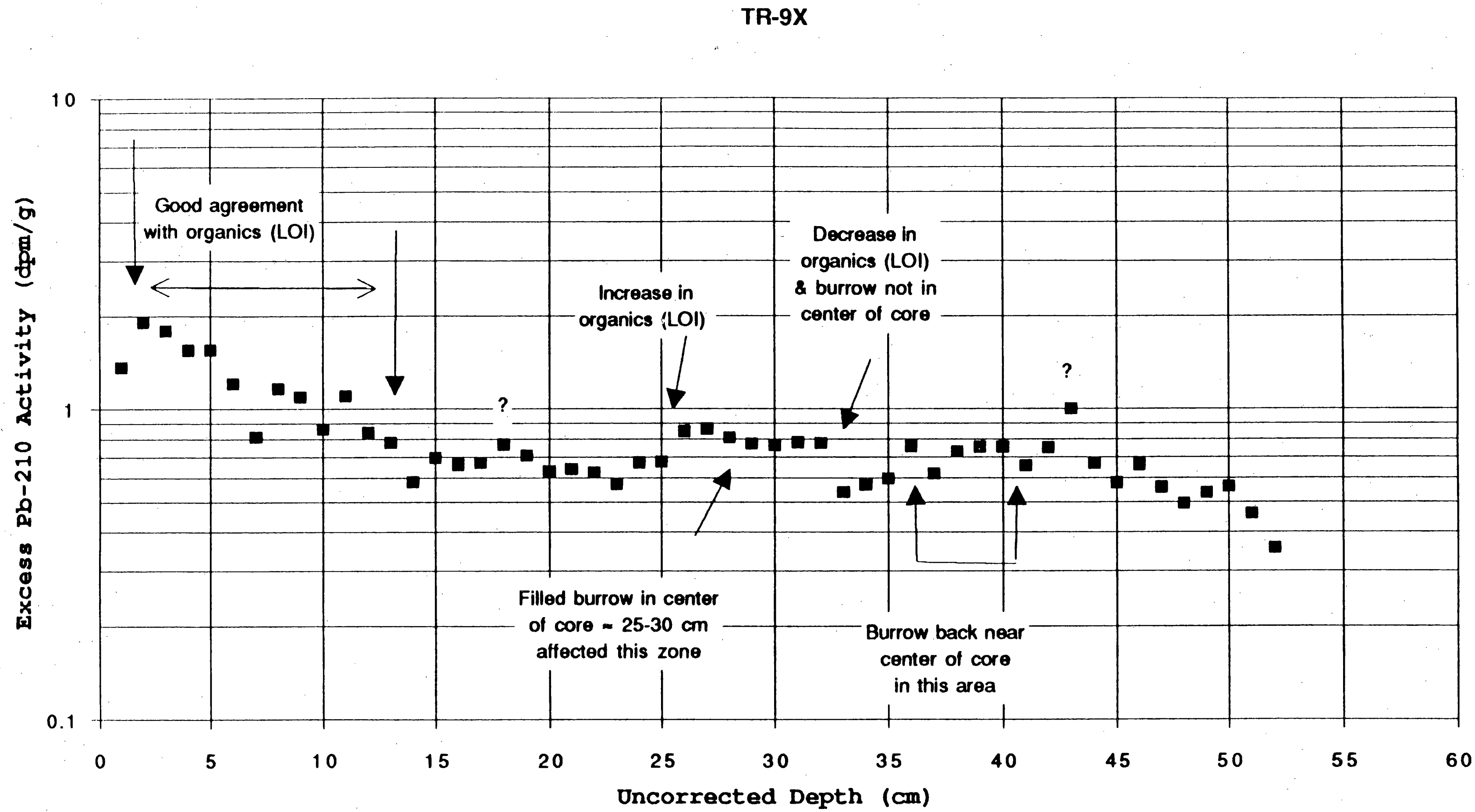


Figure 21. Core TR-9X annotated profile.

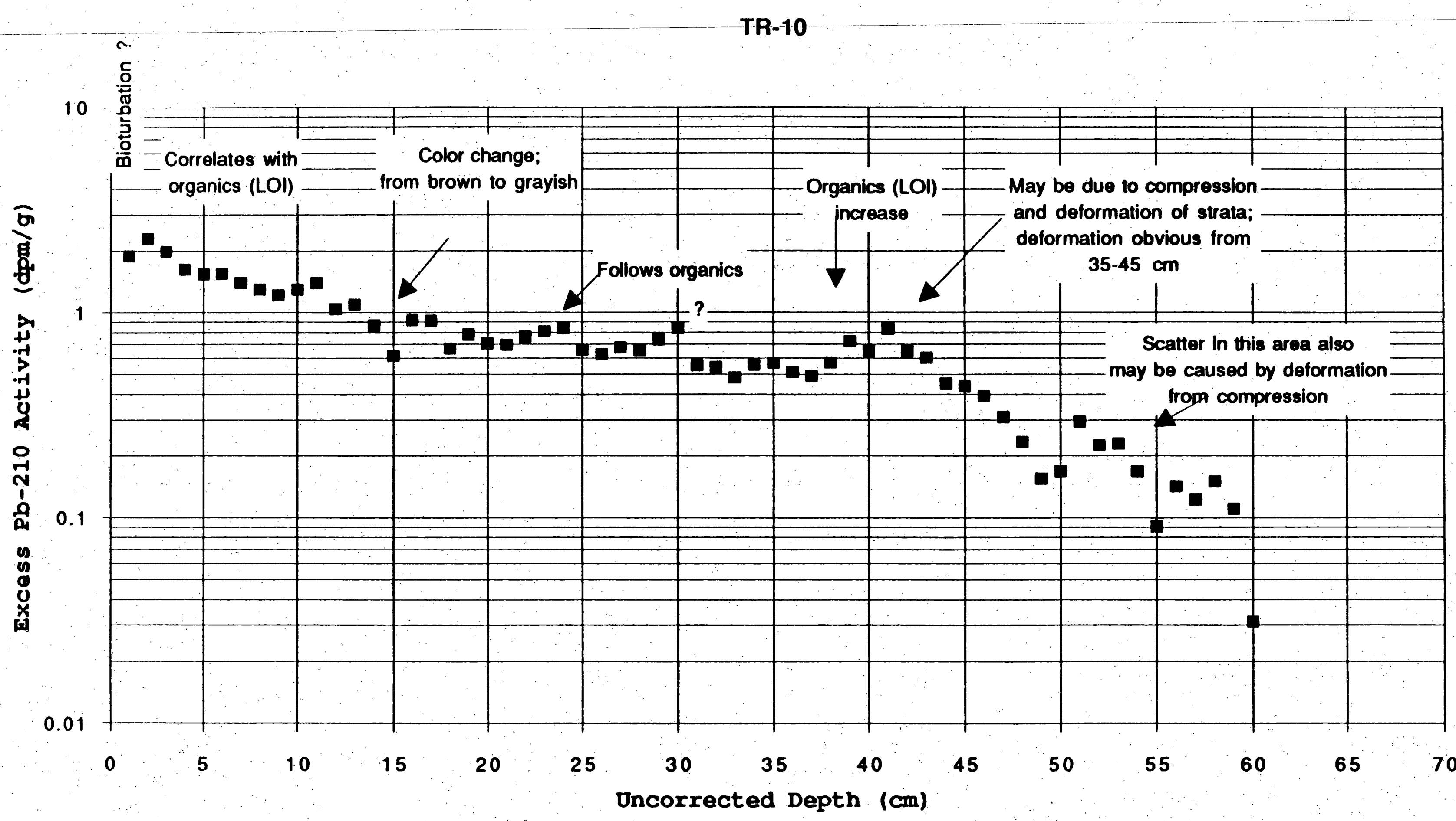


Figure 22. Core TR-10 annotated profile.

TR-11

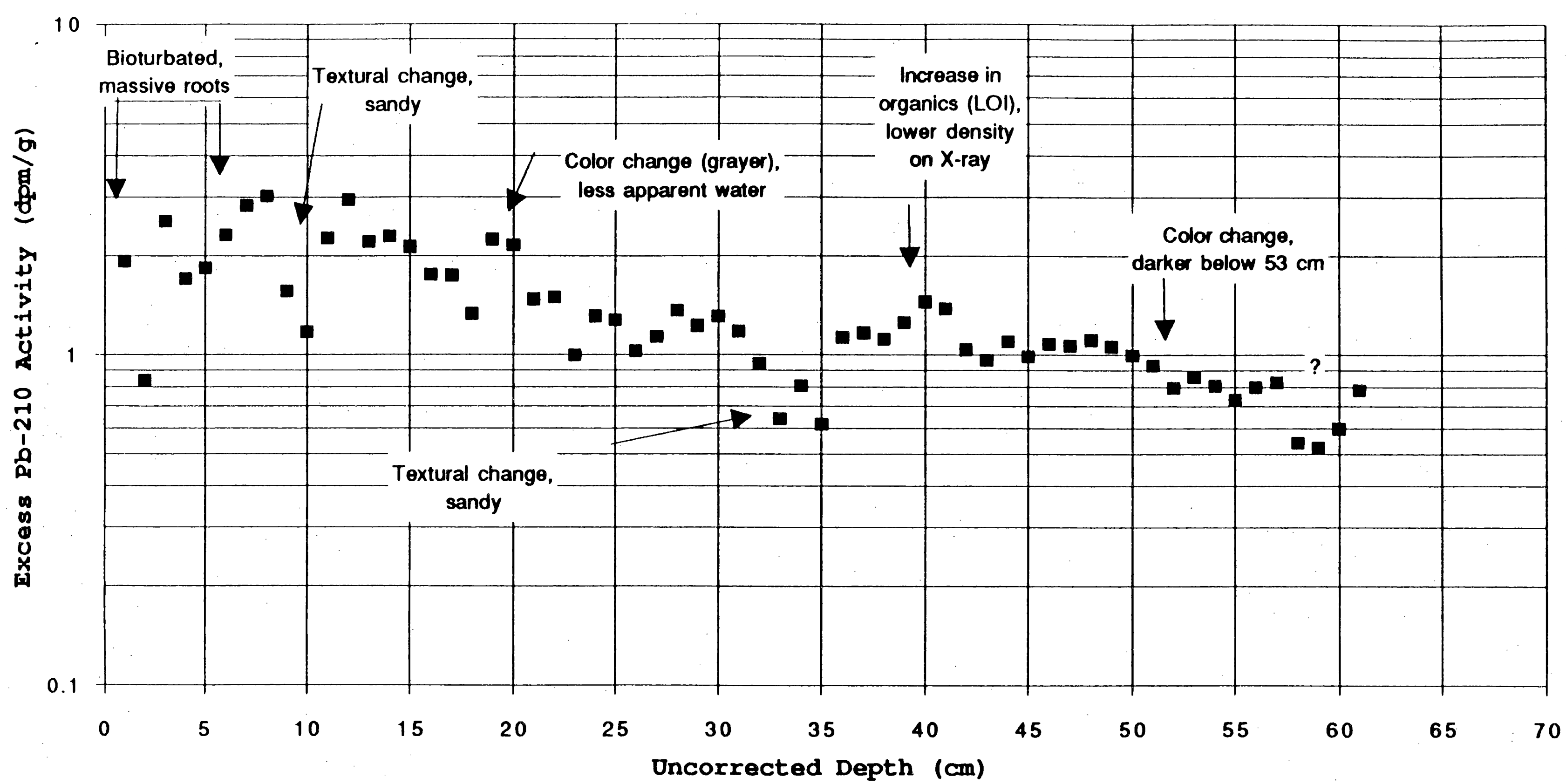


Figure 23. Core TR-11 annotated profile.

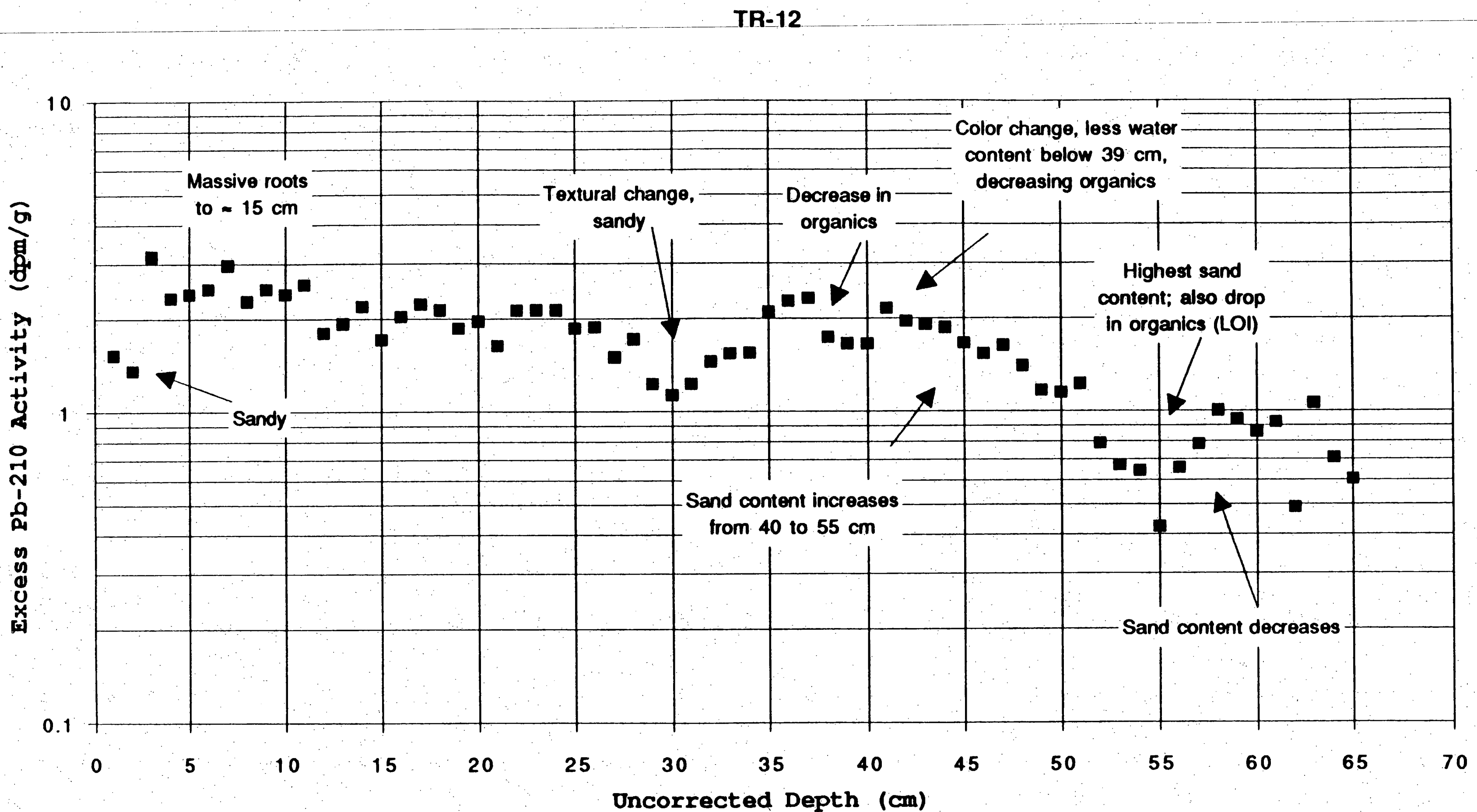


Figure 24. Core TR-12 annotated profile.

Eustatic Sea-Level Rise and Subsidence

Over the past century, sea level has been rising on a worldwide (eustatic) basis at a rate of about 1.2 mm/yr, with a rate in the Gulf of Mexico and Caribbean region of 2.4 mm/yr (Gornitz and others, 1982; Gornitz and Lebedeff, 1987). Adding compactional subsidence to these rates yields a relative sea-level rise that locally exceeds 10 mm/yr (Swanson and Thurlow, 1973; Penland and others, 1988).

A review of Galveston's long-term tide record (1909–1982) indicates that there has been an acceleration in the rate of relative sea-level rise as noted by Turner (1987) and Penland and others (1988). The rate from 1942 to 1962 is 3.2 mm/yr, and from 1962 to 1982, it is 11.5 mm/yr. However, these variations may be short-term fluctuations (based on an 18.6-yr lunar epoch) that are centered around the more constant long-term mean of 6.2 mm/yr (Turner, 1987). More recent data indicate the long-term mean is about 6.4 mm/yr (Lyles and others, 1988). Subtracting eustatic sea-level rise (1.2 mm/yr), or the Gulf of Mexico regional rise (2.4 mm/yr), from the long-term mean of 6.4 mm/yr at the Galveston tide gauge yields subsidence rates of about 4 to 5 mm/yr, or approximately 65 to 80 percent of the relative sea-level rise rate at Galveston.

Human-Induced Subsidence in the Houston–Galveston Area

Rates of "natural" compactional subsidence and eustatic sea-level rise, which together may range up to 12 mm/yr in the Galveston area (Swanson and Thurlow, 1973; Gornitz and Lebedeff, 1987; Penland and others, 1988), are dwarfed by human-induced subsidence with rates of up to 120 mm/yr in the Houston area (Gabrysch and Coplin, 1990). The major cause of human-induced subsidence is the withdrawal of underground fluids, principally ground water, oil, and gas (Pratt and Johnson, 1926; Winslow and Doyel, 1954; Gabrysch, 1969; Gabrysch and Bonnet, 1975; Kreitler, 1977; Verbeek and Clanton, 1981; Gabrysch, 1984; Kreitler and others, 1988).

In the Houston–Galveston area, up to 3 m of human-induced subsidence has occurred between 1906 and 1987 (Gabrysch and Coplin, 1990). The subsidence "bowl" encompasses an area of approximately 943,650 ha (2,330,000 acres) where a mininum of 30 cm of subsidence has occurred (fig. 25). The 60-cm (2 ft) land-surface-subsidence contour (fig. 25) intersects the western margin of the Trinity River valley, indicating that between 30 and 60 cm of subsidence occurred in the study area between 1906 and 1987. Since the late 1970's, however, rates of subsidence in some areas have decreased by an order of magnitude due to the curtailment of ground-water pumpage (Gabrysch and Coplin, 1990).

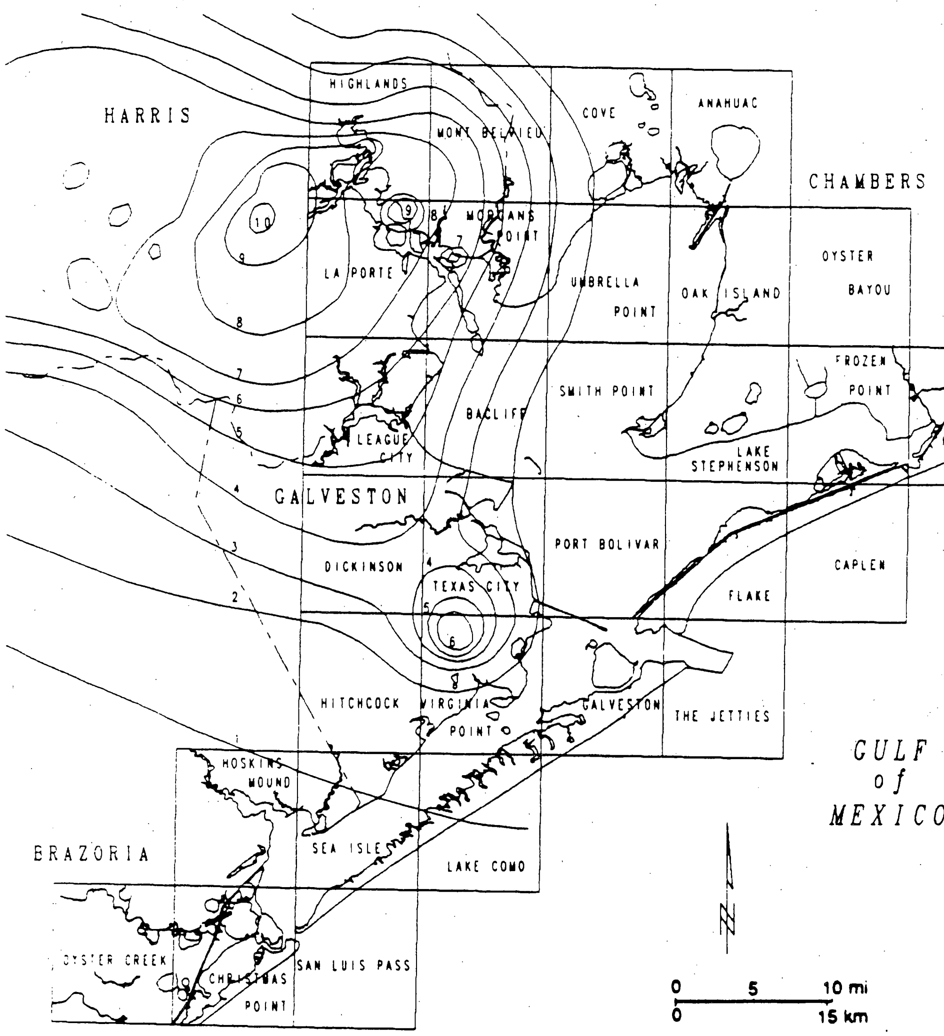


Figure 25. Land-surface subsidence in the Houston-Galveston area, 1906–1987. Subsidence contours (contour interval = 1 ft) are from Gabrysch and Coplin (1990). Grid lines and names show locations of USGS 7.5-minute quadrangles.

Subsidence in the Study Area

Releveling surveys for benchmarks located around Trinity Bay were obtained from the National Ocean Survey, National Oceanic and Atmospheric Administration. The locations of benchmarks were plotted on two USGS 7.5-minute quadrangles (Cove and Anahuac) at the northern tip of Trinity Bay (fig. 1). Rates of subsidence in mm/yr were determined for 26 benchmarks for the period 1973–1978, and for 6 benchmarks (where 1963 data were available) for the period 1963–1978 (Balazs, 1980). A releveling profile between Mont Belvieu and Anahuac (fig. 26) indicates that subsidence rates approached 25 mm/yr near Mont Belvieu but decreased to less than 10 mm/yr near Anahuac. Subsidence of benchmarks along IH 10 in the Trinity River valley ranged from about 6 to 10 mm/yr between 1973 and 1978 (fig. 26).

Releveling of benchmarks west of the delta in 1963, 1973, and 1978 indicates that subsidence rates declined from 1973 to 1978 relative to the earlier period of 1963 to 1973 (table 3). Subsidence rates in figure 26 and table 3 do not include eustatic sea-level rise. Approximately 2 mm/yr should be added to these values to obtain rates of relative sea-level rise.

Releveling surveys in 1973, 1978, and 1987 in the Pasadena area east of Houston but west of the study area show that subsidence has decreased dramatically due to curtailment of ground-water pumpage after 1976 (Gabrysch and Coplin, 1990). Subsidence at a benchmark in Pasadena decreased from approximately 90 mm/yr during 1973–1978 to 9 mm/yr during 1978–1987 (Gabrysch and Coplin, 1990). Near the coastal area at La Porte the rate of subsidence decreased by at least 90 percent from the period 1973–1978 to 1978–1987 (Holdahl and others, 1989). Although benchmarks in the Trinity River valley were not releveled in 1987, one can assume that subsidence in the valley related to Houston ground-water production has also decreased significantly.

Evidence that rates of subsidence have decreased in the Trinity River delta is the declining rate of wetland loss. The rate of wetland loss thought to be due primarily to subsidence decreased by more than 70 percent between the periods 1956–1974 and 1974–1988 (White and Calnan, 1990).

Relative Sea-Level Rise at Coring Sites

Lines of equal subsidence interpreted from benchmark releveling surveys are roughly parallel to the general orientation of the Trinity River and decline toward the east away from the center of maximum subsidence (Ratzlaff, 1980; Gabrysch and Coplin, 1990) (fig. 25). Thus,

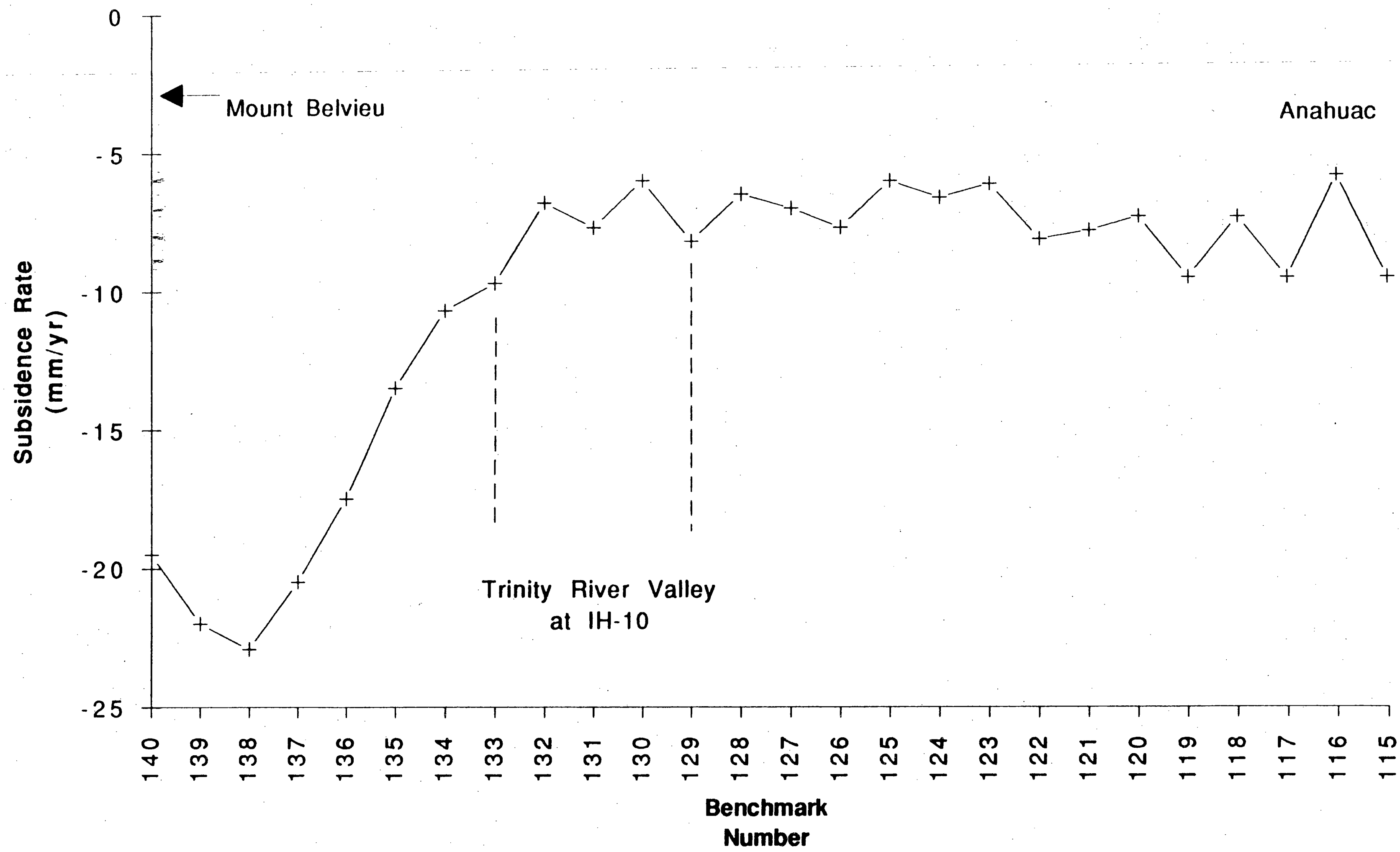


Figure 26. Subsidence rates near the Trinity River based on benchmark releveling surveys, 1973–1978. No horizontal scale. Releveling data from Balazs (1980).

Table 3. Subsidence for selected benchmarks along State Highway 565 on the west margin of the study area. See figure 1 for location of benchmarks. Vertical data from Balazs (1980).

USGS Benchmark No.	1963–1973 (mm/yr)	1973–1978 (mm/yr)	1963–1978 (mm/yr)
133	11.5	9.7	10.9
134	16.3	10.7	14.4
135	19.4	13.5	17.4
136	21.9	17.5	20.4
137	25.8	20.5	24
138	24.4	22	23.6

subsidence rates are highest in the western half of the river valley. Historically, wetland loss has been greater in the western half of the study area than the eastern half (fig. 27). This is probably due not only to subsidence but also to the location on the east side of the valley of the modern Trinity River, which has elevated the land through sediment deposition, and continues to supply larger amounts of sediment to adjacent levees than to more distant backmarsh environments.

Rates of subsidence across the Trinity River valley range from 6 to 9.7 mm/yr during 1973 to 1978 (fig. 26). The average subsidence rate in the western part of the valley (benchmarks 132 and 133, fig. 26) is approximately 8.3 mm/yr, and the average rate in the eastern part (129, 130, and 131, fig. 26) is approximately 7.3 mm/yr. Accordingly, relative sea-level rise for 1973–1978 is 10.5 and 9.7 mm/yr for the west and east sides, respectively. We assume that subsidence rates in the study area declined during the period 1978–1987 as they did near Pasadena and La Porte. If subsidence has been reduced by a similar amount (80–90 percent), then the current relative sea-level rise should be below 4 mm/yr (including 2.4 mm/yr for sea-level rise). Complicating this estimate is the unknown amount of localized subsidence associated with the Lost Lake oil field north of IH-10 and near sites TR-1X, TR-2X, and TR-3. Production at Lost Lake field (discovered in 1929) is on the decline, but the shallow producing horizon (2,320–2,700 ft) and relatively large production (cumulative production of 2,391,940 bbl as of January 1992, Railroad Commission of Texas) suggests that local subsidence may have occurred and may continue into the future. Benchmark releveling surveys include all subsidence no matter what the cause, but because releveling surveys across the Trinity River delta were not conducted in 1987, the actual decline in local subsidence, which may have been affected by the oil field, is unknown. We are currently unable to quantify the subsidence associated with the oil field.

