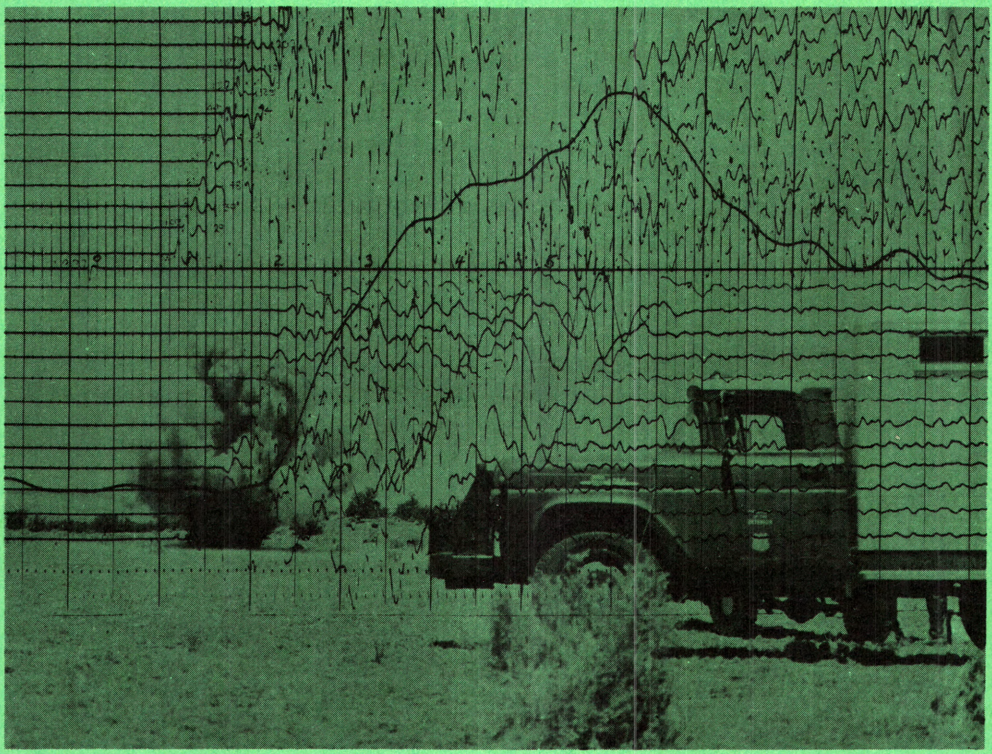
UNITED STATES DEPARTMENT OF INTERIOR

GEOLOGICAL SURVEY



# SEISMIC REFRACTION SURVEYS IN THE VICINITY OF EAGLE CITY, CLARK COUNTY, OHIO

by

Jerry H. Hassemer, Joel S. Watkins, and Norman G. Bailey

Prepared in cooperation with the
Ohio Division of Water

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## 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, in the summer of 1964 completed a seismic refraction survey in the vicinity of Eagle and Tremont Cities, Ohio (fig. 1). Similar surveys were completed in 1962 of the lower Great Miami River and Whitewater River Valleys (Watkins, 1963); in 1963 of the upper Great Miami River Valley (Watkins and Spieker, 1964) and of the Scioto River Valley (Watkins and Bailey, 1964).

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 twice during the Pleistocene Epoch. As the last glacier retreated from Clark County, floods of melt-water deposited up to 300 ft of sand and gravel, now forming the low-lands of the Mad River Valley.

The sand and gravel is highly permeable and saturated with large quantities of water of good quality. The underlying bedrock consists of limestone and dolomite, and limestone interbedded with shale. The limestone and dolomite sequence is the principal source of water along the edges of the buried valley where the sand and gravel thins. The city of Springfield has recently developed wells in the glacial deposits, and many industries in the area rely on wells in these deposits as their principal source of water. The purpose of the present survey is to

