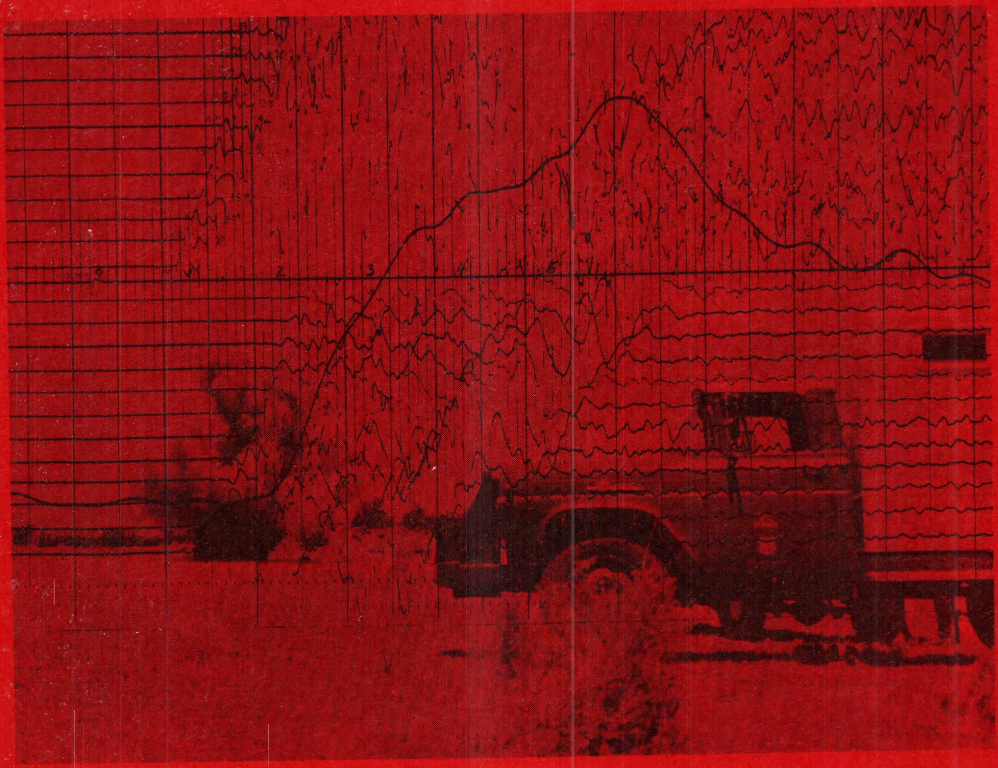

SEISMIC REFRACTION SURVEY IN GREAT MIAMI RIVER VALLEY AND VICINITY, MONTGOMERY, WARREN, AND BUTLER COUNTIES, OHIO

by

Joel S. Watkins

and

Andrew M. Spieker

U. S. Geological Survey

Prepared in cooperation with the

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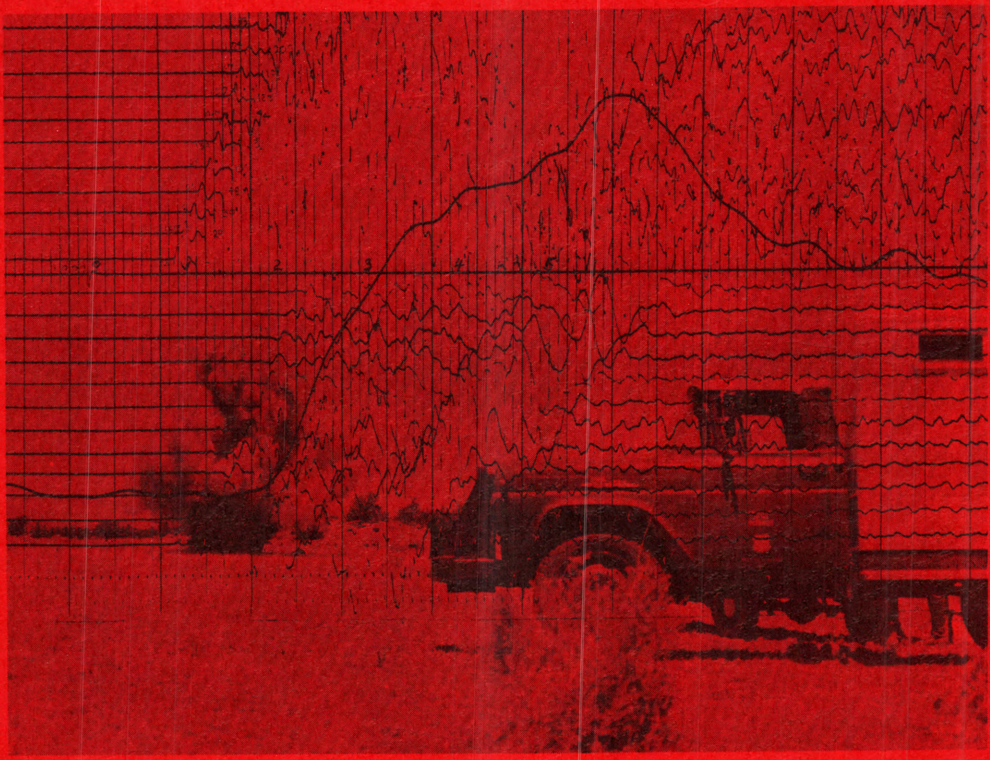

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Silver Spring, Maryland, and Columbus, Ohio

U. S. GEOLOGICAL SURVEY

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This report has not been edited or reviewed for conformity to Geological Survey standards.

