UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

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Seismic surveys of Maynard Ordnance Test Station, Maynard, Massachusetts

By

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This report and accompanying illustrations have not been edited or reviewed for conformity to Geological Survey standards or nomenclature.

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Contents

Illustrations

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Introduction

A seismic survey of the Maynard Ordnance Test Station was made as part of a study of the ground-water resources of the area by the U. S. Geological Survey for the New England Division of the U. S. Army Corps of Engineers.

Preliminary drilling had shown that throughout most of the area the crystalline rocks of the basement are overlain by 50 to 75 feet of glacial till and outwash. However, just west of the junction between the Railroad Yard and the Diagonal Road (see map) one drill hole indicated a bedrock depth of more than 100 feet. Assuming that this was an easterly-trending bedrock valley, the Corps of Engineers ran a seismic traverse along a line parallel to and about 1400 feet east of the Railroad Yard, but failed to find an extension of the valley. The main purpose of the Geological Survey's seismic work was to chart this valley and to locate any others that might exist in the area.

One week's intensive field work was done in late May 1955. Traverses A through I were completed so that profiles could be obtained around the perimeter of the area and along two lines crossing through its center.

To obtain additional information another week of field work was done early in September 1955. A long traverse was run west of White Pond on the west side of the area, and several short profiles were also obtained inside the area.

Many members of the Survey and of the Corps of Engineers furnished valuable assistance. They made the preliminary elevation surveys, furnished a considerable amount of equipment, and served as members of the field crew. We are particularly indebted to Messrs. N. M. Perlmutter of the Survey and Charles Maillard of the Corps of Engineers. The Commanding Officer and staff of the Ordnance Test Station were also extremely cooperative.

Procedure

A 12-trace portable refraction seismograph was used for all the measurements. In almost all places a 550-foot spread was used and there was 150 feet of overlap between spread positions. Shots were thus fired at traverse distances of 0 and 550 feet for the first spread, 400 and 950 feet for the second spread, and so forth. In general, one stick of dynamite in a hole 2 to 4 feet deep provided sufficient energy for each shot.

The preliminary leveling survey had provided elevation measurements every 400 feet along most of the traverses. Whenever the elevations varied significantly along a profile, the relative height of each geophone was measured by hand leveling. In general, the area is so flat that elevation corrections are almost unnecessary. However, uncertainty regarding the proper velocity for this correction may make the results less accurate in places where stream valleys cross the traverses.

In general record quality was excellent throughout the survey, and the resulting profiles should be accurate to about 10 percent of the expected depth of the bedrock surface, or to about ± 10 feet. However, in a few places minor instrumental difficulties or unavoidable sources of noise, such as strong winds, the DDT plant, the Maynard water pumping station, and the heavy highway-construction trucks traveling on Hudson Road caused poorer records and a resulting decrease in accuracy. Where such sources of error existed, the profiles are labeled accordingly.

Preliminary field interpretations were made with the standard refraction formulas for plane surfaces (Nettleton, 1940 and Dix, 1952). Final interpretations are based on a slightly modified combination of the delay time techniques of Nettleton (1940), Barthelmes (1946), and Pakiser (1955). Because of the overlap between spreads, bedrock depths should be obtainable at all points along the traverses. However, information regarding the depths of and velocities in the overburden layers is available only in the vicinity of each shot point, and even there the detector spacing, which was chosen primarily to obtain bedrock depths, was too wide for much resolution to be obtained in the overburden measurements.

Results

Almost all of the traveltime curves represent a three-layer case. The upper layer generally consists of about 3 to 15 feet of dry outwash in which the velocity is 700 to 1500 fps (an average of 1,000 fps was used in the computations). On top of two hills in the area, dry till in which the velocity is between 2,000 and 3,000 fps was found.

The second layer generally consists of water-saturated outwash in which the velocity is 4,500 to 6,000 fps; 5,500 fps was used in the computations. In a few places, either on or near the hills, the curves indicate a velocity of 6,000 to 8,000 fps representing water-saturated till. In September, after the hurricane rains of the summer, this velocity was found near the top of the largest till hill, at an elevation of 215 feet, or more than 25 feet above the water table generally found in the area. Drill holes show that a layer of till usually underlies the outwash, but this till was only detected in a few places where it was quite thick in comparison with the outwash. A smaller geophone spacing would probably have recorded the till more often, but for the thicknesses generally shown by the drilling data it is mathematically impossible to detect the till by seismic refraction (Leet, 1949).

The bedrock velocity may range from 12,000 to 20,000 fps, and drill holes have shown that both igneous and metamorphic rocks are found. However, careful examination of the seismic records failed to show any systematic regional variations of velocity. In most places an average velocity of 17,000 fps gave an adequate interpretation.

The variation of bedrock depth can be best obtained by careful examination of the profiles, but a few important features should be mentioned. The Diagonal Road traverse (CC) and that made earlier by the Corps of Engineers show that southeast of the Railroad-Yard the bedrock is generally found at shallow depths over a fairly wide area. The bedrock seems to be highest in this area beneath the high till hill in the northeast corner. However, the Railroad (GG'), Old Marlboro Road (DD') and Firehouse Road (OO') profiles show that at the extreme southeastern corner of the area the bedrock also rises to quite shallow depths. The Old Marlboro Road (DD' and HH'), Fence Line (II' and FF') and Hudson Road (EE') traverses suggest that the depth to bedrock surface is increasing along the eastern and southeastern flank of the area.

The Hudson Road (EE and KK), Concord Road (BB), and Railroad Yard (AA) traverses all show that the bedrock is shallow at the northern end of Concord Road near the main gate; indeed, bedrock crops out on the hill just north of the gate. Likewise near the southern end of Concord Road the bedrock rises on the White Pond (JJ'), Concord Road (BB') and Railroad (GG') traverses. Bedrock is believed to crop out, a short distance south of the railroad crossing.

The system of bedrock valleys appears to be fairly complex. The large valley found by the preliminary drilling is shown by the Railroad Yard traverse (AA') to stretch north-northeast, and it crosses the Hudson Road traverse (EE') between the railroad and the sharp curve by the till hill.

In the opposite direction the valley seems to fork. One arm swings northwest and is very wide where it crosses the Concord Road traverse (BB') at approximately its midpoint. This arm probably extends westward beneath White Pond and reappears at the deep point near the junction of the White Pond (JJ') and Hudson Road (KK') traverses. This conclusion is also supported by the fact that the Pig Farm Lane traverse (LL') indicates a pronounced deepening at its northern end near the edge of the pond.

The other fork of the main valley seems to stretch southward between the Railroad Yard (AA') and Concord Road (BB') traverses. The Firebreak spread (MM'), Firehouse Road traverse (OO') and the Railroad traverse (GG') all show this valley. Its width appears to be narrower than the arms that cross the Diagonal Road (CC') and Concord Road (BB') traverses but no narrower than the valley that crosses Hudson Road (EE').

The seismic profiles indicate that the deepest portion of this valley system is perhaps near the junction of the Diagonal Road (CC') and Railroad Yard (AA'). However, the total variation is less than 20 feet, and the seismic measurements cannot be considered sufficiently accurate to distinguish small variations in depths along the floor of a valley.

The White Pond Road (JJ') and Concord Road (BB') traverses also show a couple of other places where the bedrock is less shallow than in most of the area. These may represent some pattern of tributary valleys but additional traverses would probably be required to map the system.

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