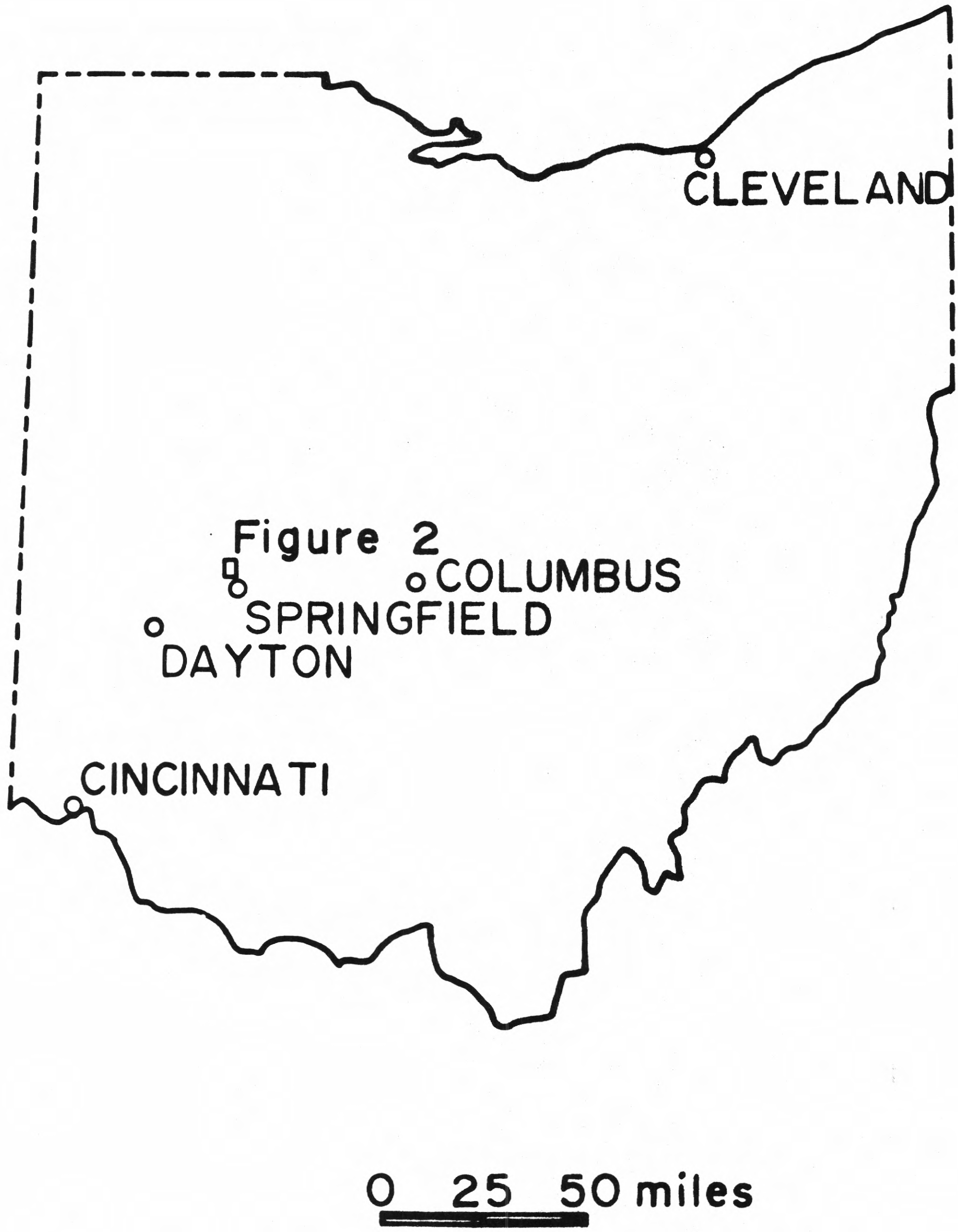


Figure 1.--Map of Ohio showing area of seismic studies, 1965.

define the thickness and extent of the important water-bearing sand and gravel deposits. Such information will make possible a more accurate evaluation of the area's water resources than has previously been possible.

## Field Procedure and Interpretation

Explosions of small buried charges of dynamite create seismic vibrations in the ground. Small detectors receive these vibrations and convert them into electrical pulses which are transmitted by cable to amplifiers. The amplified electrical pulse is then recorded on photographic paper. Velocities of the successive layers of rock traversed by the vibrations are calculated by the time duration shown on the photographic paper and the known distance between detectors. Velocities of the rock layers are used to determine the 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 is made up of unconsolidated materials above the water table that have a characteristic velocity of about 1,400 feet per second (fps). Unconsolidated sand and gravel below the water table form a second layer with a characteristic velocity of about 6,500 fps. Bedrock, which consists of limestone and dolomite, or limestone interbedded with shale, forms the third layer with velocities ranging from 13,000 fps to 17,000 fps.

Seventeen lines were shot during the survey, as shown on figure 2. The lines were either approximately 830 ft long, using 12 detectors, or approximately 2,030 ft long, using 24 detectors. The cumulative length of the lines was 23,665 ft. The length of the line depended on desired depth of penetration and available space (830-ft lines were shot only in areas where the longer cable could not be laid out). The detectors were spread at 100-ft intervals except at both ends of all lines, where the last three detectors had 25-ft intervals.

