Laurel Brook Farm Seismic Investigation

Date: 14 August, 2003 **OGS File Number**: 340739000824

Survey Type: Compressional (P) wave seismic refraction
Survey Crew: Glenn Larsen, C. Scott Brockman, and B. Sams

Site Location: On the floodplain of Rush Creek south of Bremen along State Route 664
.
County: Hocking **Township:** Marion **USGS 7½' Quadrangle:** Bremen
Latitude: N 39º 38' 14.44" **Longitude:** W 82º 25' 51.39" **Reference Datum:** NAD83
Ohio State Plane, X: 1,987,948 ft. **Y:** 596,359 ft. **Zone:** South
Line Direction: N 60° W
Note: Coordinates were determined at location of geophone no. 1, line direction measured from geophone no.1.

Purpose: This site was chosen to test a seismic model of drift thickness where actual thickness of drift over bedrock was known (10 to 20 feet) at several locations very close to the seismic line. Furthermore, the site was chosen to archive the seismic velocities of the Mississippian-age Cuyahoga formation (a shallow ODOT drilling log at the site recorded about 40 feet of fine sandstone and/or shale with very low blow-counts, less than 10).

Site Conditions: Weather conditions on site were hot and humid with no wind or breeze. Site was quiet, the primary source of random noise was generated from periodic automobile traffic along nearby State Route 664..

Seismic Investigation: : The seismic refraction survey was laid out along a straight, southeast to northwest, line 230 feet in length. P-wave refraction data were collected from a linear array of 24 geophones with distances of 10 feet between geophones. The data were collected from seven shot gathers, two shot gathers were acquired 100 feet off each end of the line and five shot gathers were acquired along the line. The seismic data were stacked 10-11 times at each shot gather to increase the signal-to-noise ratio to overcome any background noise affecting the survey. Seismic energy for the P-wave survey was generated by striking a small hardened aluminum plate with a 12-pound sledgehammer. The P-waves were detected by geophones that were sensitive to vertical ground motion, and had a natural frequency of 14 Hz.

The digitally recorded data were stored in the SEG-2 format (Subcommittee of the SEG Engineering and Groundwater Geophysics Committee, 1990). Relative elevation for each geophone was determined using a handlevel and stadia rod. Location coordinates for the seismic survey were obtained with a Garmin eMap handheld GPS unit.

Conclusions: The seismic data was processed with Oyo Corp. SeisImager/2D software using the time-term inversion method. Two velocity layers were recorded on the Laurel Brook Farm property. The velocity of the near-surface layer was calculated to be 1,010 ft/s and 10 to 14 feet thick. This layer represents unsaturated alluvial and/or lacustrine silty sand. The second layer was calculated to be 5,430 ft/s and represents saturated sandstone belonging to the Blackhand Member of the Cuyahoga Formation. The velocity contrast between the 1,010 ft/s and 5,430 ft/s layers is the water table. The seismic refraction data did not record refractive layers below a depth of 14 feet, well above the depth where low blow-counts occurred in the ODOT drilling logs. It is believed the low blow-counts occur in shale belonging to the Raccoon Member, which underlies the Blackhand Member with in the Cuyahoga Formation.

