Lakeside Lake Sedimentation Study

Submitted to:

City of Tucson

Environmental Services
100 North Stone
Tucson, Arizona 85701

Parks and Recreation
900 South Randolph Way
Tucson, Arizona 85716

Submitted by:

Paul T. Gremillion
PO Box 341
Flagstaff, Arizona 86002
928-523-5382
paul.gremillion@nau.edu

David Walker
1421 N. Palo Verde Blvd
Tucson, Arizona 85716
520-275-7110
dwalker@ag.arizona.edu

August 12, 2008

Table of Contents

List of Tables

List of Figures

Introduction

Lakeside Lake has been managed as an urban fishery, while functioning as a stormwater management pond. To promote sedimentation near the Atterbury Wash inflow, the lake has distinct north and south basins, separated by a mid-lake sill, the crest of which is at about 2 meters depth at full pool. To immobilize algal nutrients and maintain water clarity, alum is applied over the lake surface periodically. Another strategy employed in the lake to maintain water quality suitable for recreational fisheries has been to operate four aerators in the lake: two within one meter of the lake surface and two within one meter of the lake bottom.

Our objective was to survey sediment thickness in Lakeside Lake to determine the loss in capacity of the lake due to sedimentation and to assess the effect of aerators on sediment resuspension.

Methods

We used two sediment survey methods: seismic surveying and collection of intact sediment cores. Seismic profiling was conducted using an EdgeTech SB-424 seismic profiler with a 3100P topside unit. The profiling system was controlled by a laptop computer, which also logged the seismic data. A consumer-grade (Garmin 76) geographic positioning system (GPS) receiver was used to locate positions of seismic transects, sediment cores, and to create an outline of the shoreline at the time of the survey. Sediment cores were collected using a 5-cm diameter AMS pistonless corer with polyethylene core tubing. The cores were driven to hard bottom and recovered to the boat for description. On the boat, the cores were photographed and a lithologic description was recorded. The cores were not archived.

Results

Field work was conducted on June 23 and July 3, 2008. Figure 1 shows the locations of seismic tracks and sediment cores. Figures 2 and 3 show the seismic profiles shown as tracks on Figure 1. We made several short transects in the vicinity of the north and south bottom aerators to determine the effect of aerators on sedimentation. Figure 4 shows the tracks and profiles around the north aerator and Figure 5 shows tracks and profiles around the south aerator.

We attempted to collect sediment cores at nine locations. At the two locations within 30 meters of the shoreline there was no sediment overlaying the hard soilcrete lake bottom. These are shown in Figure 1 by the caption “Hard Bottom” at northwest and northeast locations in the lake. The remaining seven cores are shown in Figures 6 through 12. We described the cores using the qualitative descriptions of “organic” for black or dark sediments, “mixed organic” or "interbedded organic" for dark and lighter colored sediments, and "inorganic" for pale, tan, or granular sediments.

The sediment thickness data are summarized in Table 1. Sediment thickness ranged from 10 cm in the northwest arm of the lake to 74 cm at the west side of the south basin. Sediment thickness in the central part of both the south and north basins was consistently between 65 and 74 cm thick.

Table 1. Summary of Sediment Core Data.

Core	Total Depth (cm)	Inorganic (cm)	Mixed (cm)	Organic (cm)
1	10.0	2.0	8.0	
2	65.0	48.0	14.0	3.0
3	65.5	15.5	26.0	24.0
4	48.5	44.5		4.0
5	29.0	14.0	2.0	13.0
6	74.0	24.0	14.0	36.0
7	42.5	9.0	19.5	14.0

Discussion

The seismic system used for this study has excellent capability to profile silty or sandy sediments with low to moderate organic content and to distinguish interfaces between materials of differing density. Figure 13 shows an example from Lake Roosevelt, Arizona, using the identical equipment package that we used in Lakeside Lake. Sediment deposited after impoundment of the lake can be clearly seen draped over the native soil. To the right, layering can be distinguished as well. The layers represent contacts between sediment material of differing properties, such as density or organic content.

We see layering to some extent in Lakeside Lake. In the south basin, Transects 20 and 21 (Figure 2) show a dark image at the sediment surface with a less distinct layer underneath. We expected to see a strong reflection from the soilcrete bottom of the lake, with lighter layering above. We believe the alum, along with the high organic content of the sediment, obscured the signal.

We collected cores to provide additional information on the sediment structure of the lake. Cores from the deeper regions of the lake did indeed show zones of high organic content, indicating a focusing of lower-density organic material in deeper regions. Cores 4 and 5, collected near the inflow at the south edge of the lake, and in a shallower part of the lake, clearly indicated deposition of coarser mineral sediments. To some extent, this is shown in the layering of the seismic record from Transect 19 (Figure 3).

Sedimentation characteristics can be seen in the cores. Core 2 (Figure 7) from the north basin and Cores 3 and 6 (Figures 8 and 11) from the south basin were the cores collected from the relatively flat, deep bottom of the lake. All three cores recorded roughly the same amount of sedimentation (65 to 74 cm), but the organic content varied between the north and south basins. In Core 2, the top 48 cm of sediment have a highly consistent inorganic color, while Cores 3 and 6 show transitions between organic and inorganic. The sill separating the north and south basins was designed to allow sedimentation of coarse solids from Atterbury Wash in the south basin, while keeping the north basin relatively free from sediment. The thick and consistent inorganic sediments in Core 2 from the north basin seem to indicate that a single event, or series of events, overwashed the south basin and resulted in high sedimentation in the north basin. Prior to this presumed event, the sediments in all Cores 2 and 7 (Figures 6 and 12) from the north basin indicated organic sediments toward the bottom of the core. Our interpretation is that the sill separating the basins was effective in concentrating sediments in the south basin until recent storm events mobilized sediment with sufficient velocity to deposit a significant sediment load in the north basin. Such a period of storminess did occur within the past two years and in fact coincided with construction, and highly erosive conditions, in the vicinity of Atterbury wash to the south of and upstream from Lakeside Lake.

We estimated sediment volumes using data from the sediment cores. We used a modified Thiessen technique to draw polygons in the vicinity of each core and multiply the area within the polygon by the thickness of the core. The results are summarized in Table 2. By this rough approximation (accuracy is limited by the small number of cores collected), we estimate that about 6,700 cubic meters of sediment overlie the soilcrete bottom in the north basin and 9,300 cubic meters of sediment are in the south basin.

Table 2. Sediment Volume Estimates.