Because of possible subsidence associated with the oil field and because of the uncertainty in determining the exact amount of decline in subsidence in the study area related to reduction in ground-water usage, we recommend that a more conservative, higher rate of subsidence be used than the 4 mm/yr estimated above. Supporting this conclusion is the fact that NOS tide gauge records along the Texas coast indicate that the upper coast has the highest rate of relative sea-level rise and that all gauges north of Port Isabel indicate a rate of rise above 4 mm/yr (fig. 28). Benchmark releveling surveys also indicate higher rates along the upper coast (Paine, 1993). The tide gauge at Galveston provides the best long-term rate for the region, 6.4 mm/yr. We suggest that a relative sea-level rise rate of at least 6 mm/yr be used for all sites in the study area.

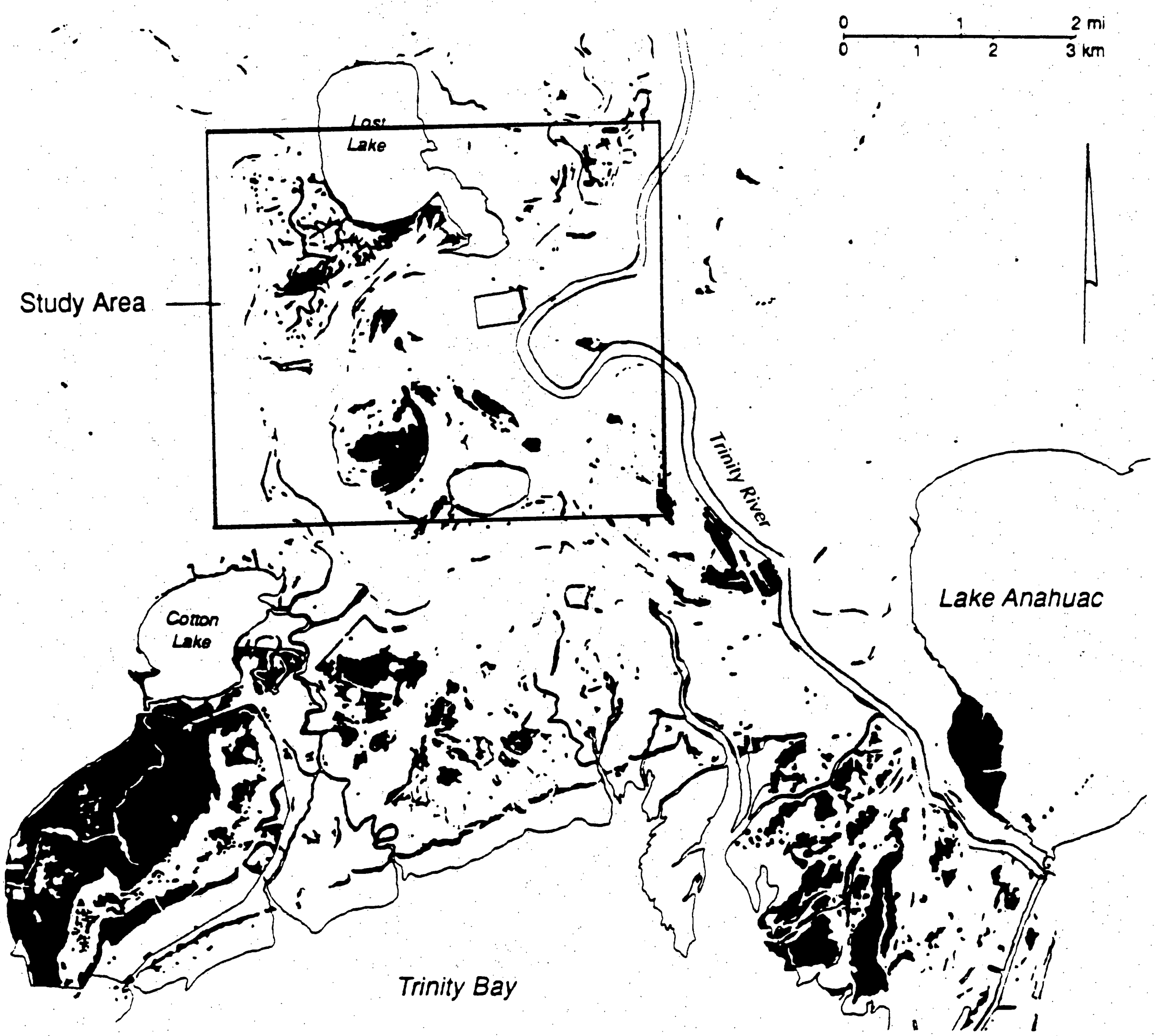


Figure 27. Distribution of marshes (shaded areas) that were displaced by water and flats between the early 1950's and 1989. The large marsh area south of Cotton Lake was affected by a power plant cooling reservoir. From White and others (1993).

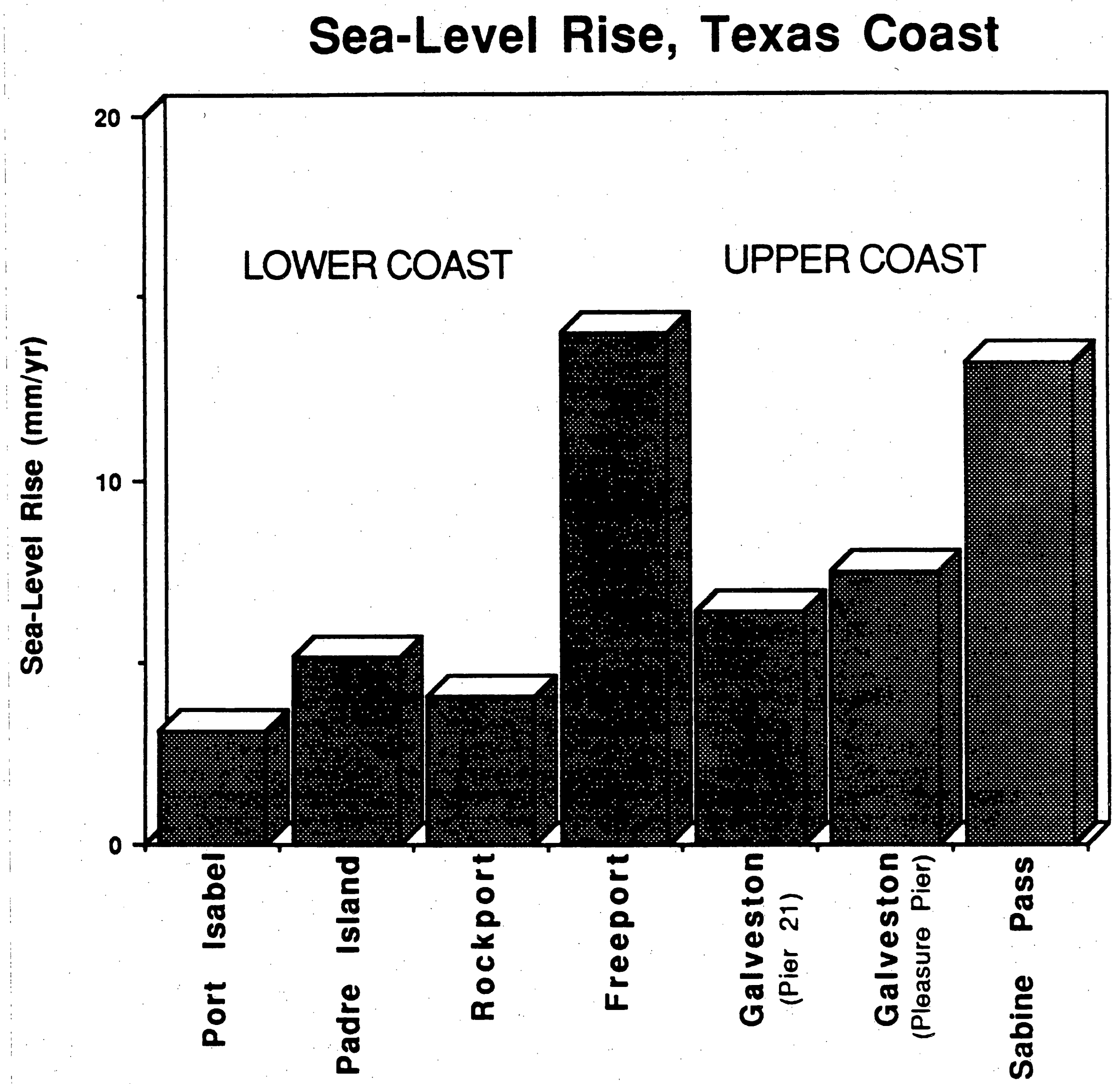


Figure 28. Sea-level rise as recorded by NOS tide gauges along the Texas coast. Data from Lyles and others (1988).

CONCLUSIONS

Excess ^{210}Pb activity decreases exponentially with depth. However, many of the profiles of log normal activity vs. depth exhibited local departures from linear relationships. Most variations in excess ^{210}Pb activity appear to correspond to physical or chemical variations in the sediments. Some of the variations are possibly due to flooding and subtle changes in organic and textural content. It is recommended that for determining sedimentation rates, samples that plot considerably outside linear trends of other samples be excluded from the calculations. However, in correlating river discharge with excess ^{210}Pb activity, subtle variations may signify a relationship between flooding and sedimentation, which, it is hoped, can be defined by the Texas Water Board's model (Longley, 1992b). The distribution of excess ^{210}Pb activity in most cores suggests at least two rates of sedimentation for different time periods. Because all cores from the Trinity River underwent some compression during coring, corrected depths should be used in determining sedimentation rates.

There is evidence that relative sea-level rise has decreased significantly in the study area due to curtailment of ground-water pumpage in the eastern part of the Houston subsidence bowl (Balazs, 1980; Holdahl and others, 1989; Gabrysch and Coplin, 1990). Still, for the purpose of determining offsetting sedimentation rates, it is recommended that a relative sea-level rise rate of at least 6 mm/yr be used for all coring sites.

ACKNOWLEDGMENTS

Funding for this study was provided by the Texas Water Development Board under Research and Planning Fund Grant Contract No. 93-483-356. Cores were analyzed for ^{210}Pb activity, weight loss-on-ignition, water content, and mineral matter by Dr. Charles Holmes of the U.S. Geological Survey, Denver. Total organic carbon and bulk density were analyzed by Steve Tweedy, Chemist in Charge of the BEG Mineral Studies Laboratory, and Raul Herrera. Textural analyses were completed by Randy Duffy and Steven Rooks, BEG Core Research Center, George Bush, Curator. Others providing assistance in the Core Research Center included Don Horton and Robert Sanchez. The authors are especially appreciative of field support provided by Jess Jackson, U.S. Soil Conservation Service. Word processing of this report was by Susan Lloyd and proofreading was by Allison Faust, under the direction of Amanda R. Masterson, Editor-in-Chief. Pasteup was by Jamie H. Coggin under the direction of Margaret L. Evans.

REFERENCES

Balazs, E. I., 1980, The 1978 Houston-Galveston and Texas Gulf Coast vertical control surveys: National Oceanic and Atmospheric Administration Technical Memorandum NOS NGS 27, 60 p.

Gabrysch, R. K., 1969, Land-surface subsidence in the Houston-Galveston region, Texas: United Nations Educational, Scientific and Cultural Organization (UNESCO), Studies and Reports in Hydrology, Land Subsidence Symposium, v. 1, p. 43–54.

_________ 1984, Ground-water withdrawals and land-surface subsidence in the Houston-Galveston region, Texas, 1906–1980: Texas Department of Water Resources Report 287, 64 p.

Gabrysch, R. K., and Bonnet, C. W., 1975, Land-surface subsidence in the Houston-Galveston region, Texas: Texas Water Development Board, Report 188, 19 p.

Gabrysch, R. K., and Coplin, L. S., 1990, Land-surface subsidence resulting from ground-water withdrawals in the Houston-Galveston region, Texas, through 1987: U.S. Geological Survey Report of Investigations No. 90-01, 53 p.

Gornitz, V., Lebedeff, S., and Hansen, J., 1982, Global sea level trend in the past century: Science, v. 215, p. 1611–1614.

Gornitz, V., and Lebedeff, S., 1987, Global sea-level changes during the past century: Society of Economic Paleontologists and Mineralogists, Special Publication no. 41, p. 3–16.

Holdahl, S. R., Holzschuh, J. C., and Zilkoski, D. B., 1989, Subsidence at Houston, Texas, 1973–87: U.S. Department of Commerce, NOAA Technical Report NOS 131 NGS 44, 21 p.

Holmes, C. W., and Martin, E. A., 1976, Rates of sedimentation, *in* Holmes, C. W., and others, Environmental studies, South Texas Outer Continental Shelf, 1976, Geology report for the Bureau of Land Management prepared by the U.S. Geological Survey, 626 p.

Kreitler, C. W., 1977, Faulting and land subsidence from ground-water and hydrocarbon production, Houston-Galveston, Texas: The University of Texas at Austin, Bureau of Economic Geology Research Note 8, 22 p.

Kreitler, C. W., White, W. A., and Akhter, M. S., 1988, Land subsidence associated with hydrocarbon production, Texas Gulf Coast (abs.): American Association of Petroleum Geologists Bulletin, v. 72, no. 2, p. 208.

Longley, W. L., 1992a, Freshwater inflow to Texas bays and estuaries: ecological relationships and methods for determining needs: Texas Water Development Board and Texas Parks and Wildlife Department, 366 p.

_________ 1992b, Analytical approach to determine sediment requirements for maintenance of the Trinity River delta: Texas Water Development Board proposal document, 5 p.

Lyles, S. D., Hickman, L. E., Jr., and Debaugh, H. A., Jr., 1988, Sea level variations for the United States, 1855–1986: National Ocean Service, Rockville, MD, 182 p.

Nittrouer, C. A., Sternberg, R. W., Carpenter, R., and Bennett, J. T., 1979, The use of Pb-210 geochronology as a sedimentological tool: application to the Washington continental shelf: Marine Geology, v. 31, p. 297–316.

Paine, J. G., 1993, Subsidence in the Texas coast: inferences from historical and late Pleistocene sea levels: Tectonophysics, v. 222, p. 445–458.

Paine, J. G., and Morton, R. A., 1986, Historical shoreline changes in Trinity, Galveston, West, and East Bays, Texas Gulf Coast: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 86-3, 58 p.

Penland, Shea, Ramsey, K. E., McBride, R. A., Mestayer, J. T., and Westphal, K. A., 1988, Relative sea level rise and delta-plain development in the Terrebone Parish region: Baton Rouge, Louisiana Geological Survey, Coastal Geology Technical Report no. 4, 121 p.

Pratt, W. E., and Johnson, D. W., 1926, Local subsidence of the Goose Creek oil field: Journal of Geology, v. 34, p. 577–590.

Ratzlaff, K. W., 1980, Land-surface subsidence in the Texas coastal region: U.S. Geological Survey Open-File Report 80-969, 19 p.

Swanson, R. L., and Thurlow, C. I., 1973, Recent subsidence rates along the Texas and Louisiana coasts as determined from tide measurements: Journal of Geophysical Research, v. 78, no. 5, p. 2665–2671.

Turner, R. E., 1987, Tide gage records, geological subsidence, and sedimentation patterns in the northern Gulf of Mexico marshes, *in* Turner, R. E., and Cahoon, D. R., eds., Causes of wetland loss in the coastal central Gulf of Mexico: Volume II: Technical narrative, Final report submitted to Minerals Management Service, New Orleans, Louisiana, Contract No. 14-12-0001-30252, OCS Study/MMS 87-0120, 400 p.

Verbeek, E. R., and Clanton, U. S., 1981, Historically active faults in the Houston metropolitan area, Texas, *in* Etter, E. M., ed., Houston area environmental geology: surface faulting, ground subsidence, hazard liability: Houston Geological Society, p. 28–68.

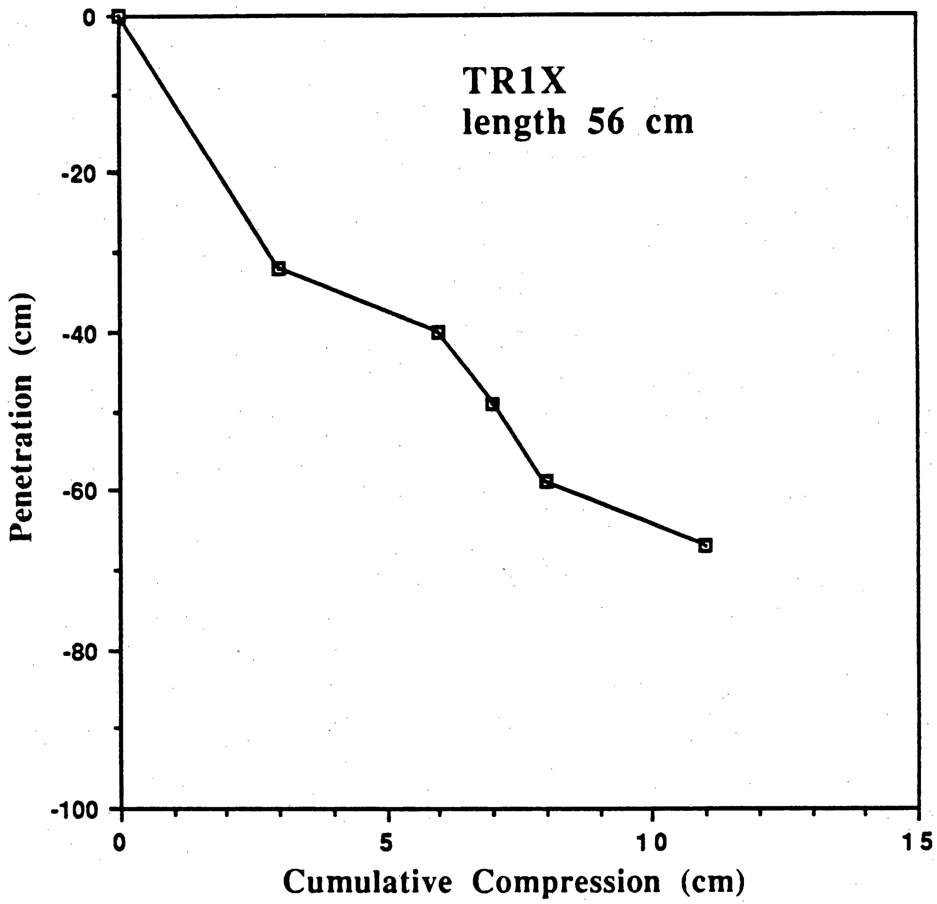
White, W. A., Calnan, T. R., Morton, R. A., Kimble, R. S., Littleton, T. G., McGowen, J. H., Nance, H. S., and Schmedes, K. E., 1985, Submerged lands of Texas, Galveston-Houston area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands: The University of Texas at Austin, Bureau of Economic Geology, Special Publication, 145 p.

White, W. A., and Calnan, T. C., 1990, Sedimentation and historical changes in fluvial-deltaic wetlands along the Texas Gulf Coast with emphasis on the Colorado and Trinity River deltas: The University of Texas at Austin, Bureau of Economic Geology, report prepared for the Texas Parks and Wildlife Department under interagency contract (88-89) 1423, 124 p., 6 appendices.

White, W. A., Tremblay, T. A., Wermund, E. G., Jr., and Handley, L. R., 1993, Trends and status of wetland and aquatic habitats in the Galveston Bay system, Texas: Galveston Bay National Estuary Program, GBNEP-31, 225 p.

Winslow, A. G., and Doyel, W. W., 1954, Land-surface subsidence and its relation to the withdrawal of ground water in the Houston-Galveston region, Texas: Economic Geology, v. 49, no. 4, p. 413–422.

APPENDIX A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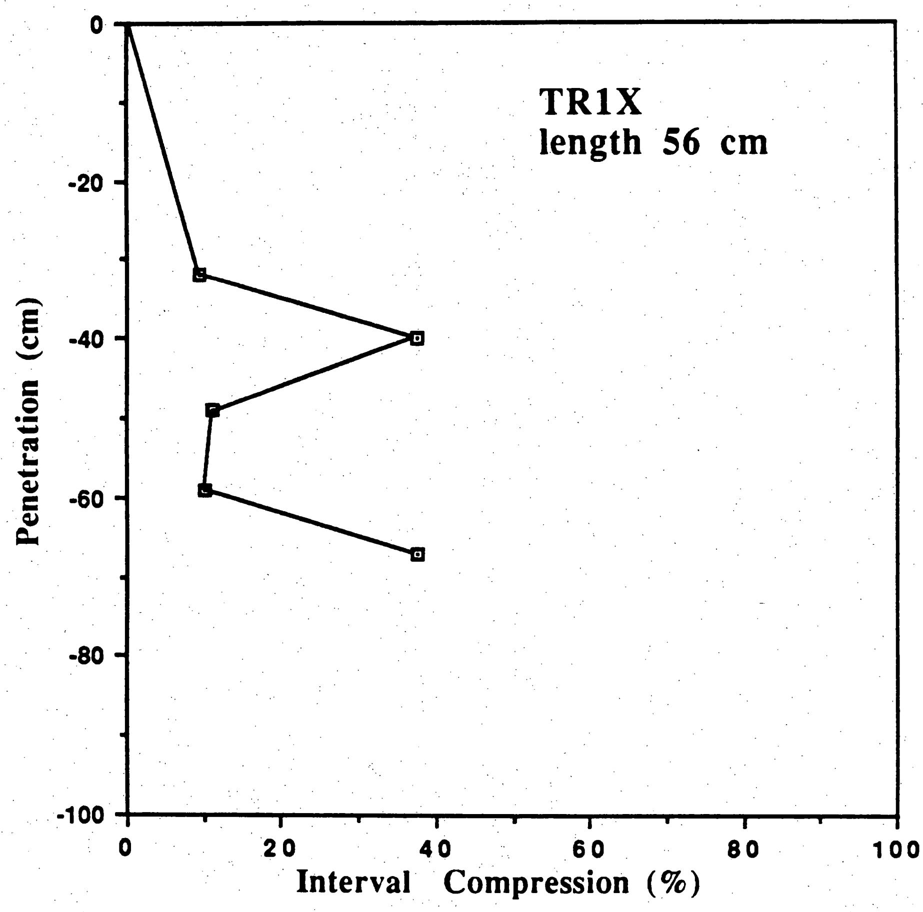