References

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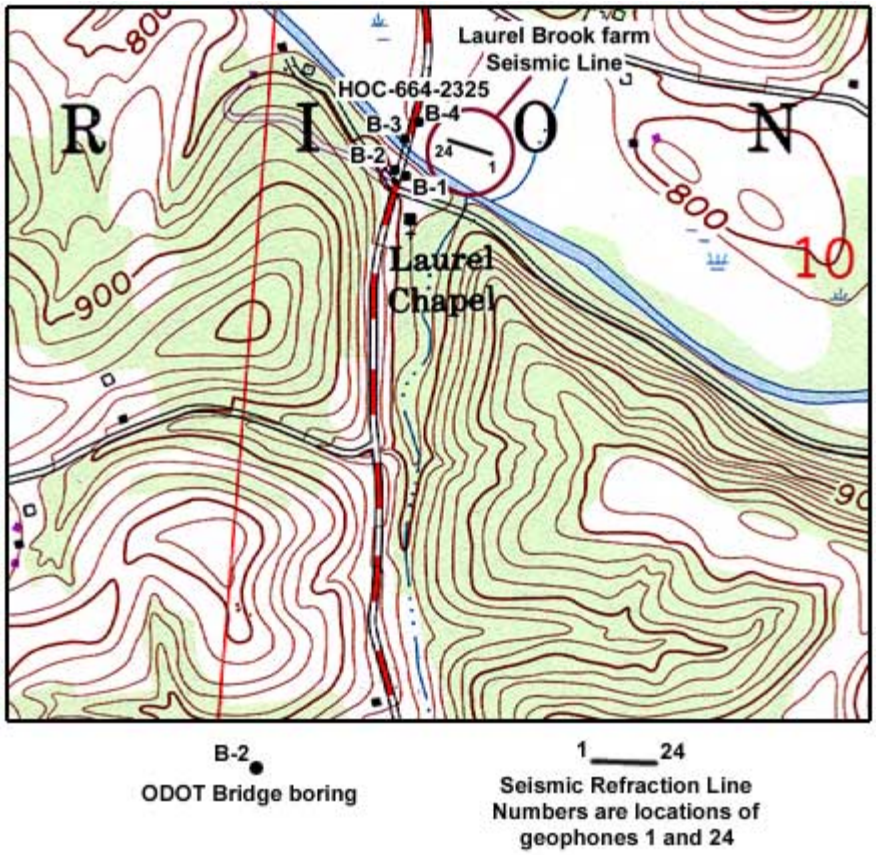

Figure 1. Map of seismic investigation. Numbers at each end of the survey line denotes the location of geophones 1 and 24.

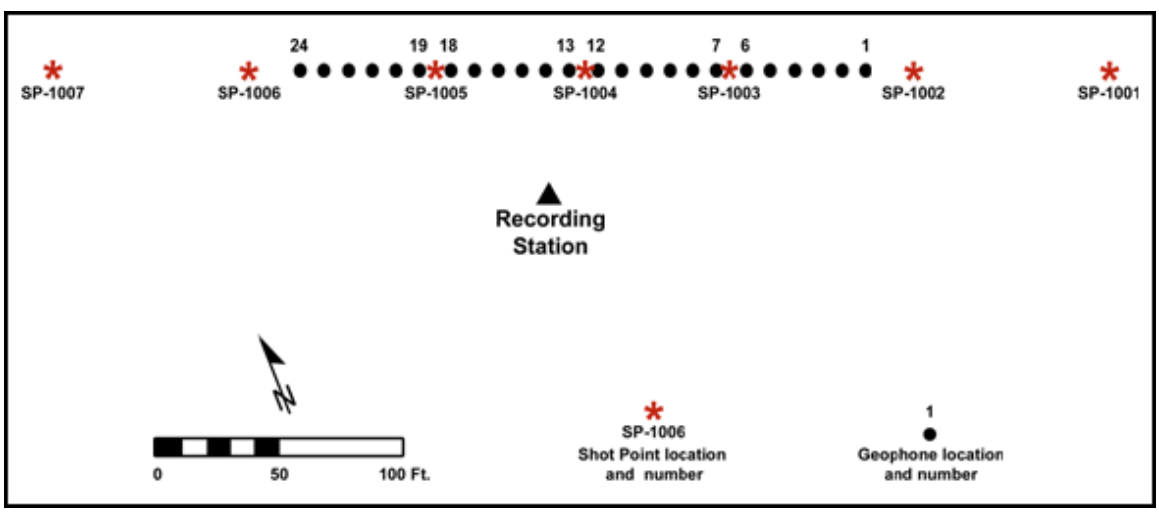

Figure 2. Seismic line diagram of geophone and shot gather locations. All locations and distances relative to shot gather 8001.