	North Basin			South Basin	
Core	**Area (m^2)**	**Total (m^3)**	**Core**	**Area (m^2)**	**Total (m^3)**
1	1,184	148	3	3,724	3,049
2	6,262	5,088	4	3,385	2,052
7	2,708	1,439	5	2,031	736
		3,444	6	3,724	3,444
Total		***6,675***			***9,282***
Grand Total		***15,957***			

The deep aerators in the north and south basins appear to affect, and be affected by, sedimentation processes. Figures 4 and 5 show seismic profiles in the vicinity of the aerators. For both aerators, the transects along one axis show the aerator vent to be at the bottom of a trough, while transects along a perpendicular axis show the aerator vent to be at the crest of a mound about 20 meters in diameter. This geometry can be caused by sediments focusing toward the central part of each basin, becoming re-suspended by the aerators, and then settling around the vicinity of the aerator.

Conclusions

We conducted seismic and sediment coring surveys to assess the nature and magnitude of sedimentation in Lakeside Lake, Tucson, Arizona. The surveys indicated that about 60 to 75 cm of sediment have accumulated over the original pond bottom in both the north and south basins, resulting in a total sediment burden of about 16,000 cubic meters in situ. From the stratigraphy of sediment from the cores, it appears that sediments in the south basin have accumulated gradually over the life of the pond and that most of the sediments in the north basin may have been deposited by one or several recent large-magnitude storm events. These events appear to have deposited sediments in both basins, but affected the north basin disproportionally. We do not have the data resolution necessary to speculate as to the precise mechanisms of transport. Seismic profiling in the vicinity of deep aerators in the north and south basins indicates that these aerators resuspend and redistribute sediments within about a 10 meter radius of the aerators.

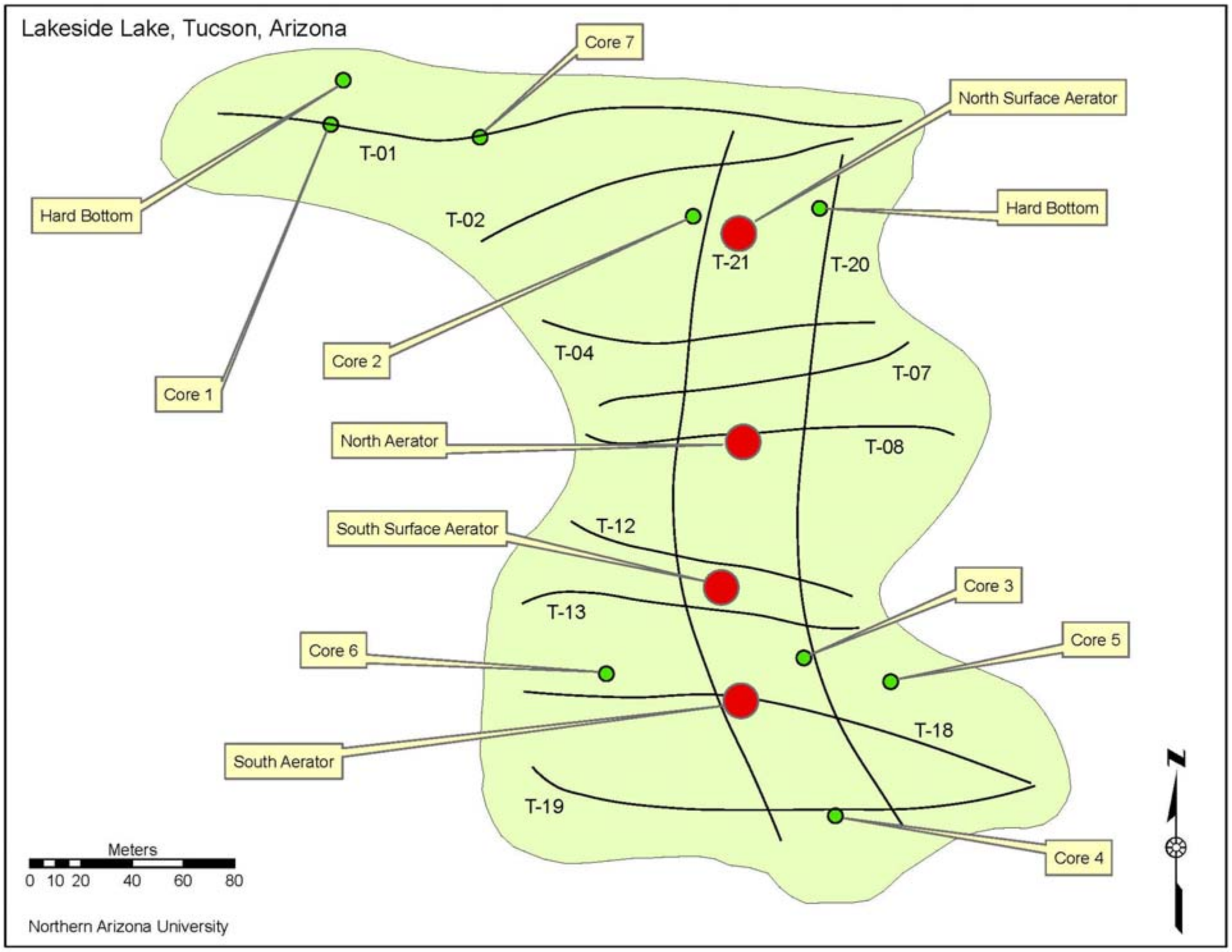

Figure 1. Lakeside Lake, Tucson Arizona. Summary of field activities on June 23 and July 3, 2008.