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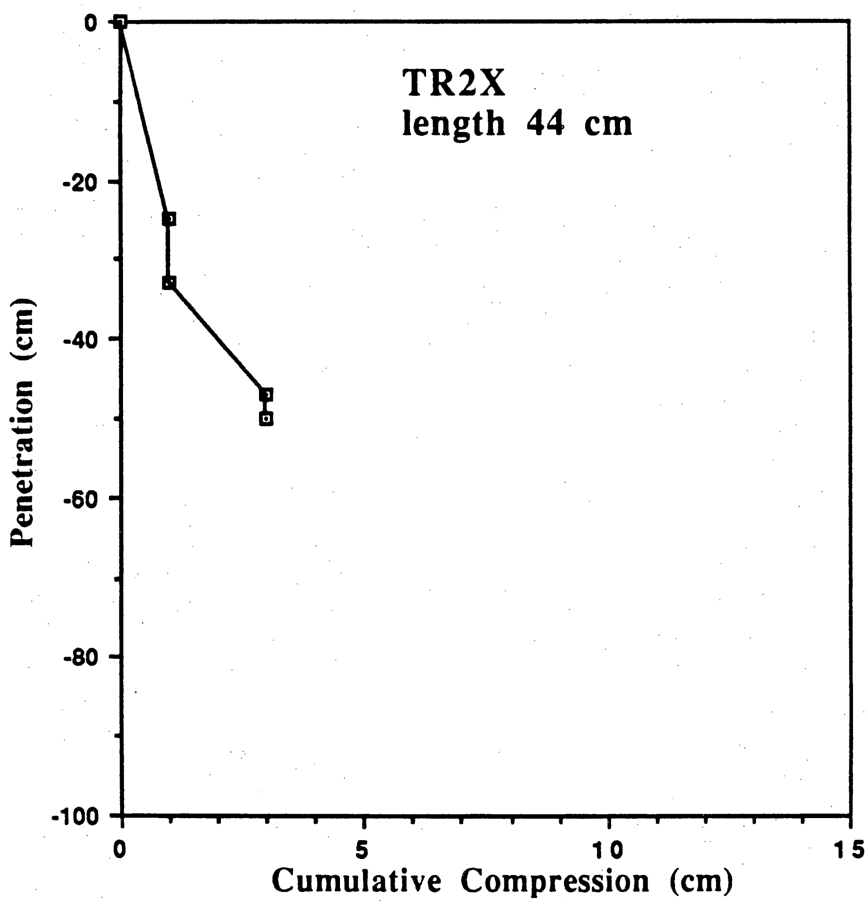
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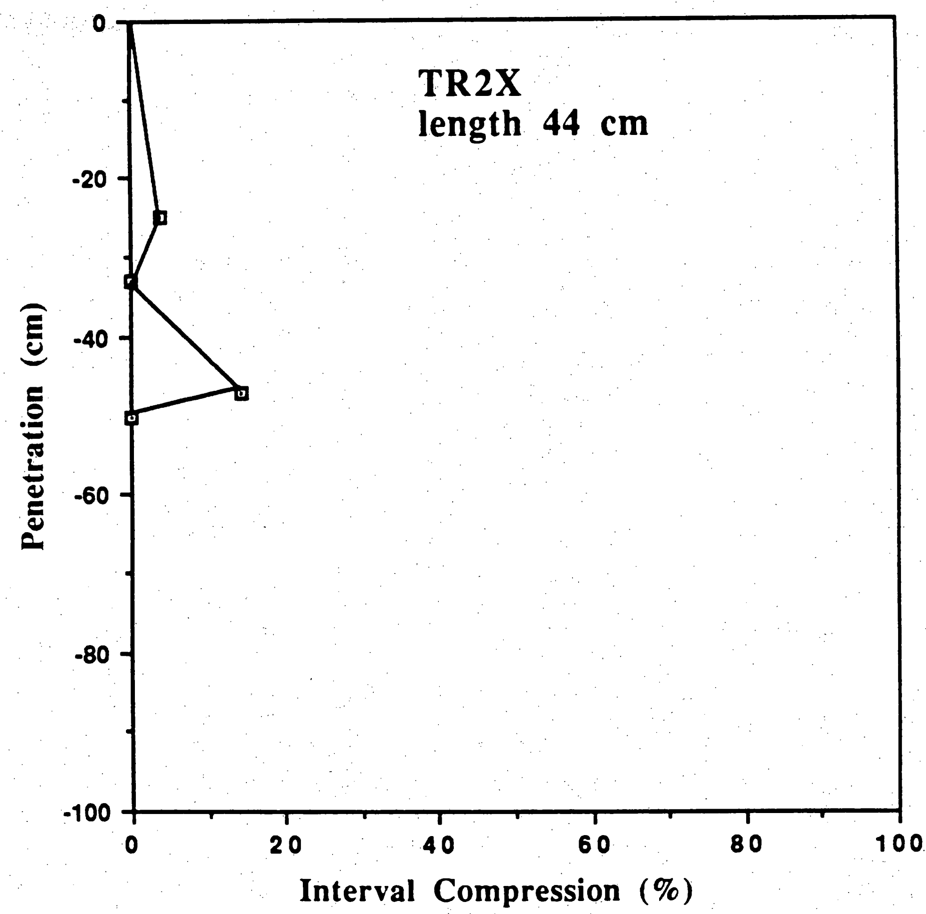
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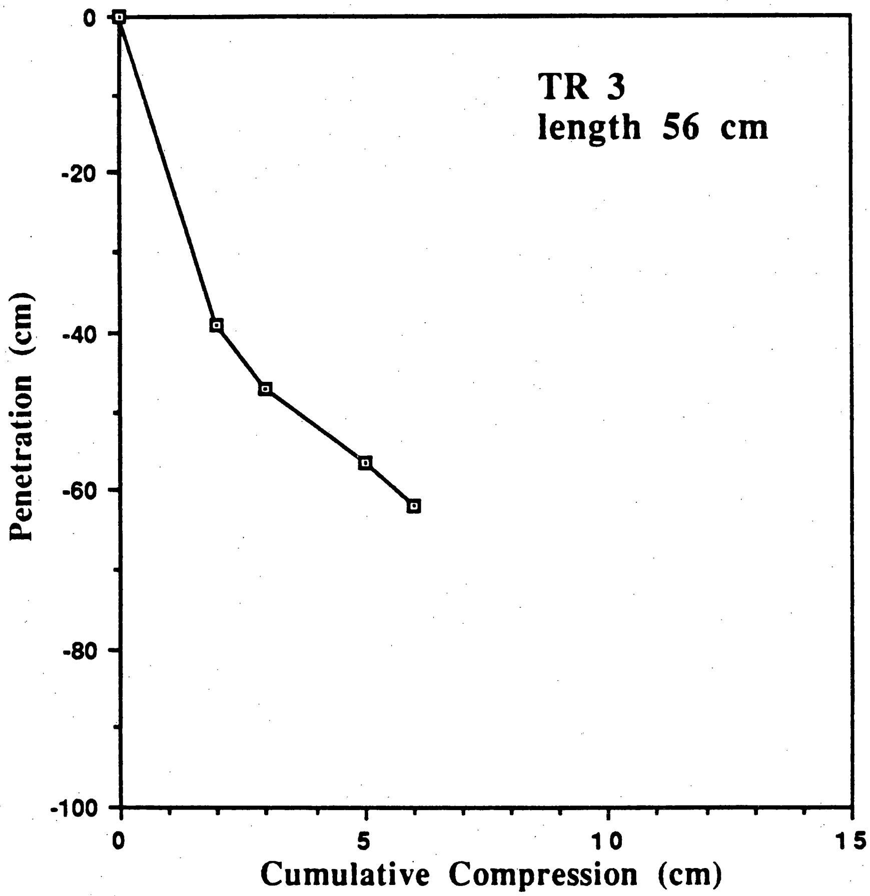
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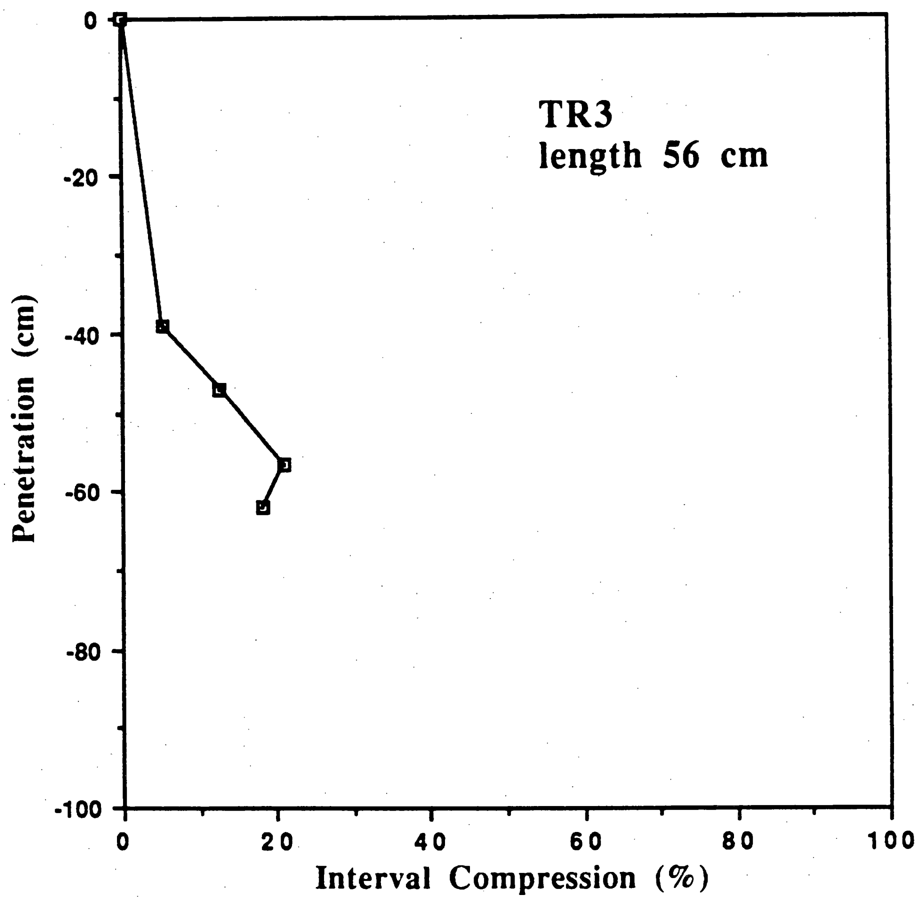
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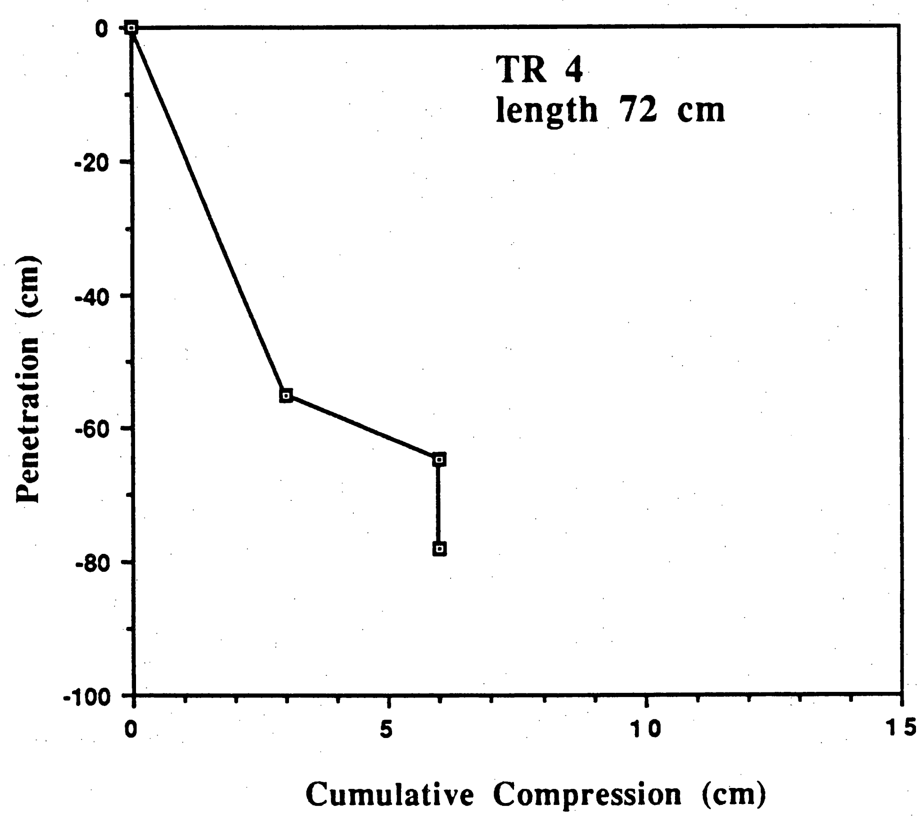
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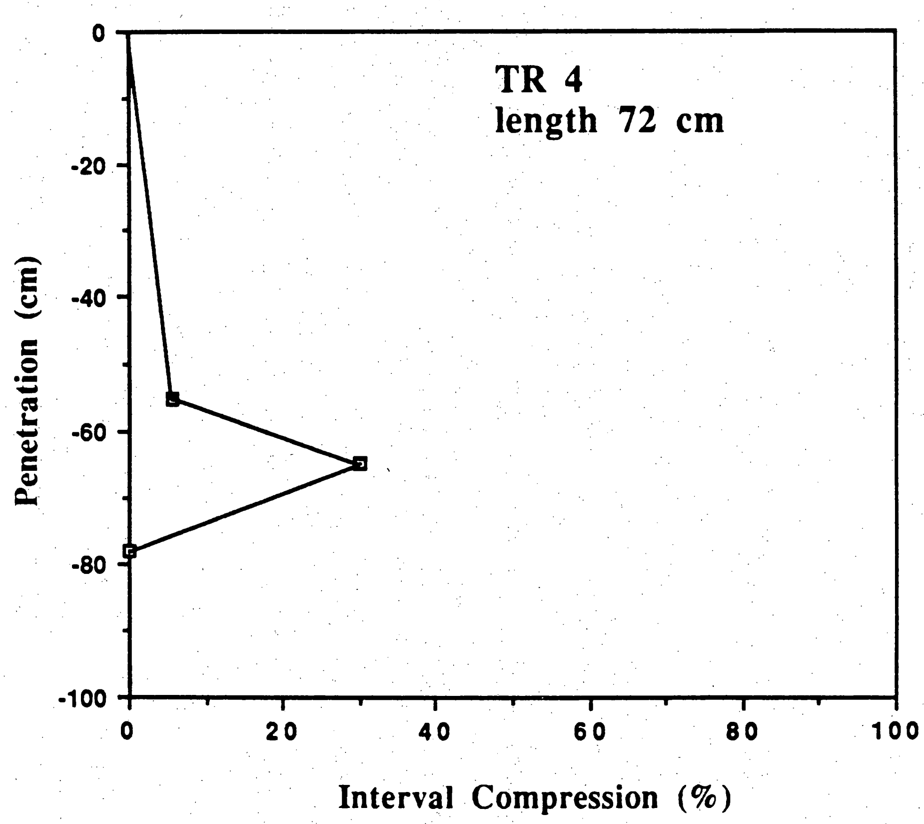

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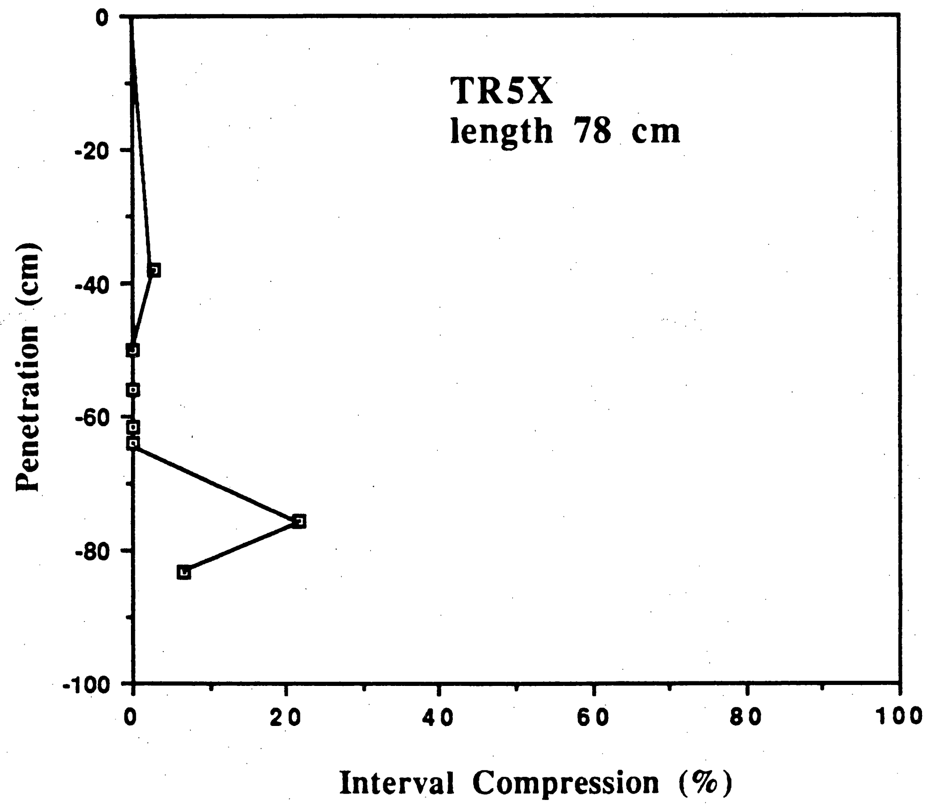

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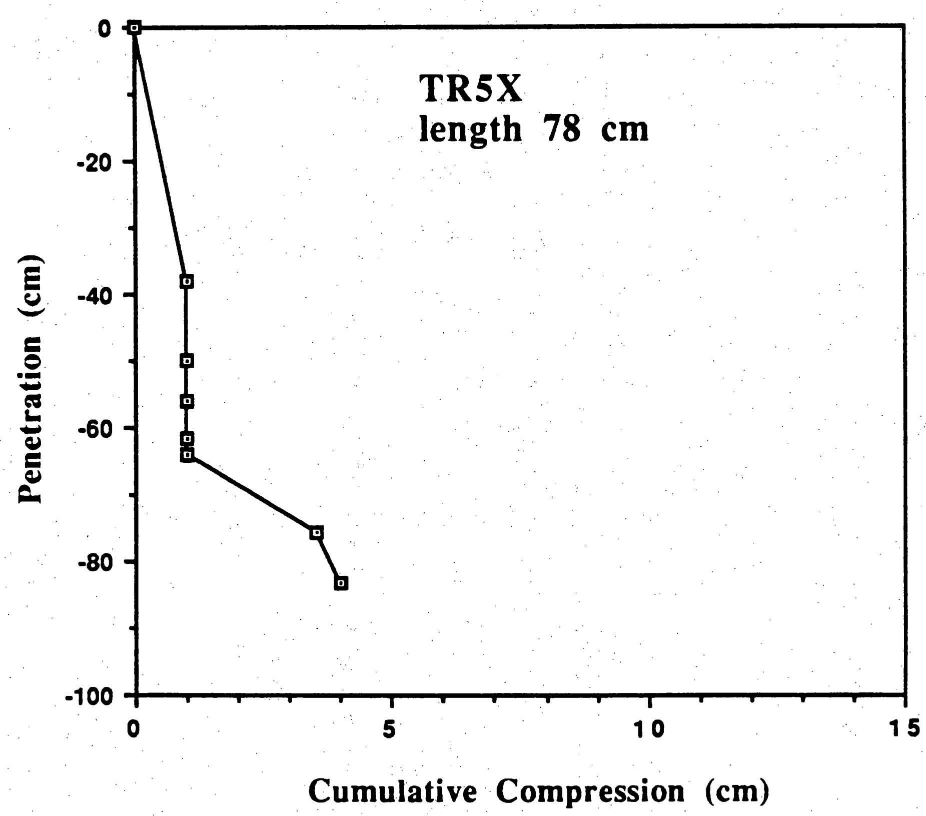
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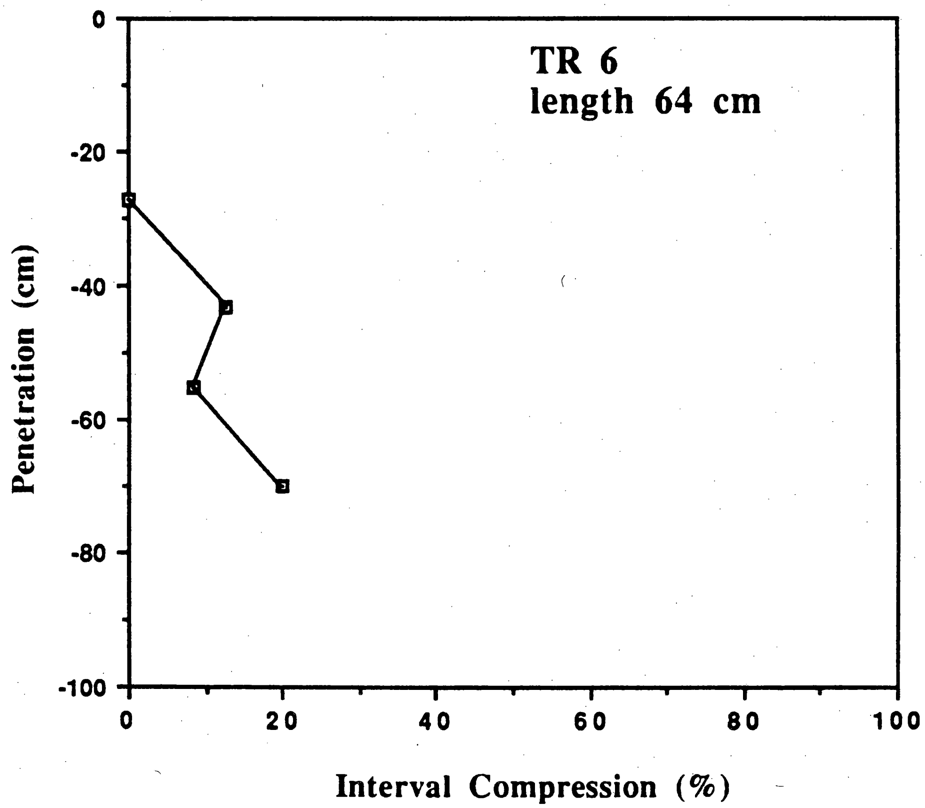

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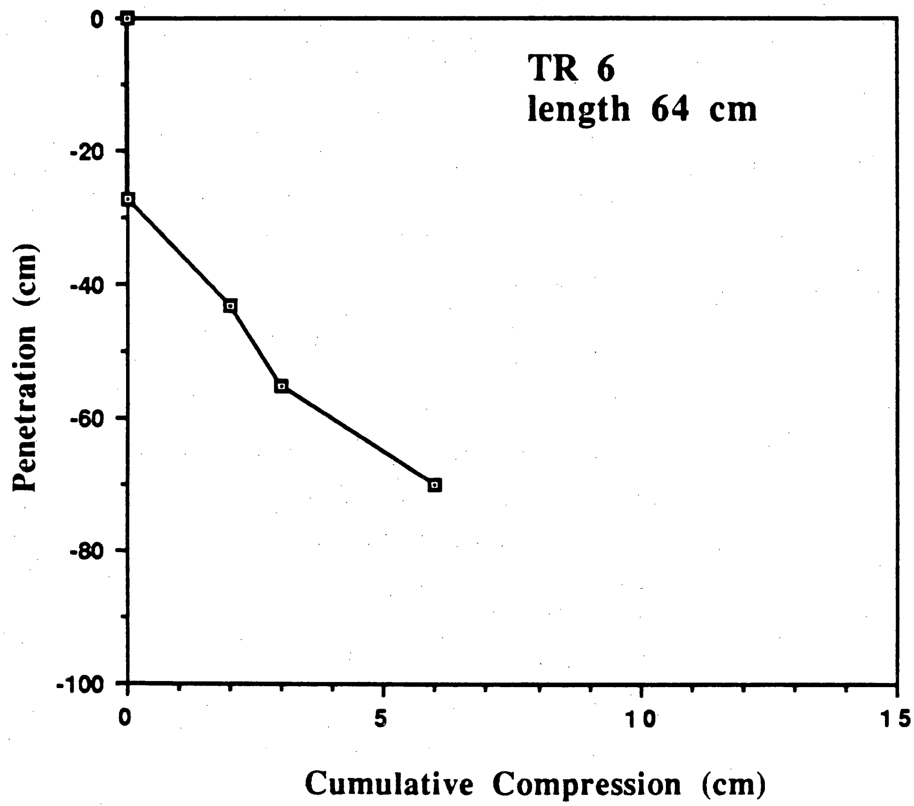
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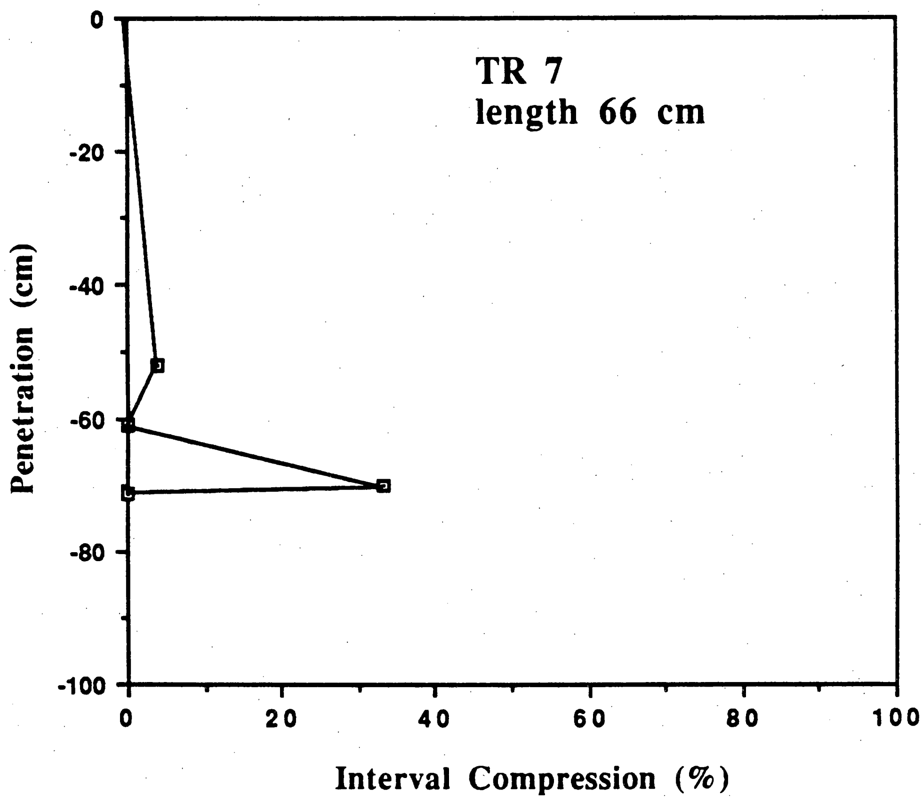

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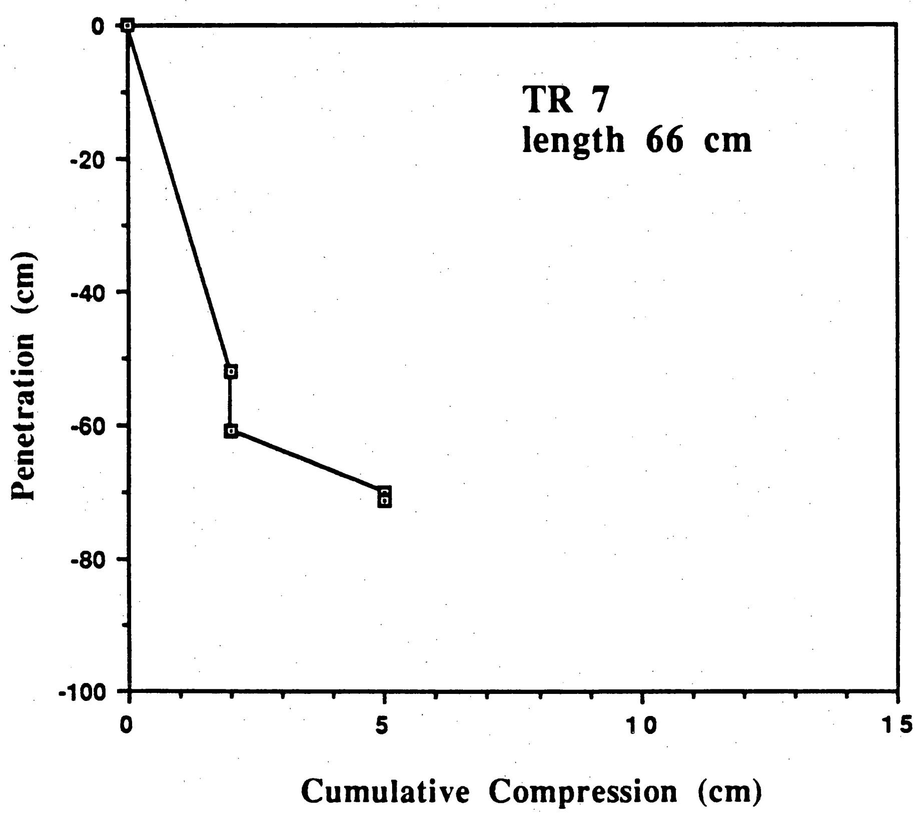
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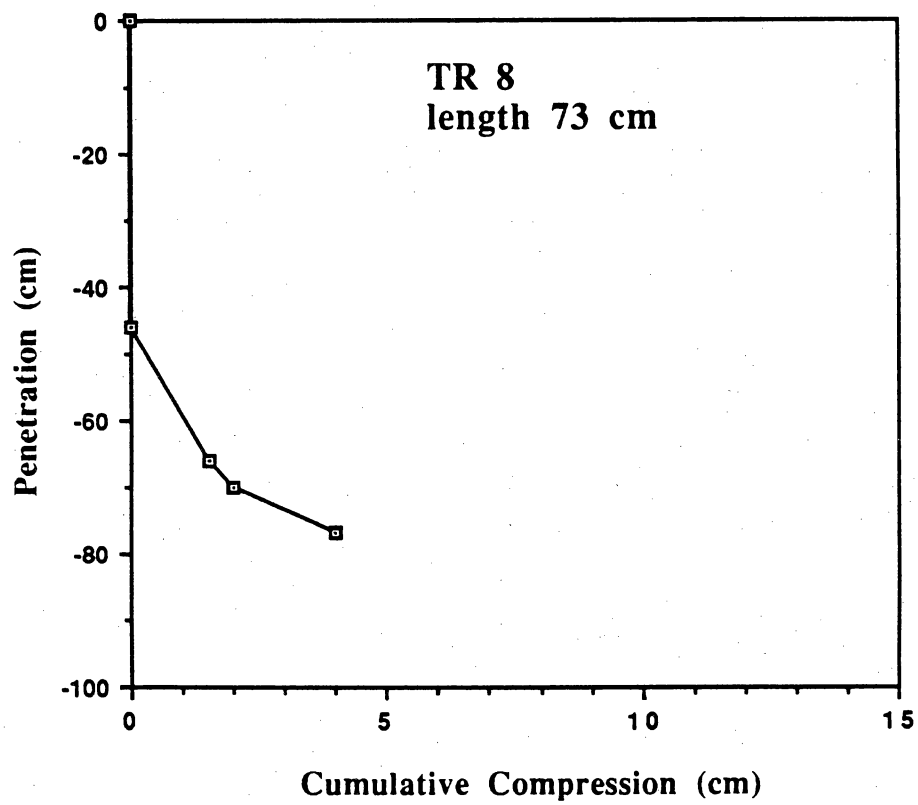
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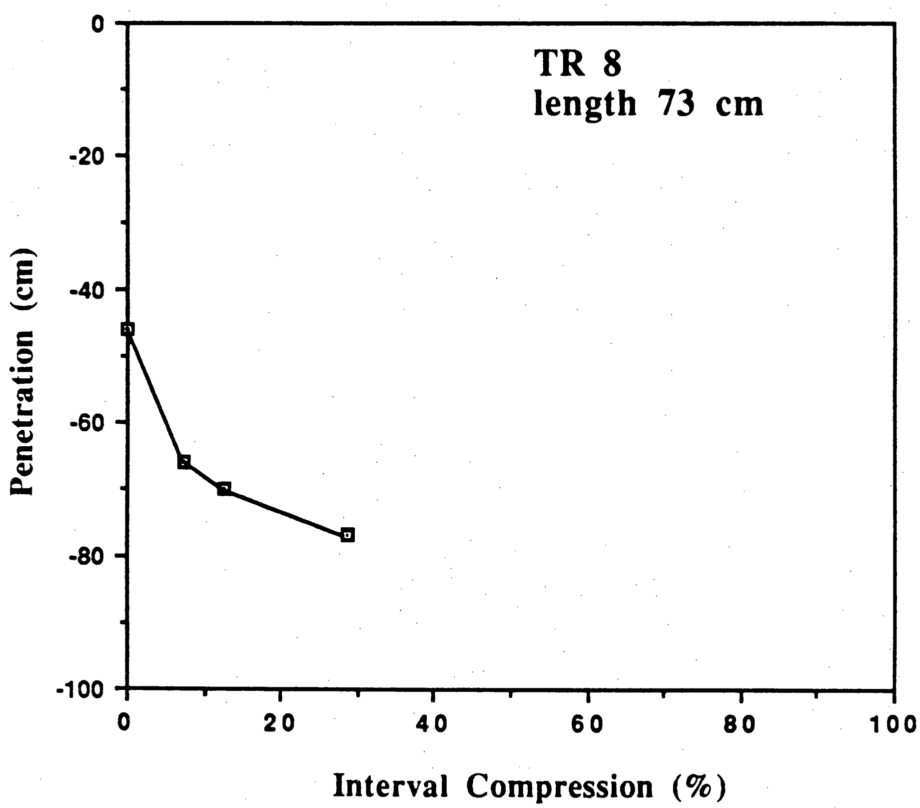
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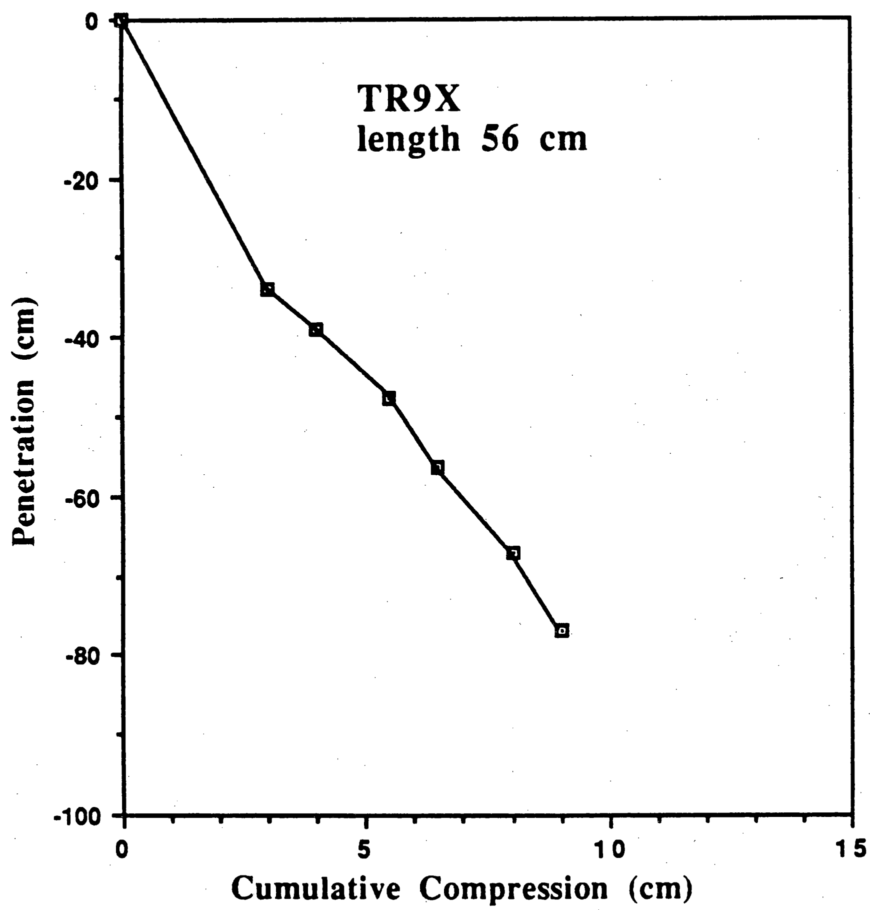