Prepared in cooperation with the

Ohio Division of Water and The Miami

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Contents

Illustrations

Purpose and Scope of the Investigation

As part of a continuing program to define the thickness and extent of water-bearing sand and gravel deposits in southwestern Ohio, the U.S. Geological Survey, in cooperation with the Ohio Division of Water and The Miami Conservancy District, completed a seismic refraction survey of the Great Miami River valley and adjacent areas between Dayton and Hamilton, Ohio, in the fall of 1963. A similar survey of the adjoining lower Great Miami River and Whitewater River valleys was completed in 1962 (Watkins, 1963; Spieker and Watkins, unpublished data).

The area of the survey includes known or inferred portions of an interglacial drainage system which is deeply entrenched into bedrock. Ohio was covered by glaciers at least three times during the Pleistocene epoch. As each glacier melted, rock fragments absorbed by the glacier were transported and deposited in these buried valleys by torrents of meltwater. The total thickness of glacial drift is over 300 feet in some places.

Much of the glacial material is highly permeable and saturated with large quantities of water of good quality. The underlying bedrock is virtually impermeable and yields only meager quantities of water. The cities of Dayton, Middletown, Hamilton, and many industries in the Miami River valley rely on wells in the glacial deposits as their principal source of water. The purpose of the present survey is to define the thickness and extent of these important water-bearing formations. Such information will make possible a more accurate evaluation of the area's water resources than has previously have been possible.

Field Procedure and Interpretation

The seismic refraction technique consists of exploding small buried charges of dynamite and then measuring velocities at which vibrations travel through the ground. Small detectors which receive the ground vibrations are attached to cables and send electrical pulses to an amplifier. Amplified electrical pulses and time durations between impulses are then recorded on photographic paper. Velocities of the successive layers of rock traversed by the vibrations calculated from photographic records are used to determine structure of subsurface rocks.

Success of the method requires that subsurface rocks lie in layers, each successive layer having a velocity significantly higher than the velocity of the layer immediately above it. Debris-filled glacial valleys generally consist of three layers. The uppermost layer is made up of unconsolidated materials above the water table which have a characteristic velocity of about 1,800 feet per second (fps). Unconsolidated silts, clays, and gravels below the water table form a second layer with a characteristic velocity of about 6,000 fps. Bedrock, which consists of shale and limestone in this area, forms the third layer with velocities ranging from 12,000 to 20,000 fps.

Hard clay and silt lenses can be detected at some places within the 6,000 fps layer. It is not generally possible to determine the thickness of these lenses because their velocities are greater than velocities of the layers immediately below. However, depth to the top of detectable lenses can be determined (see lines 17 and 22, figures 4 and 5). Energy arriving through these lenses may distort or mask energy arriving from bedrock so that it is difficult to determine precisely depth to bedrock beneath the lenses.

A total of 71 lines ranging in length from 1,100 to 9,020 feet was shot during the survey. The cumulative length of the lines exceeded 29 miles. The length of a given line depended on desired depth of penetration (longer lines record energy arriving from deeper layers), available space (1,100-foot lines were shot only in areas where longer cables could not be laid out), and detail required (shorter cables have more closely spaced detectors and consequently yield more detailed information). Most of the lines were either 2,200 or 4,400 feet long with detectors spaced at intervals of 200 and 400 feet respectively. Only two 9,020-foot lines were attempted, and one of these was duplicated by shorter lines at a later date in order to obtain more detail. Three of the lines duplicated lines shot in 1962 when only 1,100-foot cables were used.

Locations of 69 lines are shown in figures 1, 2, and 3. Lines 60 and 61 are not shown because they duplicate lines shot in 1962 outside the 1963 area of investigation. Line 71 also duplicates 1962 data, but its location is close to the 1963 area of investigation.

Figures 4 through 10 show cross sections of the bedrock surface based on interpretation of the seismic data. Each figure includes cross sections of all lines in a given U. S. Geological Survey 7 1/2-minute quadrangle. Figures 4 through 10 are numbered from north to south; thus figure 4 shows data from the northernmost quadrangle (Miamisburg) and figure 10 shows data from the southernmost quadrangle in the area of investigation (Greenhills). The profile of the bedrock surface is shown as both depth in feet below the land surface and altitude in feet above sea level. Surficial topography is shown on the cross sections except where the total relief is less than 10 feet.