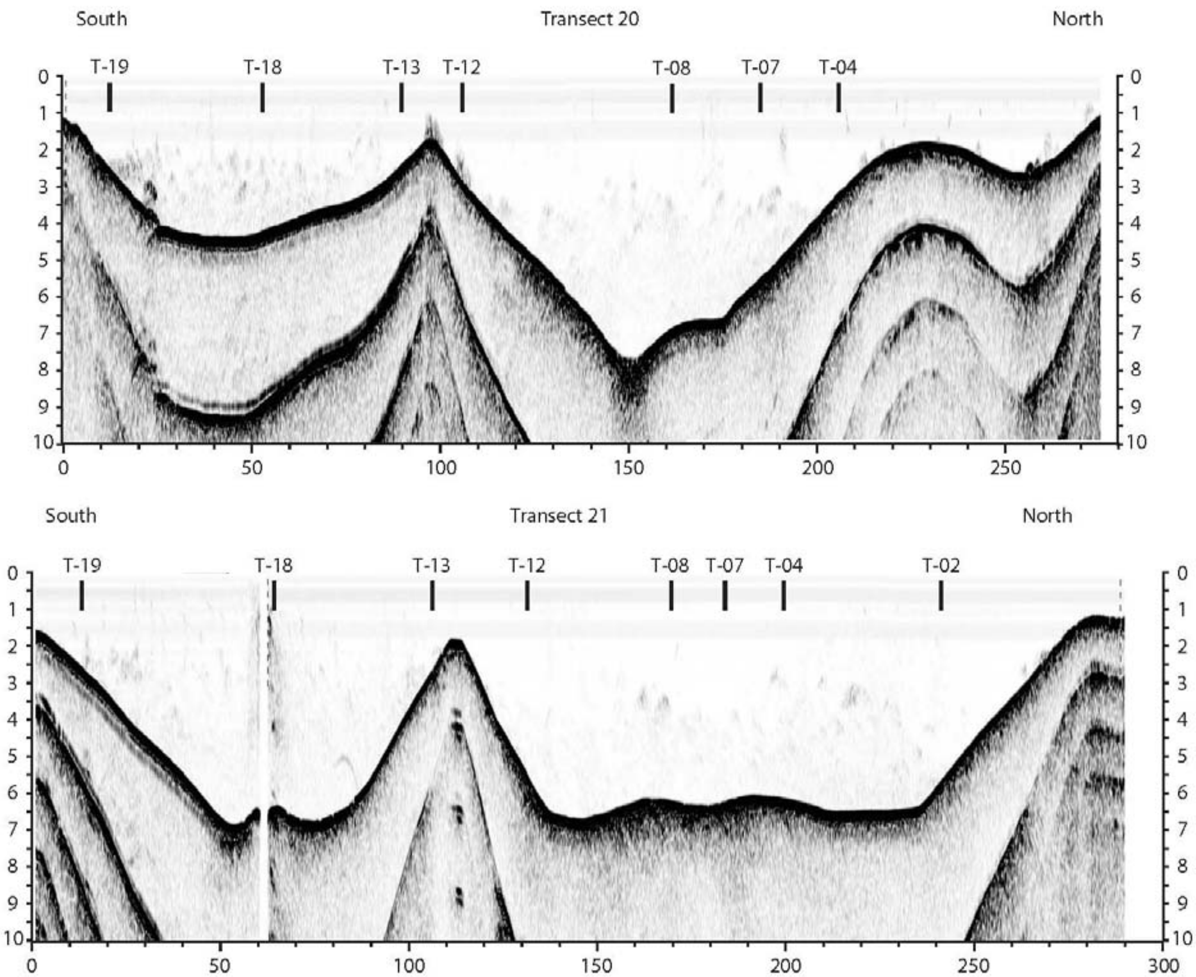

Figure 2. North-south seismic transects on Lakeside Lake. Axes are in meters. Notations at top of each chart locate intersections with perpendicular transects (Figure 3).

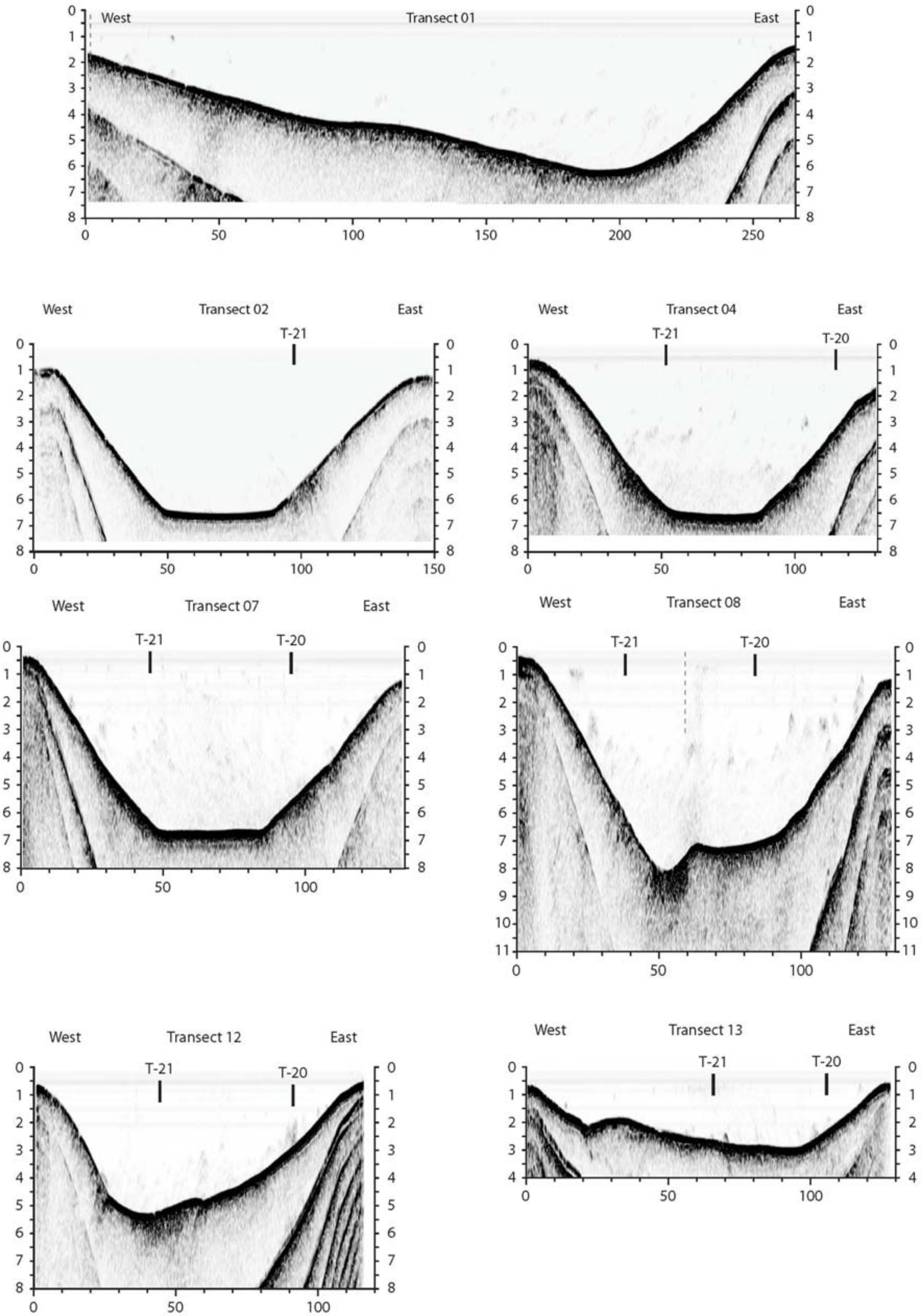

Figure 3. East-west seismic transects, Lakeside Lake. Axes are in meters.