Figure 3 shows cross sections of the bedrock surface based on the interpretation of the seismic data. Each profile shows the bedrock

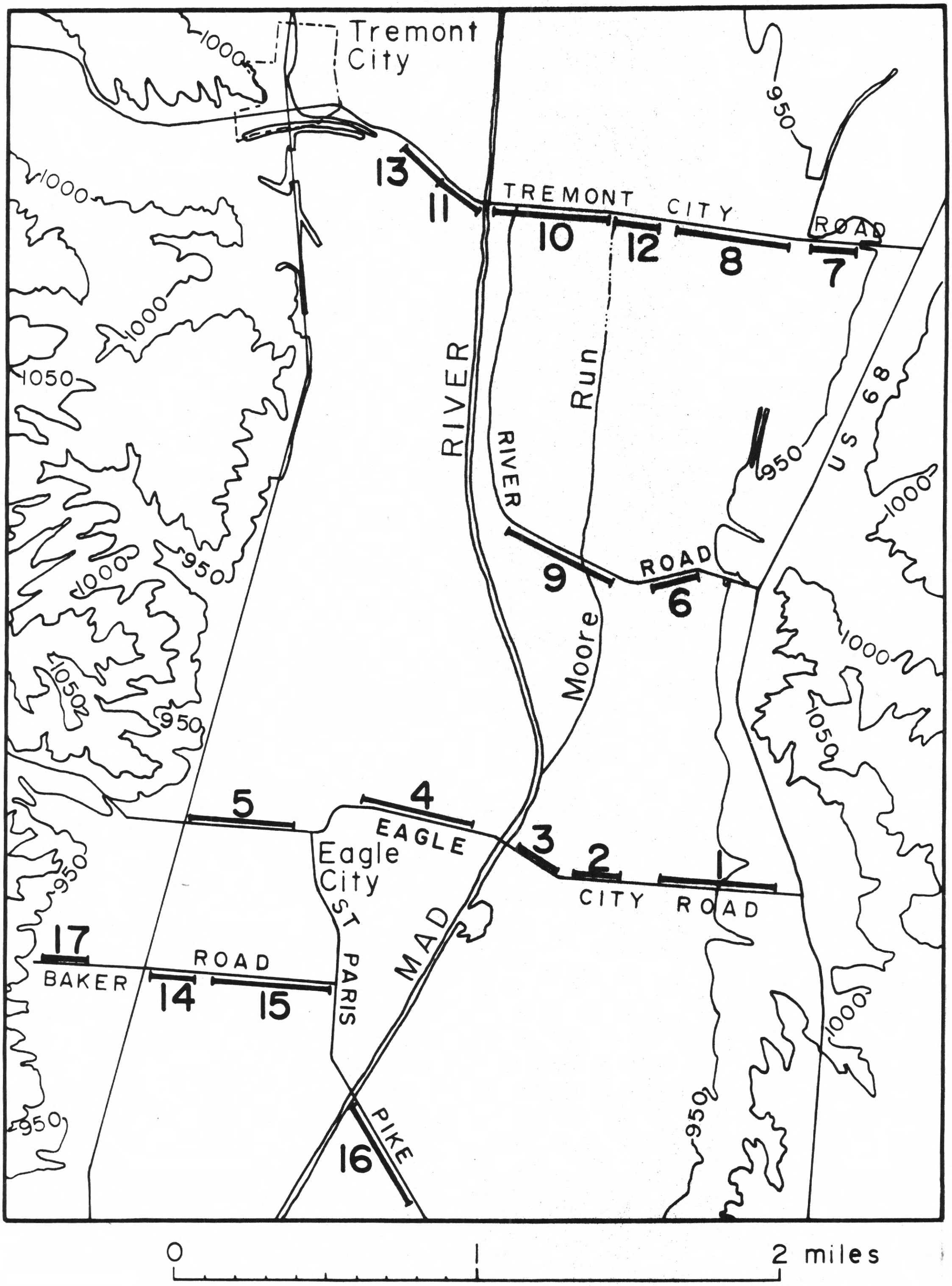


Figure 2.--Seismic lines shot in Springfield and Urbana West 7.5-minute quadrangles, Clark County, Ohio in 1965.

surface and superficial topography in feet above sea level. The accuracy of determination of the bedrock surface depends 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.

The configuration of the bedrock surface in the Mad River Valley contrasts with that observed in the Great Miami Valley where the present-day valley walls corresponded with the inner glacial stream valley walls. In the Mad River Valley, the deepest inner glacial stream appears to have had a relatively narrow valley, whose width was about 3,000 ft and whose depth ranged from 200 to 300 ft. The remainder of the present valley is covered with relatively thin deposits of alluvium whose depth rarely exceeds a hundred feet and in many places is much less.

Best locations for water wells in this valley are where present-day streams, such as the Mad River, intersect the deep channel. At these locations storage and recharge are maximum.

