District Petroleum, Inc. Seismic Investigation

Date: 23 September, 2003 **OGS File Number**: 340439000224

Survey Type: Compressional (P) seismic refraction
Survey Crew: Glenn Larsen, E. Mac Swinford, and C. Scott Brockman.

Site Location: On an abandoned segment of River Rd adjacent to Dupont Marsh State Nature Preserve, north of Knight Road and south of SR 2
County: Erie **Township:** Huron **USGS 7½' Quadrangle:** Milan
Latitude: N 41º 21' 47.49" **Longitude:** W 82º 32' 55.04" **Reference Datum:** NAD83
Ohio State Plane, X: 1,955,153 ft. **Y:** 618,093 ft. **Zone:** North
Line Direction: N 37 º E
Note: Coordinates were determined at location of geophone no. 1, line direction measured from geophone no.1.

Purpose: This investigation was a repeat of a seismic refraction survey that was conducted September 25, 2002. The first survey was an attempt to determine depth to bedrock and to see if velocity contrasts between lacustrine silt and till lithologies overlying bedrock could be identified. Three 24-channel spreads were laid out on the site at the same location. Each spread had a different group interval. The idea was to test the difference in resolution of the seismic data using 3-foot, 5-foot, and 10-foot group intervals. The results were inconclusive, no refractive layers (velocity contrasts) were identified below the ground water table (GWT). It became apparent that the depths to any refractive layers below the GWT exceeded the depth limits of the spreads. At the time, the equipment used for the study was limited to a spread with a 10-foot group interval. It was decided to redo this site using upgraded equipment and a longer spread with a 15-foot group interval capable of recording refractive layers within 80 to 90 feet of the surface.

Site Conditions: Weather conditions were good with slight breeze to wind gusts. Ground was damp to wet from rain the day before.

Seismic Refraction Survey: The investigation was laid out along a straight, southwest to northeast, line 345 feet in length. P-wave refraction data were collected from a linear spread of 24 geophones with a distance of 15 feet between geophones. Seismic energy for the survey was generated by striking a metal 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 seismic data were stacked multiple times at each source point to increase the signal-to-noise ratio to overcome any background noise affecting the survey. 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 stadia rod and a handlevel. The reference datum for the elevation data was set at the location of the first geophone. Location coordinates for the seismic survey were obtained with a Garmin handheld GPS unit.

Results: The P-wave data recorded refraction arrival times from two horizons, the ground water table and the bedrock surface. Three main velocity layers were recorded at this location. The seismic velocity in the first layer (near-surface layer) was 600 ft/s, in the second layer 5,120 ft/s, and in the third layer 8,850 ft/s. Geologic interpretation of the seismic data was aided by the soil boring drilled on the Huron Lime Co. property (1200 ft. south of the site) It was determined velocity layer 1 represents fine sandy loam of lacustrine origin (Redmond, Hole, Innis, and Wachtman, 1971) above the GWT. Velocity layer 2 represents silts and clays of lacustrine origin. Velocity layer 3 represents compacted till ranging from 60 to 84 feet deep. The contact between velocity layers 1 and 2 represents the GWT and ranging in depth from 5 to 6 feet.

References

Redmond, C.E., Hole, T.J.F., Innis, C.H., and Wachtman, M., 1971, Soil survey of Erie County, Ohio: U.S. Department of Agriculture, Soil Conservation Service, 166 p.

Subcommittee of the SEG Engineering and Groundwater Geophysics Committee, Pullan, S.E., Chairman, 1990, Recommended standard for seismic (/radar) files in the personal computer environment: Geophysics, vol. 55, no. 9, p. 1260-1271.