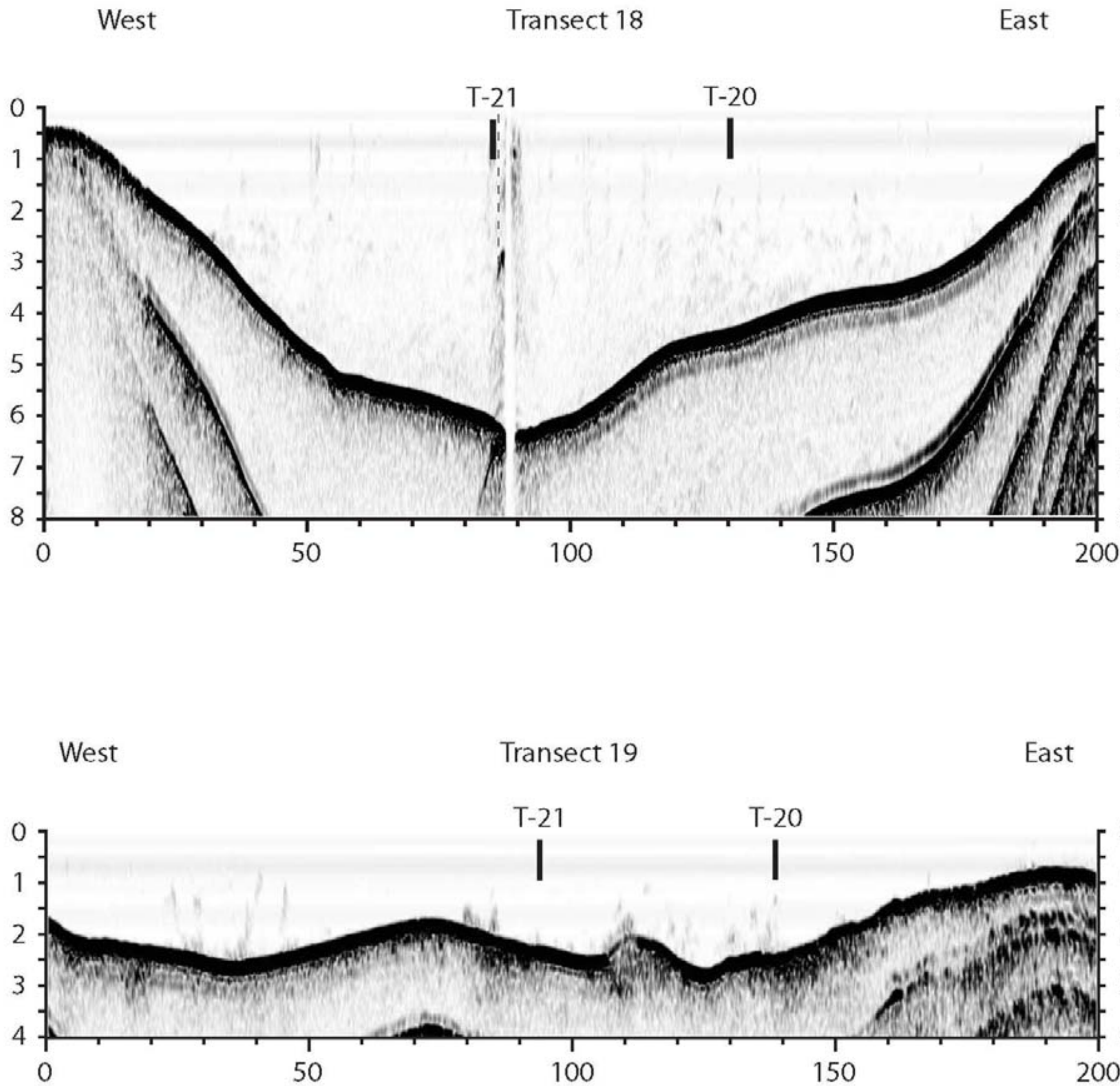

Figure 3 (concluded). East-west seismic transects, Lakeside Lake. Axes are in meters.

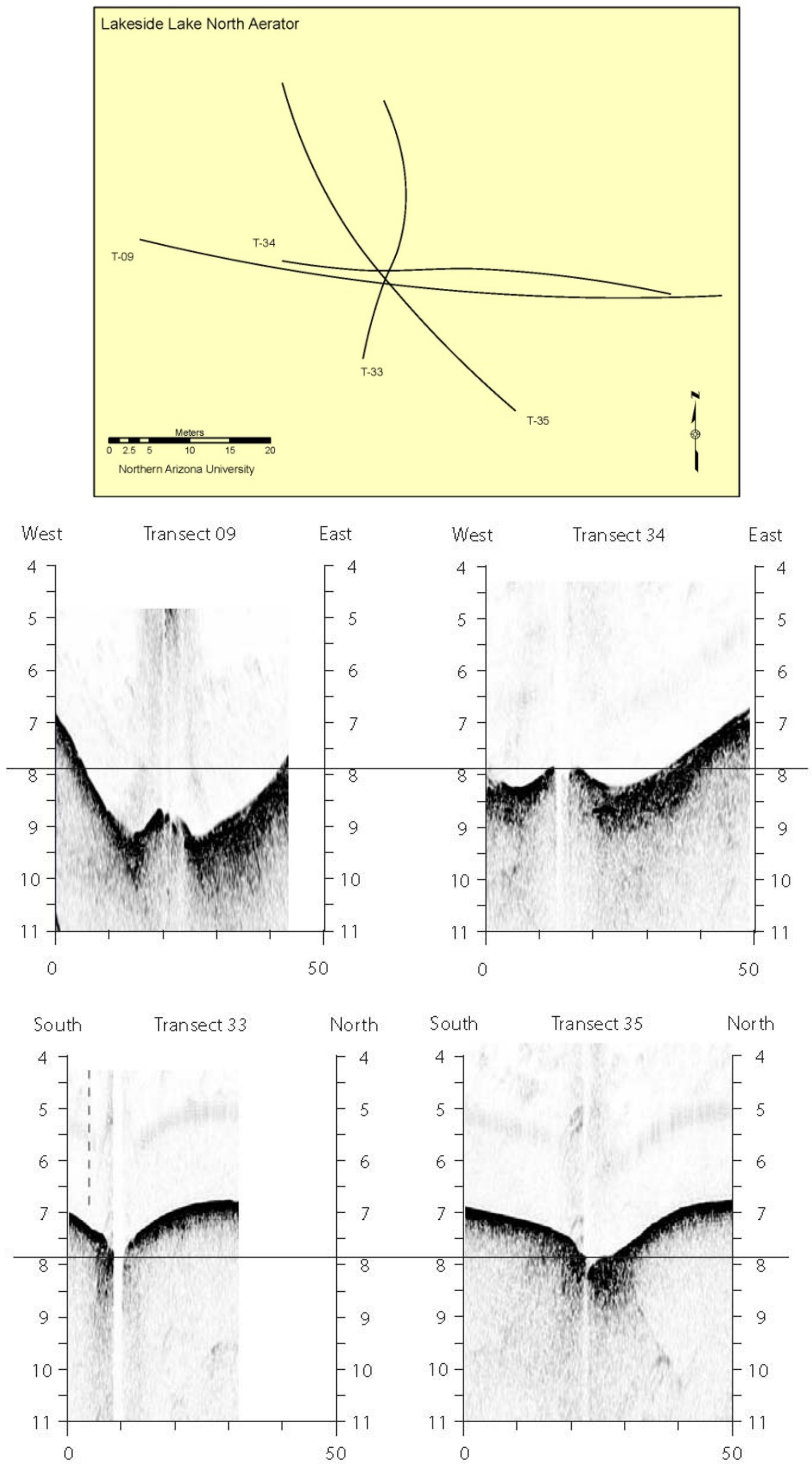

Figure 4. Seismic tracks (top) and seismic profiles (bottom) in vicinity of north aerator.