Minimum depths to bedrock, as indicated in figure 3, were computed in cases where the actual depth could not be unequivocally determined. The configuration of roads and accessibility was such that it was necessary to shoot a short spread over the deeper part of the bedrock valley. Hence, the refracted waves from the bedrock were not recorded as first arrivals, and it was necessary to use second arrivals for velocity. Minimum arrival times were computed by assuming that the refracted arrival was detected at the end geophone of each spread. An attempt to determine something about the porosity and permeability of the alluvium from the attenuation of the seismic energy was largely unsuccessful because of the nearness of the bedrock surface to the surface of the ground throughout most of the area and the consequent sparsity of first arrivals through the alluvium.

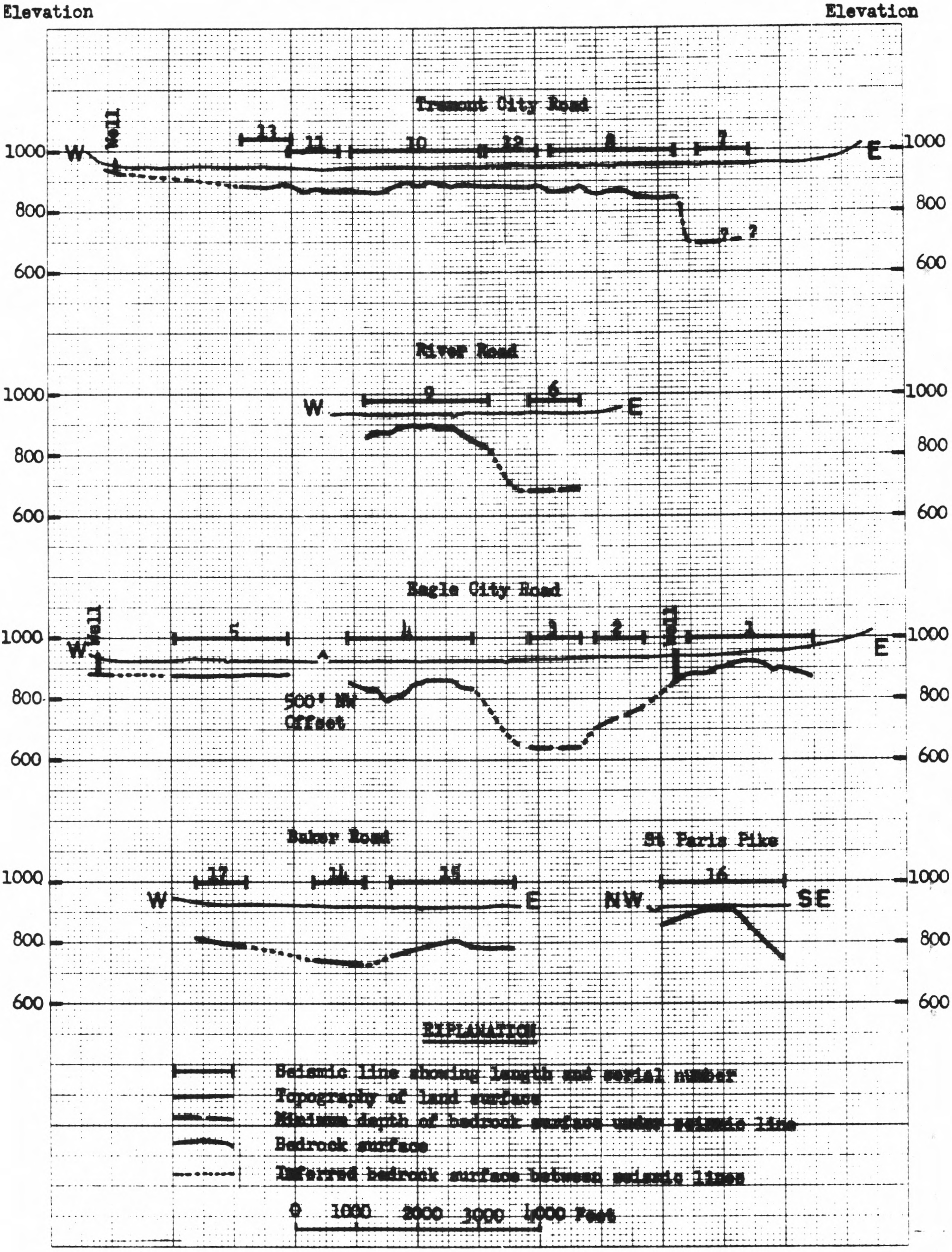



Figure 3.--Cross sections showing bedrock depths in the Springfield and Urbana West 7.5-minute quadrangles, Ohio.

## References

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