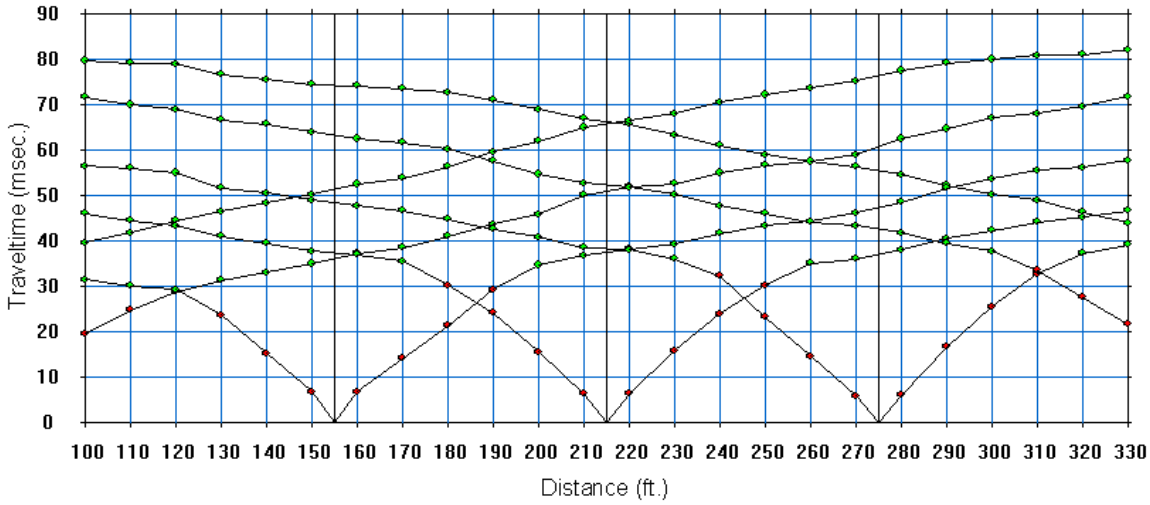

Figure 3. Travel time vs. distance plot of seismic refraction data recorded on the Laurel Brook Farm property. Red data points are P-wave travel times for velocity layer 1 and green data points are travel times for velocity layer 2.

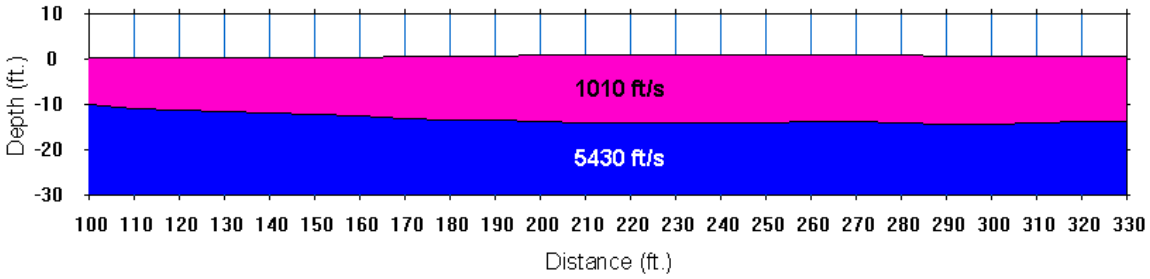

Figure 4. Velocity model of seismic refraction data observed on the Laurel Brook Farm property. Two velocity layers were recorded; a 1,010 ft/s layer and a 5,430 ft/s layer. The 1,010 ft/s layer is 10 to 14 feet thick and represents unsaturated alluvial and/or lacustrine silty sand. The 5,430 ft/s layer is saturated Mississippian-age sandstone of the Blackhand Member of the Cuyahoga Formation.

Geophone Location Data

Line No: 340739000124 **Date:** 14 August, 2003

Group Interval: 10 ft. **Group Interval:** ft.