The addition in 1963 of 2,200- and 4,400-foot cables is a significant improvement over earlier seismic surveys in Ohio. The 1,100-foot cable used in surveys prior to 1963 commonly recorded energy refracted from bedrock on only 3 or 4 detectors. The data from the longer spreads enabled determination of average depth and slope of the bedrock surface. Longer cable lengths record energy refracted by the bedrock on more detectors. These additional data make it possible to determine bedrock depths beneath many or all of the detectors on a given line. Lines 33-37 inclusive on figure 7 show good examples of this type of interpretation.

Bedrock depths determined from 1963 data are thought to be more accurate than depths determined from data of previous years because longer lines yield better data on bedrock velocities. In a shorter period of time and under more difficult field conditions, the 1963 crew surveyed more footage than the 1962 crew. Longer cables were largely responsible for this accomplishment. Although accuracy varies from location to location depending on how nearly actual ground conditions approximate the theoretical assumptions on which interpretation techniques are based, experience in Ohio indicates that results can be expected to be accurate within ± 10 percent.

Acknowledgments

The authors are indebted to an excellent field crew composed of members of the cooperating agencies. These men are Jim Kiser, The Miami Conservancy District; Norman Bailey, driller, Ohio Division of Water; and Robert Mattick, geophysicist, U.S. Geological Survey. The authors furthermore wish to express their appreciation to Max L. Mitchell, Chief Engineer, and L. C. Crawford, Hydraulic Engineer, of The Miami Conservancy District, whose complete and wholehearted cooperation greatly facilitated the completion of this survey.

Reference

Watkins, J. S., 1963, Refraction seismic studies in the Miami River, Whitewater River, and Mill Creek valleys, Hamilton and Butler Counties, Ohio: U.S. Geol. Survey open-file rept.

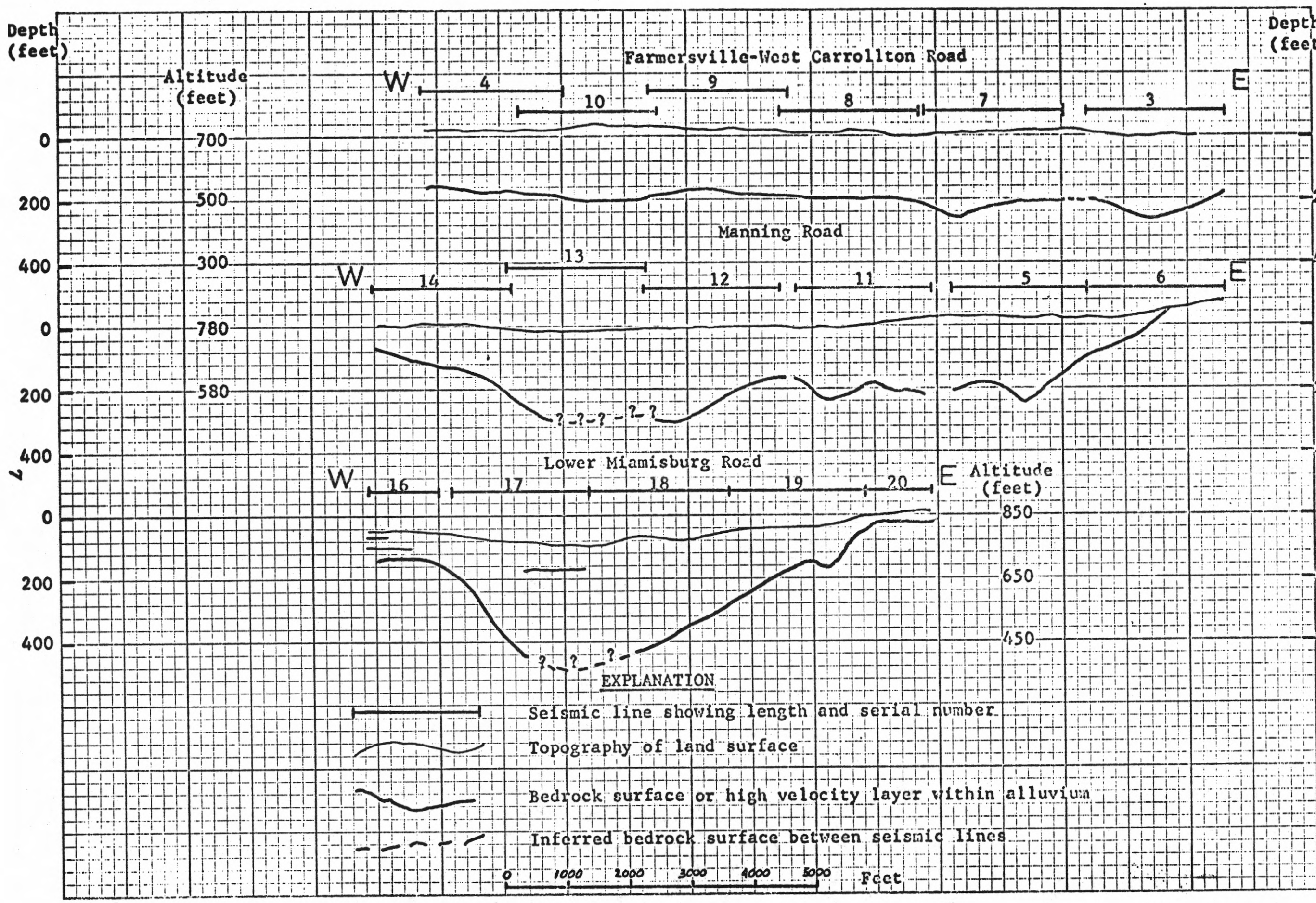

Figure 4.--Cross sections showing bedrock depths in the Miamisburg 7½ minute quadrangle, Ohio.