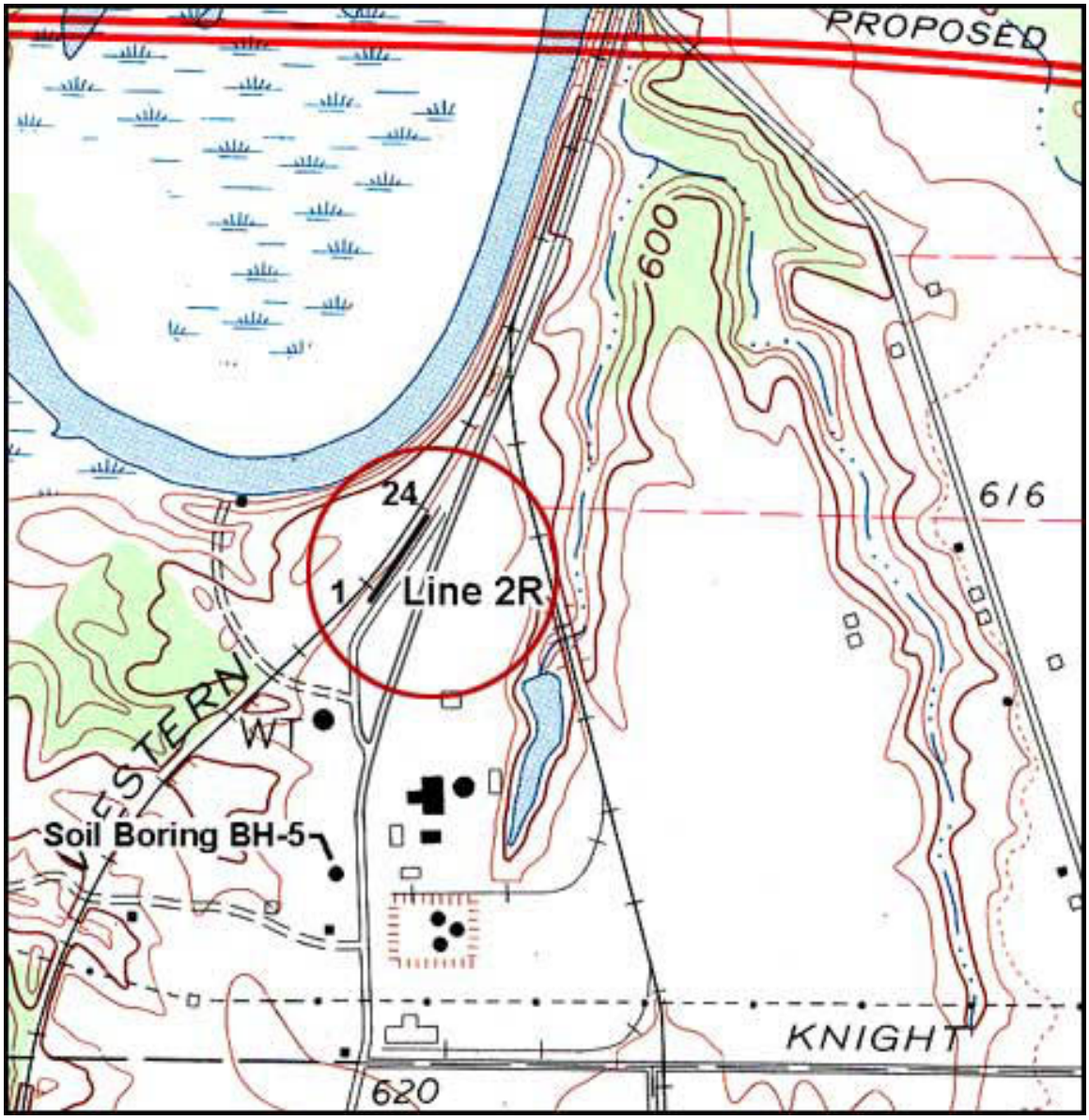

Figure 1. Location map of seismic refraction line 340439000224, on the District Petroleum Products, Inc. property. Also shown on the map is the location of the soil boring, on the Huron Lime Co. property, used in the geologic interpretation of the seismic-refraction data. Numbers on the seismic line refer to the location of geophones 1 and 24.