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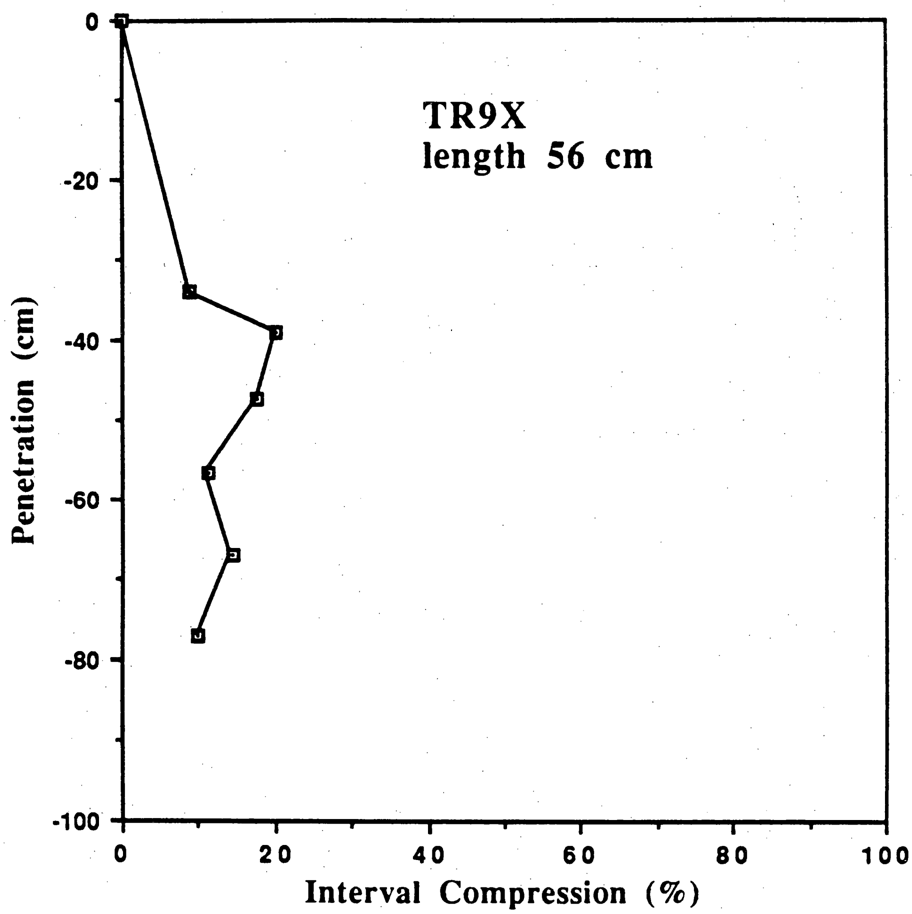
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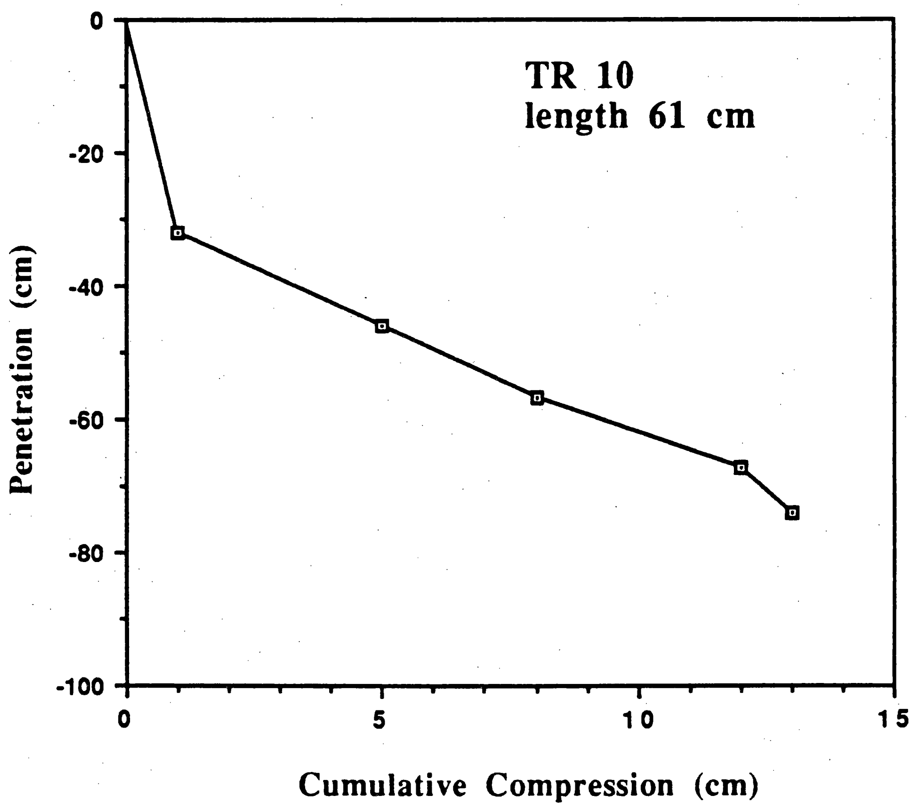
Interval Compression (%)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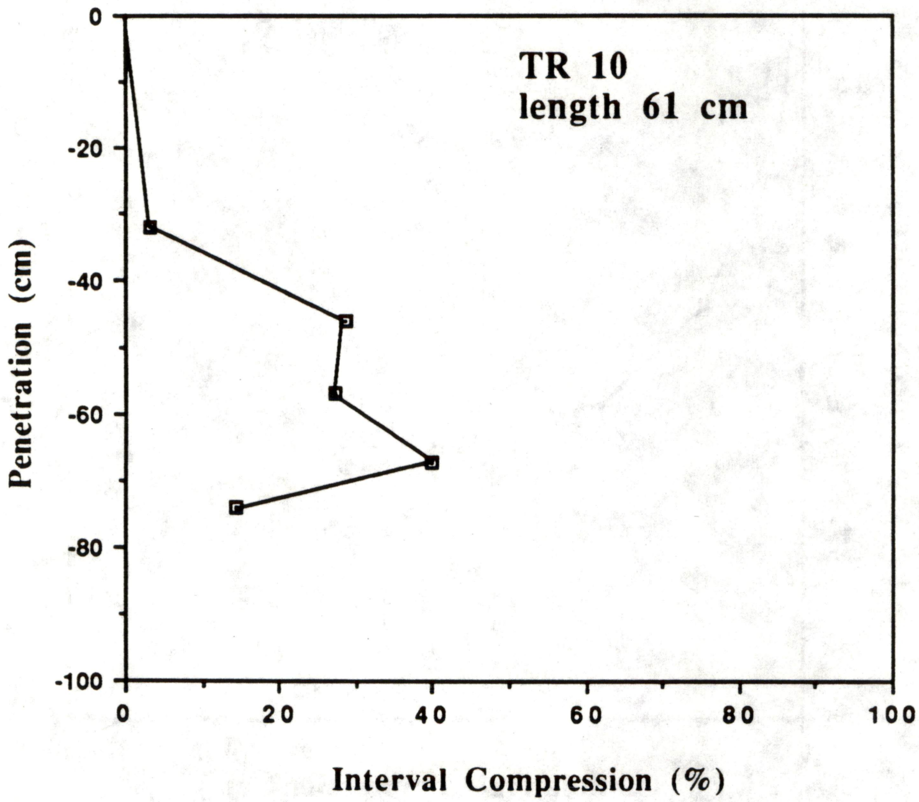
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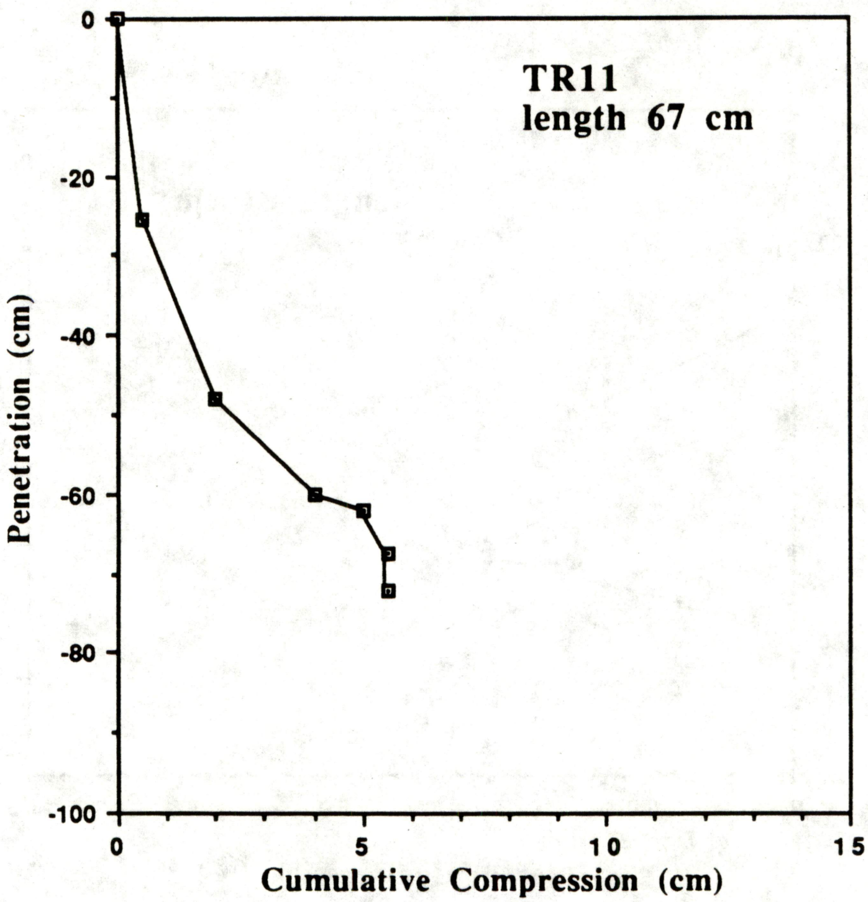
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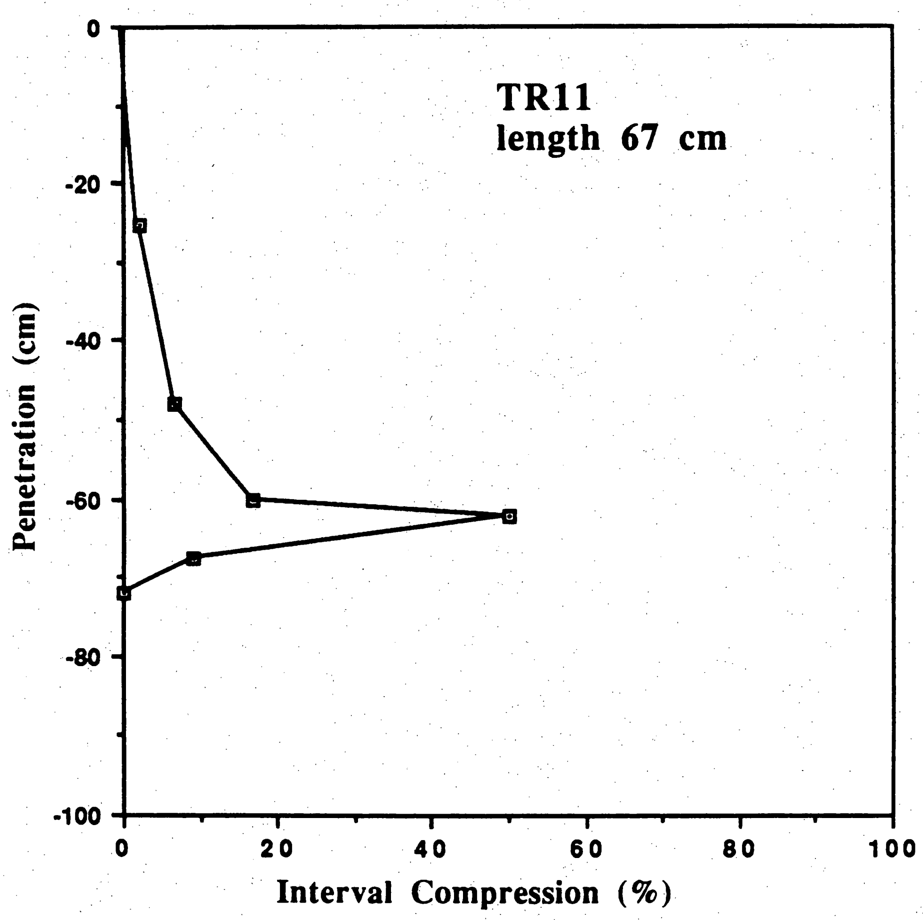
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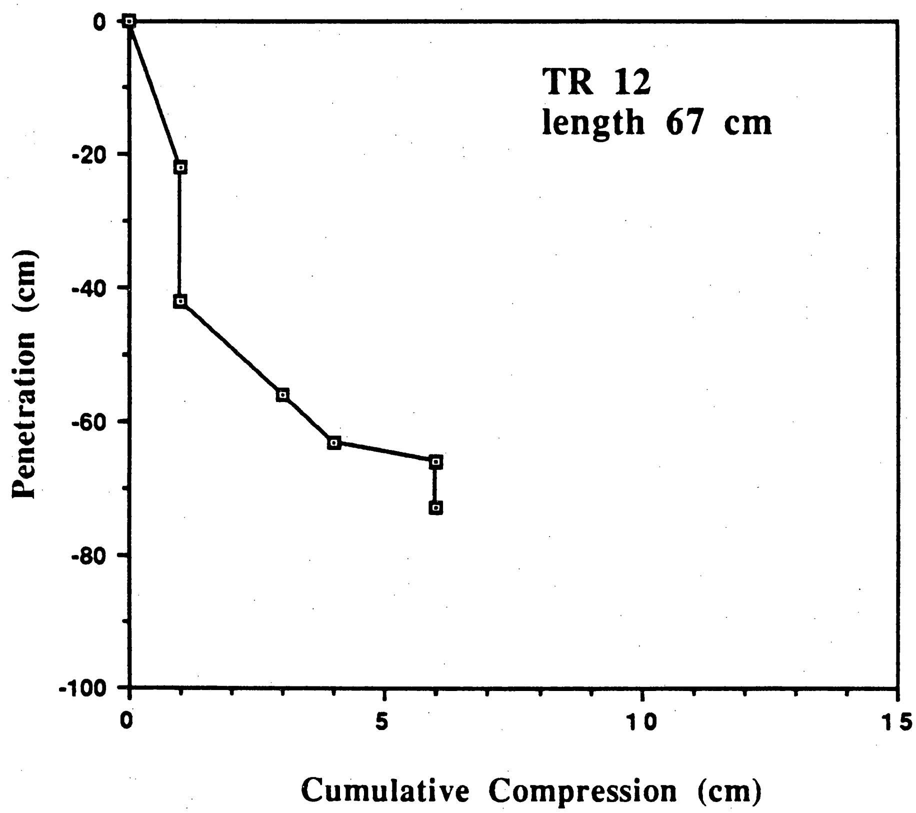
Interval Compression (%)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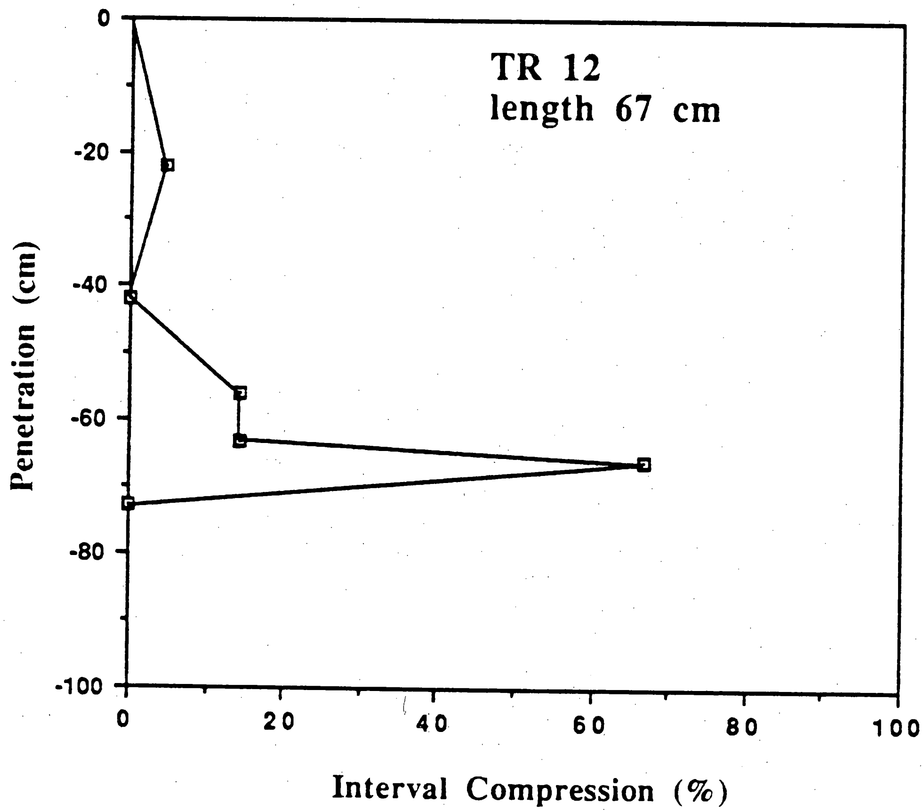
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Interval Compression (%)

APPENDIX B

TR-1X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc.	Depth (cm)	Corr. Depth
TR-1X-1	36.14	14.16	49.70	1.757	1.265		1.00	1.10
TR-1X-2	36.62	13.04	50.34	1.808	1.315		2.00	2.21
TR-1X-3	38.26	13.07	48.67	1.966	1.474		3.00	3.31
TR-1X-4	39.44	11.98	48.58	2.181	1.689		4.00	4.41
TR-1X-5	40.89	13.83	45.28	2.005	1.513		5.00	5.52
TR-1X-6	39.86	12.90	47.24	2.015	1.522		6.00	6.62
TR-1X-7	38.89	12.38	48.74	1.735	1.243		7.00	7.72
TR-1X-8	37.68	12.43	49.89	1.680	1.187		8.00	8.83
TR-1X-9	36.76	12.10	51.14	1.760	1.267		9.00	9.93
TR-1X-10	36.55	11.16	52.29	1.526	1.034		10.00	11.03
TR-1X-11	36.06	10.34	53.60	1.518	1.026		11.00	12.14
TR-1X-12	34.18	10.74	55.08	1.513	1.020		12.00	13.24
TR-1X-13	32.18	9.65	58.17	1.344	0.851		13.00	14.35
TR-1X-14	31.03	8.93	60.04	1.138	0.646		14.00	15.45
TR-1X-15	30.00	9.07	60.93	1.225	0.733		15.00	16.55
TR-1X-16	30.04	8.37	61.59	1.174	0.682		16.00	17.66
TR-1X-17	29.21	7.94	62.85	1.032	0.540		17.00	18.76
TR-1X-18	29.13	7.94	62.93	0.875	0.382		18.00	19.86
TR-1X-19	28.04	7.31	64.65	0.947	0.454		19.00	20.97
TR-1X-20	27.20	7.77	65.03	0.934	0.442		20.00	22.07
TR-1X-21	27.89	7.63	64.48	0.843	0.351		21.00	23.17
TR-1X-22	28.60	7.37	64.03	0.828	0.336		22.00	24.28
TR-1X-23	29.06	7.50	63.44	0.901	0.408		23.00	25.38
TR-1X-24	28.67	7.17	64.16	0.967	0.475		24.00	26.48
TR-1X-25	29.26	7.13	63.61	0.928	0.436		25.00	27.59
TR-1X-26	29.08	7.69	63.23	0.901	0.409		26.00	28.69
TR-1X-27	29.00	7.37	63.63	0.880	0.388		27.00	29.79
TR-1X-28	28.96	7.57	63.47	0.863	0.371		28.00	30.90
TR-1X-29	29.11	7.55	63.34	0.870	0.377		29.00	32.00
TR-1X-30	30.55	6.59	62.86	0.914	0.422		30.00	33.60
TR-1X-31	31.81	6.77	61.41	1.093	0.601		31.00	35.20
TR-1X-32	31.11	7.97	60.92	0.785	0.293		32.00	36.80
TR-1X-33	30.97	8.57	60.46	0.754	0.262		33.00	38.40
TR-1X-34	31.85	7.54	60.61	0.762	0.269		34.00	40.00
TR-1X-35	32.19	9.76	58.05	0.796	0.303		35.00	41.13
TR-1X-36	32.11	7.87	60.02	0.685	0.192		36.00	42.25
TR-1X-37	30.46	8.95	60.60	0.717	0.225		37.00	43.38
TR-1X-38	30.23	9.16	60.61	0.763	0.271		38.00	44.50
TR-1X-39	30.08	9.15	60.78	0.974	0.482		39.00	45.63
TR-1X-40	30.47	8.53	61.00	0.808	0.315		40.00	46.75
TR-1X-41	30.87	8.93	60.20	0.974	0.482		41.00	47.88
TR-1X-42	31.32	8.32	60.36	1.013	0.520		42.00	49.00
TR-1X-43	31.92	8.48	59.60	0.806	0.313		43.00	50.11
TR-1X-44	31.47	8.73	59.80	0.776	0.284		44.00	51.22
TR-1X-45	30.88	8.38	60.74	0.771	0.278		45.00	52.33
TR-1X-46	29.97	8.93	61.10	0.705	0.213		46.00	53.44
TR-1X-47	29.92	8.60	61.48	0.885	0.393		47.00	54.56
TR-1X-48	29.04	8.32	62.65	0.622	0.130		48.00	55.67

TR-1X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-1X-49	27.59	7.39	65.02	1.000	0.507	49.00	56.78
TR-1X-50	26.34	7.57	66.09	0.955	0.463	50.00	57.89
TR-1X-51	25.62	7.33	67.06	0.741	0.249	51.00	59.00
TR-1X-52	24.29	5.78	69.94	0.613	0.120	52.00	60.60
TR-1X-53	23.72	5.52	70.76	0.568	0.075	53.00	62.20
TR-1X-54	23.86	5.38	70.76	0.630	0.138	54.00	63.80
						55.00	65.40
						56.00	67.00

TR-2X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210 Unc.	Depth (cm)	Corr. Depth
TR-2X-1	45.07	15.16	39.77	1.998	1.506	1.00	1.04
TR-2X-2	45.48	15.74	38.79	1.921	1.429	2.00	2.08
TR-2X-3	44.43	16.07	39.50	1.992	1.499	3.00	3.13
TR-2X-4	43.84	15.29	40.87	1.944	1.452	4.00	4.17
TR-2X-5	42.62	15.35	42.03	1.891	1.399	5.00	5.21
TR-2X-6	40.48	14.37	45.14	1.918	1.425	6.00	6.25
TR-2X-7	40.00	13.86	46.14	2.053	1.561	7.00	7.29
TR-2X-8	40.95	12.70	46.35	1.683	1.191	8.00	8.33
TR-2X-9	35.22	11.24	53.54	1.335	0.842	9.00	9.38
TR-2X-10	33.90	10.36	55.74	1.370	0.877	10.00	10.42
TR-2X-11	32.01	10.28	57.71	1.152	0.659	11.00	11.46
TR-2X-12	31.44	10.50	58.07	1.183	0.690	12.00	12.50
TR-2X-13	29.95	9.98	60.07	1.148	0.656	13.00	13.54
TR-2X-14	29.65	10.22	60.13	1.042	0.550	14.00	14.58
TR-2X-15	30.09	10.45	59.45	1.155	0.662	15.00	15.63
TR-2X-16	29.47	9.38	61.14	1.064	0.572	16.00	16.67
TR-2X-17	29.26	9.77	60.98	0.901	0.409	17.00	17.71
TR-2X-18	30.54	10.87	58.59	0.938	0.446	18.00	18.75
TR-2X-19	32.65	11.05	56.31	0.622	0.130	19.00	19.79
TR-2X-20	32.73	11.55	55.71	1.055	0.563	20.00	20.83
TR-2X-21	34.19	10.40	55.41	1.076	0.584	21.00	21.88
TR-2X-22	33.49	9.78	56.73	0.870	0.377	22.00	22.92
TR-2X-23	31.32	9.50	59.17	0.956	0.464	23.00	23.96
TR-2X-24	31.35	9.68	58.97	0.958	0.466	24.00	25.00
TR-2X-25	30.64	9.66	59.69	0.963	0.471	25.00	26.00
TR-2X-26	30.94	10.04	59.02	1.017	0.525	26.00	27.00
TR-2X-27	32.44	10.72	56.84	0.975	0.483	27.00	28.00
TR-2X-28	33.54	9.84	56.62	0.894	0.401	28.00	29.00
TR-2X-29	34.50	9.60	55.90	0.946	0.454	29.00	30.00
TR-2X-30	33.42	9.36	57.22	0.972	0.479	30.00	31.00
TR-2X-31	33.60	9.25	57.15	0.902	0.410	31.00	32.00
TR-2X-32	35.90	9.96	54.14	0.968	0.476	32.00	33.00
TR-2X-33	35.96	11.05	53.00	0.913	0.420	33.00	34.17
TR-2X-34	36.98	11.37	51.65	0.880	0.388	34.00	35.33
TR-2X-35	37.75	11.18	51.07	0.867	0.375	35.00	36.50
TR-2X-36	37.46	9.98	52.55	0.883	0.391	36.00	37.67
TR-2X-37	38.84	11.18	49.98	0.827	0.335	37.00	38.83
TR-2X-38	38.31	10.81	50.88	0.606	0.114	38.00	40.00
TR-2X-39	37.95	10.98	51.08	0.798		39.00	41.17
TR-2X-40	38.68	10.31	51.02	0.914		40.00	42.33
TR-2X-41	38.20	10.54	51.27	0.932		41.00	43.50
TR-2X-42	40.73	10.32	48.95	0.914		42.00	44.67
						43.00	45.83
						44.00	47.00
						45.00	48.00
						46.00	49.00
						47.00	50.00

TR-3

Sample No.	% Water	LOI (% Org.)	% Min.	Pb-210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-3-1	46.61	33.80	19.60	2.968	2.476	1	1.05
TR-3-2	45.91	33.80	20.30	3.071	2.579	2	2.11
TR-3-3	46.83	34.26	18.92	3.127	2.634	3	3.16
TR-3-4	52.42	37.43	10.15	3.326	2.834	4	4.22
TR-3-5	47.92	34.06	18.02	3.382	2.890	5	5.27
TR-3-6	45.00	31.68	23.32	2.559	2.067	6	6.32
TR-3-7	44.19	32.87	22.94	2.783	2.291	7	7.38
TR-3-8	46.68	42.58	10.73	3.332	2.839	8	8.43
TR-3-9	41.11	33.33	25.56	2.333	1.840	9	9.49
TR-3-10	42.39	32.21	25.40	2.062	1.570	10	10.54
TR-3-11	46.20	34.79	19.01	2.251	1.759	11	11.59
TR-3-12	44.44	34.06	21.50	1.979	1.487	12	12.65
TR-3-13	40.69	32.34	26.97	1.778	1.286	13	13.70
TR-3-14	40.09	32.47	27.44	1.612	1.119	14	14.76
TR-3-15	48.82	33.73	17.45	2.035	1.542	15	15.81
TR-3-16	30.01	33.79	36.19	2.065	1.573	16	16.86
TR-3-17	41.29	35.98	22.73	1.828	1.335	17	17.92
TR-3-18	38.22	31.88	29.90	1.577	1.085	18	18.97
TR-3-19	33.44	31.15	35.41	1.730	1.238	19	20.03
TR-3-20	38.06	30.88	31.06	1.604	1.112	20	21.08
TR-3-21	39.68	30.63	29.69	1.644	1.152	21	22.13
TR-3-22	39.47	30.54	29.99	1.586	1.094	22	23.19
TR-3-23	37.56	30.06	32.38	1.767	1.275	23	24.24
TR-3-24	37.16	29.22	33.62	1.659	1.166	24	25.30
TR-3-25	37.48	29.37	33.16	1.578	1.086	25	26.35
TR-3-26	37.37	30.02	32.61	1.704	1.211	26	27.40
TR-3-27	37.99	29.37	32.65	1.297	0.805	27	28.46
TR-3-28	38.01	28.74	33.25	1.413	0.920	28	29.51
TR-3-29	37.45	31.52	31.03	1.305	0.812	29	30.57
TR-3-30	14.03	28.37	57.60	1.252	0.759	30	31.62
TR-3-31	33.22	31.27	35.50	1.169	0.677	31	32.67
TR-3-32	38.55	31.08	30.37	1.307	0.815	32	33.73
TR-3-33	59.69	31.09	9.22	1.627	1.135	33	34.78
TR-3-34	41.89	31.08	27.04	1.404	0.912	34	35.84
TR-3-35	34.34	31.34	34.32	1.210	0.718	35	36.89
TR-3-36	58.20	31.27	10.53	1.435	0.943	36	37.94
TR-3-37	36.88	31.08	32.05	1.443	0.951	37	39.00
TR-3-38	35.83	30.68	33.49	1.569	1.077	38	40.14
TR-3-39	36.42	30.14	33.44	1.457	0.964	39	41.29
TR-3-40	52.25	30.22	17.53	1.476	0.983	40	42.43
TR-3-41	37.26	31.47	31.27	1.346	0.854	41	43.57
TR-3-42	36.73	31.75	31.53	1.349	0.856	42	44.71
TR-3-43	36.28	31.55	32.17	1.169	0.677	43	45.86
TR-3-44	35.92	30.95	33.12	1.430	0.938	44	47.00
TR-3-45	36.24	30.48	33.28	1.264	0.772	45	48.27

TR-3 (cont.)