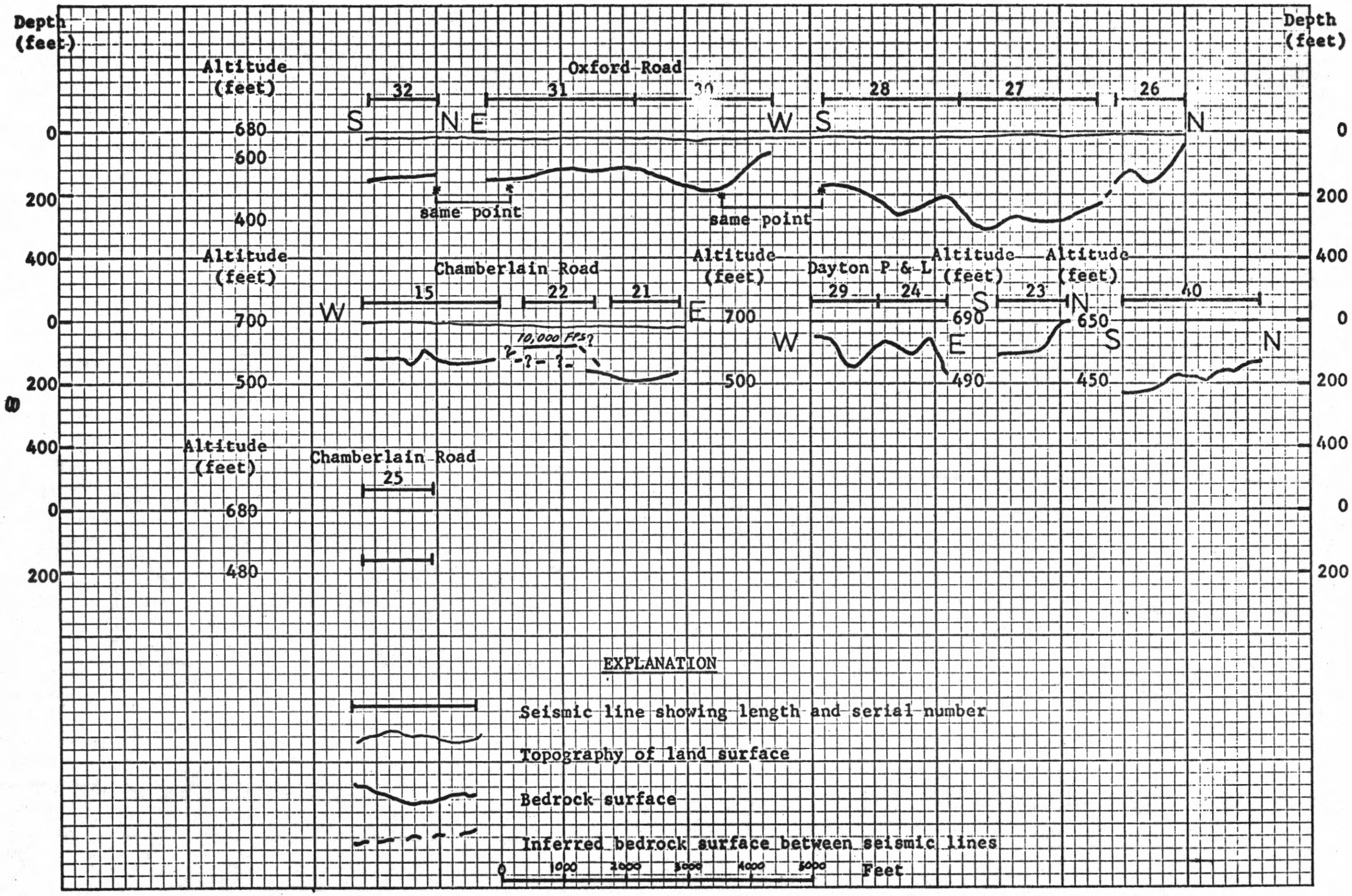

Figure 5.--Cross sections showing bedrock depths in the Franklin 7½ minute quadrangle, Ohio.