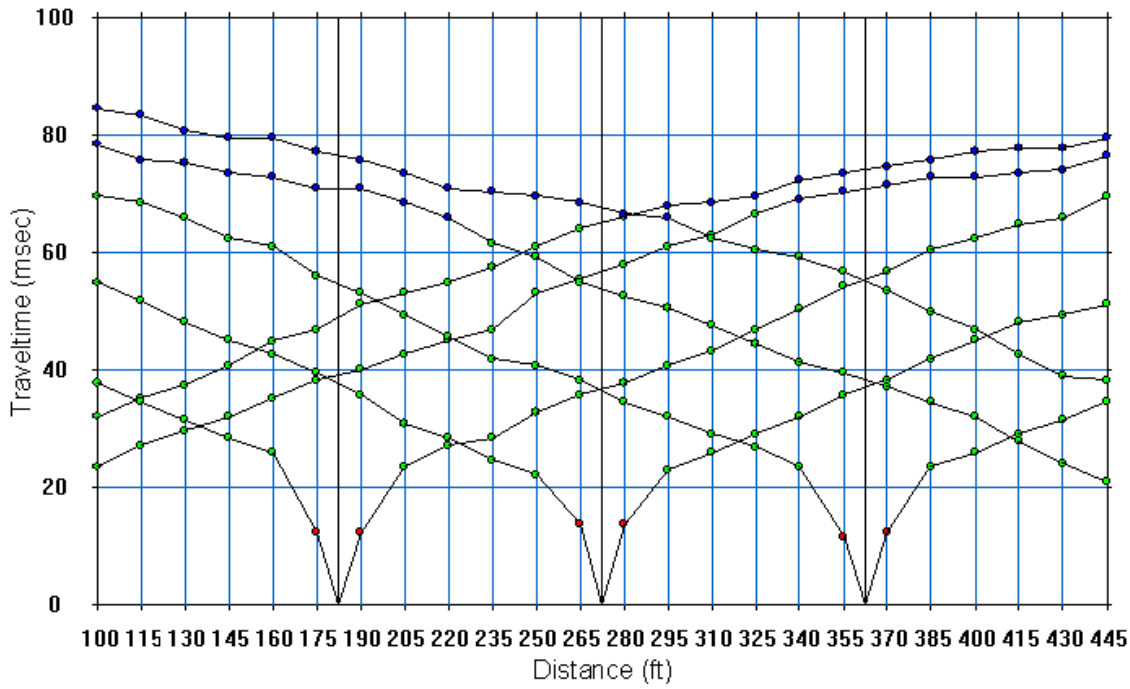

Figure 2. Time vs. distance plot of seismic refraction data recorded on District Petroleum, Inc. property. Red data points are P-wave arrival times for velocity layer 1. Green data points are arrival times for velocity layer 2. Blue data points are arrival times for velocity layer 3.

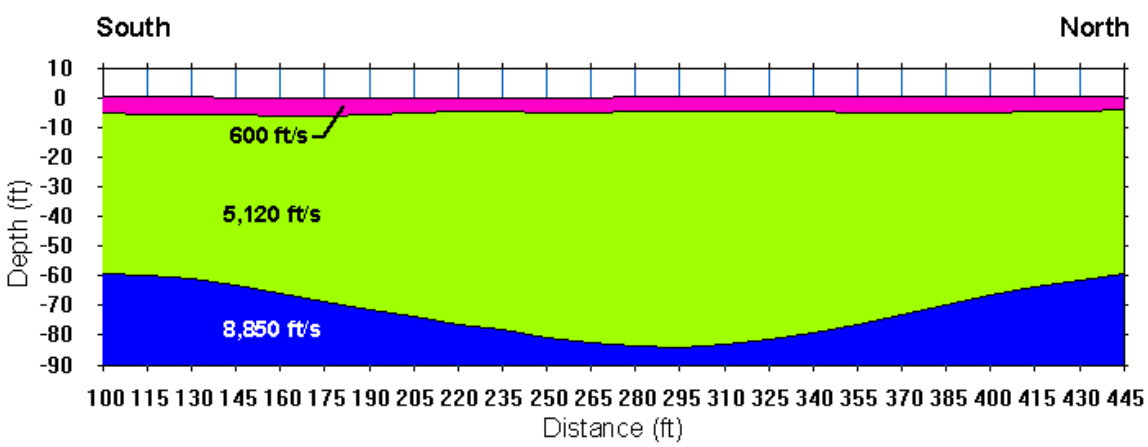

Figure 3. The velocity model of the seismic-refraction data, above, was constructed using the time-term inversion method. Three velocity layers were recorded and modeled. These layers represent, in descending order, 1) lacustrine fine sandy loam above the ground water table, 2) lacustrine silts and clays, and 3) compacted till. The contact between layers 1 and 2 represents the ground water table.

Geophone Location Data

Line No: 340439000224 **Date:** 23 September, 2003

Location: District Petroleum, Inc.