First Geophone No: 1 **X-Loc:** 100.0 **First Geophone No:** **X-Loc:**

Geophone Number	X-Location	Δ Elev.	Elevation	Geophone Number	X-Location	Δ Elev.	Elevation
1	100.0	0.4	786.4				
2	110.0	0.3	786.3				
3	120.0	0.4	786.4				
4	130.0	0.4	786.4				
5	140.0	0.4	786.4				
6	150.0	0.3	786.3				
7	160.0	0.4	786.4				
8	170.0	0.5	786.5				
9	180.0	0.6	786.6				
10	190.0	0.7	786.7				
11	200.0	0.8	786.8				
12	210.0	0.9	786.9				
13	220.0	0.9	786.9				
14	230.0	0.9	786.9				
15	240.0	0.9	786.9				
16	250.0	0.9	786.9				
17	260.0	0.9	786.9				
18	270.0	0.9	786.9				
19	280.0	0.8	786.8				
20	290.0	0.7	786.7				
21	300.0	0.7	786.7				
22	310.0	0.7	786.7				
23	320.0	0.6	786.6				
24	330.0	0.6	786.6				

Horizontal and vertical measurements in U.S. Survey Feet

Δ Elev. is the difference in elevation relative to the lowest geophone or shot point elevation.

Elevation Data of Shot Points and Geophones

Inst. Height: 5.00 ft. **Lowest Δ H:** -7.33 **Ref. Elev:** 857 ft. surveyed, ODOT.

Station	Rod Height (R.H.)			Δ R.H.	Δ H	Δ Elev.	Comments
	Feet	Inches	Dec. Ft.				
8001	5	0	5.00	0.00	0.00	0.6	
8002	5	0	5.00	0.00	0.00	0.6	
1	5	2	5.17	-0.17	-0.17	0.4	
2	5	1	5.08	-0.08	-0.25	0.3	
3	4	11	4.92	0.08	-0.17	0.4	
4	5	0	5.00	0.00	-0.17	0.4	
5	5	0	5.00	0.00	-0.17	0.4	
6	5	1	5.08	-0.08	-0.25	0.3	
8003	5	0	5.00	0.00	-0.25	0.3	
7	4	11	4.92	0.08	-0.17	0.4	
8	4	11	4.92	0.08	-0.08	0.5	
9	4	11	4.92	0.08	0.00	0.6	
10	4	10	4.83	0.17	0.17	0.7	
11	4	11	4.92	0.08	0.25	0.8	
12	4	11	4.92	0.08	0.33	0.9	
8004	5	0	5.00	0.00	0.33	0.9	
13	5	0	5.00	0.00	0.33	0.9	
14	5	0	5.00	0.00	0.33	0.9	
15	5	0	5.00	0.00	0.33	0.9	
16	5	0	5.00	0.00	0.33	0.9	
17	5	0	5.00	0.00	0.33	0.9	
18	5	0	5.00	0.00	0.33	0.9	
8005	5	0	5.00	0.00	0.33	0.9	
19	5	1	5.08	-0.08	0.25	0.8	
20	5	1	5.08	-0.08	0.17	0.7	
21	5	1	5.08	-0.08	0.08	0.7	
22	5	0	5.00	0.00	0.08	0.7	
23	5	1	5.08	-0.08	0.00	0.6	
24	5	0	5.00	0.00	0.00	0.6	
8006	5	1	5.08	-0.08	-0.08	0.5	
8007	5	6	5.50	-0.50	-0.58	0.0	

Vertical measurements in U.S. Survey Feet

Δ R.H. = Inst. Height - Rod Height (R.H.)

Δ H is the difference in height relative to the starting point of the survey, for this survey shot point 1101.

Δ Elev. is the difference in elevation relative to the lowest geophone or shot point height (Lowest ΔH). This value is used because the modeling software requires positive elevation values.

1, 2, 3,... = geophone no. 1101, 1102,... = shot point no.