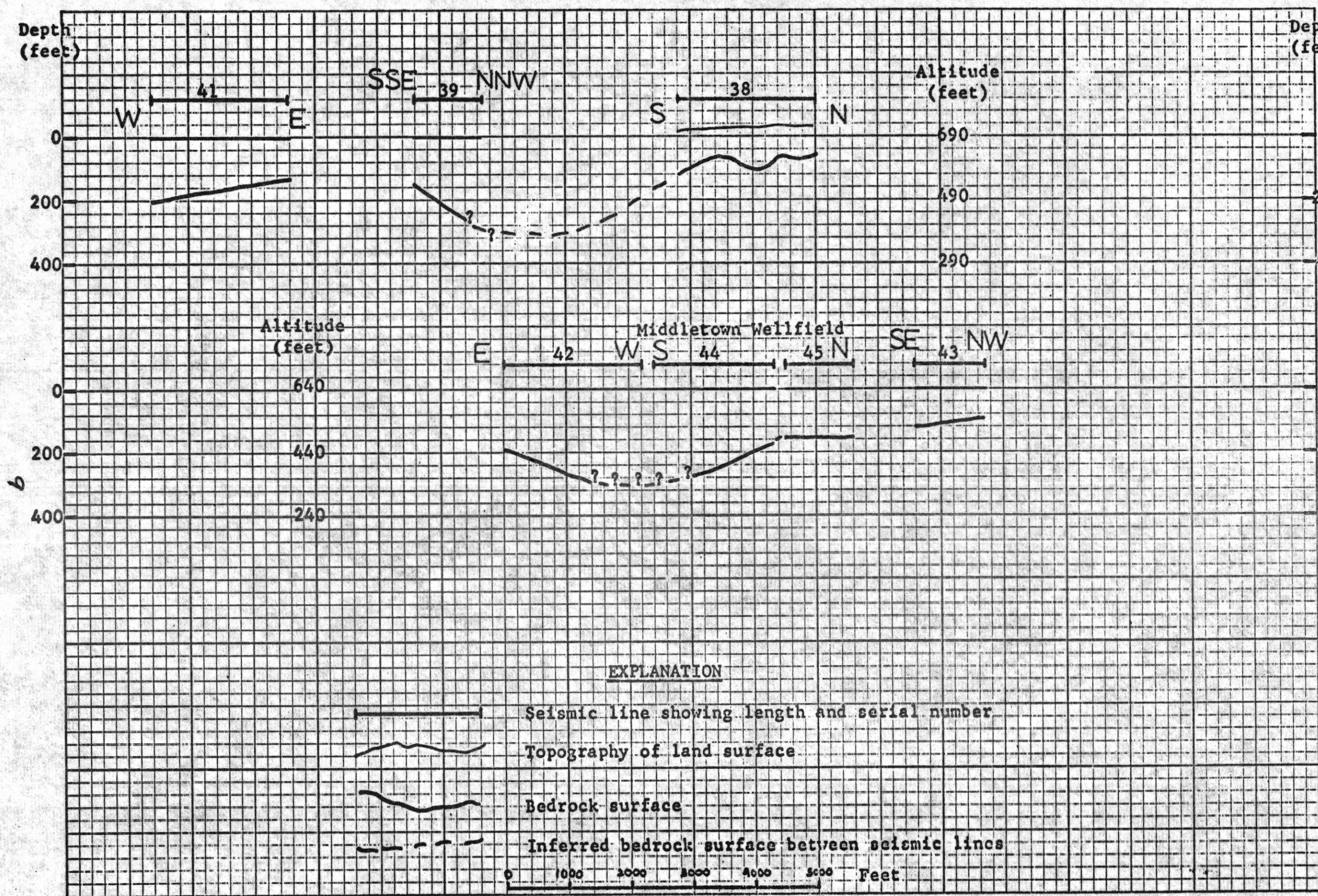

Figure 6.--Cross sections showing bedrock depths in the Middletown 7½ minute quadrangle, Ohio.