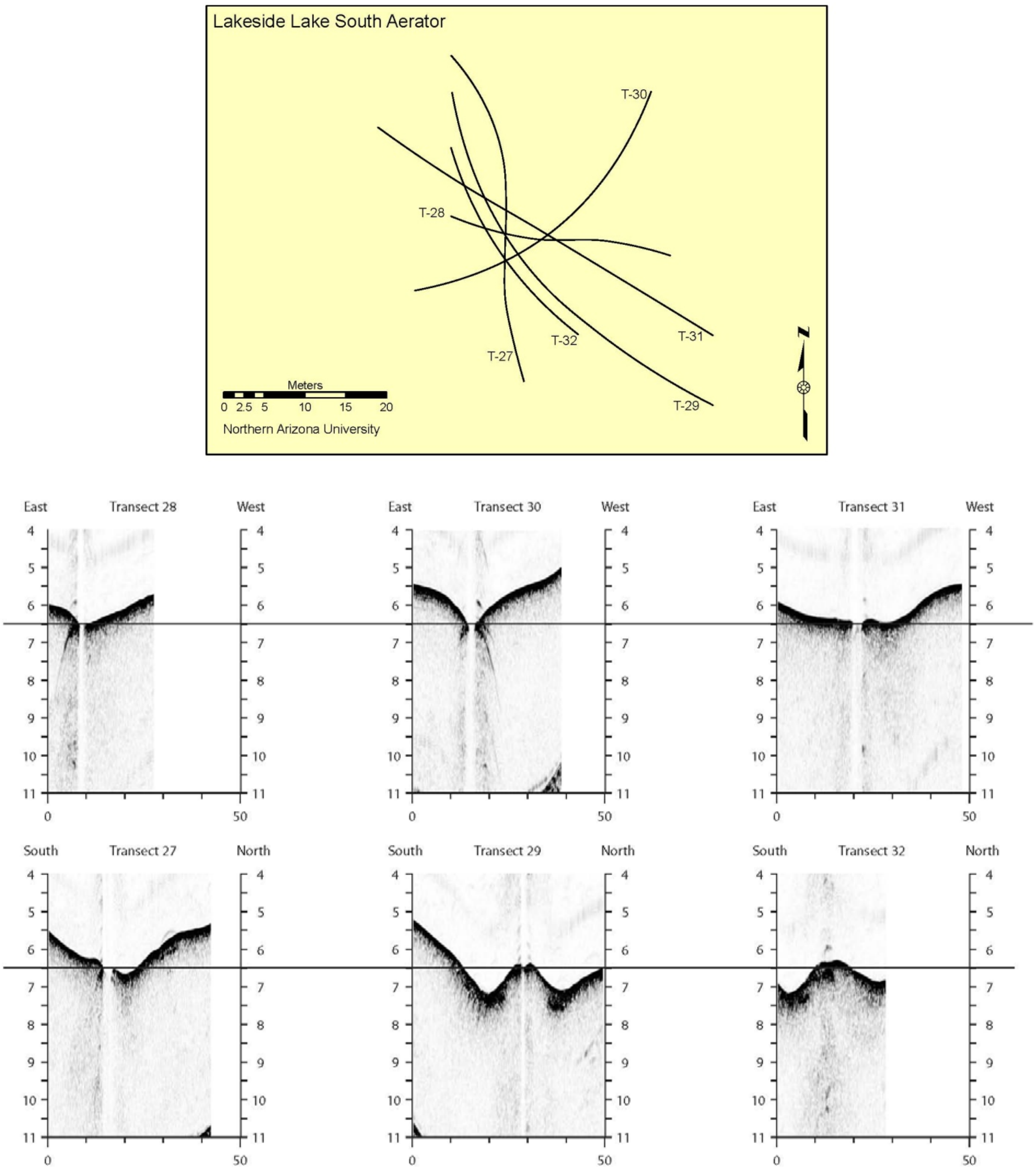

Figure 5. Seismic tracks (top) and seismic profiles (bottom) in vicinity of south aerator.

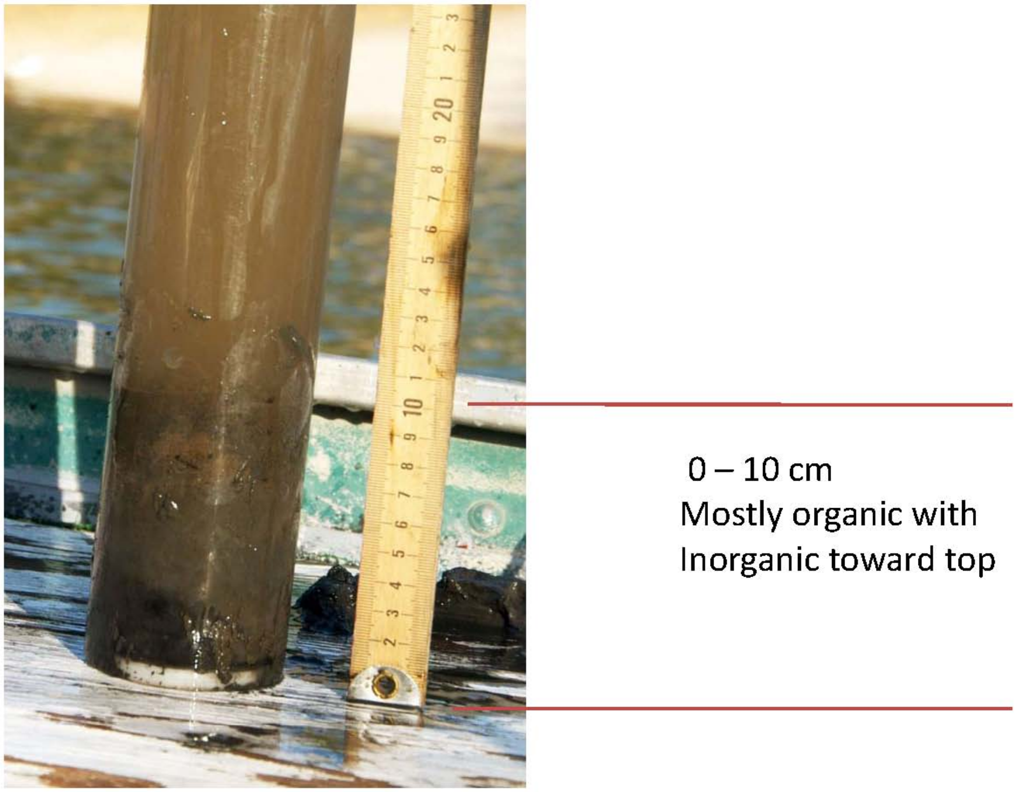

Figure 6. Photograph and description of Core 1.