Sample No.	% Water	LOI (% Org.)	% Min.	Pb-210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-3-46	36.65	30.80	32.55	1.231	0.739	46	49.53
TR-3-47	37.04	31.49	31.47	1.161	0.669	47	50.80
TR-3-48	36.93	30.74	32.33	1.200	0.707	48	52.07
TR-3-49	37.60	31.03	31.38	1.045	0.553	49	53.34
TR-3-50	36.28	30.08	33.64	0.990	0.498	50	54.60
TR-3-51	34.79	30.62	34.60	0.886	0.394	51	55.87
TR-3-52	34.11	30.95	34.94	0.971	0.478	52	57.11
TR-3-53	34.29	30.74	34.97	1.048	0.556	53	58.33
TR-3-54	33.53	30.28	36.19	0.966	0.474	54	59.55
TR-3-55	34.73	30.14	35.13	1.079	0.586	55	60.77
						56	62.00

TR-4

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc.	Depth (cm)	Corr. Depth
TR-4-1	70.72	19.86	9.43	4.271	3.820		1.00	1.06
TR-4-2	67.30	17.38	15.32	3.483	3.032		2.00	2.12
TR-4-3	55.00	11.22	33.78	2.696	2.246		3.00	3.17
TR-4-4	60.13	20.82	19.04	3.786	3.335		4.00	4.23
TR-4-5	47.86	10.20	41.94	2.429	1.978		5.00	5.29
TR-4-6	45.03	7.89	47.08	2.624	2.173		6.00	6.35
TR-4-7	47.55	10.35	42.10	2.875	2.425		7.00	7.40
TR-4-8	50.13	12.12	37.75	3.432	2.982		8.00	8.46
TR-4-9	39.55	6.65	53.80	2.294	1.843		9.00	9.52
TR-4-10	42.27	7.57	50.16	2.577	2.126		10.00	10.58
TR-4-11	41.69	7.47	50.84	2.595	2.145		11.00	11.64
TR-4-12	43.78	8.50	47.71	2.275	1.824		12.00	12.69
TR-4-13	42.31	8.55	49.15	2.382	1.932		13.00	13.75
TR-4-14	43.46	8.19	48.35	2.750	2.299		14.00	14.81
TR-4-15	41.80	7.00	51.20	2.276	1.825		15.00	15.87
TR-4-16	42.77	7.91	49.32	2.361	1.910		16.00	16.92
TR-4-17	42.33	4.92	52.75	2.305	1.854		17.00	17.98
TR-4-18	44.20	6.15	49.65	2.697	2.247		18.00	19.04
TR-4-19	42.28	7.60	50.12	2.169	1.718		19.00	20.10
TR-4-20	43.08	7.62	49.30	2.926	2.475		20.00	21.15
TR-4-21	36.51	4.57	58.92	2.378	1.928		21.00	22.21
TR-4-22	36.28	3.68	60.04	1.572	1.122		22.00	23.27
TR-4-23	43.17	5.66	51.17	2.788	2.337		23.00	24.33
TR-4-24	41.07	4.95	53.98	2.053	1.602		24.00	25.39
TR-4-25	41.92	4.95	53.13	1.912	1.462		25.00	26.44
TR-4-26	41.78	4.63	53.59	1.809	1.358		26.00	27.50
TR-4-27	40.05	4.53	55.42	1.874	1.423		27.00	28.56
TR-4-28	41.47	5.85	52.68	2.033	1.582		28.00	29.62
TR-4-29	45.95	7.32	46.73	2.553	2.102		29.00	30.67
TR-4-30	46.21	6.97	46.82	3.074	2.623		30.00	31.73
TR-4-31	45.80	6.77	47.42	2.734	2.284		31.00	32.79
TR-4-32	47.75	9.86	42.38	3.376	2.925		32.00	33.85
TR-4-33	47.87	7.87	44.26	1.331	0.881		33.00	34.90
TR-4-34	46.45	7.09	46.46	1.728	1.277		34.00	35.96
TR-4-35	45.48	6.68	47.84	2.072	1.621		35.00	37.02
TR-4-36	47.81	8.18	44.00	2.139	1.688		36.00	38.08
TR-4-37	46.96	12.39	40.65	1.375	0.924		37.00	39.14
TR-4-38	46.85	12.83	40.32	1.275	0.824		38.00	40.19
TR-4-39	44.59	11.33	44.08	1.148	0.697		39.00	41.25
TR-4-40	44.92	11.88	43.20	1.186	0.735		40.00	42.31
TR-4-41	43.42	8.97	47.61	1.089	0.639		41.00	43.37
TR-4-42	42.42	11.32	46.26	1.006	0.555		42.00	44.42
TR-4-43	40.38	11.39	48.22	1.119	0.669		43.00	45.48
TR-4-44	40.44	11.83	47.73	1.172	0.721		44.00	46.54
TR-4-45	39.78	5.02	55.20	1.098	0.647		45.00	47.60
TR-4-46	38.28	1.41	60.31	0.919	0.468		46.00	48.65
TR-4-47	36.00	1.25	62.75	0.826	0.375		47.00	49.71
TR-4-48	32.20	16.64	51.16	0.688	0.237		48.00	50.77
TR-4-49	31.55	8.00	60.45	0.673	0.223		49.00	51.83

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-4-50	30.14	6.58	63.27	0.587	0.136	50.00	52.89
TR-4-51	28.87	6.59	64.54	0.543	0.093	51.00	53.94
TR-4-52	27.36	6.71	65.93	0.528	0.077	52.00	55.00
TR-4-53	30.02	7.52	62.46	0.597	0.146	53.00	56.43
TR-4-54	30.43	7.49	62.08	0.502	0.052	54.00	57.86
TR-4-55	30.82	7.02	62.16	0.877	0.426	55.00	59.29
TR-4-56	31.05	7.77	61.18	0.564	0.113	56.00	60.72
TR-4-57	31.03	7.37	61.61	0.537	0.086	57.00	62.15
TR-4-58	31.25	6.60	62.15	0.518	0.068	58.00	63.58
TR-4-59	31.46	6.87	61.67	0.570	0.119	59.00	65.00
TR-4-60	30.38	7.25	62.37	0.527	0.076	60.00	66.00
TR-4-61	30.16	6.99	62.85	0.499	0.048	61.00	67.00
TR-4-62	28.88	5.84	65.28	0.489	0.039	62.00	68.00
TR-4-63	27.51	5.11	67.38	0.507	0.056	63.00	69.00
TR-4-64	26.75	6.46	66.79	0.547	0.096	64.00	70.00
TR-4-65	27.85	5.44	66.71	0.473	0.022	65.00	71.00
TR-4-66	25.33	5.06	69.61	0.488	0.038	66.00	72.00
TR-4-67	24.83	5.03	70.14	0.502	0.051	67.00	73.00
				0.451		68.00	74.00
						69.00	75.00
						70.00	76.00
						71.00	77.00
						72.00	78.00

TR-5X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-5X-1	63.04	31.02	5.94	3.718	3.418	1.00	1.03
TR-5X-2	65.41	27.44	7.14	3.736	3.436	2.00	2.05
TR-5X-3	62.37	32.29	5.35	3.614	3.314	3.00	3.08
TR-5X-4	59.05	30.24	10.71	4.336	4.036	4.00	4.11
TR-5X-5	60.99	25.16	13.86	4.074	3.774	5.00	5.14
TR-5X-6	73.02	18.65	8.33	2.877	2.577	6.00	6.16
TR-5X-7	69.02	15.42	15.55	2.305	2.005	7.00	7.19
TR-5X-8	68.21	15.01	16.77	2.372	2.072	8.00	8.22
TR-5X-9	65.84	14.05	20.11	2.134	1.834	9.00	9.24
TR-5X-10	66.71	14.05	19.24	2.303	2.003	10.00	10.27
TR-5X-11	67.13	17.87	15.00	2.307	2.007	11.00	11.30
TR-5X-12	66.19	21.92	11.89	2.686	2.386	12.00	12.32
TR-5X-13	67.06	23.79	9.15	2.758	2.458	13.00	13.35
TR-5X-14	73.37	22.65	3.98	2.327	2.027	14.00	14.38
TR-5X-15	65.70	15.55	18.75	1.886	1.586	15.00	15.41
TR-5X-16	67.60	16.92	15.48	1.566	1.266	16.00	16.43
TR-5X-17	65.43	16.82	17.75	1.699	1.399	17.00	17.46
TR-5X-18	67.40	18.66	13.94	1.826	1.526	18.00	18.49
TR-5X-19	62.68	14.54	22.77	1.309	1.009	19.00	19.51
TR-5X-20	55.81	11.61	32.58	1.179	0.879	20.00	20.54
TR-5X-21	53.73	10.83	35.44	1.087	0.787	21.00	21.57
TR-5X-22	51.16	9.60	39.24	1.154	0.854	22.00	22.59
TR-5X-23	52.43	10.16	37.41	1.122	0.822	23.00	23.62
TR-5X-24	52.39	9.18	38.43	1.061	0.761	24.00	24.65
TR-5X-25	52.69	8.96	38.34	1.090	0.790	25.00	25.68
TR-5X-26	54.06	9.31	36.63	1.131	0.831	26.00	26.70
TR-5X-27	55.29	9.49	35.22	1.201	0.901	27.00	27.73
TR-5X-28	55.04	9.98	34.98	1.442	1.142	28.00	28.76
TR-5X-29	53.25	9.63	37.13	0.934	0.634	29.00	29.78
TR-5X-30	52.60	9.36	38.04	1.312	1.012	30.00	30.81
TR-5X-31	51.81	8.91	39.28	1.043	0.743	31.00	31.84
TR-5X-32	48.64	8.32	43.04	1.055	0.755	32.00	32.86
TR-5X-33	46.48	7.60	45.92	1.001	0.701	33.00	33.89
TR-5X-34	47.69	7.98	44.33	1.309	1.009	34.00	34.92
TR-5X-35	45.76	7.48	46.76	0.860	0.560	35.00	35.95
TR-5X-36	41.63	6.93	51.44	0.857	0.557	36.00	36.97
TR-5X-37	36.84	7.78	55.38	1.142	0.842	37.00	38.00
TR-5X-38	36.55	7.94	55.51	0.711	0.411	38.00	39.00
TR-5X-39	34.26	7.98	57.76	0.767	0.467	39.00	40.00
TR-5X-40	34.30	7.71	57.99	0.688	0.388	40.00	41.00
TR-5X-41	32.50	7.97	59.54	0.701	0.401	41.00	42.00
TR-5X-42	33.92	7.94	58.14	0.730	0.430	42.00	43.00
TR-5X-43	33.33	8.17	58.50	0.751	0.451	43.00	44.00
TR-5X-44	34.62	7.97	57.41	0.744	0.444	44.00	45.00
TR-5X-45	32.05	8.13	59.81	0.721	0.421	45.00	46.00
TR-5X-46	30.05	7.74	62.21	0.723	0.423	46.00	47.00
TR-5X-47	29.65	8.17	62.19	0.898	0.598	47.00	48.00
TR-5X-48	29.71	8.12	62.17	0.614	0.314	48.00	49.00

TR-5X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-5X-49	29.19	7.57	63.24	0.668	0.368	49.00	50.00
TR-5X-50	29.94	8.10	61.95	0.690	0.390	50.00	51.00
TR-5X-51	28.64	7.75	63.61	0.574	0.274	51.00	52.00
TR-5X-52	28.37	7.58	64.04	0.617	0.317	52.00	53.00
TR-5X-53	28.51	8.38	63.11	0.651	0.351	53.00	54.00
TR-5X-54	28.19	7.74	64.07	0.621	0.321	54.00	55.00
TR-5X-55	28.32	8.06	63.63	0.765	0.465	55.00	56.00
TR-5X-56	28.46	7.77	63.77	0.318	0.101	56.00	57.00
TR-5X-57	30.00	8.15	61.85	0.641	0.341	57.00	58.00
TR-5X-58	29.37	7.31	63.31	0.482	0.182	58.00	59.00
TR-5X-59	29.18	7.39	63.43	0.531	0.231	59.00	60.00
TR-5X-60	28.82	7.51	63.67	0.670	0.370	60.00	61.00
TR-5X-61	29.22	7.36	63.43	0.564	0.264	61.00	62.00
TR-5X-62	28.99	7.60	63.41	0.556	0.256	62.00	63.00
TR-5X-63	28.29	8.13	63.57	0.539	0.239	63.00	64.00
TR-5X-64	28.41	7.17	64.42	0.574	0.274	64.00	65.28
TR-5X-65	28.67	6.59	64.74	0.489	0.189	65.00	66.56
TR-5X-66	28.84	6.31	64.84	0.592	0.292	66.00	67.83
TR-5X-67	29.21	6.36	64.43	0.623	0.323	67.00	69.11
TR-5X-68	28.90	6.89	64.21	0.610	0.310	68.00	70.39
TR-5X-69	29.00	6.79	64.22	0.702	0.402	69.00	71.67
TR-5X-70	30.13	6.79	63.08	0.513	0.213	70.00	72.95
TR-5X-71	30.48	7.09	62.43	0.582	0.282	71.00	74.22
						72.00	75.50

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-6-1	55.94	15.55	28.51	2.600	2.108	1.00	1.00
TR-6-2	49.48	12.45	38.07	2.298	1.806	2.00	2.00
TR-6-3	53.95	12.28	33.77	2.744	2.252	3.00	3.00
TR-6-4	52.08	11.71	36.21	2.587	2.095	4.00	4.00
TR-6-5	52.39	11.93	35.68	2.807	2.315	5.00	5.00
TR-6-6	56.81	14.14	29.05	3.214	2.722	6.00	6.00
TR-6-7	57.14	15.14	27.72	3.466	2.973	7.00	7.00
TR-6-8	45.65	6.56	47.79	1.610	1.118	8.00	8.00
TR-6-9	50.83	10.30	38.87	2.301	1.808	9.00	9.00
TR-6-10	49.72	10.10	40.18	2.519	2.026	10.00	10.00
TR-6-11	49.07	10.32	40.61	2.438	1.945	11.00	11.00
TR-6-12	43.59	8.75	47.66	2.073	1.581	12.00	12.00
TR-6-13	41.14	7.11	51.75	1.707	1.215	13.00	13.00
TR-6-14	40.11	7.36	52.54	1.728	1.236	14.00	14.00
TR-6-15	41.59	7.78	50.62	1.752	1.260	15.00	15.00
TR-6-16	42.51	6.96	50.54	1.514	1.022	16.00	16.00
TR-6-17	41.74	6.57	51.68	1.524	1.032	17.00	17.00
TR-6-18	44.27	7.16	48.57	1.345	0.852	18.00	18.00
TR-6-19	41.31	6.94	51.74	1.509	1.017	19.00	19.00
TR-6-20	39.80	6.30	53.91	1.331	0.838	20.00	20.00
TR-6-21	38.77	7.77	53.46	1.515	1.023	21.00	21.00
TR-6-22	36.47	7.55	55.98	1.406	0.913	22.00	22.00
TR-6-23	35.35	6.57	58.07	1.291	0.799	23.00	23.00
TR-6-24	33.49	5.99	60.52	0.916	0.424	24.00	24.00
TR-6-25	31.11	5.57	63.32	0.790	0.297	25.00	25.00
TR-6-26	31.41	4.76	63.83	0.800	0.308	26.00	26.00
TR-6-27	29.20	4.56	66.24	0.656	0.164	27.00	27.00
TR-6-28	29.61	3.59	66.81	0.631	0.138	28.00	28.14
TR-6-29	30.68	3.98	65.34	0.597	0.104	29.00	29.29
TR-6-30	29.68	3.18	67.14	0.575	0.083	30.00	30.43
TR-6-31	28.98	3.18	67.84	0.550	0.057	31.00	31.57
TR-6-32	29.82	3.60	66.58	0.530	0.038	32.00	32.72
TR-6-33	28.43	3.56	68.01	0.551	0.059	33.00	33.86
TR-6-34	28.03	3.37	68.60	0.583	0.091	34.00	35.00
TR-6-35	29.75	2.98	67.27	0.558	0.066	35.00	36.14
TR-6-36	28.77	2.79	68.44	0.621	0.128	36.00	37.29
TR-6-37	21.66	3.55	74.79	0.700	0.208	37.00	38.43
TR-6-38	20.84	3.95	75.21	0.734	0.242	38.00	39.57
TR-6-39	21.73	4.39	73.88	0.607	0.114	39.00	40.72
TR-6-40	21.50	4.16	74.34	0.674	0.182	40.00	41.86
TR-6-41	22.12	3.77	74.11	0.568	0.076	41.00	43.00
TR-6-42	22.59	3.39	74.02	0.602	0.110	42.00	44.09
TR-6-43	23.11	3.98	72.91	0.572	0.080	43.00	45.18
TR-6-44	22.69	3.77	73.54	0.577	0.084	44.00	46.27
TR-6-45	23.30	4.19	72.50	0.533	0.040	45.00	47.36
TR-6-46	52.57	3.98	43.45	0.524	0.032	46.00	48.45
TR-6-47	23.95	3.79	72.25	0.718	0.226	47.00	49.54
TR-6-48	24.03	4.17	71.80	0.573	0.081	48.00	50.63

TR-6

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-6-49	24.97	3.78	71.25	0.566	0.074	49.00	51.72
TR-6-50	25.48	3.99	70.53		0.008	50.00	52.81
TR-6-51	26.94	4.77	68.29	0.501	0.008	51.00	53.90
TR-6-52	28.24	5.36	66.40	0.688	0.195	52.00	55.00
TR-6-53	29.02	4.78	66.20	0.845	0.353	53.00	56.25
TR-6-54	28.43	4.79	66.78	1.038	0.545	54.00	57.50
TR-6-55	28.65	4.56	66.78	1.010	0.517	55.00	58.75
TR-6-56	28.14	7.18	64.67	1.179	0.687	56.00	60.00
TR-6-57	25.73	6.46	67.81	1.388	0.896	57.00	61.25
TR-6-58	24.44	24.21	51.34	0.874	0.381	58.00	62.50
TR-6-59	22.85	22.76	54.38	0.697	0.205	59.00	63.75
TR-6-60	22.81	23.72	53.48	0.607	0.115	60.00	65.00
TR-6-61	24.29	24.16	51.55	0.741	0.249	61.00	66.25
TR-6-62	23.62	23.50	52.89	0.712	0.219	62.00	67.50
TR-6-63	24.93	23.87	51.20	0.643	0.151	63.00	68.75
				0.703		64.00	70.00

TR-7

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-7-1	64.56	15.90	19.53	2.315	1.822	1.00	1.04
TR-7-2	62.23	17.00	20.77	2.407	1.915	2.00	2.08
TR-7-3	62.59	17.89	19.53	2.589	2.097	3.00	3.12
TR-7-4	63.21	16.22	20.57	2.336	1.843	4.00	4.16
TR-7-5	60.52	15.72	23.76	2.357	1.865	5.00	5.20
TR-7-6	65.32	20.77	13.90	2.818	2.326	6.00	6.24
TR-7-7	58.07	16.37	25.56	2.711	2.219	7.00	7.28
TR-7-8	56.63	14.90	28.47	2.212	1.720	8.00	8.32
TR-7-9	58.48	15.87	25.64	2.507	2.014	9.00	9.36
TR-7-10	54.25	13.29	32.46	2.300	1.807	10.00	10.40
TR-7-11	56.32	15.51	28.18	2.529	2.036	11.00	11.44
TR-7-12	55.72	14.17	30.11	2.319	1.827	12.00	12.48
TR-7-13	58.87	16.63	24.49	2.434	1.942	13.00	13.52
TR-7-14	55.08	13.72	31.20	1.768	1.276	14.00	14.56
TR-7-15	53.16	11.46	35.38	1.875	1.383	15.00	15.60
TR-7-16	53.57	10.91	35.51	1.743	1.250	16.00	16.64
TR-7-17	53.41	12.01	34.59	1.775	1.283	17.00	17.68
TR-7-18	52.02	12.13	35.85	1.735	1.243	18.00	18.72
TR-7-19	55.32	13.83	30.84	1.694	1.201	19.00	19.76
TR-7-20	55.00	14.37	30.63	1.767	1.274	20.00	20.80
TR-7-21	56.69	13.66	29.65	1.961	1.469	21.00	21.84
TR-7-22	55.73	12.43	31.85	1.722	1.230	22.00	22.88
TR-7-23	55.95	13.20	30.85	1.586	1.094	23.00	23.92
TR-7-24	55.33	11.90	32.76	1.339	0.846	24.00	24.96
TR-7-25	55.04	12.60	32.36	1.585	1.093	25.00	26.00
TR-7-26	56.09	12.72	31.18	1.693	1.201	26.00	27.04
TR-7-27	55.13	13.04	31.83	1.667	1.175	27.00	28.08
TR-7-28	54.52	11.59	33.89	1.676	1.184	28.00	29.12
TR-7-29	55.81	12.75	31.44	1.706	1.213	29.00	30.16
TR-7-30	57.16	11.81	31.03	1.676	1.184	30.00	31.20
TR-7-31	55.83	12.09	32.08	1.495	1.003	31.00	32.24
TR-7-32	56.19	12.15	31.66	1.467	0.975	32.00	33.28
TR-7-33	54.37	11.83	33.80	1.576	1.083	33.00	34.32
TR-7-34	55.01	12.67	32.32	1.553	1.061	34.00	35.36
TR-7-35	52.16	10.98	36.86	1.502	1.010	35.00	36.40
TR-7-36	49.31	11.55	39.14	1.399	0.907	36.00	37.44
TR-7-37	49.04	9.16	41.79	1.465	0.973	37.00	38.48
TR-7-38	47.21	9.50	43.29	1.506	1.013	38.00	39.52
TR-7-39	45.77	8.78	45.45	1.386	0.894	39.00	40.56
TR-7-40	43.31	8.50	48.19	1.231	0.738	40.00	41.60
TR-7-41	42.01	8.15	49.84	1.360	0.868	41.00	42.64
TR-7-42	41.55	6.72	51.73	1.257	0.765	42.00	43.68
TR-7-43	41.22	6.36	52.42	1.129	0.637	43.00	44.72
TR-7-44	41.69	6.89	51.42	1.257	0.765	44.00	45.76
TR-7-45	41.61	7.14	51.25	1.238	0.746	45.00	46.80
TR-7-46	19.18	6.40	74.42	1.271	0.779	46.00	47.84
TR-7-47	11.01	6.34	82.66	1.223	0.731	47.00	48.88
TR-7-48	43.55	6.90	49.55	1.270	0.778	48.00	49.92

TR-7

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-7-49	42.07	6.37	51.56	1.348	0.856	49.00	50.96
TR-7-50	25.27	5.34	69.40	1.059	0.567	50.00	52.00
TR-7-51	47.52	5.95	46.52	1.102	0.609	51.00	53.00
TR-7-52	36.84	5.92	57.24	0.966	0.474	52.00	54.00
TR-7-53	36.83	6.13	57.04	1.022	0.530	53.00	55.00
TR-7-54	38.13	5.96	55.90	1.039	0.546	54.00	56.00
TR-7-55	43.18	8.73	48.09	1.154	0.661	55.00	57.00
TR-7-56	45.02	8.95	46.04	1.100	0.607	56.00	58.00
TR-7-57	54.87	10.98	34.15	1.205	0.713	57.00	59.00
TR-7-58	46.06	10.74	43.20	1.270	0.778	58.00	60.00
TR-7-59	44.67	10.65	44.68	1.039	0.546	59.00	61.00
TR-7-60	44.69	10.32	45.00	1.082	0.590	60.00	62.50
TR-7-61	45.65	10.56	43.80	1.005	0.513	61.00	64.00
TR-7-62	47.24	9.43	43.33	1.014	0.522	62.00	65.50
TR-7-63	45.68	9.31	45.01	0.982	0.490	63.00	67.00
TR-7-64	46.12	9.60	44.28	0.895	0.403	64.00	68.50
TR-7-65	49.88	9.72	40.39	1.087	0.595	65.00	70.00
TR-7-66	47.73	9.38	42.89	1.003	0.510	66.00	71.00

TR-8

Sample No.	% Water	LOI (% Org.)	% Min.	Pb-210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-8-1	66.77	25.48	7.75	3.414	2.921	1	1.00
TR-8-2	58.35	33.33	8.32	5.073	4.581	2	2.00
TR-8-3	61.55	34.64	3.81	5.579	5.087	3	3.00
TR-8-4	68.55	27.66	3.79	3.206	2.714	4	4.00
TR-8-5	65.01	19.26	15.73	3.496	3.004	5	5.00
TR-8-6	64.07	16.13	19.8	3.461	2.969	6	6.00
TR-8-7	63.56	16.13	20.31	4.008	3.515	7	7.00
TR-8-8	61.57	15.17	23.26	3.187	2.695	8	8.00
TR-8-9	60.16	14.2	25.64	2.257	1.765	9	9.00
TR-8-10	59.42	13.49	27.09	2.218	1.726	10	10.00
TR-8-11	59.13	13.29	27.58	2.252	1.76	11	11.00
TR-8-12	58.1	12.75	29.15	2.329	1.836	12	12.00
TR-8-13	56.1	12.43	31.47	1.847	1.355	13	13.00
TR-8-14	54.84	12.52	32.63	1.723	1.231	14	14.00
TR-8-15	54.19	12.75	33.06	1.734	1.242	15	15.00
TR-8-16	53.37	12.65	33.98	1.893	1.401	16	16.00
TR-8-17	54.82	12.55	32.63	1.702	1.21	17	17.00
TR-8-18	54.68	13.24	32.08	2.194	1.702	18	18.00
TR-8-19	54.31	12.6	33.09	1.749	1.257	19	19.00
TR-8-20	53.07	13.57	33.36	1.726	1.234	20	20.00
TR-8-21	57.28	14.44	28.27	2.06	1.567	21	21.00
TR-8-22	57.6	13.82	28.58	2.166	1.674	22	22.00
TR-8-23	56.72	14.36	28.92	2.056	1.563	23	23.00
TR-8-24	56.71	14.66	28.63	2.03	1.538	24	24.00
TR-8-25	55.38	13.52	31.1	2.009	1.516	25	25.00
TR-8-26	51.78	12.18	36.05	1.669	1.177	26	26.00
TR-8-27	48.81	11.98	39.21	1.218	0.725	27	27.00
TR-8-28	47.15	11.38	41.47	1.263	0.771	28	28.00
TR-8-29	45.97	10.8	43.23	1.406	0.914	29	29.00
TR-8-30	47.03	10.14	42.83	1.42	0.928	30	30.00
TR-8-31	47.07	10.58	42.35	1.44	0.948	31	31.00
TR-8-32	46.11	11.33	42.56	1.516	1.024	32	32.00
TR-8-33	46.52	11.73	41.75	1.56	1.068	33	33.00
TR-8-34	47.48	11.58	40.94	1.637	1.145	34	34.00
TR-8-35	47.23	11.13	41.64	1.731	1.239	35	35.00
TR-8-36	46.91	11.29	41.8	1.703	1.211	36	36.00
TR-8-37	36.65	9.34	54.01	1.141	0.648	37	37.00
TR-8-38	37.23	9.96	52.81	1.149	0.657	38	38.00
TR-8-39	37.67	10.69	51.64	1.149	0.657	39	39.00
TR-8-40	38.37	10.74	50.9	0.961	0.469	40	40.00
TR-8-41	39.21	11.9	48.89	0.886	0.394	41	41.00
TR-8-42	39.58	15	45.42	0.981	0.489	42	42.00
TR-8-43	42.6	16.27	41.13	1.056	0.563	43	43.00
TR-8-44	36.75	16.8	46.45	0.876	0.384	44	44.00

TR-8 (cont.)