Group Interval: 15 ft. P-wave **Group Interval:** ft. S-wave

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	0.8	615.8				
2	115.0	0.4	615.4				
3	130.0	0.6	615.6				
4	145.0	0.3	615.3				
5	160.0	0.0	615.0				
6	175.0	0.0	615.0				
7	190.0	0.0	615.0				
8	205.0	0.1	615.1				
9	220.0	0.3	615.3				
10	235.0	0.3	615.3				
11	250.0	0.3	615.3				
12	265.0	0.3	615.3				
13	280.0	0.4	615.4				
14	295.0	0.4	615.4				
15	310.0	0.5	615.5				
16	325.0	0.7	615.7				
17	340.0	0.7	615.7				
18	355.0	0.7	615.7				
19	370.0	0.5	615.5				
20	385.0	0.5	615.5				
21	400.0	0.5	615.5				
22	415.0	0.8	615.8				
23	430.0	0.5	615.5				
24	445.0	0.8	615.8				

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 Geophones

Inst. Height: 5.00 ft. **Lowest Δ H:** -0.50 **Ref. Elev:** 615 ft. topo. est.

Station	Rod Height (R.H.)			Δ R.H.	Δ H	Δ Elev.	Comments
	Feet	Inches	Dec. Ft.				
2007	5	0	5.00	0.00	0.00	0.5	
2006	4	9	4.75	0.25	0.25	0.8	
24	5	0	5.00	0.00	0.25	0.8	
23	5	3	5.25	-0.25	0.00	0.5	
22	4	8	4.67	0.33	0.33	0.8	
21	5	4	5.33	-0.33	0.00	0.5	
20	5	0	5.00	0.00	0.00	0.5	
19	5	0	5.00	0.00	0.00	0.5	
2005	5	1	5.08	-0.08	-0.08	0.4	
18	4	9	4.75	0.25	0.17	0.7	
17	5	0	5.00	0.00	0.17	0.7	
16	5	0	5.00	0.00	0.17	0.7	
15	5	2	5.17	-0.17	0.00	0.5	
14	5	1	5.08	-0.08	-0.08	0.4	
13	5	0	5.00	0.00	-0.08	0.4	
2004	5	0	5.00	0.00	-0.08	0.4	
12	5	1	5.08	-0.08	-0.17	0.3	
11	5	0	5.00	0.00	-0.17	0.3	
10	5	0	5.00	0.00	-0.17	0.3	
9	5	1	5.08	-0.08	-0.25	0.3	
8	5	2	5.17	-0.17	-0.42	0.1	
7	5	1	5.08	-0.08	-0.50	0.0	
2003	5	0	5.00	0.00	-0.50	0.0	
6	5	0	5.00	0.00	-0.50	0.0	
5	5	0	5.00	0.00	-0.50	0.0	
4	4	9	4.75	0.25	-0.25	0.3	
3	4	8	4.67	0.33	0.08	0.6	
2	5	2	5.17	-0.17	-0.08	0.4	
1	4	7	4.58	0.42	0.33	0.8	
2002	4	5	4.42	0.58	0.92	1.4	
2001	5	0	5.00	0.00	0.92	1.4	

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 SP-1.

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.

Data Acquisition Parameters

Survey Type	**P-Wave**
Recording System	Geometrics Geode
Data Format	SEG-2
Acquisition	24 channel
Source	12 lb sledgehammer
Geophones	14 Hz Vertical
Geophone Array	Linear
Line length	345 ft
Geophone spacing	15 ft.
Source Offset	2 offend at 100 ft., 2 offend at 20 ft., and 3 inline
Sampling Interval	0.125 msec
Record Length	0.200 sec
Preamp Gains	All geophones 36dB
Filters	None