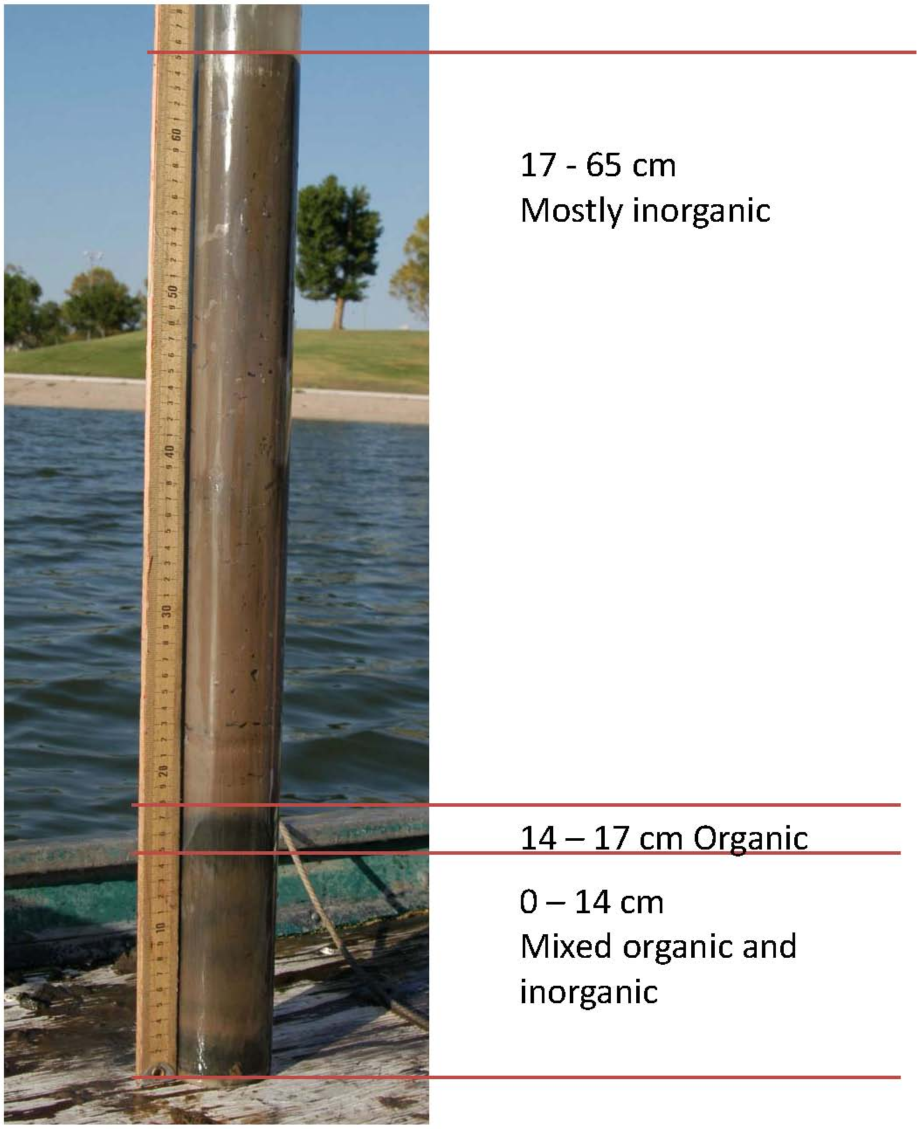

Figure 7. Photograph and description of Core 2.

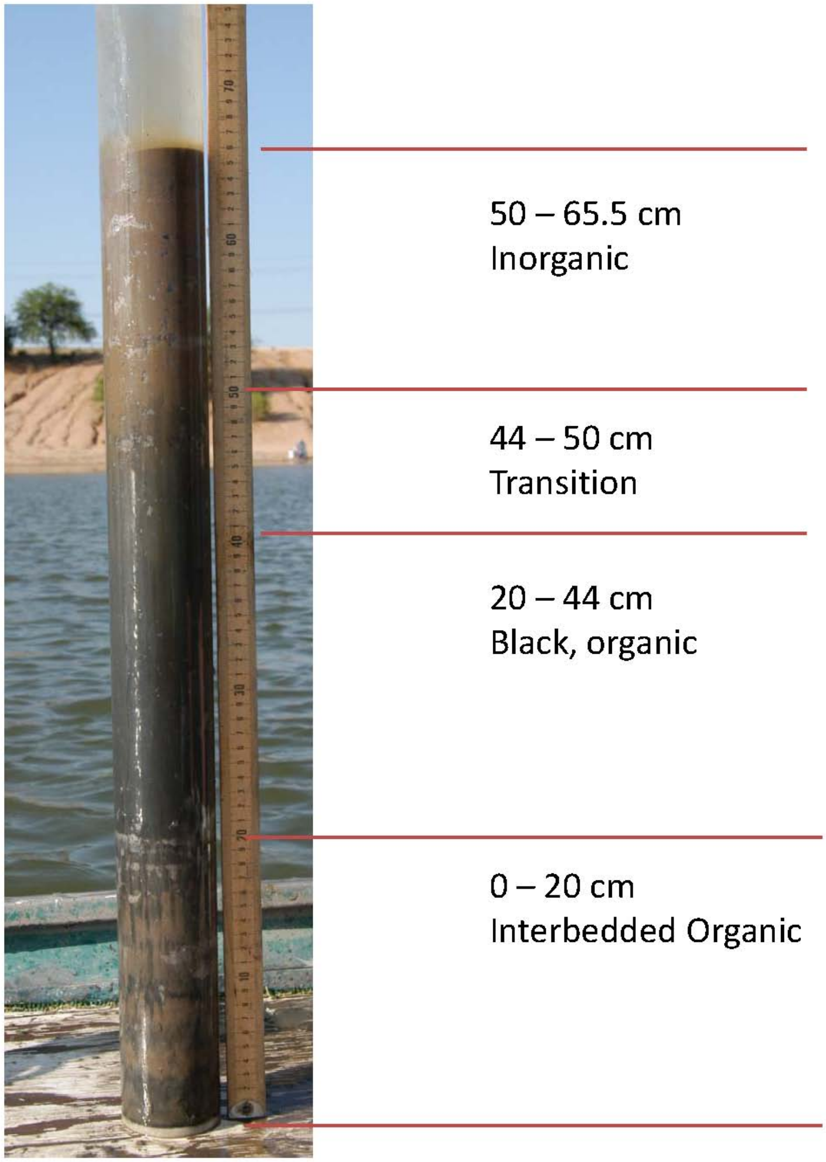

Figure 8. Photograph and description of Core 3.