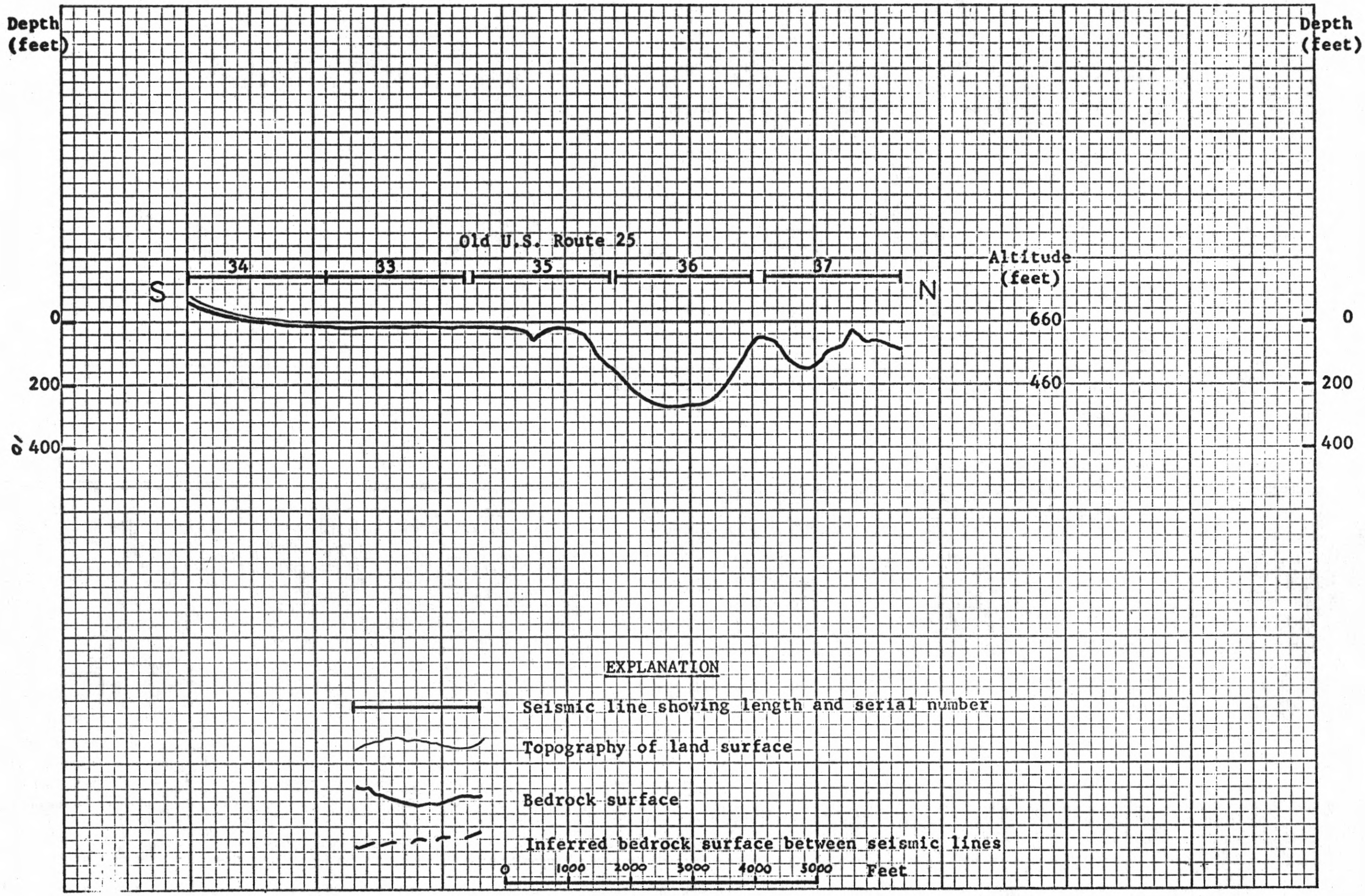

Figure 7.--Cross sections showing bedrock depths in the Monroe 7½ minute quadrangle, Ohio.