P-wave Velocity Model Data

Geophone Location and Elevation Data			Velocity Layer Depth (Top)[1]		Velocity Layer Depth (Top)[2]		Velocity Layer Thickness	
Geo.	X-Loc.	Δ Elev.	2	3	2	3	1	2
1	100.0	0.8	-5.1	-59.6	-5.9	-60.4	5.9	54.5
2	115.0	0.4	-5.4	-60.0	-5.8	-60.4	5.8	54.6
3	130.0	0.6	-5.5	-61.2	-6.1	-61.8	6.1	55.7
4	145.0	0.3	-5.7	-63.2	-6.0	-63.5	6.0	57.5
5	160.0	0.0	-6.0	-65.9	-6.0	-65.9	6.0	59.9
6	175.0	0.0	-5.9	-68.7	-5.9	-68.7	5.9	62.8
7	190.0	0.0	-5.6	-71.4	-5.6	-71.4	5.6	65.8
8	205.0	0.1	-5.2	-73.8	-5.3	-73.9	5.3	68.7
9	220.0	0.3	-4.7	-76.2	-5.0	-76.5	5.0	71.4
10	235.0	0.3	-4.6	-78.4	-4.9	-78.7	4.9	73.8
11	250.0	0.3	-4.8	-80.6	-5.1	-80.9	5.1	75.8
12	265.0	0.3	-4.8	-82.5	-5.1	-82.8	5.1	77.7
13	280.0	0.4	-4.7	-83.8	-5.1	-84.2	5.1	79.0
14	295.0	0.4	-4.6	-84.0	-5.0	-84.4	5.0	79.3
15	310.0	0.5	-4.5	-83.2	-5.0	-83.7	5.0	78.7
16	325.0	0.7	-4.6	-81.6	-5.3	-82.3	5.3	77.1
17	340.0	0.7	-4.8	-79.4	-5.5	-80.1	5.5	74.6
18	355.0	0.7	-5.0	-76.6	-5.7	-77.3	5.7	71.6
19	370.0	0.5	-5.2	-73.4	-5.7	-73.9	5.7	68.2
20	385.0	0.5	-5.3	-69.9	-5.8	-70.4	5.8	64.7
21	400.0	0.5	-5.1	-66.6	-5.6	-67.1	5.6	61.5
22	415.0	0.8	-4.7	-63.7	-5.5	-64.5	5.5	59.0
23	430.0	0.5	-4.4	-61.3	-4.9	-61.8	4.9	56.9
24	445.0	0.8	-4.2	-59.1	-5.0	-59.9	5.0	54.8

[1] Datum 0.00 feet [2] Below surface (geophone elevation)
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.

Soil Boring Log

Location: Huron Lime Co., Land fill facility
Date Drilled: 5/19/1993
Drilling Method: 4¼ in. I.D. Hollow Stem Auger
Drilling Company: TolTest, Inc.

Boring Number: BH-5/MW-5
Total Depth: 65 ft.
Casing Elevation: 615 ft. (topo. Est.)
Static Water Level: 11 ft.

Depth (Feet)	Geologic Description	Geologic Interpretation
0	Soft to medium stiff brown to red brown SILT with some clay and few fine sand seams, damp	Lacustrine Silt and Clay
5		
10	- with gray mottling and some sand - becomes moist	
15		
20	- becomes soft gray SILT and CLAY with trace of fine sand	
25		
30	Very soft to soft gray SILTY CLAY with red blotches throughout the sample, damp to moist	
35		
40		

This record is a modified version of the original Soil Boring Log by TolTest, Inc. Geologic interpretation by the ODNR, Division of Geological Survey. Copies of the original record and location maps are on file at the Ohio Environmental Protection Agency, Northwest District Office, Bowling Green, Ohio.

Soil Boring Log

Location: Huron Lime Co., Land fill facility
Date Drilled: 5/19/1993
Drilling Method: 4¼ in. I.D. Hollow Stem Auger
Drilling Company: TolTest, Inc.

Boring Number: BH-5/MW-5
Total Depth: 65 ft.
Casing Elevation: 615 ft. (topo. Est.)
Static Water Level: 11 ft.

Depth (Feet)	Geologic Description	Geologic Interpretation
40		Lacustrine Silt and Clay
	- becomes CLAYEY SILT with pebbles throughout the sample	
45	-becomes medium stiff with trace pebbles	Till
50	Medium Stiff gray CLAY with some silt, damp to dry	
55	- becomes stiff - with pebbles and red blotches throughout	
60		
65	Bottom of boring 65.0 feet	

This record is a modified version of the original Soil Boring Log by TolTest, Inc. Geologic interpretation by the ODNR, Division of Geological Survey. Copies of the original record and location maps are on file at the Ohio Environmental Protection Agency, Northwest District Office, Bowling Green, Ohio.

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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