Figure 9. Photograph and description of Core 4.

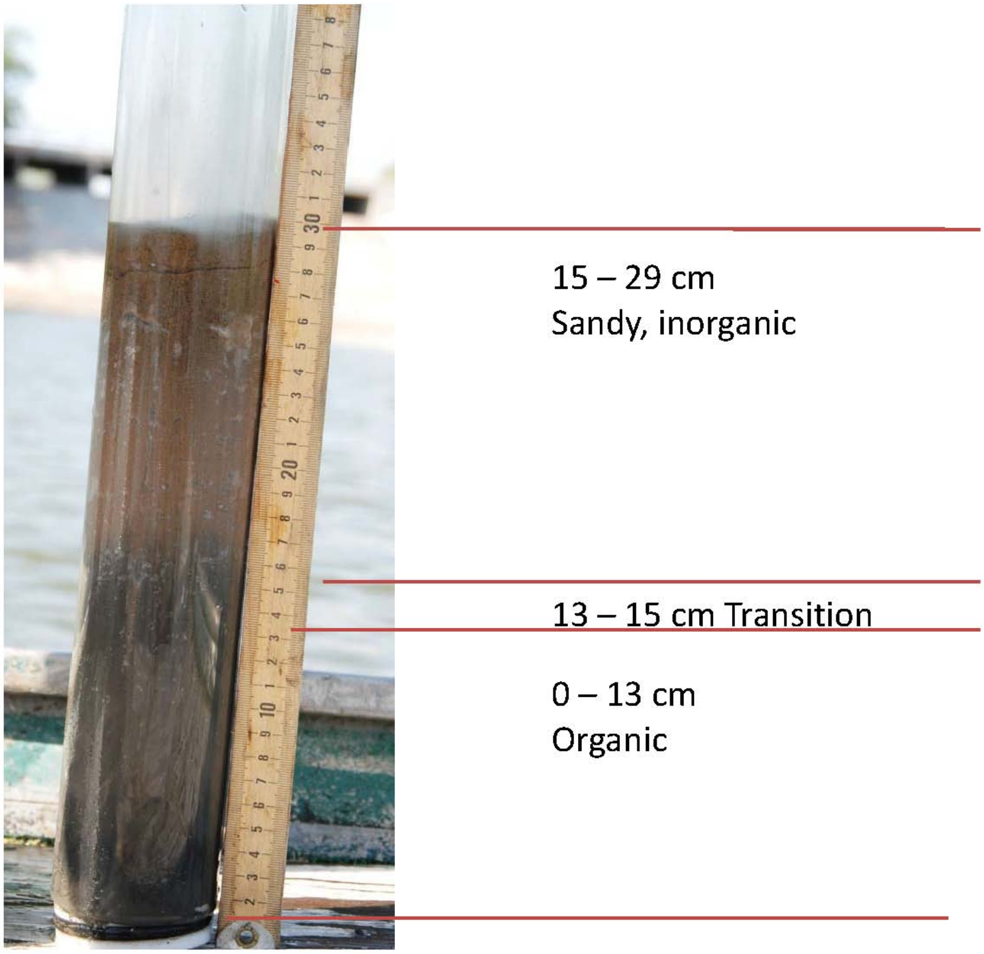

Figure 10. Photograph and description of Core 5.

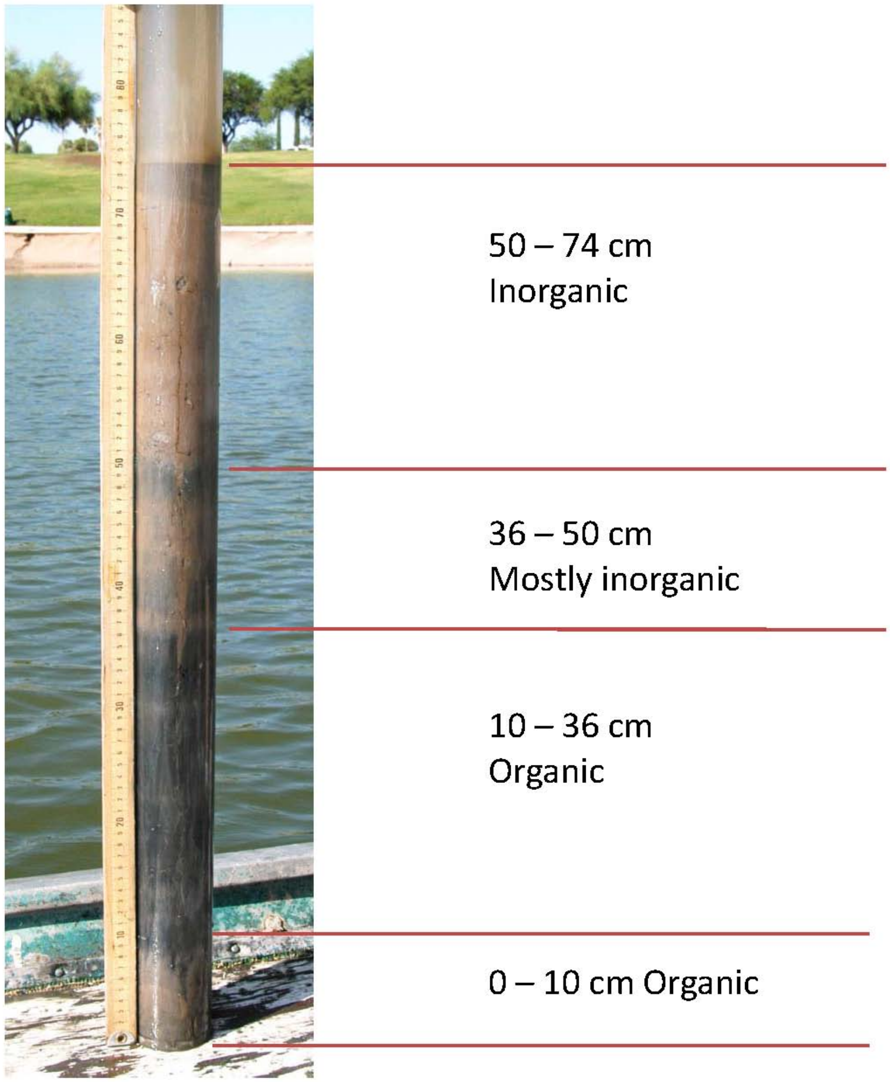

Figure 11. Photograph and description of Core 6.