Sample No.	% Water	LOI (% Org.)	% Min.	Pb-210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-8-45	42	15.51	42.5	0.763	0.271	45	45.00
TR-8-46	36.89	14.59	48.52	1.069	0.577	46	46.00
TR-8-47	39.3	14.74	45.96	0.814	0.321	47	47.08
TR-8-48	35.85	14.06	50.09	0.706	0.214	48	48.16
TR-8-49	36.95	12.3	50.75	0.93	0.437	49	49.24
TR-8-50	34.84	12.13	53.04	0.607	0.115	50	50.32
TR-8-51	33.63	10.98	55.39	0.607	0.115	51	51.41
TR-8-52	31.47	10.74	57.79	0.652	0.159	52	52.49
TR-8-53	30.72	10.54	58.74	0.652	0.16	53	53.57
TR-8-54	32.48	10	57.52	0.697	0.205	54	54.65
TR-8-55	35.76	9.96	54.28	0.706	0.213	55	55.73
TR-8-56	36.08	9.8	54.12	0.64	0.148	56	56.81
TR-8-57	36.17	9.7	54.12	0.952	0.46	57	57.89
TR-8-58	35.93	8.58	55.48	0.68	0.187	58	58.97
TR-8-59	36.69	9.16	54.15	0.596	0.104	59	60.05
TR-8-60	36.24	8.75	55.01	0.643	0.15	60	61.14
TR-8-61	35.62	7.71	56.67	1.088	0.596	61	62.22
TR-8-62	35.3	8.33	56.37	0.507	0.015	62	63.30
TR-8-63	34.96	7.95	57.09	0.942	0.449	63	64.38
TR-8-64	35.17	7.97	56.86	0.939	0.446	64	65.46
TR-8-65	33.96	7.13	58.91	0.934	0.441	65	66.57
TR-8-66	34.52	7.17	58.31	0.89	0.398	66	67.71
TR-8-67	34.35	7.55	58.1	0.857	0.365	67	68.86
TR-8-68	34.41	7.36	58.24	0.739	0.247	68	70.00
TR-8-69	35.48	6.6	57.92	0.926	0.434	69	71.40
TR-8-70	36.06	8	55.94	0.961	0.469	70	72.80
TR-8-71	35.51	7.77	56.72	0.917	0.425	71	74.20
TR-8-72	35.68	6.53	57.79	0.748	0.255	72	75.60
						73	77.00

TR-9X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-9X-1	52.59	16.92	30.49	1.859	1.367	1.00	1.10
TR-9X-2	59.58	18.11	22.30	2.401	1.909	2.00	2.20
TR-9X-3	60.47	17.47	22.06	2.279	1.787	3.00	3.29
TR-9X-4	52.61	16.77	30.63	2.039	1.547	4.00	4.39
TR-9X-5	54.27	15.87	29.86	2.048	1.556	5.00	5.49
TR-9X-6	50.73	12.33	36.95	1.700	1.208	6.00	6.58
TR-9X-7	46.72	10.93	42.35	1.305	0.813	7.00	7.68
TR-9X-8	49.36	13.39	37.26	1.655	1.162	8.00	8.78
TR-9X-9	49.90	12.33	37.77	1.587	1.095	9.00	9.87
TR-9X-10	43.19	9.76	47.05	1.354	0.861	10.00	10.97
TR-9X-11	42.99	11.00	46.01	1.593	1.100	11.00	12.07
TR-9X-12	42.43	9.96	47.61	1.334	0.841	12.00	13.17
TR-9X-13	39.53	8.32	52.16	1.270	0.777	13.00	14.26
TR-9X-14	37.52	7.52	54.96	1.074	0.582	14.00	15.36
TR-9X-15	37.00	7.19	55.81	1.190	0.698	15.00	16.46
TR-9X-16	33.81	7.98	58.20	1.153	0.660	16.00	17.55
TR-9X-17	33.90	7.74	58.36	1.163	0.670	17.00	18.65
TR-9X-18	32.07	7.17	60.75	1.259	0.767	18.00	19.75
TR-9X-19	32.97	7.92	59.11	1.201	0.709	19.00	20.84
TR-9X-20	29.47	6.77	63.75	1.124	0.631	20.00	21.94
TR-9X-21	33.04	6.52	60.44	1.133	0.641	21.00	23.04
TR-9X-22	32.50	6.39	61.11	1.117	0.624	22.00	24.13
TR-9X-23	32.00	6.57	61.42	1.065	0.573	23.00	25.23
TR-9X-24	34.20	6.53	59.26	1.164	0.672	24.00	26.33
TR-9X-25	37.71	6.69	55.60	1.170	0.677	25.00	27.42
TR-9X-26	40.39	7.16	52.45	1.338	0.846	26.00	28.52
TR-9X-27	38.43	7.33	54.24	1.356	0.864	27.00	29.62
TR-9X-28	38.63	6.35	55.02	1.302	0.809	28.00	30.71
TR-9X-29	39.42	6.36	54.22	1.267	0.774	29.00	31.81
TR-9X-30	38.13	6.19	55.69	1.254	0.762	30.00	32.91
TR-9X-31	34.67	5.88	59.44	1.272	0.780	31.00	34.00
TR-9X-32	35.93	6.13	57.94	1.267	0.775	32.00	35.25
TR-9X-33	35.39	6.88	57.73	1.031	0.539	33.00	36.50
TR-9X-34	37.88	5.58	56.54	1.063	0.571	34.00	37.75
TR-9X-35	38.86	6.34	54.80	1.087	0.595	35.00	39.00
TR-9X-36	39.27	6.37	54.36	1.250	0.757	36.00	40.21
TR-9X-37	39.66	8.37	51.97	1.113	0.621	37.00	41.42
TR-9X-38	37.48	8.93	53.60	1.221	0.729	38.00	42.63
TR-9X-39	37.03	9.11	53.86	1.245	0.753	39.00	43.84
TR-9X-40	37.65	8.73	53.61	1.245	0.752	40.00	45.05
TR-9X-41	36.61	8.57	54.82	1.150	0.657	41.00	46.26
TR-9X-42	37.70	8.35	53.95	1.243	0.751	42.00	47.50
TR-9X-43	37.55	8.51	53.93	1.492	1.000	43.00	48.63
TR-9X-44	37.92	8.66	53.41	1.160	0.668	44.00	49.75
TR-9X-45	38.67	8.73	52.60	1.070	0.577	45.00	50.88
TR-9X-46	39.20	8.12	52.68	1.154	0.661	46.00	52.00
TR-9X-47	38.41	9.09	52.50	1.051	0.559	47.00	53.13
TR-9X-48	38.39	8.68	52.93	0.989	0.496	48.00	54.25

TR-9X

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-9X-49	39.20	7.75	53.04	1.030	0.537	49.00	55.38
TR-9X-50	39.80	8.28	51.91	1.056	0.563	50.00	56.50
TR-9X-51	39.13	8.55	52.32	0.954	0.461	51.00	57.67
TR-9X-52	38.32	7.74	53.94	0.850	0.358	52.00	58.83
						53.00	60.00
						54.00	61.17
						55.00	62.33
						56.00	63.50
						57.00	64.67
						58.00	65.83
						59.00	67.00

TR-10

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-10-1	63.84	17.40	18.76	2.385	1.893	1.00	1.03
TR-10-2	64.71	20.09	15.20	2.781	2.288	2.00	2.06
TR-10-3	57.24	16.97	25.80	2.480	1.988	3.00	3.10
TR-10-4	53.75	13.55	32.71	2.122	1.630	4.00	4.13
TR-10-5	53.20	13.92	32.89	2.035	1.543	5.00	5.16
TR-10-6	51.51	13.37	35.12	2.041	1.548	6.00	6.19
TR-10-7	48.10	12.50	39.40	1.893	1.400	7.00	7.22
TR-10-8	46.39	11.90	41.71	1.795	1.303	8.00	8.26
TR-10-9	44.44	12.30	43.25	1.712	1.220	9.00	9.29
TR-10-10	42.80	11.16	46.05	1.793	1.301	10.00	10.32
TR-10-11	42.32	11.78	45.91	1.892	1.400	11.00	11.35
TR-10-12	38.86	11.16	49.98	1.533	1.041	12.00	12.38
TR-10-13	37.70	9.33	52.97	1.590	1.098	13.00	13.42
TR-10-14	38.25	9.52	52.23	1.363	0.871	14.00	14.45
TR-10-15	37.65	10.14	52.21	1.107	0.614	15.00	15.48
TR-10-16	36.76	9.15	54.10	1.414	0.922	16.00	16.51
TR-10-17	35.01	8.91	56.08	1.404	0.911	17.00	17.54
TR-10-18	35.74	8.37	55.89	1.158	0.666	18.00	18.58
TR-10-19	36.58	7.77	55.65	1.276	0.784	19.00	19.61
TR-10-20	36.10	7.52	56.37	1.202	0.710	20.00	20.64
TR-10-21	36.36	6.19	57.45	1.192	0.700	21.00	21.67
TR-10-22	36.41	7.37	56.22	1.256	0.764	22.00	22.70
TR-10-23	35.80	8.37	55.83	1.303	0.811	23.00	23.74
TR-10-24	35.18	7.98	56.84	1.328	0.836	24.00	24.77
TR-10-25	35.41	7.77	56.82	1.155	0.662	25.00	25.80
TR-10-26	36.13	7.74	56.13	1.120	0.628	26.00	26.83
TR-10-27	36.22	7.89	55.89	1.171	0.679	27.00	27.86
TR-10-28	36.81	7.17	56.02	1.149	0.656	28.00	28.90
TR-10-29	36.04	7.55	56.40	1.229	0.737	29.00	29.93
TR-10-30	37.48	7.20	55.32	1.334	0.842	30.00	30.96
TR-10-31	36.62	6.20	57.18	1.047	0.555	31.00	32.00
TR-10-32	35.57	8.17	56.27	1.035	0.543	32.00	33.40
TR-10-33	35.30	7.31	57.38	0.975	0.482	33.00	34.80
TR-10-34	35.95	7.55	56.49	1.050	0.558	34.00	36.20
TR-10-35	36.53	7.75	55.72	1.060	0.568	35.00	37.60
TR-10-36	36.26	6.97	56.76	1.007	0.515	36.00	39.00
TR-10-37	32.53	10.14	57.33	0.983	0.491	37.00	40.40
TR-10-38	32.52	9.76	57.72	1.062	0.570	38.00	41.80
TR-10-39	32.78	9.58	57.64	1.215	0.722	39.00	43.20
TR-10-40	33.18	9.50	57.31	1.143	0.651	40.00	44.60
TR-10-41	33.08	9.58	57.34	1.324	0.832	41.00	46.00
TR-10-42	31.89	9.92	58.19	1.142	0.650	42.00	47.38
TR-10-43	32.79	8.68	58.53	1.095	0.602	43.00	48.75
TR-10-44	33.32	9.16	57.52	0.942	0.450	44.00	50.13
TR-10-45	33.65	8.55	57.80	0.930	0.438	45.00	51.50
TR-10-46	33.25	8.15	58.60	0.884	0.392	46.00	52.88
TR-10-47	31.97	9.33	58.70	0.803	0.310	47.00	54.25
TR-10-48	31.30	9.54	59.15	0.727	0.235	48.00	55.63

TR-10

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-10-49	32.59	8.53	58.87	0.648	0.155	49.00	57.00
TR-10-50	31.27	7.95	60.78	0.661	0.169	50.00	58.67
TR-10-51	30.15	7.54	62.31	0.787	0.295	51.00	60.34
TR-10-52	29.02	8.55	62.43	0.718	0.226	52.00	62.01
TR-10-53	28.09	8.57	63.34	0.723	0.231	53.00	63.68
TR-10-54	29.02	8.13	62.84	0.660	0.168	54.00	65.35
TR-10-55	29.95	7.55	62.50	0.583	0.091	55.00	67.00
TR-10-56	29.60	6.94	63.46	0.634	0.142	56.00	68.17
TR-10-57	29.00	6.19	64.82	0.615	0.123	57.00	69.34
TR-10-58	28.77	5.79	65.44	0.643	0.151	58.00	70.51
TR-10-59	27.54	5.54	66.91	0.603	0.111	59.00	71.68
TR-10-60	27.93	4.76	67.30	0.524	0.031	60.00	72.85
						61.00	74.00

TR-11

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-11-1	69.73	23.12	7.15	2.412	1.919	1.00	1.02
TR-11-2	68.63	18.53	12.84	1.328	0.835	2.00	2.04
TR-11-3	63.85	20.92	15.23	3.033	2.540	3.00	3.06
TR-11-4	58.38	15.00	26.62	2.192	1.700	4.00	4.08
TR-11-5	73.23	14.50	12.27	2.332	1.839	5.00	5.10
TR-11-6	62.15	18.18	19.67	2.799	2.307	6.00	6.12
TR-11-7	62.01	18.48	19.51	3.328	2.836	7.00	7.14
TR-11-8	57.23	16.28	26.48	3.524	3.031	8.00	8.16
TR-11-9	47.11	9.93	42.97	2.052	1.559	9.00	9.18
TR-11-10	48.31	10.96	40.73	1.665	1.173	10.00	10.20
TR-11-11	55.02	13.94	31.05	2.756	2.264	11.00	11.22
TR-11-12	57.54	16.52	25.94	3.446	2.954	12.00	12.24
TR-11-13	53.93	11.31	34.76	2.697	2.204	13.00	13.26
TR-11-14	54.59	14.05	31.37	2.784	2.291	14.00	14.28
TR-11-15	51.34	12.72	35.94	2.620	2.128	15.00	15.30
TR-11-16	52.23	11.62	36.15	2.247	1.755	16.00	16.32
TR-11-17	17.20	10.91	71.89	2.234	1.741	17.00	17.34
TR-11-18	52.70	12.16	35.14	1.824	1.332	18.00	18.36
TR-11-19	61.43	11.57	27.00	2.726	2.234	19.00	19.38
TR-11-20	47.41	11.34	41.25	2.643	2.150	20.00	20.40
TR-11-21	53.68	12.41	33.90	1.965	1.472	21.00	21.42
TR-11-22	52.42	9.79	37.79	1.987	1.494	22.00	22.44
TR-11-23	52.55	11.98	35.47	1.488	0.996	23.00	23.46
TR-11-24	49.41	11.35	39.24	1.801	1.309	24.00	24.48
TR-11-25	50.09	10.40	39.51	1.767	1.275	25.00	25.50
TR-11-26	52.25	11.29	36.45	1.518	1.026	26.00	26.57
TR-11-27	59.10	14.14	26.76	1.626	1.134	27.00	27.64
TR-11-28	55.13	12.27	32.60	1.857	1.365	28.00	28.71
TR-11-29	52.50	12.50	35.00	1.717	1.225	29.00	29.78
TR-11-30	53.64	11.63	34.72	1.799	1.307	30.00	30.85
TR-11-31	50.63	9.52	39.85	1.669	1.177	31.00	31.92
TR-11-32	46.79	10.34	42.87	1.435	0.943	32.00	32.99
TR-11-33	45.68	10.01	44.30	1.134	0.641	33.00	34.06
TR-11-34	46.26	8.26	45.48	1.297	0.805	34.00	35.13
TR-11-35	46.58	9.62	43.80	1.109	0.617	35.00	36.20
TR-11-36	46.73	10.65	42.63	1.624	1.132	36.00	37.27
TR-11-37	46.83	11.51	41.66	1.660	1.168	37.00	38.34
TR-11-38	45.77	13.16	41.07	1.610	1.118	38.00	39.41
TR-11-39	45.08	12.44	42.48	1.747	1.254	39.00	40.48
TR-11-40	45.16	13.22	41.62	1.942	1.449	40.00	41.55
TR-11-41	46.73	14.11	39.16	1.874	1.382	41.00	42.62
TR-11-42	43.78	12.30	43.92	1.530	1.038	42.00	43.69
TR-11-43	46.17	11.55	42.28	1.455	0.963	43.00	44.76
TR-11-44	46.73	11.51	41.75	1.591	1.099	44.00	45.83
TR-11-45	46.15	12.98	40.87	1.482	0.989	45.00	46.90
TR-11-46	45.55	13.55	40.90	1.574	1.082	46.00	48.00
TR-11-47	26.12	11.94	61.94	1.557	1.064	47.00	49.20
TR-11-48	48.26	13.31	38.42	1.599	1.107	48.00	50.40

TR-11

Sample No.	% Water	LOI (% Org.)	% Min.	Pb 210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-11-49	47.41	13.76	38.83	1.553	1.061	49.00	51.60
TR-11-50	45.01	11.03	43.96	1.488	0.995	50.00	52.80
TR-11-51	44.65	11.34	44.01	1.423	0.930	51.00	54.00
TR-11-52	44.72	11.04	44.25	1.289	0.797	52.00	55.20
TR-11-53	43.51	11.61	44.88	1.351	0.858	53.00	56.40
TR-11-54	42.52	11.21	46.28	1.301	0.809	54.00	57.60
TR-11-55	44.23	10.62	45.15	1.226	0.733	55.00	58.80
TR-11-56	43.35	12.48	44.17	1.291	0.798	56.00	60.00
TR-11-57	44.78	10.59	44.63	1.319	0.827	57.00	62.00
TR-11-58	42.60	10.37	47.03	1.035	0.543	58.00	63.10
TR-11-59	40.41	10.06	49.53	1.018	0.525	59.00	64.20
TR-11-60	40.48	10.19	49.34	1.090	0.598	60.00	65.30
TR-11-61	43.46	9.74	46.80	1.276	0.784	61.00	66.40
				1.440		62.00	67.50
				1.312		63.00	68.50
				1.014		64.00	69.50
				0.992		65.00	70.50
				0.930		66.00	71.50
						67.00	72.50

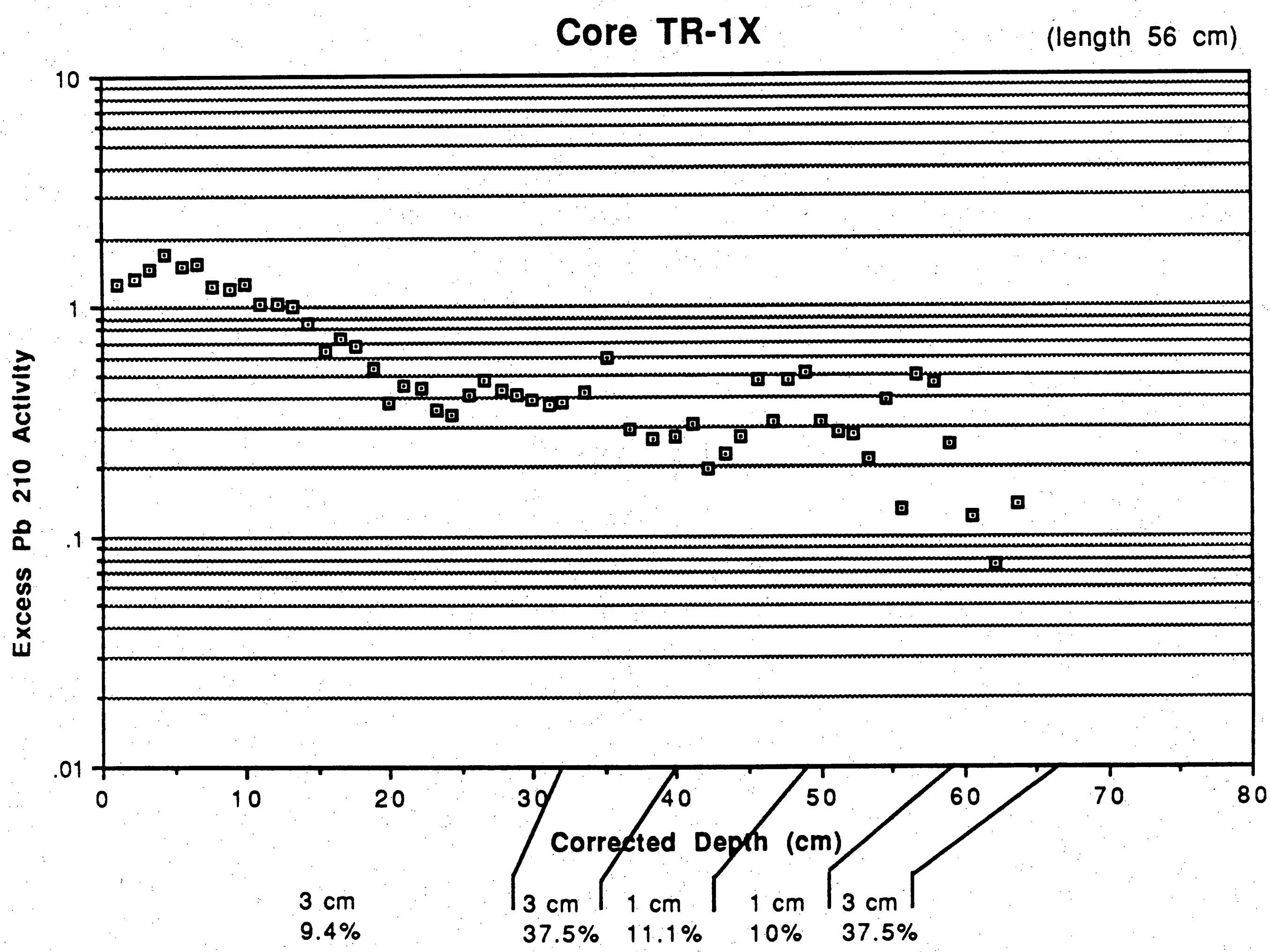
210 Pb values move down 1cm. 210 Pb results in top cm were not usable

TR-12

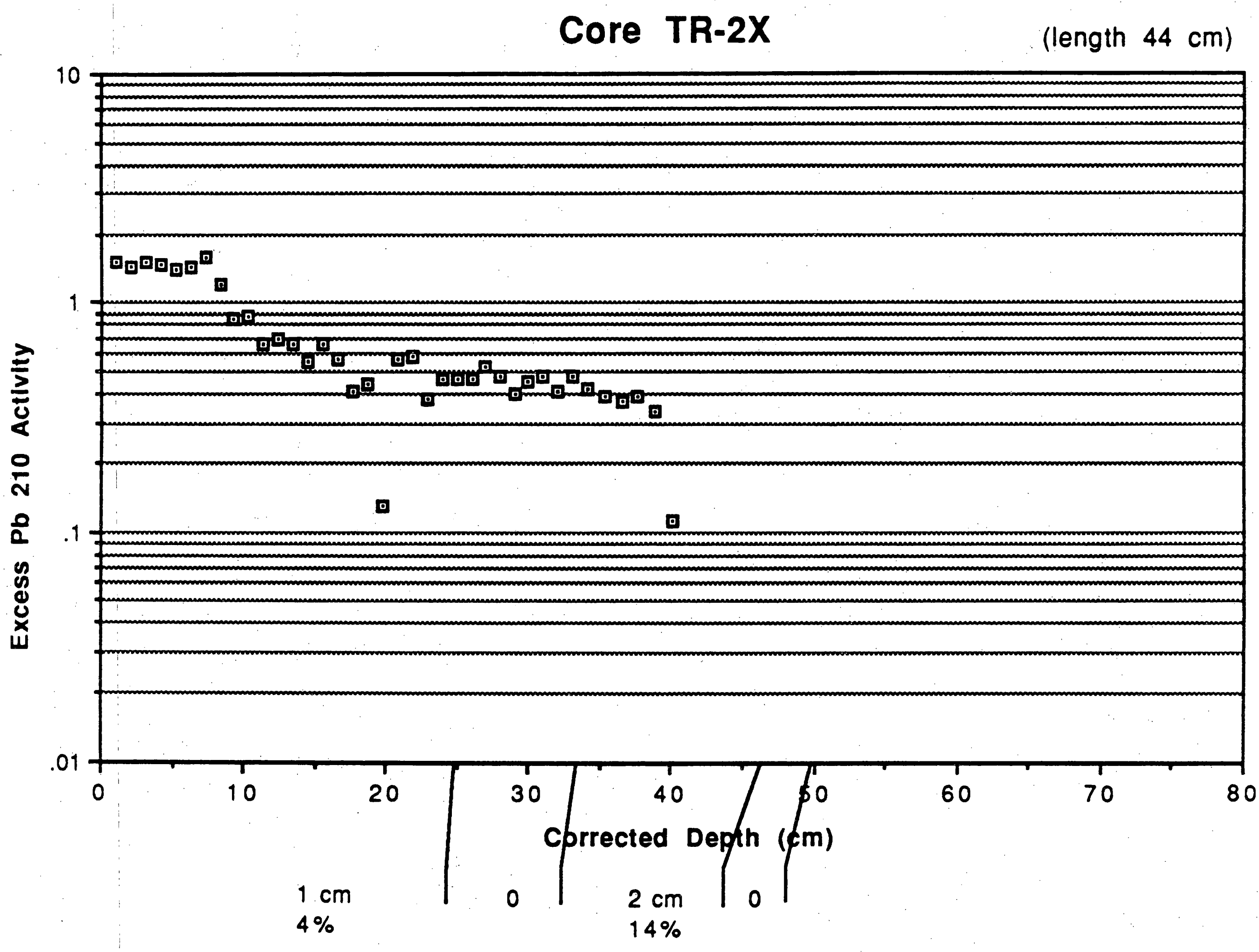
Sample No.	% Water	LOI (% Org.)	% Min.	Pb-210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-12-1	74.67	16.87	8.46	2.015	1.523	1.00	1.05
TR-12-2	71.27	19.22	9.51	1.854	1.362	2.00	2.10
TR-12-3	67.37	20.22	12.41	3.671	3.179	3.00	3.14
TR-12-4	66.54	20.86	12.59	2.819	2.327	4.00	4.19
TR-12-5	69.53	20.80	9.67	2.894	2.402	5.00	5.24
TR-12-6	72.60	18.26	9.14	2.984	2.492	6.00	6.29
TR-12-7	75.24	18.73	6.03	3.468	2.976	7.00	7.33
TR-12-8	71.05	19.60	9.35	2.768	2.276	8.00	8.38
TR-12-9	70.29	18.87	10.84	2.983	2.491	9.00	9.43
TR-12-10	69.11	20.45	10.44	2.889	2.397	10.00	10.48
TR-12-11	67.61	20.49	11.90	3.067	2.575	11.00	11.52
TR-12-12	67.77	16.78	15.45	2.288	1.796	12.00	12.57
TR-12-13	67.10	15.44	17.46	2.414	1.922	13.00	13.62
TR-12-14	61.27	15.79	22.94	2.678	2.186	14.00	14.67
TR-12-15	62.44	13.98	23.58	2.197	1.705	15.00	15.71
TR-12-16	61.61	13.76	24.63	2.519	2.027	16.00	16.76
TR-12-17	63.57	13.39	23.04	2.716	2.224	17.00	17.81
TR-12-18	63.81	13.75	22.45	2.616	2.124	18.00	18.86
TR-12-19	64.48	14.15	21.37	2.348	1.856	19.00	19.90
TR-12-20	64.48	12.89	22.63	2.448	1.956	20.00	20.95
TR-12-21	64.64	14.23	21.13	2.126	1.634	21.00	22.00
TR-12-22	64.29	13.98	21.73	2.612	2.120	22.00	23.00
TR-12-23	65.16	14.05	20.79	2.618	2.126	23.00	24.00
TR-12-24	64.69	14.21	21.11	2.618	2.126	24.00	25.00
TR-12-25	64.26	13.37	22.37	2.350	1.858	25.00	26.00
TR-12-26	65.35	14.75	19.90	2.363	1.871	26.00	27.00
TR-12-27	62.76	15.71	21.52	1.992	1.500	27.00	28.00
TR-12-28	59.88	15.86	24.26	2.202	1.710	28.00	29.00
TR-12-29	59.08	15.20	25.72	1.721	1.229	29.00	30.00
TR-12-30	56.25	15.49	28.26	1.622	1.130	30.00	31.00
TR-12-31	56.03	15.29	28.67	1.721	1.229	31.00	32.00
TR-12-32	57.34	14.81	27.85	1.940	1.448	32.00	33.00
TR-12-33	61.20	14.07	24.74	2.031	1.539	33.00	34.00
TR-12-34	62.50	14.86	22.64	2.036	1.544	34.00	35.00
TR-12-35	59.34	14.72	25.94	2.587	2.095	35.00	36.00
TR-12-36	63.20	15.31	21.49	2.758	2.266	36.00	37.00
TR-12-37	63.25	12.20	24.56	2.813	2.321	37.00	38.00
TR-12-38	60.18	11.75	28.07	2.229	1.737	38.00	39.00
TR-12-39	49.74	12.52	37.74	2.146	1.654	39.00	40.00
TR-12-40	47.99	11.92	40.09	2.143	1.651	40.00	41.00
TR-12-41	47.33	11.96	40.71	2.644	2.152	41.00	42.00
TR-12-42	45.92	11.25	42.83	2.444	1.952	42.00	43.17
TR-12-43	45.62	11.63	42.75	2.400	1.908	43.00	44.33
TR-12-44	45.64	11.75	42.61	2.354	1.862	44.00	45.50
TR-12-45	44.45	11.11	44.44	2.156	1.664	45.00	46.67
TR-12-46	43.77	12.07	44.16	2.024	1.532	46.00	47.83
TR-12-47	43.37	10.31	46.32	2.120	1.628	47.00	49.00
TR-12-48	42.52	9.83	47.66	1.892	1.400	48.00	50.17
TR-12-49	46.33	8.79	44.88	1.660	1.168	49.00	51.33
TR-12-50	40.72	8.29	50.99	1.644	1.152	50.00	52.50
TR-12-51	40.41	8.56	51.03	1.718	1.226	51.00	53.67
TR-12-52	66.25	9.25	24.51	1.282	0.790	52.00	54.83
TR-12-53	36.18	6.50	57.33	1.161	0.669	53.00	56.00
TR-12-54	34.58	5.78	59.64	1.134	0.642	54.00	57.17

TR-12 (cont.)