Data Acquisition Parameters

Survey Type	**P-Wave**
Recording System	Geometrics Geode
Data Format	SEG-2
Acquisition	24 channel
Source	12 pound sledge hammer
Geophones	14 Hz Vertical
Geophone Array	Linear
Line length	230 ft
Geophone spacing	10 ft.
Source Offset	2-100 ft. offend plus 5 inline
Sampling Interval	0.125 msec
Record Length	0.200 sec
Preamp Gains	All geophones 36dB
Filters	None

Velocity Model Data

Geophone Location and Elevation Data			Velocity Layer Elev (Top)[1]		Velocity Layer Depth (Top)[2]		Velocity Layer Thickness	
Geo.	X-Loc.	Elev.	2	3	2	3	1	2
1	100.0	0.4	-10.2		-10.6		10.6	
2	110.0	0.3	-10.9		-11.2		11.2	
3	120.0	0.4	-11.4		-11.8		11.8	
4	130.0	0.4	-11.6		-12.0		12.0	
5	140.0	0.4	-11.8		-12.2		12.2	
6	150.0	0.3	-12.2		-12.5		12.5	
7	160.0	0.4	-12.7		-13.1		13.1	
8	170.0	0.5	-13.0		-13.5		13.5	
9	180.0	0.6	-13.3		-13.9		13.9	
10	190.0	0.7	-13.5		-14.2		14.2	
11	200.0	0.8	-13.7		-14.5		14.5	
12	210.0	0.9	-14.0		-14.9		14.9	
13	220.0	0.9	-14.1		-15.0		15.0	
14	230.0	0.9	-14.1		-15.0		15.0	
15	240.0	0.9	-14.1		-15.0		15.0	
16	250.0	0.9	-14.0		-14.9		14.9	
17	260.0	0.9	-13.8		-14.7		14.7	
18	270.0	0.9	-13.8		-14.7		14.7	
19	280.0	0.8	-14.2		-15.0		15.0	
20	290.0	0.7	-14.4		-15.1		15.1	
21	300.0	0.7	-14.4		-15.1		15.1	
22	310.0	0.7	-14.2		-14.9		14.9	
23	320.0	0.6	-13.9		-14.5		14.5	
24	330.0	0.6	-13.7		-14.3		14.3	

[1] Datum 0.00 feet [2] Below surface (geophone elevation)
Horizontal and vertical measurements in U.S. Survey Feet.

Structure Foundation Investigation
Ohio Department of Transportation
Office of Geotechnical Engineering
1600 West Broad Street
Columbus, Ohio 43223

Structure Foundation Investigation - Bridge Boring

Bridge Number: HOC-664-2325 over Rush Creek
Sec: HOC-664-23.25

Boring Number: B-1 **Surface Elev:** 799.0 ft. **Water Elev:**
County: Hocking **Township:** Marion **Section Number:** 10
Date Started: 9/24/1990 **Sampler Type:** SS **Dia:** 1 3/8"
Date Completed: 9/24/1990 **Casing Length:** **Dia:**
Station & Offset: 1227+45, 12' Rt. (Rear Abutment)

Log of Boring

Elev.	Top	Bottom	Std. Pen. (N)	Drillers Description	Geologic Interpretation
799.0	0.0	0.5	Augered	----------Subbase----------	Silty sand Alluvial or Lacustrine
798.5	0.5	5.0		Brown silty sandy gravel	
794.0	5.0	10.0	5/7/46		
789.0	10.0	15.0	8/13/13		
784.0	15.0	20.0	2/3/5	Gray & brown sandy silt, tr. of organic	
779.0	20.0	25.0	1/2/2	Gray sandy silt	
774.0	25.0	29.0	1/2/2		
770.0	29.0	30.0	10/50	Gray silty sand	Top of Bedrock
769.0	30.0	40.0		Sandstone, brown and brownish-gray, medium-firm to coarse-grained, conglomeritic in part, badly broken. Core loss 14%	Cuyahoga Formation Blackhand Ss. Mbr. Outcrops in creek bed
759.0	40.0			Bottom of boring	

This record is a modified version of the original ODOT boring log. Geologic interpretation by the ODNR, Division of Geological survey. Copies of the original ODOT record and location maps are on file at the Division of Geological Survey.