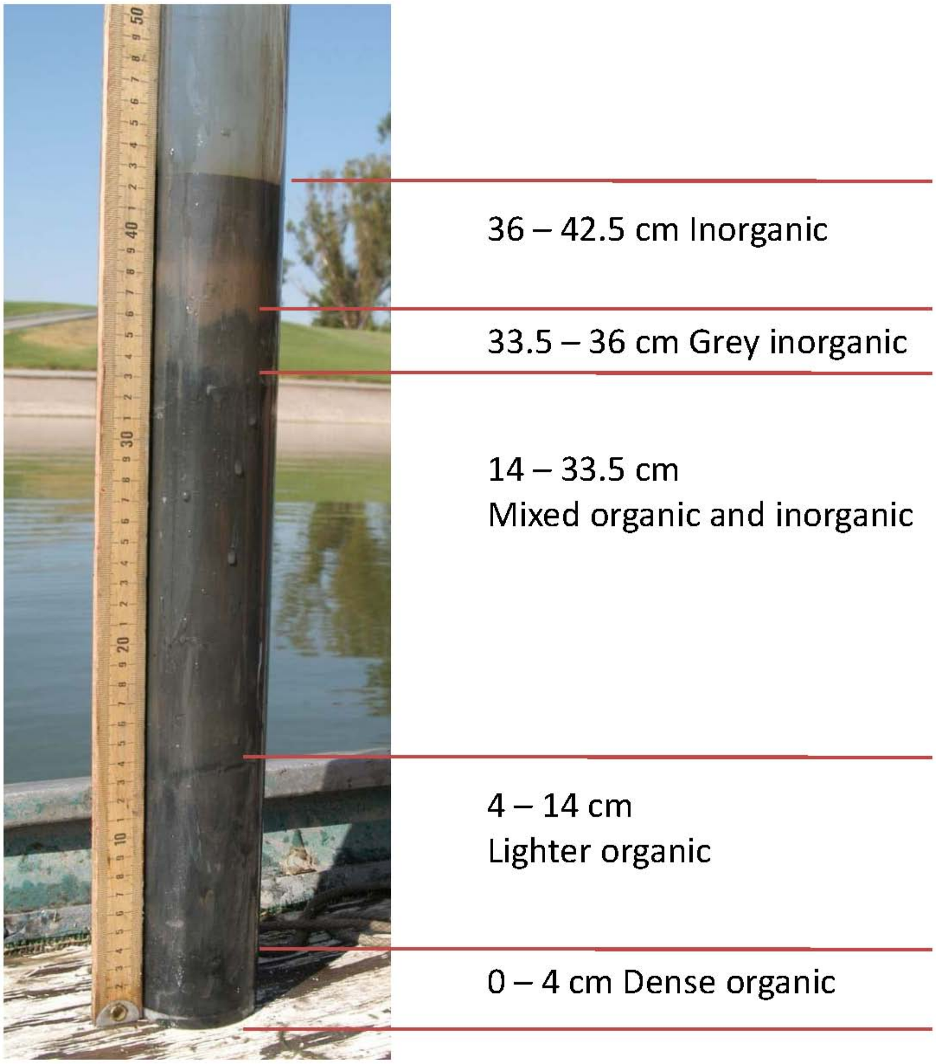

Figure 12. Photograph and description of Core 7.

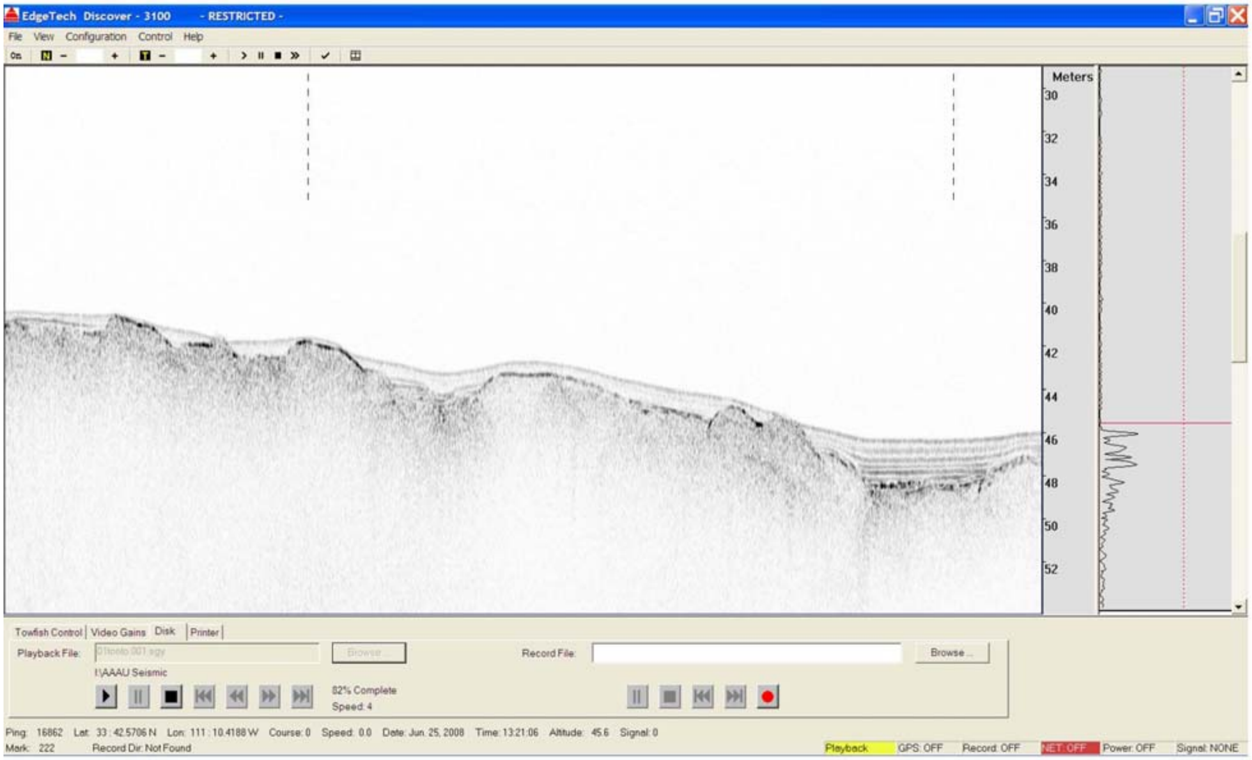

Figure 13. Seismic profile from the Tonto arm of Lake Roosevelt, Arizona.