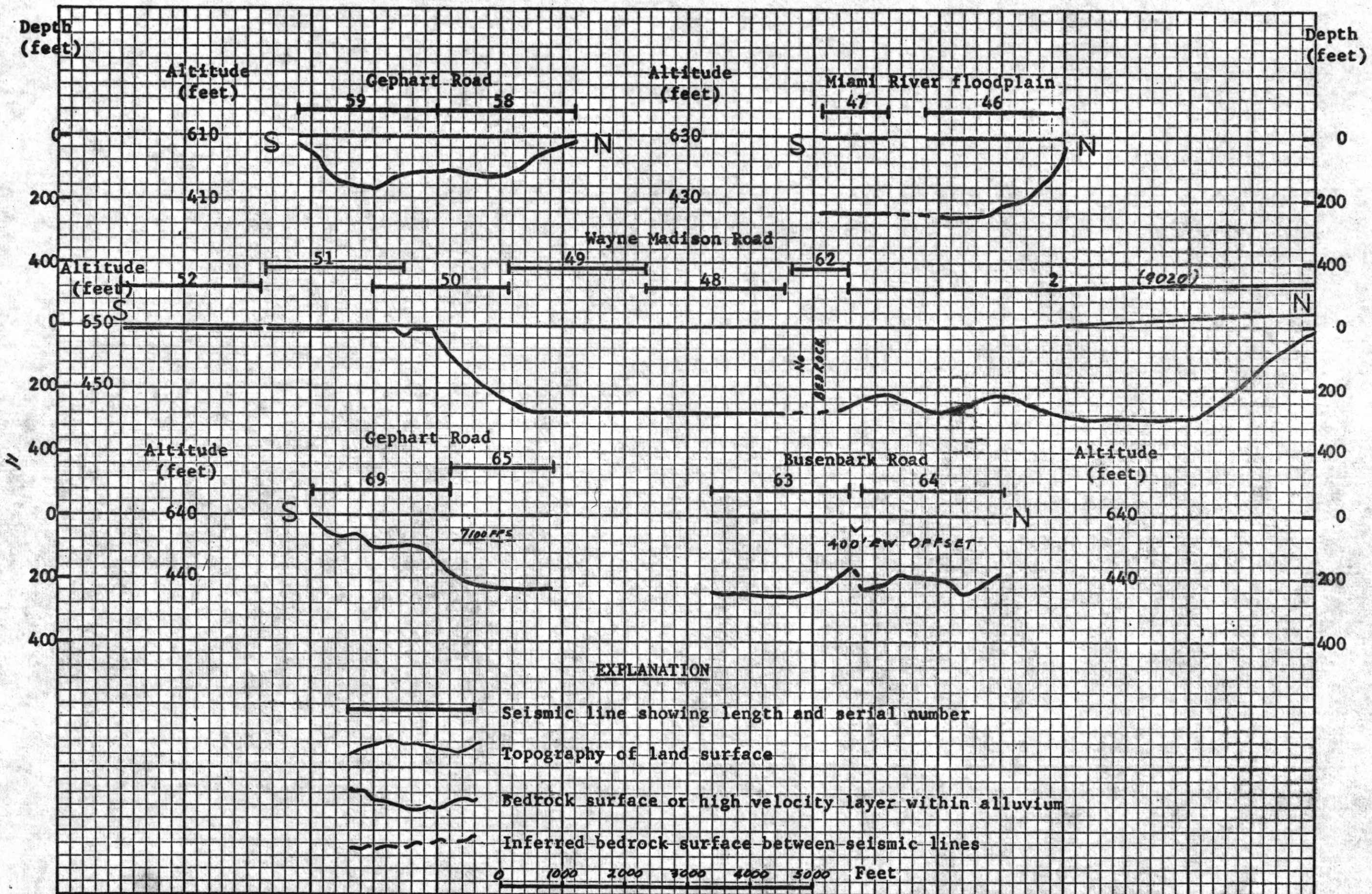

Figure 8.--Cross sections showing bedrock depths in the Trenton 7½ minute quadrangle, Ohio.