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1600 West Broad Street
Columbus, Ohio 43223

Structure Foundation Investigation - Bridge Boring

Bridge Number: HOC-664-2325 over Rush Creek
Sec: HOC-664-23.25

Boring Number: B-2 **Surface Elev:** 798.3 ft. **Water Elev:**
County: Hocking **Township:** Marion **Section Number:** 10
Date Started: 9/25/1990 **Sampler Type:** SS **Dia:** 1 3/8"
Date Completed: 9/25/1990 **Casing Length:** **Dia:**
Station & Offset: 1227+51, 16' Lt. (Rear Abutment)

Log of Boring

Elev.	Top	Bottom	Std. Pen. (N)	Drillers Description	Geologic Interpretation
798.3	0.0	0.2	Augered	----------Sod----------	Silty sand Alluvial or Lacustrine
798.1	0.2	5.0		Brown silty gravelly sand	
793.3	5.0	10.0	1/7/16		
788.3	10.0	15.0	6/7/5	Brown gravelly sandy silt	
783.3	15.0	20.0	2/2/2	Gray silt	
778.3	20.0	25.0	4/7/8		
773.3	25.0	27.0	50 (0.4')	Gray silty sand	Top of Bedrock
771.3	27.0	35.0		Sandstone, brown and brownish-gray, medium-firm to coarse-grained, conglomeritic in part, badly broken and jointed. Core loss 3%.	Cuyahoga Formation Blackhand Ss. Mbr. Outcrops in creek bed
763.3	35.0			Bottom of boring	

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1600 West Broad Street
Columbus, Ohio 43223

Structure Foundation Investigation - Bridge Boring

Bridge Number: HOC-664-2325 over Rush Creek
Sec: HOC-664-23.25

Boring Number: B-3 **Surface Elev:** 783.5 ft. **Water Elev:** 767.0 ft.
County: Hocking **Township:** Marion **Section Number:** 10
Date Started: 9/25/1990 **Sampler Type:** SS **Dia:** 1 3/8"
Date Completed: 9/25/1990 **Casing Length:** **Dia:**
Station & Offset: 1229+20, 126' Lt. (Forwardr Abutment)

Log of Boring

Elev.	Top	Bottom	Std. Pen. (N)	Drillers Description	Geologic Interpretation
783.5	0.0	0.5	Augered	Weed & topsoil	Silty sand Alluvial or Lacustrine
783.0	0.5	5.0		Brown clayey silt	
778.5	5.0	10.0	1/1/1		
773.5	10.0	15.0	1/1/2	Brown & gray sandy silt, trace of organic	
768.5	15.0	16.5		Gray gravelly sandy silt, trace of organic	Bedrock weathered/soft Blackhand Sandstone Outcrops in creek bed
767.0	16.5	18.0	2/3/5		
765.5	18.0	19.5	1/4/5	Gray silty sandy gravel	
764.0	19.5	21.0	3/2/4	Gray gravelly sandy silt	
762.5	21.0	22.5	3/13/16	Gray sandy gravelly silt	
761.0	22.5	24.0	7/6/8	Gray sandy silt	
759.5	24.0	27.5	3/5/11		
			5/7/10	Brown silty gravelly sand	
756.0	27.5	28.5	50 (0.3)	Brown weathered sandstone	Blackhand Sandstone
755.0	28.5	35.0		Sandstone, brown & brownish-gray, medium-firm, medium to coarse grained, conglomeritic in part, badly broken and jointed. Core loss 7%	
748.5	35.0			Bottom of Boring	

This record is a modified version of the original ODOT boring log. Geologic interpretation by the ODNR, Division of Geological survey. Copies of the original ODOT record and location maps are on file at the Division of Geological Survey.