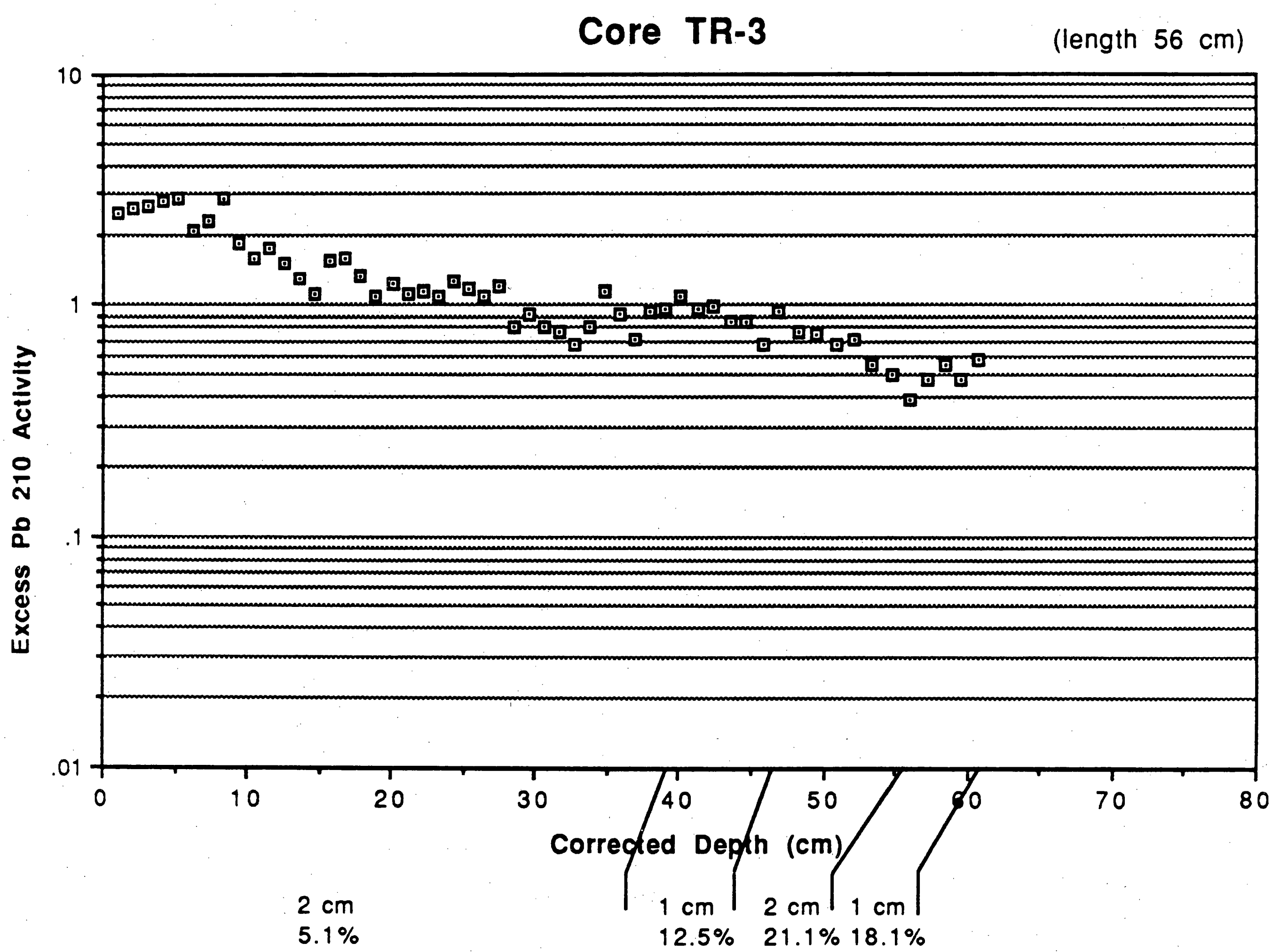
Sample No.	% Water	LOI (% Org.)	% Min.	Pb-210	Excess Pb 210	Unc. Depth (cm)	Corr. Depth
TR-12-55	31.86	5.54	62.60	0.918	0.426	55.00	58.33
TR-12-56	30.02	4.53	65.45	1.149	0.657	56.00	59.50
TR-12-57	34.03	5.82	60.15	1.275	0.783	57.00	60.67
TR-12-58	38.73	8.05	53.22	1.495	1.003	58.00	61.83
TR-12-59	43.22	9.63	47.15	1.435	0.943	59.00	63.00
TR-12-60	43.38	9.66	46.96	1.349	0.857	60.00	66.00
TR-12-61	41.79	10.46	47.75	1.411	0.919	61.00	67.00
TR-12-62	41.51	9.46	49.03	0.983	0.491	62.00	68.00
TR-12-63	41.33	10.72	47.95	1.552	1.060	63.00	69.00
TR-12-64	42.32	8.72	48.96	1.201	0.709	64.00	70.00
TR-12-65	42.30	10.74	46.95	1.095	0.603	65.00	71.00
TR-12-66	40.99	9.99	49.02	1.891		66.00	72.00
						67.00	73.00

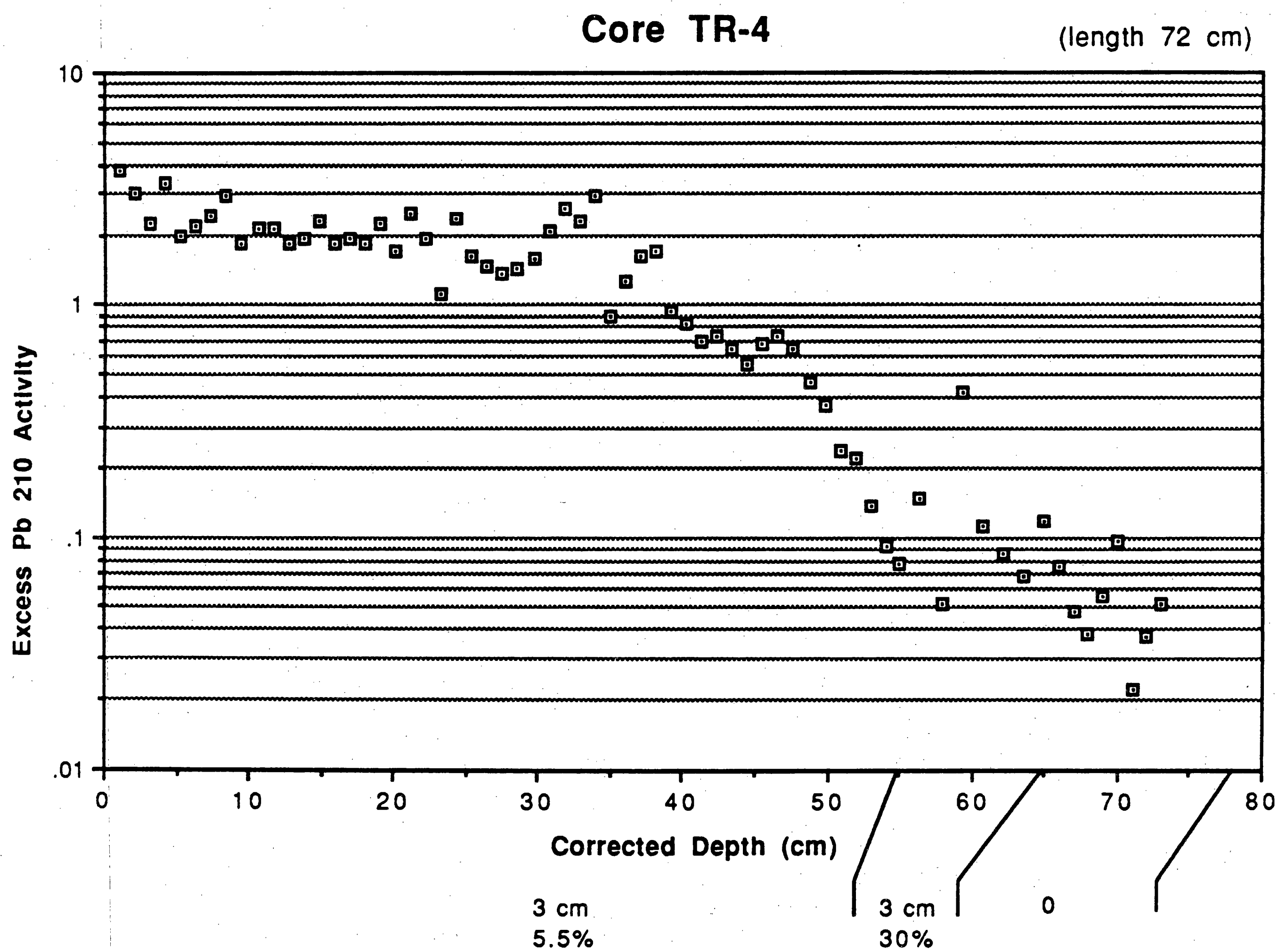


Core TR-1X
(length 56 cm)
10
1
.1
.01
Excess Pb 210 Activity
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
3 cm
9.4%
3 cm
37.5%
1 cm
11.1%
1 cm
10%
3 cm
37.5%

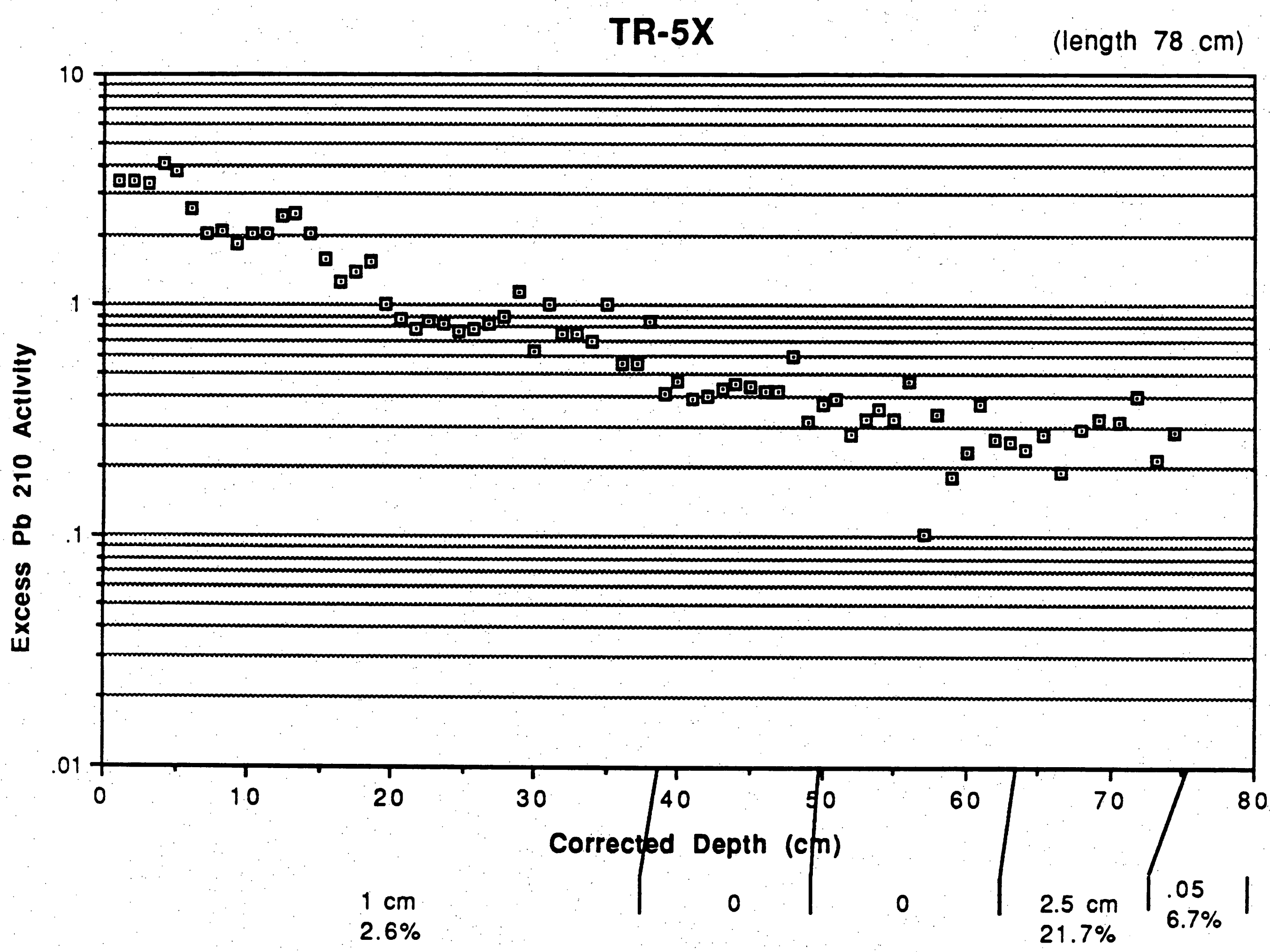


Core TR-2X
(length 44 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
1 cm
4%
0
2 cm
14%
0

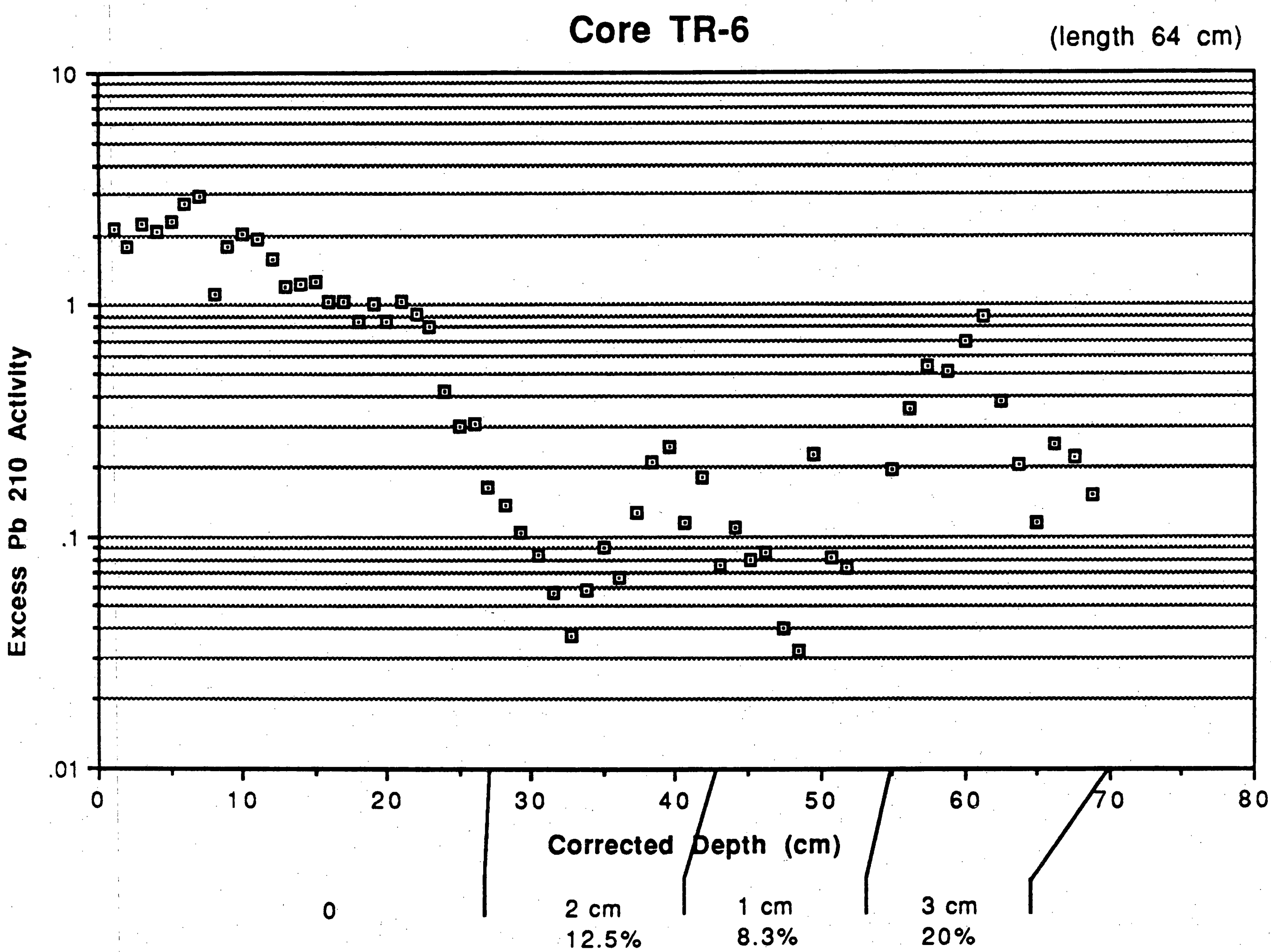

Core TR-3
(length 56 cm)
10
1
.1
.01
Excess Pb 210 Activity
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
2 cm
5.1%
1 cm
12.5%
2 cm
21.1%
1 cm
18.1%

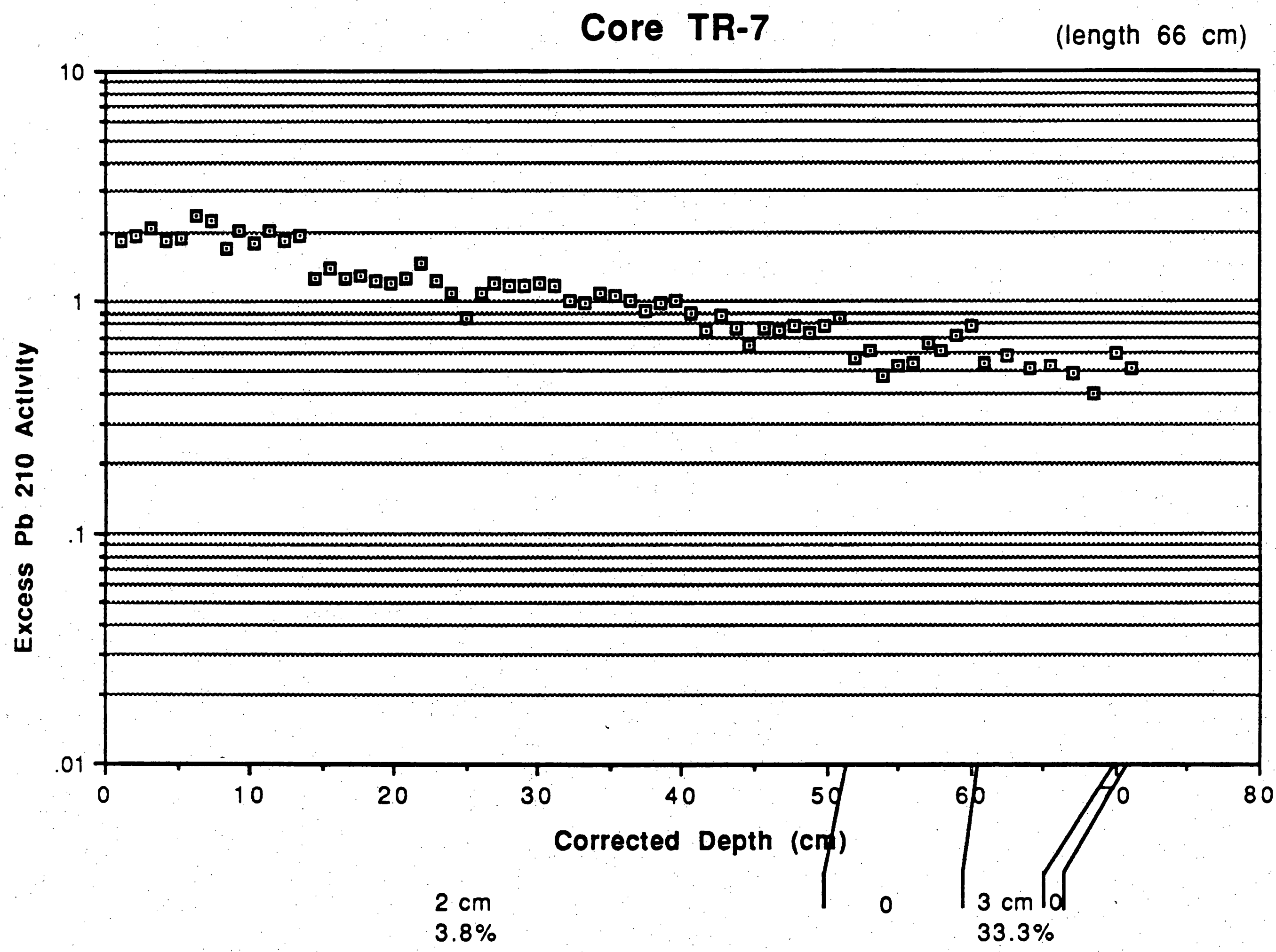


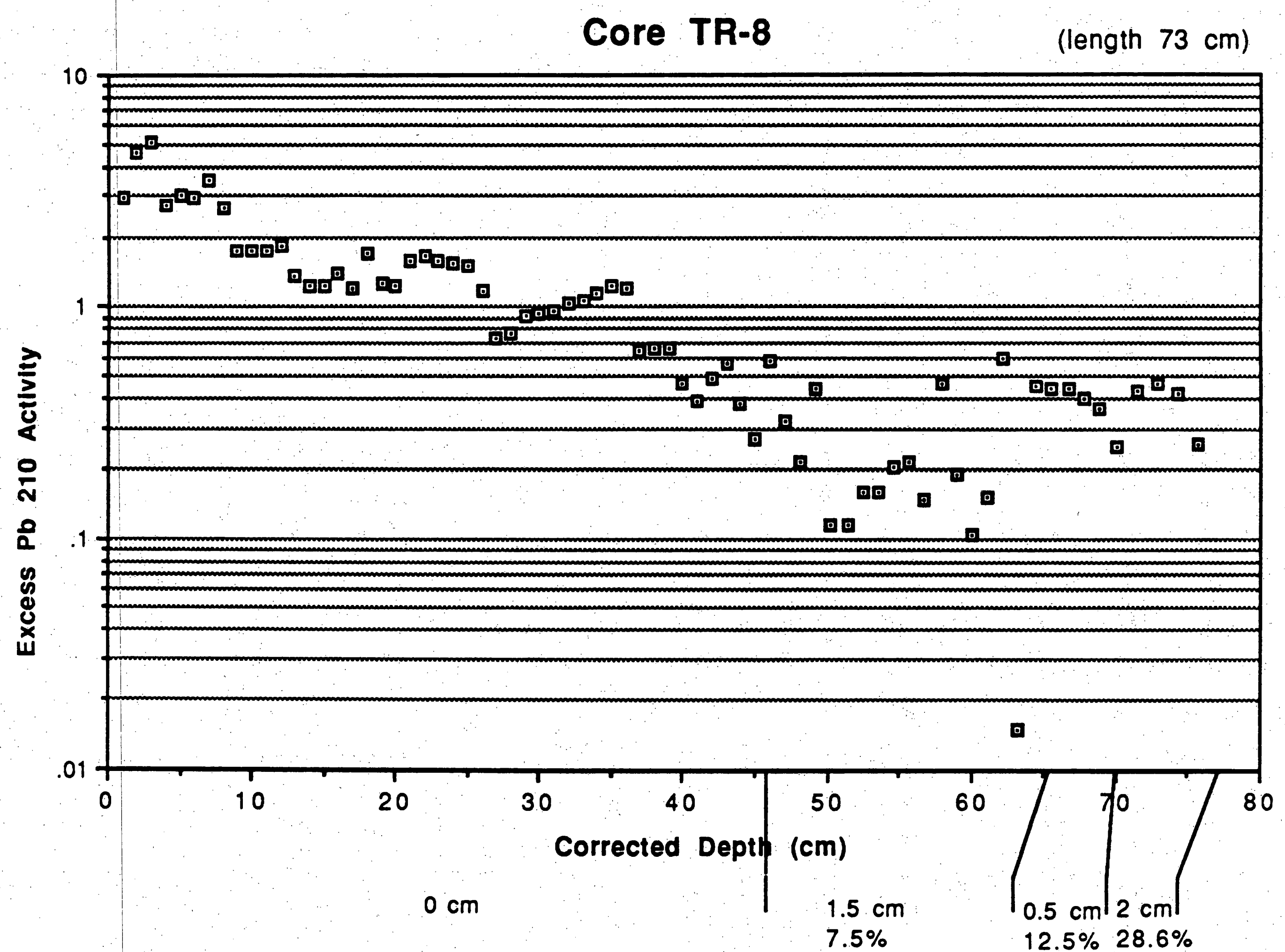
Core TR-4
(length 72 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
3 cm
5.5%
3 cm
30%
0

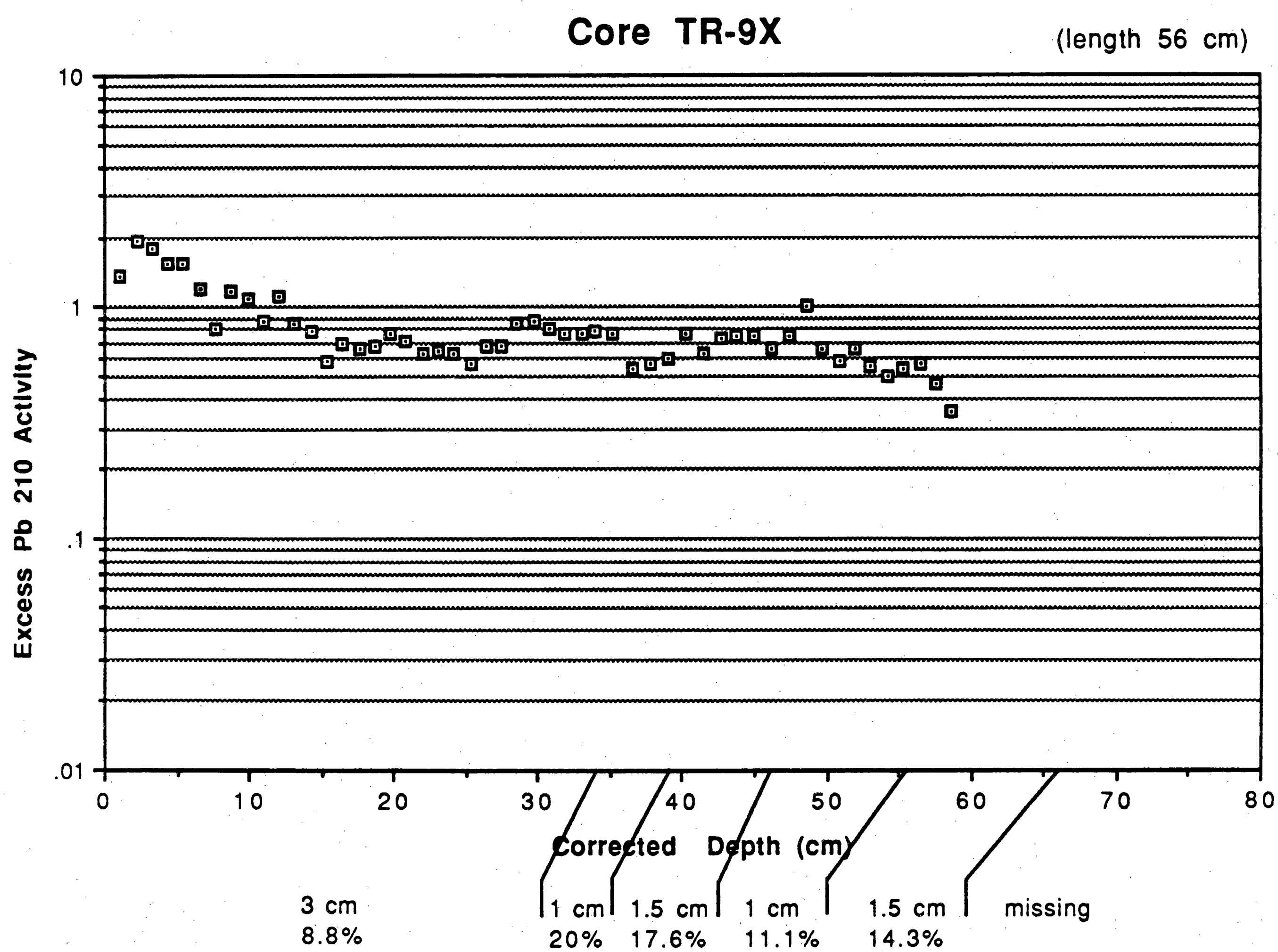


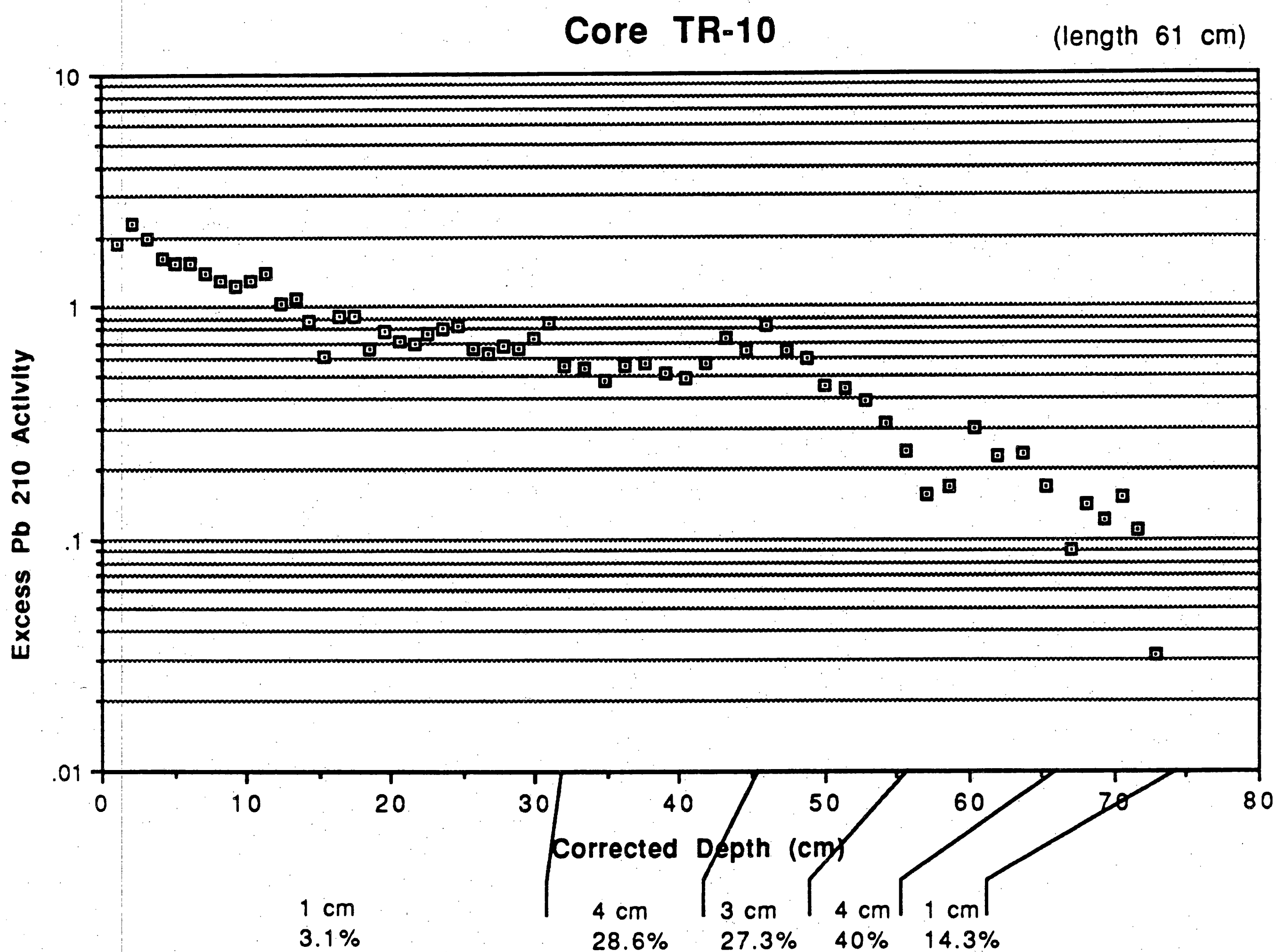
TR-5X
(length 78 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
1 cm
2.6%
0
0
2.5 cm
21.7%
.05
6.7%