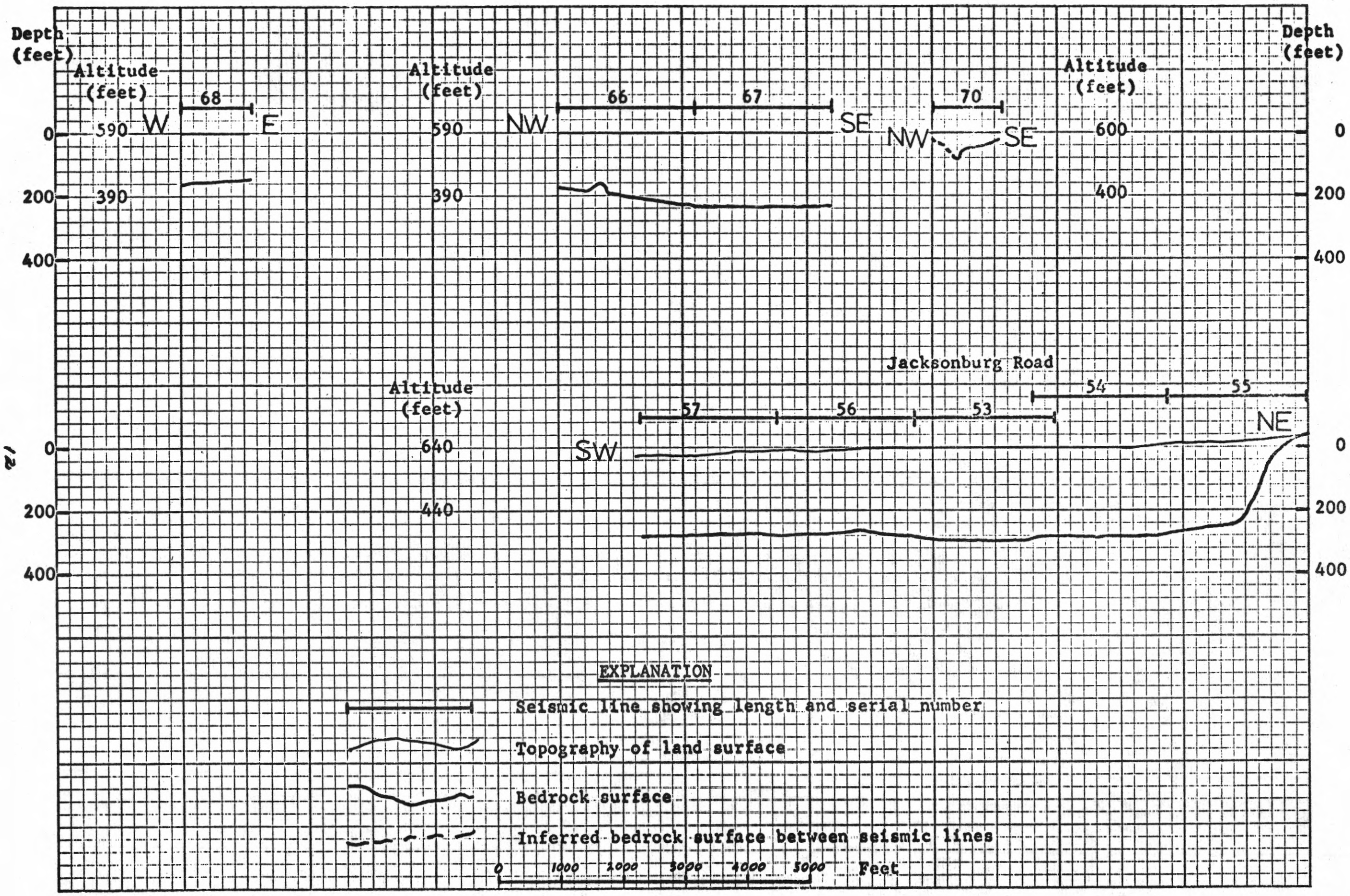

Figure 9.--Cross sections showing bedrock depths in the Hamilton 7½ minute quadrangle, Ohio

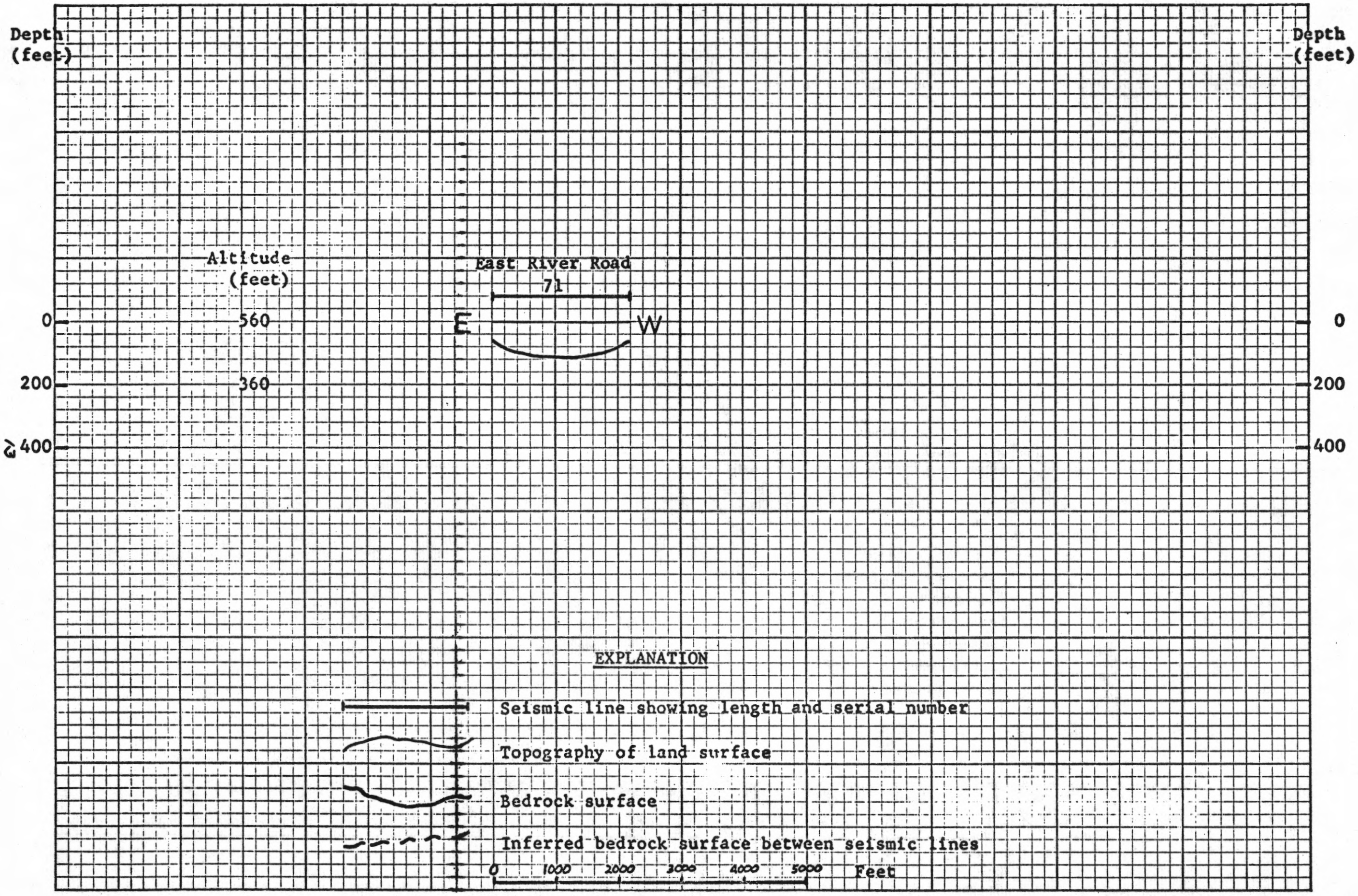

Figure 10.--Cross sections showing bedrock depths in the Greenhills 7½ minute quadrangle, Ohio.