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Structure Foundation Investigation - Bridge Boring

Bridge Number: HOC-664-2325 over Rush Creek
Sec: HOC-664-23.25

Boring Number: B-4 **Surface Elev:** 790.0 ft. **Water Elev:**
County: Hocking **Township:** Marion **Section Number:** 10
Date Started: 9/24/1990 **Sampler Type:** SS **Dia:** 1 3/8"
Date Completed: 9/25/1990 **Casing Length:** **Dia:**
Station & Offset: 1229+67, 16' Rt. (Forward Abutment)

Log of Boring

Elev.	Top	Bottom	Std. Pen. (N)	Drillers Description	Geologic Interpretation
790.0	0.0	5.0			Silty sand Alluvial or Lacustrine
785.0	5.0	10.0	4/6/8	Gray sandy silt	
780.0	10.0	15.0	1/1/3	Brown sandy silt	
775.0	15.0	20.0	4/5/7		
770.0	20.0	21.5		Gray silty gravelly sand	Top of Bedrock
768.5	21.5	23.0	10/19/19		
767.0	23.0	24.5	7/6/9	Gray silty clay	Cuyahoga Formation Blackhand Ss. Mbr. Outcrops in creek bed
765.5	24.5	26.0	5/9/9	Gray silty gravelly sand	
764.0	26.0	27.5	6/12/7	Gray silty sandy gravel	
762.5	27.5	29.0	6/11/19	Gray sandy silt	
761.0	29.0	30.0	13/28/ 50	Gray sandy silt	
760.0	30.0	32.5	22/35/70		
757.5	32.5	35.0	----------	No recovery-sand & gravel (driller's description)	
755.0	35.0	37.5		Gray silty gravelly sand	
752.5	37.5	38.5	8/23/20		
751.5	38.5	40.0		Gray silty sand	
750.0	40.0	45.0	24/63/65	Gray silty gravelly sand	
745.0	45.0	50.0	2/3/3	Gray silty sand	Cuyahoga Formation Raccoon Sh. Mbr.?
740.0	50.0	55.0	4/6/5		
735.0	55.0	60.0	6/9/11	Gray silt	
730.0	60.0	65.0	1/2/2		
725.0	65.0	72.0	6/6/6	Gray clayey silt	
718.0	72.0	73.5	5/5/5*		
716.5	73.5			Bottom of boring	

* Rod penetrated by weight of tool

This record is a modified version of the original ODOT boring log. Geologic interpretation by the ODNR, Division of Geological survey. Copies of the original ODOT record and location maps are on file at the Division of Geological Survey.

Ohio Department of Natural Resources
Division of Geological Survey

Seismic Investigations

Explanation of Contents

The reports, analyses, documents, and data in this document were compiled as part of seismic investigations done in the state of Ohio by the Ohio Department of Natural Resources (ODNR), Division of Geological Survey. The seismic investigations measured compressional-wave (P-wave) and shear-wave (S-wave) velocities and surface wave phase velocities to produce depth models characterizing the subsurface geology of the buried bedrock surface and the overlying sediments. The data collected were also used to determine the in situ elastic and seismic properties of soils and bedrock.

The file numbering scheme used for these investigations follow an API code format:

File 341419000724

34 = API state code (Ohio in this example)
141 = API county code (Ross County in this example)
9 = blank
0007 = code for survey number (survey no. 7 in this example)
24 = code for refraction and MASW surveys

History

The seismic equipment was purchased in 2001 by the ODNR Division of Geological Survey, Geologic Mapping Group with grant monies from Central Great Lakes Geologic Mapping Coalition (CGLGMC). This equipment provides a rapid and inexpensive means of determining the depth to bedrock and characterizing the stratigraphy of surficial materials in geologically complex areas. The equipment is portable, can be used in a wide range of situations, requires no dedicated vehicle, and can be used with minimal personnel and travel expense. The ODNR Division of Geological Survey started using the seismic system July 2002

Data Set Credit

The seismic data was acquired for the Statewide Surficial Mapping Project, funded by STATEMAP Geologic Mapping Program, Central Great Lakes Geologic Mapping Coalition (CGLGMC), and Ohio Seismic Network (OhioSeis).

Use Constraints

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