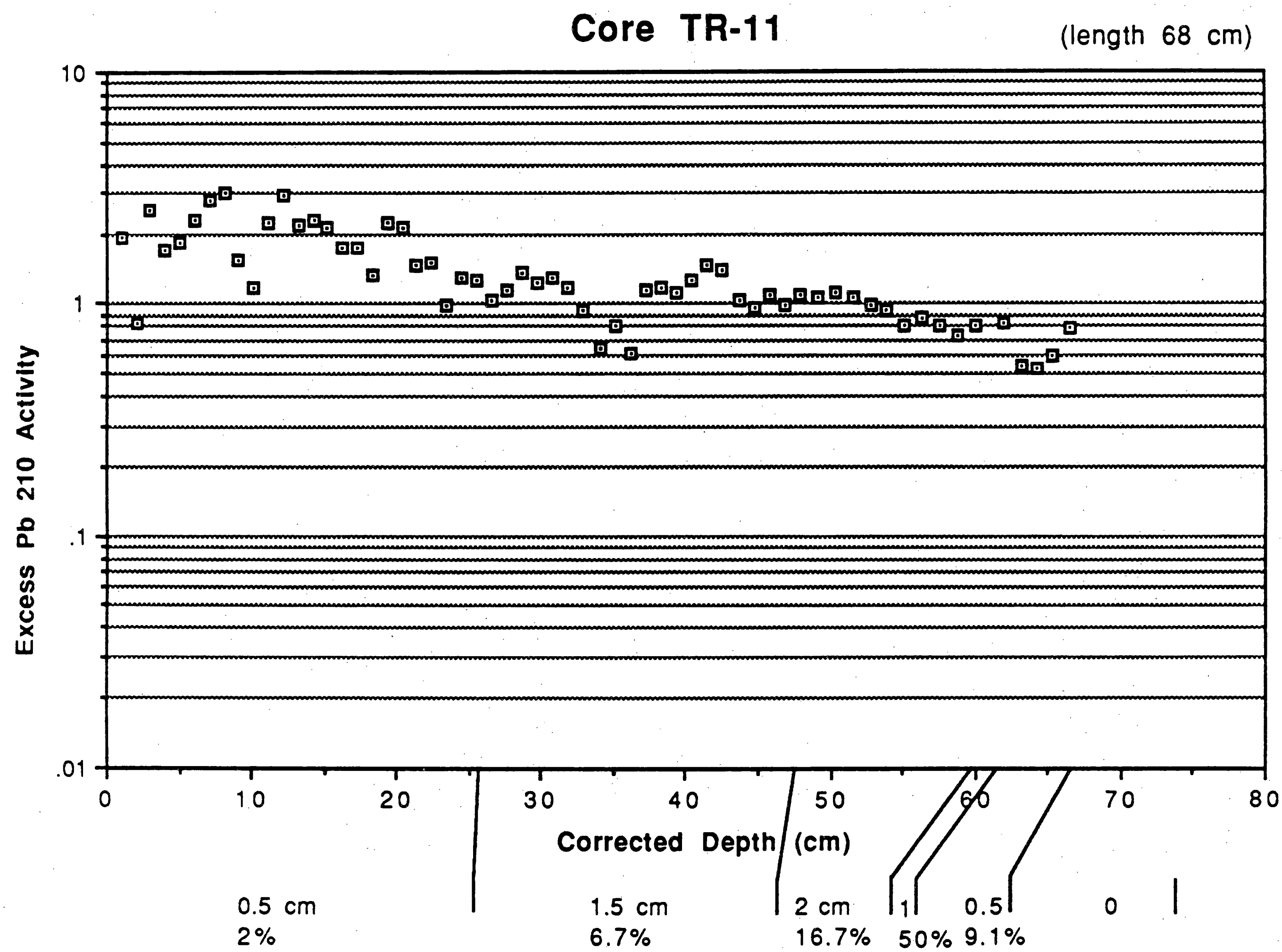

Core TR-6
(length 64 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
0
2 cm
12.5%
1 cm
8.3%
3 cm
20%


Core TR-7
(length 66 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
2 cm
3.8%
0
3 cm
33.3%
0

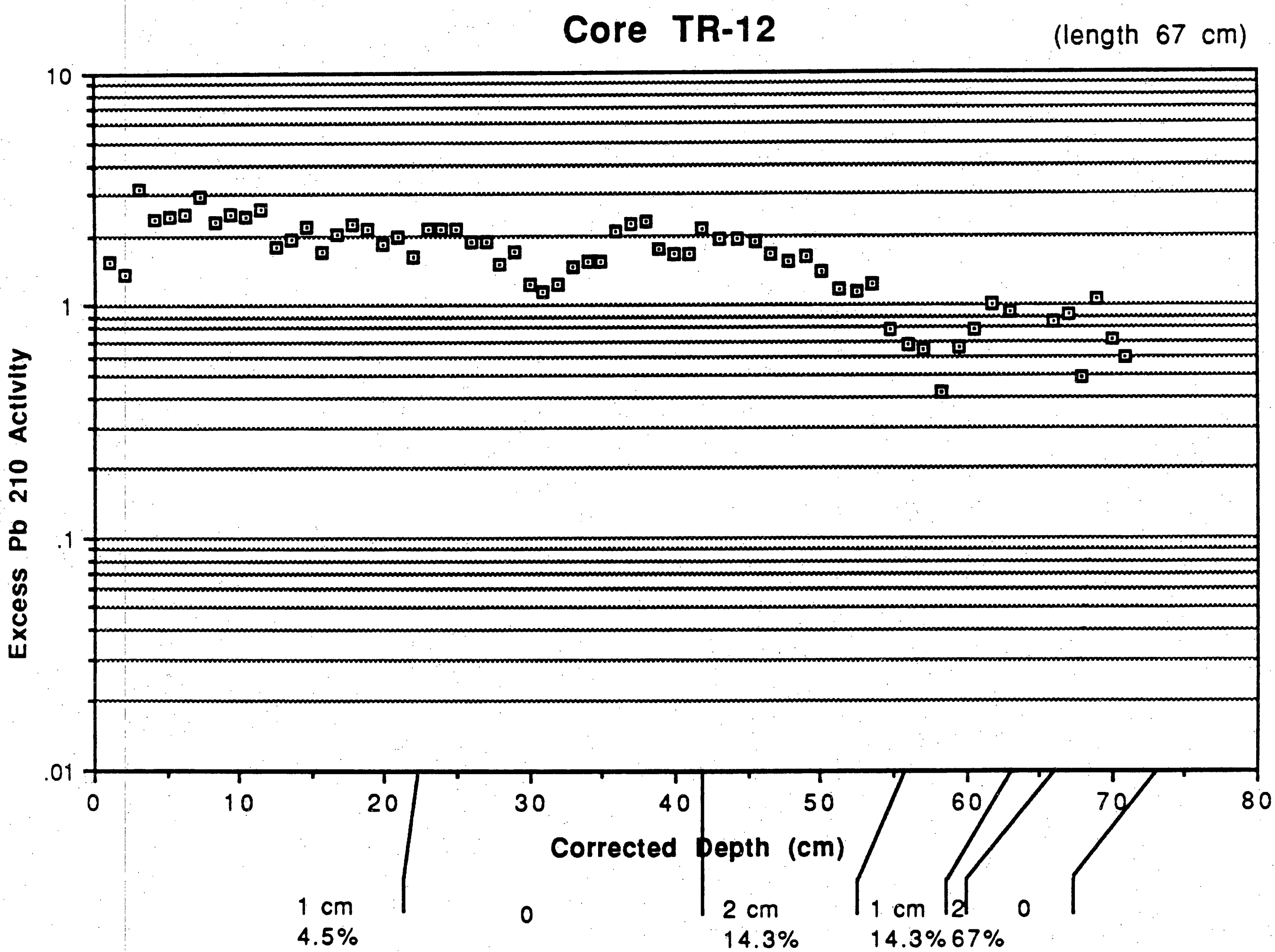

Core TR-8
(length 73 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
0 cm
1.5 cm
7.5%
0.5 cm
12.5%
2 cm
28.6%


Core TR-9X
(length 56 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
3 cm
8.8%
1 cm
20%
1.5 cm
17.6%
1 cm
11.1%
1.5 cm
14.3%
missing


Core TR-10
(length 61 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
1 cm
3.1%
4 cm
28.6%
3 cm
27.3%
4 cm
40%
1 cm
14.3%



Core TR-11
(length 68 cm)
10
1
.1
.01
Excess Pb 210 Activity
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
0.5 cm
2%
1.5 cm
6.7%
2 cm
16.7%
1
50%
0.5
9.1%
0



Core TR-12
(length 67 cm)
Excess Pb 210 Activity
10
1
.1
.01
0
10
20
30
40
50
60
70
80
Corrected Depth (cm)
1 cm
4.5%
0
2 cm
14.3%
1 cm
14.3%
2
67%
0

APPENDIX C

ANALYSIS REPORT

UNIVERSITY STATION, BOX X
AUSTIN, TEXAS 78713-7508
(512) 471-7721 (ext 426)

MINERAL STUDIES LABORATORY
BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

INVESTIGATOR:	PROJECT/ACCOUNT:	DATE:	REPORT #:
B. White	Trinity River	July 16, 1993	R-051-93

MSL ID# 93-772 to 93-783

SAMPLE PREPARATION / TREATMENT
These samples were obtained using a cork borer of known diameter to extract a cylindrical specimen from one-half of a sediment core. Three specimens were taken from each core (near the bottom, middle, near the top). During sampling, the length of each sample was determined by measuring the depth of the hole left after sampling. This was to eliminate error due to known compaction during sub-sampling.

The samples were placed in pre-weighed containers and weighed to determine the total weight. The samples were then dried in a drying oven to constant weight at 105 deg.C. The loss of weight was then attributed to loss of moisture and calculated to represent a percent of the original mass (% moisture).

The resulting solids were pulverized in a diamonite mortar and pestle and analyzed for total carbon content via the coulometric carbon analyser. Conditions: 950 deg.C, pure oxygen atmosphere, standard scrubbers, approx. 50 mg. sample size, blank corrected. This recovered carbon is assumed to be the organic carbon of each sample due to absence of mineral carbon (see COMMENTS, below).

SAMPLE ANALYSIS METHODS

Constituents	Technique	MSL Procedure
Moisture content	Gravimetric	---------
Bulk density	Gravimetric, calculation	---------
Total Carbon	Coulometric carbon analyser	ref: SWI 1.7, ASTM D 4129-82

RESULTS
Sample analysis results are presented in Table 1. The associated QA/QC analysis results are presented in Table 2 and Table 3.

COMMENTS
Several samples were tested for the presence of mineral carbon, all tests found no measureable quantity of mineral carbon.

This completes the requested analyses for these samples.

SAMPLE DISPOSITION:
The remains of these samples are being archived at the MSL.

ANALYST:
Herrera, Tweedy

ANALYSIS REPORT

UNIVERSITY STATION, BOX X
AUSTIN, TEXAS 78713-7508
(512) 471-7721 (ext 426)

MINERAL STUDIES LABORATORY
BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

TABLE 1
SAMPLE ANALYSIS RESULTS

MSL ID #	LOCATION ID#	DEPTH Uncorr. (cm)	MOISTURE (wt %)	BULK DENSITY (g/cc)	TOTAL CARBON (wt %, oven dried)
93-772	TR1X /base + 4	51	26.7	1.16	1.06
93-773	TR1X /base + 28	27	31.5	0.73	1.04
93-774	TR1X /base + 49	6	43.4	0.47	3.53
93-775	TR2X /base + 4	40	38.6	0.87	1.62
93-776	TR2X /base + 22.5	22	34.7	0.72	1.10
93-777	TR2X /base + 40	4	45.7	0.38	4.39
93-778	TR5X /base + 4	74	32.3	0.99	1.44
93-779	TR5X /base + 34.8	43	34.1	0.71	1.85
93-780	TR5X /base + 61	8	67.0	0.19	6.60
93-781	TR9X /base + 4	52	42.6	0.56	2.03
93-782	TR9X /base + 29.2	27	36.4	0.86	1.22
93-783	TR9X /base + 48	8	57.3	0.35	4.66

TABLE 2
REFERENCE MATERIAL RESULTS
(WT % TOTAL CARBON)

MSL ID#	FOUND	TRUE VALUE	BIAS	%BIAS
NBS-1a	9.68	9.76	-0.08	-0.81

TABLE 3
REPLICATE SAMPLE ANALYSIS

MSL ID#	%CARBON
93-781-1	2.04
93-781-2	2.06
93-781-3	2.00
MEAN	2.03
STDEV	0.03
RELSTDEV	1.58

ANALYSIS REPORT

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MINERAL STUDIES LABORATORY
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THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

INVESTIGATOR:	PROJECT/ACCOUNT:	DATE:	REPORT #:
B.. White	Trinity River	July 16, 1993	R-028-93

MSL ID# 93-216 TO 93-239

SAMPLE PREPARATION / TREATMENT
These samples were obtained using a cork borer of known diameter to extract a cylindrical specimen from one-half of a sediment core. Three specimens were taken from each core (near the bottom, middle, near the top). During sampling, the length of each sample was determined by measuring the depth of the hole left after sampling. This was to eliminate error due to known compaction during sub-sampling.

The samples were placed in pre-weighed containers and weighed to determine the total weight. The samples were then dried in a drying oven to constant weight at 105 deg.C. The loss of weight was then attributed to loss of moisture and calculated to represent a percent of the original mass (% moisture).

The resulting solids were pulverized in a diamonite mortar and pestle and analyzed for total carbon content via the coulometric carbon analyser. Conditions: 950 deg.C, pure oxygen atmosphere, standard scrubbers, approx. 50 mg. sample size, blank corrected. This recovered carbon is assumed to be the organic carbon of each sample due to absence of mineral carbon (see COMMENTS, below).

SAMPLE ANALYSIS METHODS

Constituents	Technique	MSL Procedure
Moisture content	Gravimetric	---------
Bulk density	Gravimetric, calculation	---------
Total Carbon	Coulometric carbon analyser	ref: SWI 1.7, ASTM D 4129-82

RESULTS
Sample analysis results are presented in Table 1. The associated QA/QC analysis results are presented in Table 2 and Table 3.

COMMENTS
This completes the requested analyses for these samples.

SAMPLE DISPOSITION The remains of these samples are being archived at the MSL.

ANALYST: Herrera, Tweedy

ANALYSIS REPORT

UNIVERSITY STATION, BOX X
AUSTIN, TEXAS 78713-7508
(512) 471-7721 (ext 426)

MINERAL STUDIES LABORATORY
BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

TABLE 1
SAMPLE ANALYSIS RESULTS

MSL ID #	LOCATION ID#	DEPTH Uncorr.(cm)	MOISTURE (wt %)	BULK DENSITY (g/cc)	TOTAL CARBON (wt %, oven dried)
93-216	TR3 /base+4.5	50	42.4	0.67	2.35
93-217	TR3 /base+27	28	40.7	0.75	1.88
93-218	TR3 /base+46	9	45.4	0.69	3.82
93-219	TR4 /base+4	65	27.3	1.07	0.97
93-220	TR4 /base+35	33	46.2	0.72	3.30
93-221	TR4 /base+55.5	12	44.8	0.63	2.58
93-222	TR6 /base+4	60	27.4	1.03	0.32
93-223	TR6 /base+31	33	26.0	1.19	0.62
93-224	TR6 /base+55.5	8	33.2	1.02	1.22
93-225	TR7 /base+4	62	47.1	0.63	4.67
93-226	TR7 /base+31	35	50.2	0.42	2.66
93-227	TR7 /base+58	8	59.1	0.43	6.27
93-228	TR8 /base+4	68	40.2	0.93	2.02
93-229	TR8 /base+37	35	49.4	0.54	2.72
93-230	TR8 /base+57	15	61.6	0.31	2.50
93-231	TR10 /base+4.3	56	30.9	1.04	1.87
93-232	TR10 /base+30	30	37.9	0.89	1.37
93-233	TR10 /base+53.4	7	49.2	0.45	5.10
93-234	TR11 /base+6.0	61	47.2	0.63	2.83
93-235	TR11 /base+34	33	44.5	0.63	2.34
93-236	TR11 /base+58	9	53.9	0.49	3.13
93-237	TR12 /base+4.4	62	43.5	0.70	4.44
93-238	TR12 /base+34	33	54.8	0.28	3.08
93-239	TR12 /base+59	8	66.3	0.26	7.72

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THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

TABLE 2
REFERENCE MATERIAL RESULTS

MSL ID#	FOUND	TRUE VALUE	BIAS	%BIAS
NBS-1a	9.66	9.76	-0.1	-1.02

TABLE 3
REPLICATE SAMPLE ANALYSIS

MSL ID#	%CARBON	MSL ID#	%CARBON
93-225	4.73	93-235	2.32
93-225	4.66	93-235	2.32
93-225	4.63	93-235	2.37
MEAN	4.67	MEAN	2.34
STDEV	0.05	STDEV	0.03
RELSTDEV	1.07	RELSTDEV	1.28

ANALYSIS REPORT

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THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

INVESTIGATOR:	PROJECT/ACCOUNT:	DATE:	REPORT #:
B.. White	Trinity River	July 16, 1993	R-057-93

MSL ID# 93-876 to 93-933

SAMPLE PREPARATION / TREATMENT
These samples were obtained using the cork borer used to recover samples for bulk density.

The samples were dried in a drying oven to constant weight at 105 deg.C. The resulting solids were pulverized in a diamonite mortar and pestle and analyzed for total carbon content via the coulometric carbon analyser. Conditions: 950 deg.C, pure oxygen atmosphere, standard scrubbers, approx. 50 mg. sample size, blank corrected. This recovered carbon is assumed to be the organic carbon of each sample due to absence of mineral carbon (see COMMENTS, below).

SAMPLE ANALYSIS METHODS

Constituents	Technique	MSL Procedure
Total Carbon	Coulometric carbon analyser	ref: SWI 1.7, ASTM D 4129-82

RESULTS
Sample analysis results are presented in Table 1. The associated QA/QC analysis results are presented in Table 2 and Table 3.

COMMENTS
Several samples were tested for the presence of mineral carbon, all tests found no measureable quantity of mineral carbon.

This completes the requested analyses for these samples.

SAMPLE DISPOSITION:
The remains of these samples are being archived at the MSL.

ANALYST:
Herrera, Tweedy

ANALYSIS REPORT

UNIVERSITY STATION, BOX X
AUSTIN, TEXAS 78713-7508
(512) 471-7721 (ext 426)

MINERAL STUDIES LABORATORY
BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

TABLE 1
SAMPLE ANALYSIS RESULTS

SPL ID# core/ Uncorr.depth (cm)	MSL ID#	TOTAL CARBON (WT %, dry basis)
TR4 / 1	93-876	7.21
TR4 / 3	93-877	7.31
TR4 / 9 to 10	93-878	8.7
TR4 / 16 to 17	93-879	2.02
TR4 / 23 to24	93-880	2.11
TR4 / 32	93-881	3.37
TR4 / 33	93-882	3.24
TR4 / 35 to 36	93-883	3.5
TR4 / 43 to 44	93-884	2.8
TR4 / 48 to 49	93-885	2.17
TR4 / 52	93-886	1.56
TR4 / 53	93-887	1.67
TR4 / 54	93-887B	1.65
TR4 / 55	93-888	1.61
TR4 / 58	93-889	1.56
TR4 / 59	93-890	1.54
TR4 / 61	93-891	1.41
TR4 / 64	93-892	1.18
TR4 / 68	93-893	0.88
TR11 / 1	93-894	4.52
TR11 / 2	93-895	4.52
TR11 / 4 to 5	93-896	3.29
TR11 / 7	93-897	6.31
TR11 / 10	93-898	3.58
TR11 / 12	93-899	4.15
TR11 / 14 to 15	93-900	2.44
TR11 / 17 to 18	93-901	2.37
TR11 / 19 to 20	93-902	2.94
TR11 / 23	93-903	3.22
TR11 / 24 to 25	93-904	2.19
TR11 / 26	93-905	2.62
TR11 / 28	93-906	2.71
TR11 / 33 to 34	93-907	3.28
TR11 / 36 to 37	93-908	7.3
TR11 / 40 to 41	93-909	3.35
TR11 / 43	93-910	2.57
TR11 / 48 to 49	93-911	2.6
TR11 / 61	93-912	3.21
TR11 / 66	93-913	5.56
TR12 / 1 to 2	93-914	7.05
TR12 / 5 to 6	93-915	10.9
TR12 / 8	93-916	6.5
TR12 / 15 to 16	93-917	4.59
TR12 / 19	93-918	3.9
TR12 / 232 22	93-919	4.95
TR12 / 26 to 27	93-920	4.81
TR12 / 32 to 33	93-921	3.15

ANALYSIS REPORT

UNIVERSITY STATION, BOX X
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MINERAL STUDIES LABORATORY
BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

STEVEN W. TWEEDY
CHIEF CHEMIST

TABLE 1 Cont...

SPL ID# core/ Uncorr. depth (cm)	MSL ID#	TOTAL CARBON (WT %, dry basis)
TR12 / 34 to 35	93-922	3.14
TR12 / 37 to 38	93-923	4.45
TR12 / 39 to 40	93-924	3.64
TR12 / 42	93-925	3.97
TR12 / 46	93-926	2.88
TR12 / 51 to 52	93-927	3.44
TR12 / 54 to 55	93-928	2.63
TR12 / 56	93-929	3.24
TR12 / 59 to 60	93-930	4.02
TR12 / 63	93-931	4.7
TR12 / 64	93-932	4.33
TR12 / 65 to 66	93-933	4.83

TABLE 2
REFERENCE MATERIAL RESULTS

(WT % TOTAL CARBON)

MSL ID#	FOUND	TRUE VALUE	BIAS	%BIAS
NBS-1a	9.70 (7)	9.76	-0.06	-0.60

TABLE 3
REPLICATE SAMPLE ANALYSIS

MSL ID#	%CARBON	MSL ID#	%CARBON
93-885	2.18	93-894	4.50
93-885	2.17	93-894	4.50
93-885	2.17	93-894	4.54
MEAN	2.17	MEAN	4.52
STDEV	0.01	STDEV	0.02
RELSTDEV	0.26	RELSTDEV	0.44
93-904	2.20	93-914	7.02
93-904	2.19	93-914	7.07
93-904	2.18	93-914	7.07
MEAN	2.19	MEAN	7.05
STDEV	0.01	STDEV	0.02
RELSTDEV	0.37	RELSTDEV	0.34
93-924	3.64		
93-924	3.66		
93-924	3.63		
MEAN	3.64		
STDEV	0.01		
RELSTDEV	0.35		

TEXTURAL ANALYSIS REPORT

Bureau of Economic Geology
Core Research Center
Sedimentology Laboratory

Methods

Sample splits (approximately 15g) were taken from cores and combined with 300 ml water, sealed and dispersed via a reciprocal shaker for 2 hours. Each sample was then wet sieved separating gross organics (-1 phi/2 mm), sand (4 phi / 63 micron) and silt /clay.

Gross organic and sand fractions were dried and wieghed. Sand fractions were then treated with hydrogen peroxide, dried and weighed.

Silt and clay fractions were concentrated with magnesium chloride and washed.

Several samples were analyzed for organic matter in the silt clay fraction by dispersing to 1000ml and performing a pipette analysis for total weight. These samples were then treated with hydrogen peroxide concentrated and washed.

Samples were dispersed to 1000ml in a graduated cylinder with sodiumhexametaphosphate. Pipette analysis was then performed on each sample for silt (4-63 micron) and clay (< 4 micron) .

Total organics is the combination of gross organics, sand organics and, when applicable, silt /clay organics.

Analysis is reported as weight % of total weight. Total weight is calculated by combining total organic, sand and silt /clay weights.

TEXTURAL REPORT

CORE TR-4

Requestor's Name Bill White

Date :6/15/93

Project: Trinity River

Gravel/Sand: -1 Phi/2 mm
Sand/Silt: 4 Phi/63 micron
Silt/Clay: 8 Phi/4 micron

Requested Completion Date: 7/15/93

CORE NO./UNCORR. DEPTH (CM)	PEROXIDE SAND	TREATMENT MUD	GROSS ORGANICS (WT %)	TOTAL WT % GRAVEL	TOTAL WT% SAND	TOTAL WT % SILT	TOTAL WT. % CLAY
TR 4/1	Y	N	21.34	0.00	1.92	32.09	44.65
TR 4/3	Y	N	15.99	0.00	1.71	34.55	47.75
TR 4/9 to 10	Y	N	13.33	0.00	8.14	33.81	44.72
TR 4/16 to 17	Y	N	4.25	0.00	2.90	35.62	57.22
TR 4/23 to 24	Y	N	2.91	0.00	5.41	47.50	44.18
TR 4/32	Y	N	4.56	0.00	3.75	31.95	59.74
TR 4/33	Y	N	3.81	0.00	5.82	30.80	59.57
TR 4/35 to 36	Y	N	7.80	0.00	8.44	31.64	52.13
TR 4/43 to 44	Y	N	3.08	0.00	6.55	27.16	63.22
TR 4/48 to 49	Y	N	7.59	0.00	6.36	23.26	62.80
TR 4/52	Y	N	0.93	0.00	6.31	38.39	54.37
TR 4/53	Y	N	0.97	0.00	5.92	39.83	53.27
TR 4/54	Y	N	6.01	0.00	6.44	35.98	51.58
TR 4/55	Y	N	5.12	0.00	6.07	37.34	51.47
TR 4/58	Y	N	4.54	0.00	4.87	35.79	54.79
TR 4/59	Y	N	1.02	0.00	3.24	35.91	59.83
TR 4/61	Y	N	0.73	0.00	2.19	38.14	58.93
TR 4/64	Y	N	0.60	0.00	3.45	39.45	56.50
TR 4/68	Y	N	2.08	0.00	7.58	39.77	50.57

TEXTURAL REPORT

CORE TR-11

Requestor's Name Bill White

Date :6/15/93

Project: Trinity River

Requested Completion Date: 7/15/93

Gravel/Sand: -1 Phi/2 mm
Sand/Silt: 4 Phi/63 micron
Silt/Clay: 8 Phi/4 micron

CORE NO./UNCORR. DEPTH (CM)	PEROXIDE TREATMENT SAND	MUD	GROSS ORGANICS (WT %)	TOTAL WT % GRAVEL	TOTAL WT% SAND	TOTAL WT % SILT	TOTAL WT. % CLAY
TR 11/1cm	Y	N	11.03	0.00	1.77	22.70	64.50
TR 11/2	Y	N	8.88	0.00	0.85	24.68	65.58
TR 11/4 to 5	Y	N	5.55	0.00	1.63	35.42	57.40
TR 11/7	Y	N	9.86	0.00	2.65	31.86	55.63
TR 11/10	Y	N	5.81	0.00	8.76	23.41	62.02
TR 11/12	Y	N	6.16	0.00	0.57	16.48	76.79
TR 11/14 to 15	Y	N	2.97	0.00	0.36	16.18	80.49
TR 11/18	Y	N	3.37	0.00	0.11	16.14	80.38
TR 11/19 to 20	Y	N	2.65	0.00	0.21	17.03	80.11
TR 11/23	Y	N	3.40	0.00	0.45	24.21	71.94
TR 11/24 to 25	Y	N	2.37	0.00	0.41	25.03	72.19
TR 11/26	Y	N	3.45	0.00	0.78	19.28	76.49
TR 11/28	Y	N	3.66	0.00	1.03	16.10	79.21
TR 11/33 to 34	Y	N	5.52	0.00	2.82	17.58	74.08
TR 11/36 to 37	Y	N	7.77	0.00	1.41	12.21	78.60
TR 11/40 to 41	Y	N	11.27	0.00	1.23	8.72	78.78
TR 11/43	Y	N	3.31	0.00	0.21	6.86	89.62
TR 11/48 to 49	Y	N	8.37	0.00	0.26	12.58	78.79
TR 11/61	Y	N	3.24	0.00	3.82	18.91	74.03
TR 11/66	Y	N	8.38	0.00	3.83	23.17	64.62

TEXTURAL REPORT

CORE TR-12

Requestor's Name: Bill White

Date :6/15/93

Project: Trinity River

Gravel/Sand: -1 Phi/2 mm
Sand/Silt: 4 Phi/63 micron
Silt/Clay: 8 Phi/4 micron

Requested Completion Date: 7/15/93

CORE NO./UNCORR. DEPTH (CM)	PEROXIDE SAND	TREATMENT MUD	GROSS ORGANICS (WT %)	TOTAL WT % GRAVEL	TOTAL WT% SAND	TOTAL WT % SILT	TOTAL WT. % CLAY
TR 12/1 to 2 cm	Y	N	20.66	0.00	5.22	24.24	49.88
TR 12/5 to 6	Y	N	18.12	0.00	1.19	28.76	51.94
TR 12/8	Y	N	11.54	0.00	1.94	26.41	60.11
TR 12/15 to 16	Y	Y	11.35	0.00	3.67	15.50	69.48
TR 12/19	Y	N	9.14	0.00	3.73	17.22	69.91
TR 12/22	Y	Y	12.72	0.00	3.66	14.85	68.78
TR 12/26 to 27	Y	Y	11.93	0.00	5.04	15.49	67.54
TR 12/32 to 33	Y	Y	11.20	0.00	7.22	14.43	67.15
TR 12/34 to 35	Y	Y	15.65	0.00	6.41	13.02	64.91
TR 12/37 to 38	Y	Y	10.10	0.00	4.88	15.54	69.47
TR 12/39 to 40	Y	N	6.69	0.00	2.78	16.40	74.13
TR 12/42	Y	N	7.99	0.00	4.29	13.73	73.99
TR 12/46	Y	N	3.39	0.00	5.87	14.05	76.70
TR 12/51 to 52	Y	N	2.53	0.00	7.44	22.84	67.19
TR 12/54 to 55	Y	N	5.98	0.00	11.48	26.68	55.87
TR 12/56	Y	N	6.27	0.00	11.93	26.22	55.59
TR 12/59 to 60	Y	N	5.42	0.00	7.09	25.07	62.41
TR 12/63	Y	N	5.58	0.00	6.31	23.80	64.31
TR 12/64	Y	N	6.05	0.00	6.72	25.29	61.95
TR 12/65 to 66	Y	N	11.30	0.00	5.28	22.65	60.76